Success Stories of Advanced Biofuels for Transport

FAST PYROLYSIS BIO-OIL PRODUCTION PLANT EMPYRO

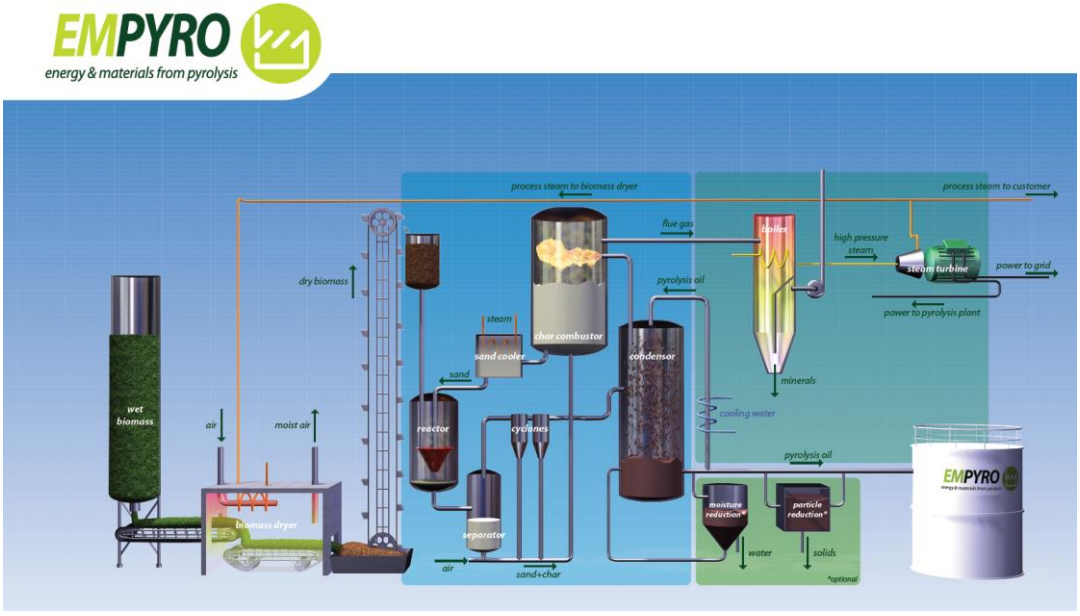
Year of plant start-up:	2015
Location:	Netherlands
Technology:	Fast Pyrolysis
Plant capacity:	24.000 tons/year of FPBO (Fast Pyrolysis Bio-Oil)
Operational experience achieved:	Since start-up over 30.5 million litres (36 kton) of FPBO have been produced as of mid-2018. Currently in operation 24/7 and producing at design capacity. All FPBO that was produced has been used by our customer (to replace natural gas).
Total Capital Expenditure:	25 million EUR
Principle feedstocks:	Wood residue (from local Dutch suppliers). Other cellulosic biomass types under investigation.
Feedstock Capacity:	36.000 tons/year (dry matter)
Products/markets:	Main use currently: Replacing natural gas as heating fuel to produce high-temperature steam in the boiler of an industrial client. Side use: FPBO produced at Empyro was provided to researchers in over 20 countries so far. Their research ranges from the production of fungible biofuels for automotive and aviation to bio-based chemicals. In the pipeline: • Production of renewable transport fuels from FPBO both via the co-refining route (this will be done with the FPBO from a new plant under construction for Pyrocell in Sweden, starting in 2021), as well as via the standalone upgrading route by hydrodeoxygenation. • Use of FPBO as a renewable substitute for fossil-based chemicals such as bitumen, phenols and creosote in the process industry. By-products: Steam (6.5 MW net) and power (0.5 MW net) bringing the overall efficiency to 85-90%.
Technology Readiness Level (TRL):	TRL 9

DESCRIPTION

The commercial production of fast pyrolysis bio-oil started at the opening of Empyro in May 2015. Since then (by mid-2018) more than 30 million litres (36 kton) of FPBO has been produced and delivered to our client Friesland Campina, who applied all the delivered FPBO in their steam boiler to replace natural gas. The excess energy that the Empyro plant produces has all been sold to AkzoNobel in the form of steam and to the grid in the form of power.

The history of Empyro starts in the late eighties at BTG Biomass Technology Group, when the concept of fast pyrolysis with a rotating cone reactor was invented. Since then BTG worked on the further development and scale-up of this technology and finally in 2008 BTG Bioliquids was founded as an independent company to commercialise the technology. A year later the separate company Empyro was founded with the aim of building and operating the first commercial fast pyrolysis plant in the Netherlands. It took five years to get everything ready for construction, including financial closure, biomass and FPBO delivery contracts, permits, detailed engineering, etc. Then in 2014 the construction started, resulting in start-up of the plant in 2015, in time and on budget. The skid-based modular construction approach by Zeton made it possible to assemble the plant on site in only eight days. After a ramp-up period in the first couple of years ('teething troubles') Empyro is now producing at its design capacity.

In January 2019 Empyro was acquired by Twence, a local waste processing company, which further demonstrates that the plant operates successfully. In April and July of 2019, two plants similar to Empyro (same size) were sold to clients in Finland (GFN) and Sweden (Pyrocell), respectively, showing the excellent replicability of the concept. Both plants are currently under construction. The plant in Finland is scheduled for start-up in 2020, the plant in Sweden in 2021. FPBO produced by Pyrocell will be co-processed by Preem in its refinery to produce advanced biofuels.



Process flow scheme showing Empyro's fast pyrolysis process using our modified rotating cone technology.

Stakeholders involved:	FrieslandCampina, AkzoNobel, BTG, Zeton, European project partners, Twence, TechnipFMC.
Financing Support:	To demonstrate biomass pyrolysis technology on commercial scale the Empyro project was financially supported by the European Commission under the Seventh Framework Programme (Grant Agreement 239357), by the Dutch government through the cross-sectoral programme Biobased Economy of the topsectors Energy and Chemistry, and by the Province of Overijssel via the Overijssel Energy Fund.
Contribution to Sustainable Development Goals:	Empyro contributes to multiple sustainable development goals. Most notably to SDG13 on climate change, as it results in a GHG reduction >90% across the entire value chain. By using FPBO the Borculo site of FrieslandCampina (FC) saves 10 million m3 of natural gas per year and reduced its GHG emissions by 15%. The fact that our biomass is sustainably sourced ('Better Biomass' certification) means that this fuel and the low carbon footprint products of FC support the SDGs 12 and 15 on sustainable consumption and production and on sustainable use of terrestrial ecosystems. BTG Bioliquids works hard to make this sustainable resource available for all (SDG 7), by supporting e.g. the development of residential FPBO boilers, as well as by developing FPBO-based advanced biofuels. Lastly the close cooperation between BTG, BTG Bioliquids, FC, AkzoNobel and Zeton in the east of the Netherlands pushed the development of the region (SDG 8), as was recognized by the local government in their support for Empyro.
Contribution to GHG emission reduction in transports:	Advanced biofuels are made from sustainable biomass residues and offer GHG reduction of over 60% compared to fossil fuels. Large volumes of advanced biofuels can be made from FPBO by direct upgrading or even by co-refining it in existing oil refineries.
Employment:	Empyro process operators, process engineer, plant manager, truck drivers (oil and biomass), financial controller, maintenance, cleaning, etc. yields about 20 FTE direct jobs, excluding the further supply chain (biomass preparation and oil application). Additional jobs are created now the construction of new FPBO plants takes off. Construction of one Empyro-type plant yields 100 full-time jobs in the Netherlands, plus additional jobs on site for the construction and subsequent operation.
Replicability and scale-up potential:	The replicability and scale-up potential of this technology is outstanding, also because our fast pyrolysis technology is flexible in terms of feedstock. Our model is to deliver dozens of Empyro plants all over the world. These will be built at the source of the biomass residue such as sawmills, sugar cane mills, sunflower oil production plants etc. The FPBO produced by multiple of these Empyro sized units will be shipped to a central (bio-)refinery in order to benefit from economy of scale. That way advanced biofuels can be produced in large volumes and at a competitive price.

Success factors:

The coming years FPBO is to become a commodity in the use for renewable energy applications and by co-refining for advanced biofuels. Important factors to achieve this are mandates by the government (like in the RED2), and/or creating incentives by either subsidising sustainable resources or imposing a taxation on the use of fossil resources (i.e. high CO_2 price).

For practical implementation of new FPBO production plants the integration of heat with existing industry is beneficial for both financial viability and sustainability.

When it comes to the production of advanced biofuels from FPBO by co-refining a practical accounting method such as a mass-balance approach is important to make this route possible for refiners, given the huge complexity of their existing installations.

Constraints:

The main constraint at this point in time is the fact that the production costs of FPBO are still higher than those of most fossil fuels. In comparison to renewable alternatives FPBO is very cost-effective, but oil and gas products are typically still cheaper. That is why government incentives are key to the success of FPBO-based fuels and products. Examples of such incentives are the fossil carbon taxes that are employed by Finland and Sweden.

The Empyro fast pyrolysis plant

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More information: https://www.btg-btl.com/en

https://www.nonfossilfuture.today/

The ART Fuels Forum brings together 100 experts and leaders representing the alternative transportation fuels Industry to facilitate discussions, elaborate common positions on policy issues and identify market penetration opportunities and barriers for these fuels. The Forum is established and financed by the European Commission under the project name "Support for alternative and renewable liquid and gaseous fuels forum (policy and market issues)".

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