



Biomass-based Fuels: Renewable Gasoline

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Our interview-based newsletter features innovative energy technologies and businesses from around the world.

Announcements

GreenTechEurope.org launches this month! A single platform for all of Europe's environmental technologies relating to energy, transport, carbon reduction, energy efficiency, water, and more. Check in to see Europe's latest technologies or to submit your own innovations.



Featuring: Primus Green Energy Inc.

In the latest edition of our newsletter, LRI Staff interviewed Primus Green Energy's Dr. George Boyajian, Vice President of Business Development. Primus Green Energy is a US-based biofuel company that uses waste wood streams and energy crops like Miscanthus to produce a high-octane gasoline that requires no further refining. Their expansion model is based around local sources of biomass within a 50-mile radius. Primus also has the potential of producing petrochemicals such as xylene and toluene, as well as diesel and the components for jet fuel.

The Renewable "Drop-in" Fuel

Unlike other biofuel companies that produce "bio-crudes" or other products that require further refining, Primus Green Energy produces a steady stream of 93-octane gasoline. Primus began through a partnership between Dr. Moshe Ben Reuven, and IC Green Energy, the environmental arm of Israel Corporation. Identifying mutual areas of interest and expertise, IC Green and Dr. Ben Reuven decided to make a run at creating a solution for "drop-in" renewable gasoline from biomass. "Drop-in" means the fuel is compatible with regular combustion engines. Primus was officially launched in 2008, and has since built a pilot plant, and is currently building a demonstration plant. So: that's \$40 million, one investor, and discovery to commercial stage in four years.

Primus uses multiple feedstocks to produce their gasoline, including natural gas and biomass. Their favoured feeds are premium wood pellets and the energy crop, Miscanthus, a grass that grows to 7 feet tall and can yield 15 tons/acre of biomass; ten times more than a mature forest in terms of carbon. Wood pellets are in wide use across Europe in coal-fired power plants, while in the US they are used primarily in domestic heating stoves.

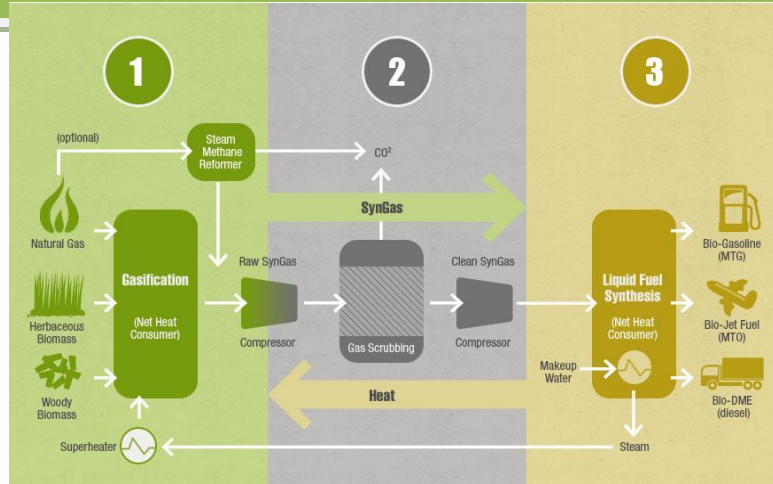
Miscanthus has grown in both popularity and notoriety over the past few years for its potential to replace corn as the chief biofuel feedstock. The schematic from Primus below compares their performance.



Controversy!

GHG Emissions & Food Security

Two of the key public concerns surrounding the use of biofuels are the often exaggerated greenhouse gas (GHG) reduction benefits and the inherent threat to food prices. For their gasoline production process, Primus calculated an 80% reduction in GHG emissions relative to gasoline refined from crude oil. Primus also has a local resource expansion model, ensuring that plants are located near biomass sources, ideally a 50-mile radius. Given the low use of pulp wood for new builds in the US, there is an excess of wood, which is largely bought up at present by Europe for use as wood pellets in coal-fired power plants. Considering Miscanthus, this somewhat unseemly crop tends to be planted on marginal land that is either fallow or unprofitable, thus avoiding interference with food crops. Miscanthus also has low capital costs and requires little maintenance and labour. Once planted, crops can be harvested annually for up to 15 years without any additional planting.



The Primus Process

*Economical.
Practical.
Local.*

Using several steps, Primus' patented operation turns biomass into ready-to-use gasoline.







1. Biomass crops or wood pellets are procured from local sources. All material is pelletized.
2. The pellets enter a gasifier, where a thermo-chemical process uses superheated steam and pressure to turn the pellets into "syngas"; a mixture of Hydrogen (H₂) and Carbon Monoxide (CO).
3. The syngas is cleaned of any sulphur and carbon dioxide impurities with a standard "scrubbers".
4. The syngas enters Primus' four-reactor liquid fuel synthesis system. These are commercial catalytic reactors that take the influent gas through a proprietary system, stepping from methanol to gasoline through hydrotreatment in the final reactor.
5. Out of "the spigot" at the back flow water and Primus' 93-octane gasoline, which are separated by density.
6. The gasoline is ready for use

Primus can currently convert 27% of their biomass feedstocks into gasoline, equating to roughly 95 gallons of gasoline per ton of feedstock. This is twice as high as anyone else in the green gasoline market, and has been demonstrated at scale, independently verified, and conforms to ASTM standards for gasoline. As Primus continues to progress towards commercial production, they expect to reach yields of upwards of 110 gallons per ton.

Presently, depending on inputs, Primus produces gasoline at the equivalent of \$60-70 per barrel of crude oil. This is excluding any tax credits or renewable energy incentives from the US government, showing the level-playing field between Primus and other fossil fuels. On the open spot market today, Primus' gasoline would sell in the US for \$3.40/gallon; going at a 20% premium to unleaded fuel. The following table below shows a comparison with other fuels.

	Fossil Fuel Gasoline	Ethanol	Bio-Diesel	Primus Bio-Gasoline
Uses	Drop-in	Fuel oxygenate	Substitute for diesel	Drop-in
Energy density (MJ/gallon)	132	89	126	132
Cost per gallon	\$3.10	\$2.23	\$3.00	\$1.69*
Displacement of food crops	None	High	Medium	None
Availability	Worldwide	US-Brazil	Europe	US and then worldwide
Lifecycle Carbon Dioxide Emissions	24.3 lbs/gallon	14.6 lbs/gallon	5.84 lbs/gallon	4.86 lbs/gallon

*Cost to produce excluding debt burden from full scale commercial plant

Raw material alliances:	Engineering alliances:	Distribution and commercialization alliances:
 Locally-grown feedstock (PA)	 EPC contractor for 1st commercial plant	 Fuel distribution (off-taker)
 Wood pellet & herbaceous material	 Engineering Services for 1st Commercial Plant	 Commercialize bio-jet fuel for DoD applications

Versatility and Long-term Growth

Given that Primus has grown on the capital of a single investor, IC Green Energy, this has allowed the company to have a very deliberate direction, not wasting time trying to obtain funds or program support. Primus also has a strong engineering partner in world-renowned Bechtel Hydrocarbon Solutions Inc., who have built similar biofuel plants. Looking long-term, the demonstration plant being built by Bechtel is not a scale-up version of the Primus pilot plant, but a scaled-down version of a future commercial plant.

Although Primus focuses operations around high-octane gasoline, their facilities are capable of manufacturing other products as well. Depending on how they dial in their reactors, Primus can also produce xylene and toluene, which sell in the region of \$7 per gallon. Other variations to plant operation also enable Primus to use the same feedstocks to make diesel fuel or the precursors to jet fuel. Thus with a single technology platform, Primus can instantly transition into four different fuel or organic chemical markets.

As they look to the future, Primus plans to expand along the East Coast, and then move gradually south and west, either building their own plants or entering into licensing or joint-venture agreements. There are refineries and blenders all over the country, so selling their product will not be difficult. Shipping costs are also decreased as their finished product can be transported by truck or shipped by train, reducing expenses on account of their locally sourced raw feedstocks.

The Future of the Biofuel Market

Dr. Boyajian said the following on how the biofuel market will develop in the US:

We [Primus] have no doubt that the biofuel market will grow at a rapid pace. Although ethanol certainly has its obvious drawbacks, it's proliferation has shown that the US can produce biofuels at scale and infuse them into the infrastructure. We see a lot of strategic money being allocated as the biofuel market grows and the US edges towards fuel independence, and it's likely that advanced biofuels will grow to constitute more than 30-40% of the fuel mix over the next 10-20 years. These new fuels will tend to be "drop-in" and more fungible than ethanol, leading to better economics, environmental impacts and public approval.

Work with Primus Green Energy

With strong backing from investor IC Green Energy, Primus Green Energy Inc. is interested in discussing joint-ventures and licensing opportunities with all global parties, as well as project proposals for potential plant locations

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For more information:

- Visit Primus' [website](#).

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