

Energy Solutions... Delivered

## Biofuels Production Technology Development

BIOFUELS PRODUCTION PROCESSES TURN RENEWABLE RAW MATERIALS INTO VALUABLE ENERGY PRODUCTS IN MINUTES INSTEAD OF MILLENIA



Thermal, chemical, and catalytic processes can turn renewable biomass resources into bio-methane or longer-chain hydrocarbons such as gasoline, jet, or diesel fuel that can be used in the motor, aviation, and marine fuel pools. These processes expand and diversify the supply of resources that can be used for energy security, environmental sustainability, cost savings, and quality of life. Experts at GTI use special facilities to develop and test innovative processes to achieve this transformation efficiently and economically.

Gas Technology Institute (GTI) has unique capabilities in alternative energy development, encompassing a broad range of biofuel and bio-methane production technologies. These include thermochemical processes based on gasification and catalytic conversion, as well as various routes for production of bio-gas and high-quality bio-methane.

We have been actively involved in biomass conversion research and development for over 60 years, and have extensive experience in the design, construction, and operation of thermochemical conversion systems such as gasification.



GTI worked with Haldor-Topsoe to demonstrate their TIGAS™ process to convert syngas into gasoline. This pilot-scale project converted 20 tons per day of wood into “green” gasoline by fully integrating and optimizing pilot-scale gasification, syngas cleanup, and syngas conversion processes at GTI’s gasification campus. The team on this DOE-funded project also included Andritz Carbona, UPM-Kymmene, and Phillips 66.



More than 10,000 gallons of 92-octane biogasoline were produced for fleet testing. Results were excellent—there was no difference in emissions, mileage, or engine wear, and in 2015, the green-gasoline blend was registered by EPA as an approved motor fuel.

This renewable fuel has 74% lower greenhouse gas emissions than petroleum-based fuel, and the estimated cost is \$2.56 per gallon.

GTI experts invented, tested, and patented IH<sup>2</sup>®, a catalytic thermochemical process that converts non-food biomass feedstocks—such as wood, agricultural residues, algae, and aquatic plants—directly into gasoline, jet and diesel drop-in transportation fuels for less than \$2.50/gallon with greater than 60% reduction in greenhouse gas emissions.

DOE and industrial funding enabled rapid development of the IH<sup>2</sup> technology from initial proof-of-principle experiments through continuous testing in a 50 kg/day pilot plant, and provided support for recently completed engineering work to design a 5 ton/day demonstration unit and techno-economics for commercial-scale 1,000 ton/day units.

GTI signed an exclusive worldwide licensing agreement with CRI Catalyst Company (CRI) for the technology, and CRI invested the capital to build the pilot-scale plant at GTI and support process improvements. Three commercial licenses have been put in place since June 2013.





GTI worked with Gills Onion and their Advanced Energy Recovery System that converts 100% of onion waste by digestion into bio-gas that is subsequently put through a gas cleaning and conditioning process to make it suitable for use in an ultra-clean 500 kW fuel cell power plant.

To support the design of a commercial biofuels plant in Europe, pilot-scale gasification campaigns, testing integrated syngas production and processing systems, were carried out in GTI's gasification facilities. Testing provided Andritz Carbona and their client UPM-Kymmene, a global forestry company, with performance data for their biomass-to-liquids (BTL) process design. In 2012 the European Commission selected to support through the NER-300 program a commercial plant in France at a nominal 5000 BBL/day production capacity.

GTI's staff and its advanced research facilities provide the necessary resources for the evaluation and testing of all types of feedstocks and conversion products. We help clients acquire and assess application- and technology-specific information needed to design experimental and commercial plants for power, fuels and chemical production.

GTI has extensive background in gas processing and clean-up technologies to produce gaseous and liquid biofuels suitable for a wide range of applications: pipeline quality gas, liquid transportation fuels, renewable chemicals, and hydrogen.



GTI developed and patented a small-scale liquefaction technology that creates liquefied natural gas (LNG) from landfill gas, wastewater bio-gas, digester gas, and stranded natural gas reserves. The liquefaction system incorporates features that enable cost-effective capital pricing to be achieved at a small scale while also having greater conversion efficiency.

The technology is in use at the Altamont Landfill near Livermore, California, which produces 13,000 gallons of LNG per day from renewable landfill gas. GTI partnered with Waste Management and Linde North America for demonstration at the site.

## Laboratories & Facilities

GTI has a broad array of facilities for alternative and renewable energy development. We can host testing at all scales, from bench-top to laboratory to pilot plant.



### Pilot-Scale Gasification Campus

> **Flex-Fuel Test Facility (FFTF)**—The Henry R. Linden Flex-Fuel Test Facility evaluates gasification processes integrated with downstream syngas clean-up at up to 6 MWth input to facilitate the commercialization of advanced technologies.

GTI worked with DOE and others on a pilot effort to demonstrate the beneficial use of carbon dioxide through a process designed to capture CO<sub>2</sub> from fossil-fuel power plant stack gas, generate photosynthetically fixed biomass (macroalgae), and convert the macroalgae at high efficiency to renewable methane fuel that can be utilized in the power plant or introduced to a natural gas pipeline.

> **Advanced Gasification Test Facility (AGTF)**—This five-story facility is integrated with process equipment in the FFTF and houses advanced gasifier, gas processing, and syngas conversion bays to allow feed-to-product integrated process development testing.

### Thermochemical Conversion Laboratory

Within these facilities, GTI staff operate specialized equipment to evaluate fossil and renewable feedstocks for gasification, pyrolysis, or hydroconversion performance.

### Gas Processing Laboratory

In this lab GTI develops and assesses gas processing technologies (e.g., membranes, solvents, and adsorbents) which can be used to remove contaminants such as sulfur and CO<sub>2</sub>.

### Analytical Chemistry Laboratory

We also have an accredited analytical chemistry lab on site that provides comprehensive services, including solid fuel and liquid hydrocarbon analyses.

### For More Information

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