



Renewable Energy That Makes Financial Sense



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THE COMPANY STORY

Overview. Proton Power, Inc. (“PPI”) has developed proprietary, patent-protected, clean renewable energy systems for the cost-effective conversion of a wide variety of feedstocks into diesel fuel, electricity, or hydrogen. All PPI systems produce a high quality, semi-activated carbon biochar product that produces significant enhancements to productivity and growth in agricultural plants, animals, and poultry, and it can be used as an effective filtration component in many industrial and agricultural applications. Also, research has revealed that graphene is present in large quantities in PPI biochar, and PPI has subsequently developed a proprietary process to upgrade the biochar into high-quality graphene products. In addition, the process water produced by PPI diesel production systems can be used in many agricultural applications. Importantly, PPI systems are financially viable at a relatively small scale making them easy to locate close to feedstock supplies. Finally, the PPI story wouldn’t be complete without acknowledgment of the significant reduction in carbon footprint for PPI technology inherent to all of the system application types. Carbon savings range from a net negative carbon footprint to a slightly positive carbon footprint depending upon which system type is used and what is done with the biochar product. With any PPI system type, the carbon savings are substantial.

History. PPI began research in 2008 and is currently in approximately mid-stage product and technology commercialization. While initially focused on the production of a hydrogen-rich syngas from biomass feedstocks for the generation of low-cost electricity, subsequent Company advancements now greatly expand the capability of this technology to produce diesel fuel, high quality biochar, and high quality graphene. The technology is extremely flexible with regard to acceptable feedstocks. PPI has tested more than 120 varieties of feedstocks in its Lab that are acceptable for use by the PPI equipment – including Municipal Solid Waste (“MSW”) after appropriate pre-processing of the MSW.

The early focus of the company on hydrogen production led to the brand name of CHyP from the concept of “Cellulose to Hydrogen Power.” Next, PPI developed the capability to use the syngas produced by its CHyP pyrolysis units to power natural gas gensets in order to produce electricity in a financially viable manner. In addition, over the past several years the CHyP system has been combined with PPI proprietary fuel conversion technologies leading to the ability to produce road-ready diesel fuel that meets ASTM D975 standards via a

direct conversion process from feedstock to diesel fuel. PPI systems achieve significant environmental benefits, and they produce valuable co-products such as a high-grade biochar and water.

Customer Interest: The Company initiated discussions with domestic and international customers in 2012, and customer interest has been high. From 2016 to 2018, for example, PPI hosted over 300 customer visits that were attended by almost 1000 prospective customers, and interest in the development of PPI systems remains high. These visits have resulted in multiple orders ranging from diesel to electricity to biochar-only systems.

Initial Demonstration and Commercial Facilities: In December of 2011 PPI obtained its first order for a commercial biomass-to-electricity system from Wamper's Farm Sausage ("Wampler's"). The system was designed to produce 500 net kW of electricity and is located at Wampler's sausage plant near Lenoir City, Tennessee. Work began on the plant in early 2012, and the plant was commissioned the following year. The electricity generated provides power to the customer's manufacturing process, and surplus electricity is diverted to the grid.

PPI, via a relationship with the University of Tennessee ("UT"), began investigations as to whether the syngas produced by CHyP units could ultimately be used to produce fuels. In 2011, UT purchased a single CHyP unit from PPI that it then used for experiments in this and other areas. PPI was allowed access to this unit, but access was difficult and limited, so early in the development of the PPI biomass-to-diesel technology it was apparent that there is a need for a demo system that would enable PPI to conduct research and development ("R&D") on a commercial-sized system on a round-the-clock basis.

To accommodate those needs, PPI constructed a demo system at a site that it had previously purchased near Rockwood, Tennessee. The initial demo system was commissioned and became operational in May of 2014. R&D testing was immediately initiated on a 24/7 basis to expedite the development of the PPI diesel technology.

In February of 2014, PPI signed a contract to sell the entire Rockwood site to a customer from Singapore whereby PPI was to ultimately build a system consisting of 6 production modules capable of producing a total of approximately 20,700 gallons per day from woody biomass arriving at the site in the form of whole logs.

The first production module was brought online in February, 2017, and the second module was completed in August, 2020. Ownership of that plant has changed a number of times over the years, including a recent change of ownership in July of 2021. At the time of this writing, the intentions of the new owner are unclear.

Subsequent to those initial projects PPI has built a solid pipeline of additional projects that are either already under construction or in the final phases of development.

Business Structure

Operations Model: The Company's current operating model for its systems business is to sell its equipment to end user customers as opposed to the Build, Own, Operate (BOO) model where PPI would own and operate the completed system. This allows PPI to direct available funds toward research and development (R&D) efforts – efforts that are ongoing on a 24/7 basis.

Sales Force: PPI has a network of more than 30 independent sales representatives with outreach to customers worldwide. Sales reps are selected for their existing C-level relationships in the private sector.

Field and Construction Partners: Overall project engineering and construction, including installation of the PPI equipment, is accomplished by teaming with a select number of qualified Engineering, Procurement, and Construction contractors (EPCs) to enable global coverage. PPI is in the process of building this network of preferred providers. Also, PPI's diesel system has been tested and qualified by Aon, a major insurer that is able to offer a variety of backstop performance warranty insurance instruments on the PPI technology.

Ongoing System Operations and Maintenance: Similarly, operations and maintenance ("O&M") required for installed customer systems are executed by either: 1) a network of qualified O&M contractors that contract

directly with the customer, or 2) O&M done by the customer with training provided by PPI. PPI's intention is to support customer service needs via pre-qualified O&M contractors.

Patents: PPI has applied for 18 U.S. patents and all have been issued. PPI has applied for patents in 42 countries and 20 have been issued.

PPI TECHNOLOGY FOR DIESEL FUEL APPLICATIONS

There are two primary categories of proprietary technologies that comprise the majority of the Intellectual Property (IP) contained in PPI systems. These technological assets are strategic and provide the sustainable and defensible competitive advantage for PPI:

1. **CHyP Pyrolysis Units:** A proprietary technology that produces an industry-leading hydrogen-rich stream of syngas from biomass or waste feedstocks.
2. **Fuel Conversion System:** A proprietary and multilayered process of converting the PPI hydrogen-rich syngas into ASTM D975 diesel fuel.

CHyP Pyrolysis Units

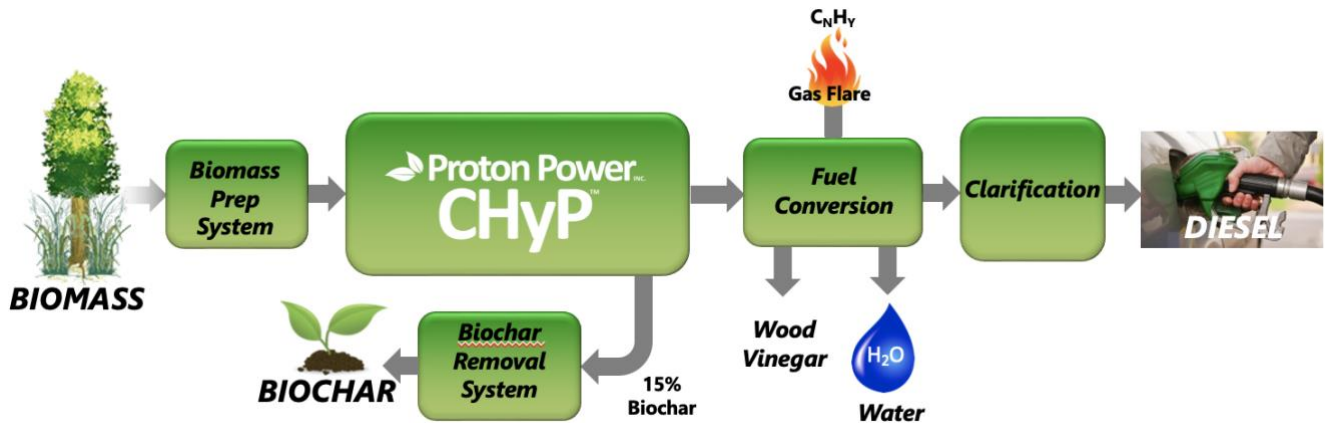
The CHyP pyrolysis unit is the primary technology component that is utilized in all system applications. It is also the component that makes PPI technology and systems unique due to its ability to process feedstocks at very high temperature – approximately 1100C or 2000F – compared to most pyrolysis or gasification units that operate in the 300C to 600C range. Operating at this high temperature enables different chemical reactions to happen which, in turn, cause the syngas produced by the CHyP unit to contain diesel molecules so that direct conversion of the syngas to diesel fuel is possible for PPI diesel systems – without the need for expensive catalysts. Equally important, the high temperature at which the CHyP units operate is directly responsible for the significantly higher quality biochar that is produced by all PPI systems. While the operating parameters are different for each application, the CHyP unit platform is consistent across all applications thereby allowing PPI to obtain significant cost leverage and application flexibility.

The CHyP unit utilizes an unconventional form of pyrolysis to heat feedstocks in the absence of oxygen. While there are many manufacturers that build pyrolytic gasifiers, the PPI CHyP unit is different in many important ways:

1. Feedstock is fed through the reaction chamber using an auger instead of using a fluidized bed process that is common to other systems. This allows for more uniform heat transfer to the feedstock that, in turn, leads to more consistent results.
2. As noted previously, the CHyP unit operates at a much higher temperature range compared to other pyrolysis gasifiers. This allows for a fundamentally different chemical reactions to take place in the gasifier as the feedstock is broken down to form syngas.
3. PPI research has carefully selected unique reactor designs and special materials resulting in a higher energy syngas composition and enhanced system reliability.
4. The CHyP unit has been engineered to operate in a wide variety of applications. This flexible design enables manufacturing cost leverage and system reliability advantages that facilitate an attractive economic model. The PPI system can be financially viable at much smaller sizes compared to competitors' systems, and the modular design facilitates easy scale-up to larger applications.

The amount of high-quality biochar produced by a CHyP units depends somewhat upon the application, but it is generally in the range of 10% to 15% of the dry weight of the incoming feedstock. Because of the inherent process differences from other gasification technologies, the marketability and quality of the PPI carbon biochar is superior to that produced by other processes, thereby resulting in a significant positive revenue contribution to the overall financial performance of a PPI system.

Diesel Production Process



The flow diagram above shows a simplified view of the PPI process to convert biomass into diesel fuel.

The first steps of the process are to ensure that the feedstock is properly sized and dried, if necessary, for optimized performance of the CHyP units based upon the type of feedstock and its condition as delivered to the project site. For a diesel system, the feedstock must be dried to a maximum of 10% moisture content (MC). However, if drying is necessary, the heating load for the drying process can be furnished through the combustion of the tail gas produced as a co-product of the process.

Next, the properly sized and dried feedstock is introduced into the CHyP units for pyrolysis at 1100C. The output from the CHyP units is syngas that is a mixture straight chain and aromatic diesel molecules, water molecules, and light hydrocarbons. In addition, a very high quality biochar is produced by the CHyP units that can be a significant contributor to the financial performance of the system.

The syngas then enters the fuel conversion module via an exit pipe from the CHyP units. The hot syngas is cooled in a PPI proprietary venturi mixing valve. The cooling and mixing process causes a liquid mixture of water, diesel fuel, and light gases ("tail gas") to exit the venturi.

The liquid-vapor mixture is then routed to liquid-vapor separator tanks that separate the diesel fuel/water mixture from the tail gas. The tail gas then exits the system where it typically goes to a thermal oxidizer (provided by others) where it is combusted for emissions control. The combustion heat can be used to dry the incoming feedstock.

The liquid mixture of diesel fuel and water produced by the liquid-vapor separator is then pumped to an oil-water separator where the diesel fuel is separated from the process water. The process water from this unit is collected in a holding tank prior to introduction into a water treatment system (provided by others), or the process water may be used as an agricultural stimulant.

The diesel fuel goes through a cartridge filter bank to remove any remaining tars and particulates before being collected in a holding tank prior to entering a clarification module (provided by others). At this point, the diesel fuel meets ASTM D975 performance requirements except for conductivity. An additive to improve conductivity is required, and this is usually added at the retail level of the fuel distribution chain, just as it is for petro-diesel.

The clarification module changes the color of the fuel from an opaque reddish-brown color to a clear, light yellow color to make the fuel acceptable for on the road use in the US. Also, some additional sulfur is removed from the fuel by this process. At this point the diesel fuel is ready to be pumped to the intermediate storage tanks (provided by others) for laboratory analysis.

Below are some design and capability highlights for the PPI fuel conversion process that set it apart from other known fuel conversion systems.

1. The combination of PPI's CHyP technology and the fuel conversion process results in a PPI diesel system that is scalable and financially viable across a wide range of configurations. As mentioned earlier, small system sizes with design capacities of 1.5 Million gallons per year are functional and have high utility while optimum economic returns occur for system sizes with design capacities in the 6 Million gallons per year range and above.
2. The footprint for a PPI diesel system is small – only 5 to 10 acres are needed for a 6 Million gallon per year system. Locating the system near feedstock supplies reduces transportation costs and avoids a major pitfall of larger syngas facilities.
3. The PPI diesel system uniquely produces diesel fuel that satisfies ASTM D975 requirements. This diesel is chemically equivalent to petroleum-based fuels – which makes it easier for customers to find markets for that fuel product.
4. The combined capabilities of PPI's fuel conversion process coupled with PPI's CHyP gasifier technology produces synthetic fuels for production costs between \$1.20 and \$1.95 per gallon depending upon the cost of feedstock.
5. In today's environment, the environmental impact of any process is an important consideration. Depending upon a particular system and system configuration, a PPI system can deliver an overall system profile from "neutral" to potentially "net negative" on the carbon impact scale.
6. In contrast to most feedstock conversion technology systems, a PPI facility operates under normal to slightly positive pressure and does not require infusion of other ingredients such as oxygen or chemical catalysts.

The combination of potentially three important revenue streams – diesel fuel, high quality biochar, and process water – provide PPI the opportunity to offer its customers excellent financial returns.

PPI DIESEL SYSTEM BY THE NUMBERS

Below are some representative values for a 6 module PPI diesel system with a design capacity of 8.8M gallons/yr (121,000 liters/yr) of diesel fuel. These values assume a greenfield project located in Tennessee, USA, and can vary substantially based upon utility costs, biomass costs, biomass type/quality, labor costs, prices realized for the offtake products, and other local factors.

- Total estimated turnkey CapEx: US\$120M
- Annual Op-Ex: US\$12.2M
- Annual Gross Revenue: US\$53.9M
- Diesel production cost: US\$1.62/gallon
- IRR: 39%
- Simple payback: 2.6 years
- Annual biomass required: 82,000 short dry tons (74,545 dry metric tonnes) delivered to CHyP units
- Annual electricity consumption: 38,800 MWh
- Annual renewable diesel production: 7.4M gallons (28.0M liters) at 85% system uptime
- Annual biochar production: 10,650 short tons (9682 metric tonnes)
- Process water production: 3.5M gallons

GRAPHENE

The most recent business development opportunity that PPI is actively pursuing is the production of graphene.

Graphene is a substance that has many extremely positive attributes in the areas of strength of materials, electrical conductivity, thermal conductivity, and more. The issue that has limited graphene's use in the marketplace is its very high cost (initially up to \$500 per gram) due to very high production costs and small product yields.

The biochar produced by PPI's high-temperature process is composed of a very high proportion of graphene.

PPI has developed a proprietary process that produces a high-quality graphene (PPI calls it, "ProCene") from the biochar that is produced as a co-product from all PPI systems. PPI's process enables it to produce ProCene at very high volumes and at significant low production costs – a quantum improvement for the graphene market. It is noteworthy that an important key to making ProCene of consistently high quality is to start with the high quality biochar (PPI calls it, "Pro-C") that is only available from PPI CHyP units.

PPI has also perfected a process to convert PPI biochar to a medium grade graphene, called "ProCnano", that lends itself well to applications such as strengthening concrete, anti-corrosive paints and coatings and many other applications.

PPI intends to retain the intellectual property to produce ProCene and ProCnano. These products are, therefore, produced and distributed by PPI directly.

FACILITIES

PPI operations are headquartered in Lenoir City, TN, with manufacturing and office space totaling 89,000 sq. ft. across three locations on 50+ acres of land. Included in these three facilities is an 11,000 square foot laboratory facility dedicated to ongoing PPI research and development.

ABOUT PROTON POWER, INC.

Proton Power is a C corporation registered in the state of Tennessee as of October 3, 2005. Headquarters are located in Lenoir City, Tennessee.

For more information about the company, please contact Sam C. Weaver, CEO, at scweaver@protonpower.com or (865) 389-4713.

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