

DOE Bioenergy Technologies Office (BETO) 2015 Project Peer Review

Alpena Biorefinery



March 25, 2015

Demonstration and Market Transformation
Technology Area Review

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American Process, Inc.

Goal Statement

The goal of the AB was to demonstrate a modular, technically successful, and financially viable process of making cellulosic ethanol from woody biomass extract at wood processing facilities.

The project objectives and the value proposition of the AB promote the national goals of energy independence, greenhouse gas reduction, and green job creation and retention. A successful outcome of the Alpena Biorefinery project has been commercial sales of the first ever cellulosic ethanol RINS generated from woody biomass in the US, under the EPA's Renewable Fuels Standard Program.

April 2011

Alpena Biorefinery

Green Power+ Commercial Demonstration Plant

March 2012



Alpena Biorefinery

Green Power+ Commercial Demonstration Plant

March 2012

Alpena Biorefinery

Recognized by EPA one of the first five biorefineries to produce cellulosic ethanol in 2012

April 2012

Alpena Biorefinery - Fermentors





July 2013

Alpena Biorefinery
Ethanol Distillation Columns Successful Startup

Nov 2013



CONFIDENTIAL MATERIAL

8

Alpena Biorefinery - First Ethanol Shipment

1st Commercial woody cellulosic ethanol in USA

Nov 2013

THANK YOU
City of Alpena
Devere
Georgia Tech
GranBio
MEDC
Michigan Forest Council
Michigan Tech
Nancy Ho
NMTC (RDP CCML WF
State of Michigan
Tenaska
US DOE

Alpena Biorefinery - First Ethanol Shipment

April 2014

04.18.14



GREAT LAKES
PETROLEUM
CORPORATION

Alpena Biorefinery
First Cellulosic Ethanol Shipment



Quad Chart Overview

Timeline

- Project start date
 - BP-1: 12/04/2009
 - BP-2A: 12/15/2010
 - BP-2B: 09/29/2011
 - Construction Start Date: 02/25/2011
- End Demonstration:
 - December 31, 2014
- Percent complete: 100%

Budget

	Total Costs FY 10 – FY 12	FY 13 Costs	FY 14 Costs	Total Planned Funding (FY 15-Project End Date
DOE Funded	17.8 MM	3.3 MM	1.2 MM	-
Project Cost Share (Comp.)*	6.4 MM	1.5 MM	.5 MM	-

Barriers

- Barriers addressed
 - **Demonstration** – Successful Commercial scale-up and ethanol sales. Continuing Improvements
 - **Feedstock** - co-location at pulp mills, biomass power plants, and pellet mills
 - **Conversion** – Lower production costs by increasing the value of residual biomass at wood processing facilities by conversion to fuels and chemicals

Partners

Partners: GranBio, Decorative Panels International, Michigan Technological University

Licenses: Purdue-Ho yeast from GreenTech America

Project management

- Construction: DeVere
- Start-up and commissioning: API
- Operations: APER (subsidiary of API)

1 - Project Overview

The Alpena Biorefinery (AB) was constructed in Alpena, Michigan, at the Decorative Panels International hardboard manufacturing facility.



The goal of the AB was to demonstrate a modular, technically successful, and financially viable process of making cellulosic ethanol from woody biomass extract at wood processing facilities.

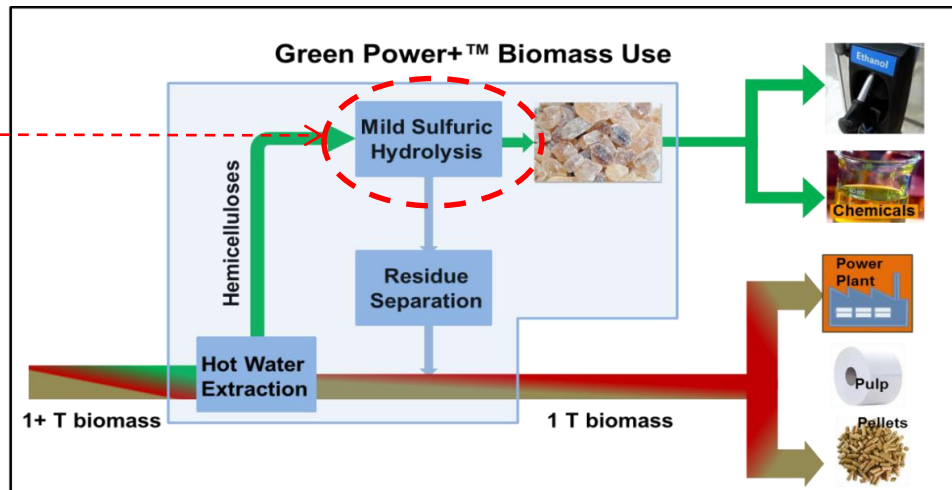
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Green Power+ Technologies

U.S. Patent App.
2013 granted No.
13/026,280



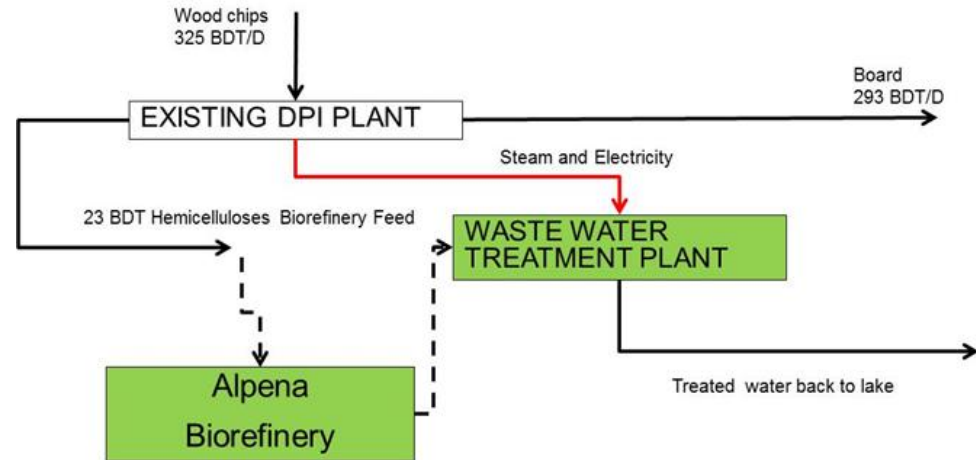
GreenPower+

- Bolt on solution using only hemicelluloses
- Using hot compressed water for extraction of hemicellulose

2 – Approach (Technical)

Biorefinery Co-location
with Host Plant

DPI Process extracts 10% of
wood to waste stream

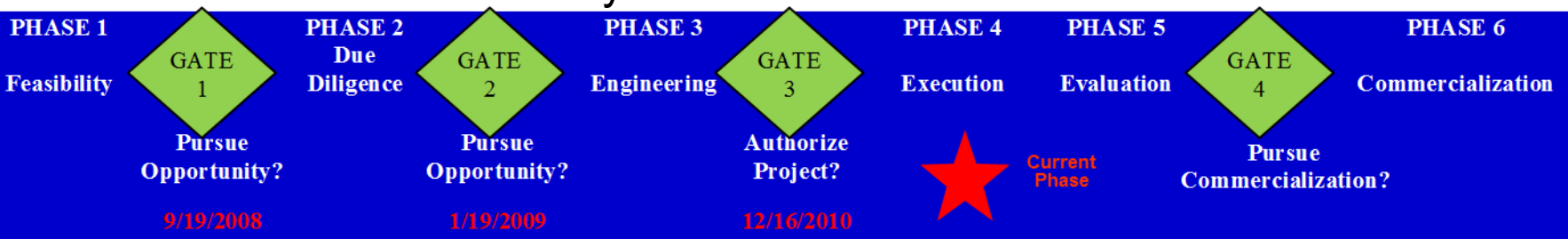


- Key factors that were addressed that effect the technical and commercial viability of the project are:
 - Continuous acid hydrolysis of wood sugars
 - Water removal/concentration using economical Vapor Compression Evaporation and membranes
 - Efficient inhibitor removal (in progress)
 - Lignin removal - proprietary technique
 - Propagation of yeast from vial
 - Co-fermentation of C5 and C6 sugars
 - D&D of cellulosic beer
 - Removal of methanol and acidity

2 – Approach (Management)

API's PMP incorporates:

- **Earned Value Management** measures actual project performance against a baseline that integrates work scope, cost, and schedule. Regular structured project review meetings.
- **Change Control Process** to analyze, communicate, approve and record project changes
- **Live, comprehensive heat and material balance** existing as both steady state and dynamic simulation models
- **Risk Management Plan** to identify project risks and create a response plan to mitigate the risks. Up-to-date critical list. Critical vendor trials.
- **QC** in place for lab tests, engineering, equipment specs & purchasing
- **Stage-Gate Process** with phases defined by specific activities & deliverables with increasing detail & accuracy and decreasing technical & economic uncertainty and risk.



3 – Technical Accomplishments/ Progress/Results

Project Goal	Achieved?	Comments
Demonstrate concentration, hydrolysis, and simultaneous fermentation of five- and six carbon sugars in a near-scale industrial facility.	Yes	Results from Independent Engineer Review Test
Integration with host wood processing plant	Yes	The Alpena Biorefinery uses the waste stream of a collocated hardboard plant to produce commercial cellulosic ethanol.
Lignin removal	Yes	Proprietary method
Effective removal of inhibitors - sugar platform for other biofuels / biochemicals	Yes	Proprietary method
Continuous co-fermentation of C5 and C6 sugars with ethanol yield > 80% of theoretical	Yes	Results from Independent Engineer Review Test
Secure product off-takes	Yes	The cellulosic ethanol, and associated RINS, are being sold for transportation use through Tenaska Commodities, LLC, a multi-commodity marketing and trading company
Co-production of sugars / ethanol with other products	Demonstrated	Currently not in production for market reasons. Some additional development needed

3 – Technical Accomplishments/ Progress/Results (cont'd)

Most important accomplishments achieved since last review:

1. First ethanol sale (4,157 USG conventional): November 11, 2013
2. The first cellulosic ethanol RINS shipped and sold April 18, 2014



API's Green Power+ Plans

In Progress



Licensed Green Power+ plants

Δ 150x

Δ 450x



Concept

Lab

Pilot

Demonstration

2008

2009

2010

2011

2012

2013

2014

2015

2016

2017

2018

3 – Technical Accomplishments/ Progress/Results (cont'd)

Key milestones for the project :

- Start construction: February 25, 2011.
- First start-up: April 2012 – November 2012
- Start-up with lignin removal system: June 3, 2013
- First ethanol sale: Aug 22, 2013
- First cellulosic ethanol RINs generated: April, 18, 2013
- Potassium acetate start-up: July 31, 2014
- DOE Performance Test August 13-23, 2014
- End Demonstration: December 31, 2014
- Continued optimization - 2015

4 – Relevance

- **Demonstrated Production:** Cellulosic ethanol production and commercial sale. First commercial plants for GreenPower+ technology anticipated by 2016
- **Low cost ethanol production:** Commercial production at <\$2/USG
- **High Impact Replication potential by 2022:**
 - Model is synergistic with co-production of pellets, biomass electricity, and Kraft pulp.
 - Co-location of Alpena Biorefinery project at an existing wood product facility validates our commercialization strategy. A co-location lesson learned is to allow 12+ months for co-location agreements to be finalized during commercial plant implementation.
 - Low specific and total CAPEX for commercial projects = Low replication financial barrier
 - Large Replication potential of process unit operations
- **Abundant biomass feedstock:** GreenPower+ can employ woody biomass, agricultural and urban residues and perennial crops as feedstock.
- **Greenhouse Gas reductions:** Ranging 65% - 100+% over gasoline¹

1. Shonnard and Handler, "Life Cycle Assessment of API Green Power Plus Ethanol: Greenhouse Gas Emissions and Savings Compared to Petroleum Gasoline" 2012 Internal Report"

5 – Future Work

With the completion of the Alpena Biorefinery project under the DOE scope, American Process is continuing to improve its technology with several process modifications to increase the level of production of cellulosic ethanol from the biorefinery. These projects are being self-funded and are outside the scope of the DOE awards.

These projects include:

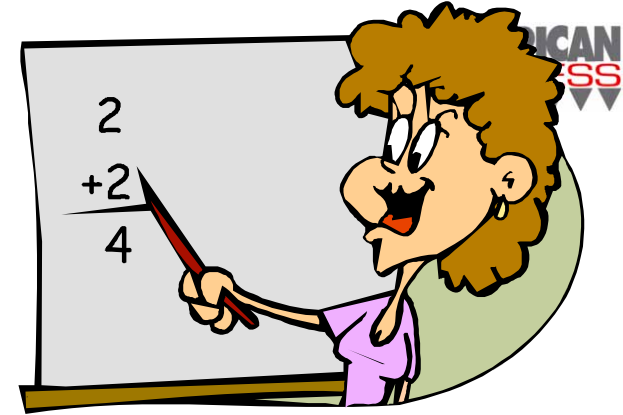
1. Removal of Fermentation Inhibitors by Steam Stripping
2. Yeast Propagation System Modifications ✓
3. Distillation

American Process is also moving forward with the commercialization of the technology developed at the plant, which is being marketed as “GP+, GP++ and GP3+” for greenfield and co-location at pulp mills, biomass power plants, sugarcane mills and pellet mills

Summary

- As of the 2013 review the Alpena Biorefinery project was 70% complete. The project has now been completed with the successful achievement of project goals and the commercial sale of cellulosic ethanol
- The Alpena Biorefinery Project has successfully demonstrated the commercial potential of API's GreenPower+ technology.
- By co-locating GreenPower+ Plants with existing mills, production costs are less and value is added to existing facilities
- The GreenPower+ technology developed at the Alpena Biorefinery can employ woody biomass, agricultural and urban residues and perennial crops as feedstock for viable low cost ethanol production
- API will continue to improve its process as it moves forward with commercialization

Lessons Learned



- Leverage existing “across the fence” infrastructure to mitigate:
- It takes a village, a town - the whole world!
- By nature of these projects.. “scope cannot be frozen”
- Location, location, location!
- Financial Risk of “first of a kind” – very high
- A continuous team thread is needed from R&D to startup to operations
- What is the right scale for a first of a kind?

- Most Important ! Keep going

Thank You!

API would like to extend our gratitude to the DOE for their support of this project.

DOE funding of the Alpena Biorefinery has been instrumental in enabling API to demonstrate processes for renewable materials, fuels and chemicals from biomass.