

Thermal Gasification of Biomass United States Update

IEA Bioenergy Task 33

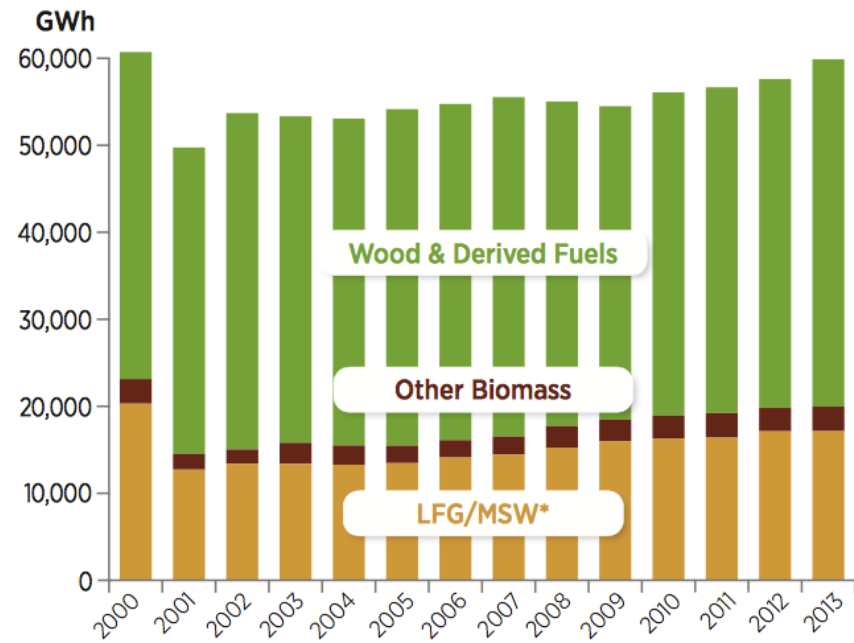
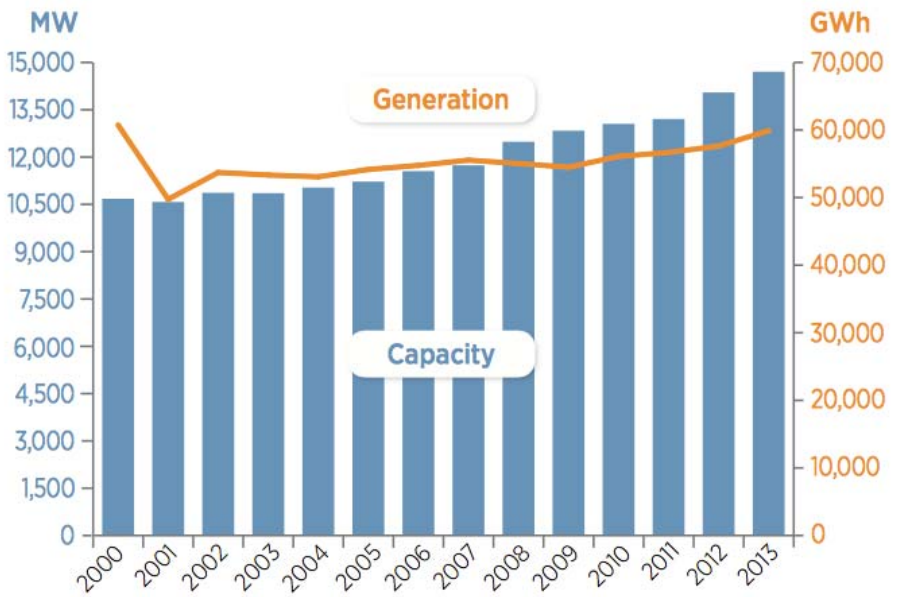
First Semiannual Task Meeting 2016

Trondheim, Norway

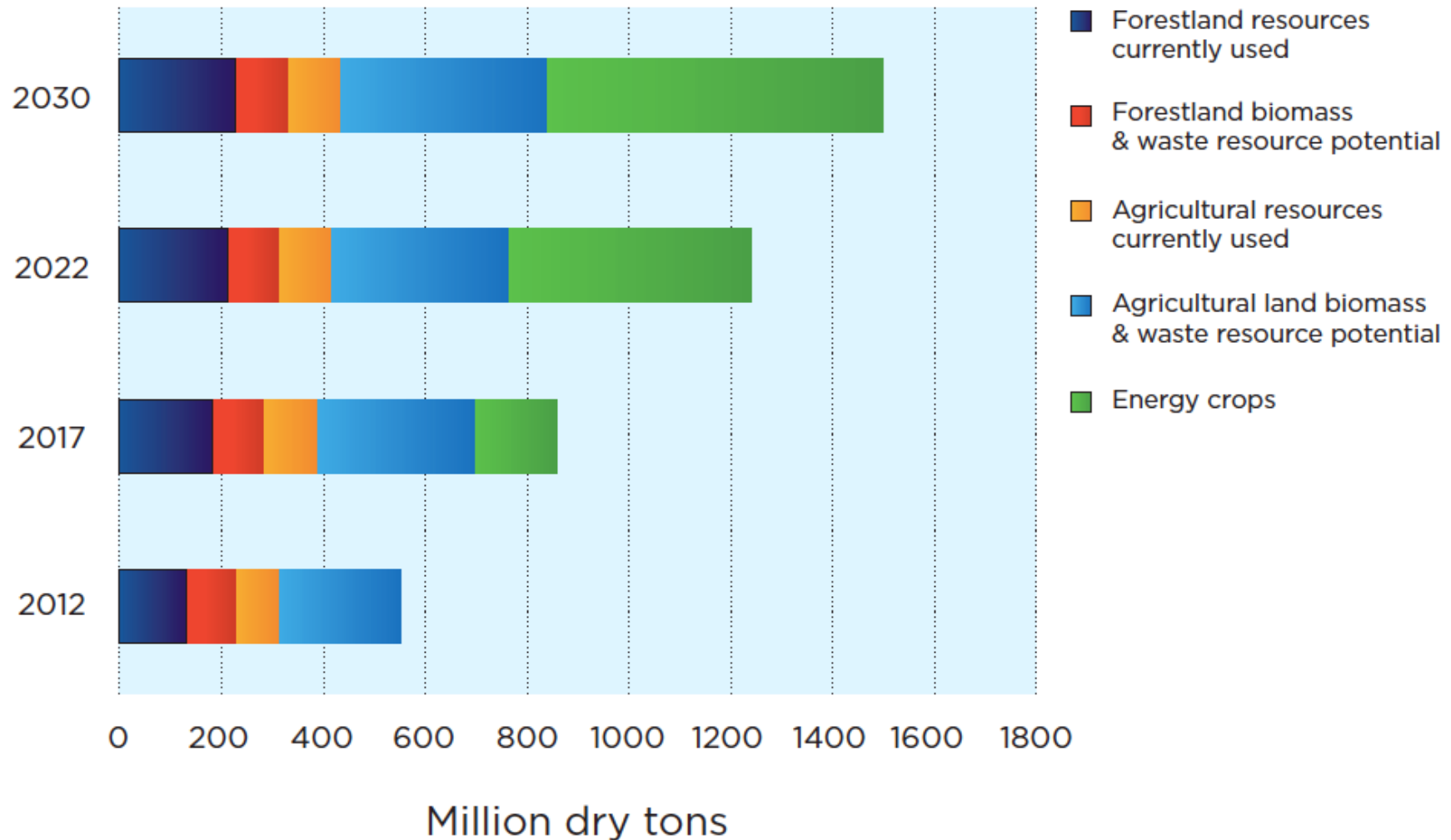
24 May 2016

Kevin Whitty

Biopower in the U.S.



Estimated Total Biomass Available (high yield case)

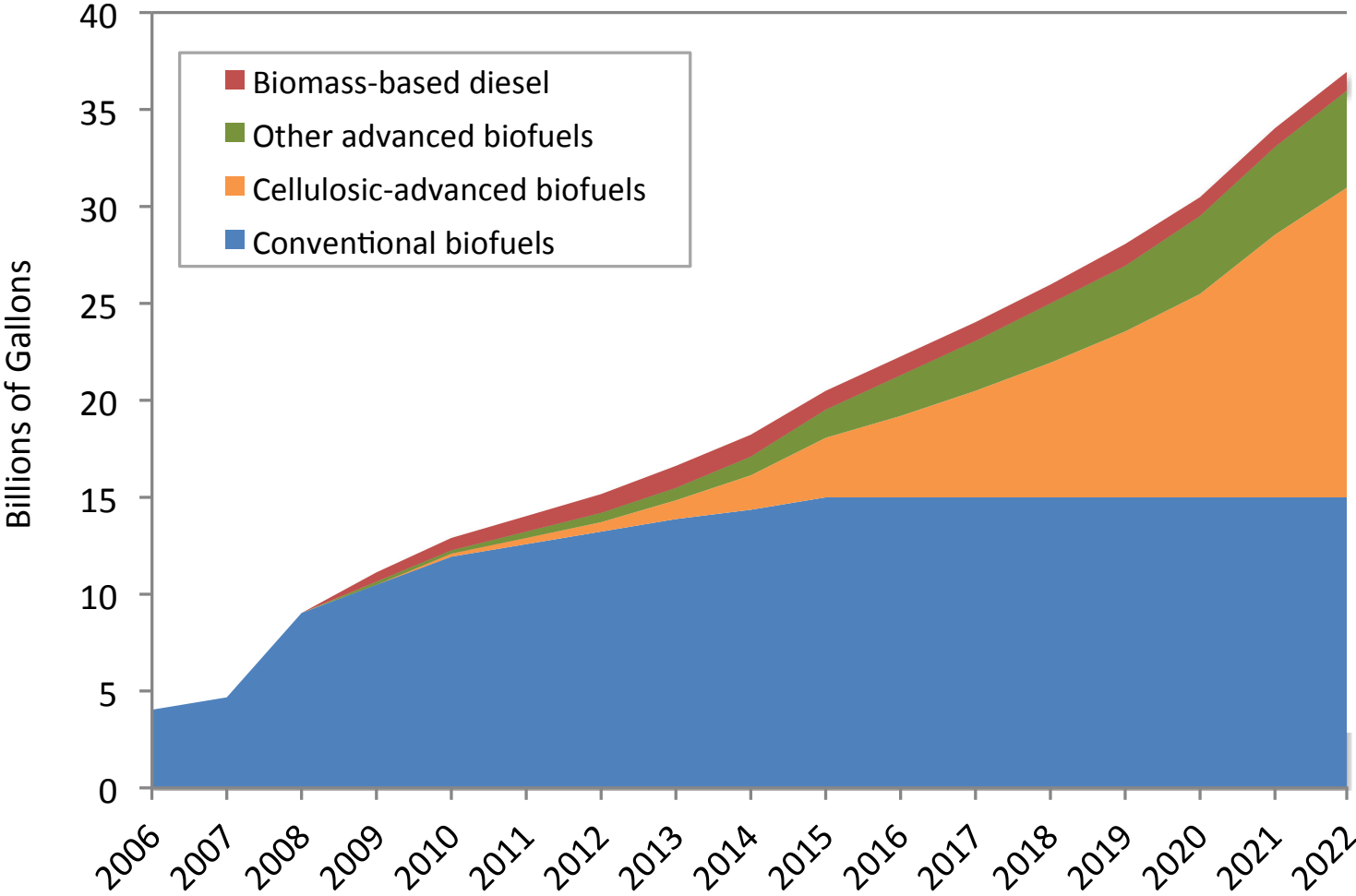


Source: U.S. DOE Billion Ton Update (2011)

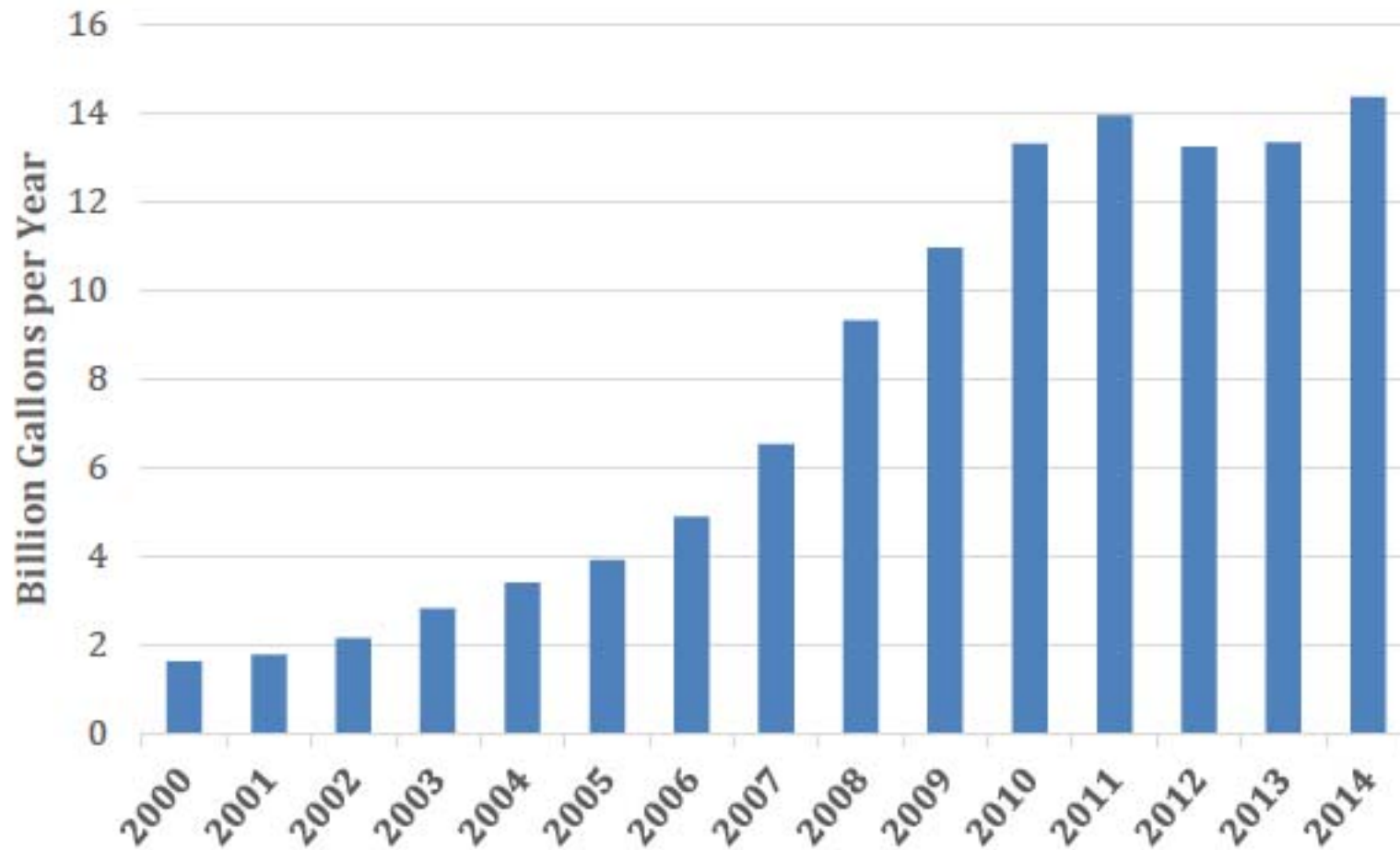
U.S. Federal Policy and Incentives for Biomass Technologies

- Renewable Fuel Standard (EPA)
 - Establishes goals for biofuel usage in the US (36 billion gal of biofuel by 2022)
- Repowering Assistance Biorefinery Program (USDA)
 - Reimburses up to 50% of cost as incentive to convert fossil fuel refineries into biorefineries
- The Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program (USDA)
 - Assists in the development, construction, and retrofitting of new and emerging technologies for the development of Advanced Biofuels, Renewable Chemicals, and Biobased Product Manufacturing by providing loan guarantees for up to \$250 million.
- Biomass Crop Assistance Program (USDA)
 - Advanced Biofuel Feedstock Incentives: annual and matching payments for producers of advanced feedstocks.
- U.S. DOE Bioenergy Technologies Office (BETO)
 - Subset of US Department of energy. RDD&D Program.

Renewable Fuel Standard



Ethanol Production Capacity



U.S. Federal Programs

- U.S. DOE
 - Focus on biofuels – primarily focused on biochemical and algae
 - Some support of gasification
 - Aviation biofuels in particular are of interest
 - Support for some gasification-to-aviation biofuels projects
- U.S. Dept of Agriculture
 - Thermochemical conversion to fuels and power
- U.S. Dept of Defense
 - Interest in gasification of waste

State Policies in Support of Bioenergy

- Less than 15 states have policies specifically incentivizing biomass usage
- Most common types of incentive: incentives, tax credits, rebates
- Policies encourage:
 - Use of biomass in heating (excluding wood)
 - Industry production/collection of biomass
 - Funding of equipment, businesses, or homes using biomass
 - Installation of biomass CHP plants
 - Agricultural production for use in electrical generation
- Plant Construction or Equipment Incentivized
 - New Mexico
 - South Carolina
 - Illinois
 - New Jersey
 - Michigan

The Demise of Coal

- Significant pushback against coal power in past year
- Many coal fired power plants being shut down, coal mining jobs being lost
- Some loss due to increase of natural gas usage
 - Simple implementation
 - Lower CO₂
 - Public perception that natural gas is clean
- Much loss due to EPA regulations, since CO₂ is now considered a pollutant regulated by EPA
 - Clean Power Plan
- More interest in biopower and biomass cofiring

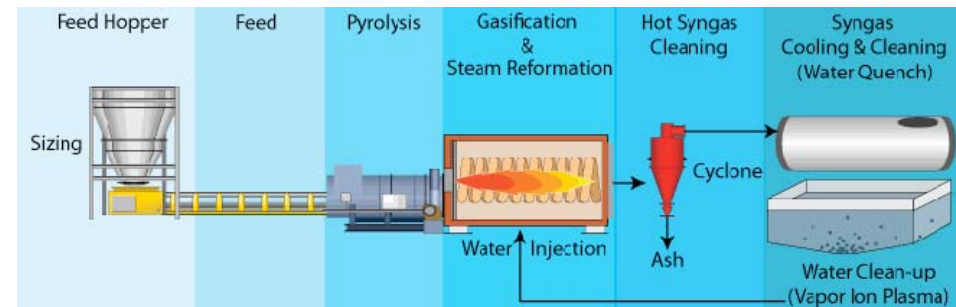
Fulcrum Bioenergy Sierra Biofuels Plant

- Waste to FT fuels
- 200,000 t/y MSW
- Designed for 10 million gallons syncrude
- TRI gasifier
- Agreement with United Airlines
- Collaboration with Tesoro
- Startup expected late 2017



Red Rock Biofuels

- Biomass to FT fuels
- Lakeview, Oregon
- TCG Global gasifier
- Veolocys for FT
- Targeting jet fuel
- Target completion 2016
- \$182 million investment
- Recent partnership announced with FedEx
 - provide 3 million gal/y of biofuels
 - blended to 7 million gal/y
 - 2017 to 2024



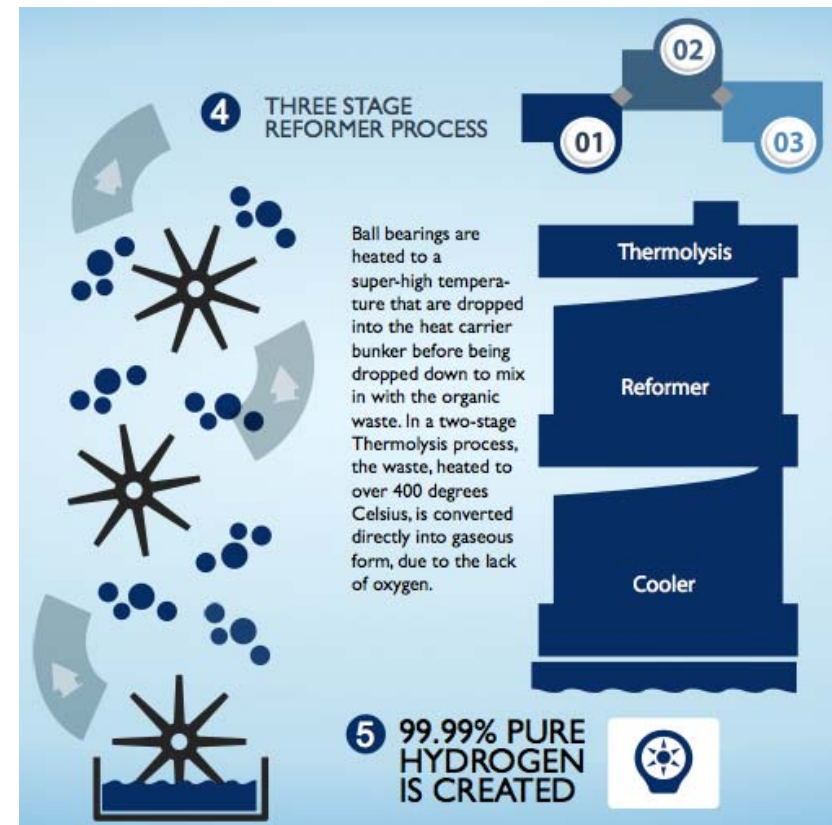
LanzaTech Freedom Pines Biorefinery

Soperton, Georgia

- Biofuel production through LanzaTech's syngas fermentation technology
- Concord Blue chosen as gasification technology provider. Gasifier installation began 2014.
- Target to combine gasifier and fermentation in 2015
- No new news of note



Freedom Pines
Biorefinery



INEOS Indian River Bioenergy Center

INEOS Bio, Vero Beach, Florida

- Feedstock: Vegetable and yard waste, MSW
- Products: Ethanol and power
- Scale: 300 tons feed/day
- Gasification technology: Proprietary oxygen-blown
- Cost: More than \$130 million
- Stopped in early 2015 to address technical issues

