Thrust Area 3: Biomass (Thermo-Chemical Conversion)

Feasibility, Sustainability and Economic Analysis of Solar Assisted Biomass Conversion

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Description: The main deterrent for commercialization of biomass conversion processes is the cost of conversion; particularly the need to sacrifice as much as 30% of the energy content in the biomass for the thermo chemical conversion step. We want to research and develop the concept to use solar thermal energy from concentrating units to provide energy for the biomass gasification step. We also propose to evaluate the sustainability of such a process.

Overall Objective: The overall objective is to conduct a theoretical analysis of solar assisted thermo chemical conversion of biomass from the point of view of energy efficiency, economic feasibility, environmental impact, and long term sustainability of renewable energy production.

Budget: $45,238
Universities: USF

Progress Summary

The overall objective for this FESC project was to conduct a theoretical analysis of solar assisted thermochemical conversion of biomass from the point of view of energy efficiency, economic feasibility, environmental impact, and long term sustainability of renewable energy production.

We completed a comparative study of the solar assisted biomass conversion versus unassisted conversion to liquid fuels. A feasibility study by NREL for converting biomass to alcohol fuels served as a basis for these calculations, though we focused more on the production of drop in fuels such as gasoline, diesel and jet fuel. Our study using computer generated mass and energy balance models combined with economic evaluation and profitability analysis showed that while solar assisted biomass conversion provided advantages in terms of carbon emissions, the capital cost of installing a solar thermal energy station made the process less attractive when compared to the conventional process. Life cycle analysis of the processes are currently in progress.

Funds leveraged/new partnerships created: We have submitted a number of proposals following up on this work, but none has been funded yet.

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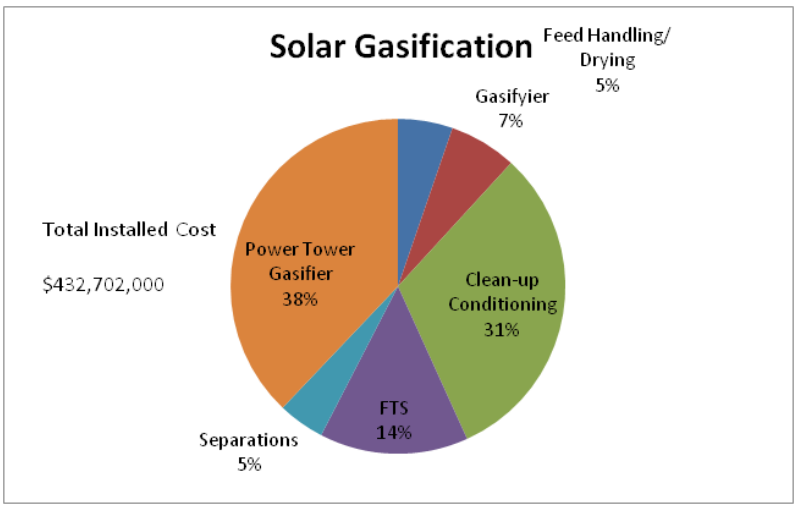
The project is motivated by the following factors:

- Increasing global demand for fossil fuels
- Global political instability
- Increasing fossil fuel prices
- Potential fossil fuel shortage in the future
- Increasing environmental impacts associated to fossil fuels
- The U.S. should be able to sustainably displace around 30% of the country's current petroleum consumption by 2030.

The overall objective for this FESC project was to conduct a theoretical analysis of solar assisted thermochemical conversion of biomass from the point of view of energy efficiency, economic feasibility, environmental impact, and long term sustainability of renewable energy production. The specific objectives for our group are to evaluate the design, economic feasibility and environmental impacts and long term sustainability of solar assisted biomass conversion and identify the opportunities for technological improvement.

To achieve the above objectives, two different systems were compared: (1) biomass conversion without solar unit and (2) solar assisted biomass conversion. The two processes were compared using using a computer simulation and economic analysis model developed using CHEMCAD process simulation package. We have completed a life cycle assessment (LCA) that will assess the environmental impacts associated with the system (1) using the data from the NREL report. A comparative LCA will be performed for the system (2) using the technical data from our simulations.

A process design using the NREL report as a basis indicate that the solar assisted conversion costs more based on the current estimates of the costs of solar concentrating units. As the costs of the parabolic troughs used for solar energy conversion is reduced (mass production will lower costs) the use of solar energy to assist the gasification step will become more economical. The following figure shows the capital cost breakdown for a solar assisted plant.



To date, the life cycle assessment (LCA) for the biomass conversion process described in the NREL report has been completed. The overall process input into GaBi – a LCA software has been completed. The life cycle assessment for the second system is currently under development in GaBi. The results from two systems will be compared to evaluate the benefits of solar assisted biomass conversion from environmental perspective.

Publications resulting from the project:

1. *Matt Wetherington and Babu Joseph* . Cost Models for a Biomass Based Transportation Fuels Plant. Florida Energy Systems Consortium Annual Summit. University of Central Florida, Orlando, Sept 2010.
2. M. Pinilla, Q. Zhang, B. Joseph. LCA: Mixed Alcohol Synthesis via Indirect Liquefaction of Biomass, Paper presented at AEESP distinguished lecture series Symposium, USF, Feb 2011.
3. M. Pinilla, Qiong Zhang, and Babu Joseph, " Comparative Life Cycle Assessment of Biofuels and Electricity Production from Algal Biomass, 2011 FESC Summit, University of Florida, Gainesville, Florida, Sept 27-28, 2011.
4. M. Pinilla, Qiong Zhang, and Babu Joseph, "Comparative Life Cycle Assessment of Lignocellulosic Biomass Conversion into Different Energy Products", 2011 FESC Summit, University of Florida, Gainesville, Florida, Sept 27-28, 2011.