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Title: The Efficient Conversion of Non-Food Based Biomass into Fuels

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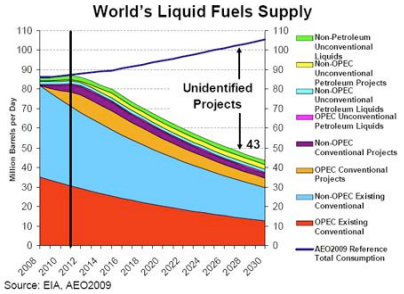
Biological resources
Reading Room
RCRA

# What is the challenge?

**Reducing Dependence on Oil and Fossil Fuels**

**World energy demand is increasing, and oil reserves are declining.**

Current petroleum resears maybe insufficient to meet growing worldwide demand for energy. In addition, there is a growing concern about the adverse impact carbon dioxide emisions from the combusion of fossile fuels on the environment. It is essential that we develop alternative sources for oil and fossile fuels.



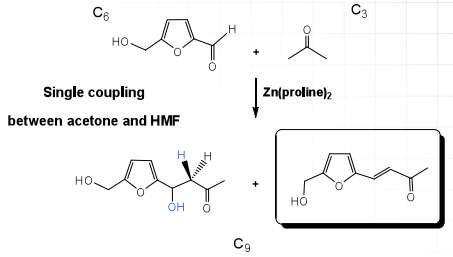

**Projected Future Fuel Production.**

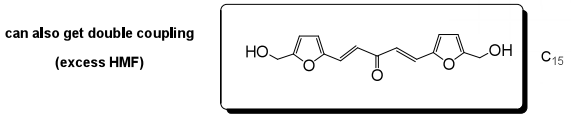
Non-food biomass, (lignocellulose) is currently the an attractive renewable carbon resource. Forest and agrilcultural wastes, such as wood chips, corn stover, husks and straw, are composed of primarily of lignin and cellulose. Moreover, switchgrass is cellulose rich and yields about five times more energy than it takes to grow it, making the plant a far more efficient fuel source than corn. It grows naturally across wide swaths of the country and can be grown in marginal crop land thus, making it and ideal plant for fuel production.

**Switch Grass**

# What have we learned so far?

Using a variety of organocatalysts, aldol reactions can be carried out at ambient temperatures in a variety of solvents, including water. This provides us with a convenient way to lengthen carbon chains on the way to fuels. This chemistry appears to be applicable to a number of readily available biomass-derived molecules that have differing numbers of carbon atoms and begins with the furan derivatives of cellulose. Illustrative example of generation of C9 and C15 fragments is shown below.




**Examples of selective aldol reactions using readily available C3- and C6- synthons.**

From biomass derived molecules, we now have a method with which to prepare species with carbon atom numbers that are in line with those necessary for fuels applications. We are currently working on methods to remove the oxygens atoms on the carbon chain giving the desired hydrocarbons.

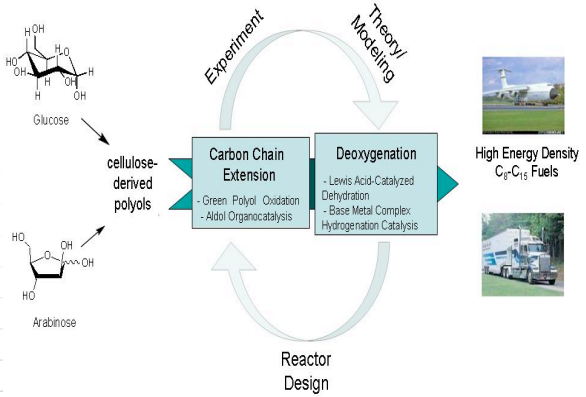
# What is our innovation?

Currently biomass is treated at very high temperatures in gasifiers to access various organic compounds in a pyrolysis step (sometimes greater than 500ºC). Pyrolysis oil is composed of many caron containing compounds and is formed along with a less volatile solid called char. Char is then further heated at greater than 700ºC to form carbon monoxide and hydrogen gass which is then reconstructed into hydrocarbons using a process called "syn gas". This process is low yielding giving rise to many waste products and also requires up-front energy which increases costs.

Catalysts Can Potentially Transforms Carbohydrates (Sugars) and Sugar Like Molecules into Fuelds More Selectively and More Efficiently Than Current Approaches

Cellulose comprises around 33% of plant biomass. 100 billion metric tons of cellulose are biosynthesized each year!

Cellulose can easily be converted to lots of sugars. Sugars and sugar derivatives (furans) can act as biorenewable sources of fuels




**Process for converting biomass into high energy density fuel.**

# Why is this important for our nation?

**The potential benefits of biomass conversion to fuel for the US is enormous:**

- **More than 1 billion tons of biomass can be produced in the US per year without affecting food, feed and fiber uses and production*: Joint USDA/DOE Study 2006.***
- **Efficient conversion of renewable biomass to hydrocarbons can account for 100% of current US petroleum imports.**
- **The development of effective biomass conversion technologies that integrate with existing fuel production and distribution infrastructure allows a shift away from our dependence on foreign petroleum imports**
- **Success will provide enabling science for efficient conversion of carbohydrates to high energy density fuels.**