

Overview of Bioenergy Research Mississippi State University

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Establishing the SERC

In 2006, MSU received DOE funding to establish the Sustainable Research Energy Research Center. Several existing bioenergy strategic initiatives were integrated into the SERC

Goals were

- Develop coordinated approach to biorenewable energy research at MSU
- Generate knowledge that supports the sustainable energy industry
- Train a workforce to support sustainable energy companies
- Develop and promote policies that encourage sustainable energy development

Mississippi State University Sustainable Energy Research Center Goal

Develop new engineering and scientific knowledge and serve as a catalyst to create sustainable energy industries in the Southeastern US.

Feedstocks

Develop sustainable systems to supply biomass for both petro- and biorefineries.

Processes

Develop conversion processes to provide the building blocks for multiple fuel platforms.

Products

Develop technologies to produce fuels, chemicals and power from fuel and chemical building blocks.

MISSISSIPPI STATE UNIVERSITY Sustainable Energy Center

Feedstocks

Products

Uses

- Woody Biomass
- Lignocellulose

Bio-oil

Petro- and Biorefineries

- Wastewater Sludge
- Other Lipid Sources
- Lignocellulose

Bio-crude

Petro- and Biorefineries

- Lignocellulose

Cellulosic Ethanol

Biorefineries

- Woody Biomass
- Lignocellulose

Syngas to Gasoline

Gasoline

Bio-oil Production

Bio-oil is oil created from heating biomass (trees) under oxygen limited conditions.

Potential to be direct feedstock in existing petroleum plants

Research topics include:

- optimization of pyrolysis process
- evaluation of agricultural feedstocks
- improve composition of bio-oil



Forests



**Pine
plantation**



Small-diameter timber

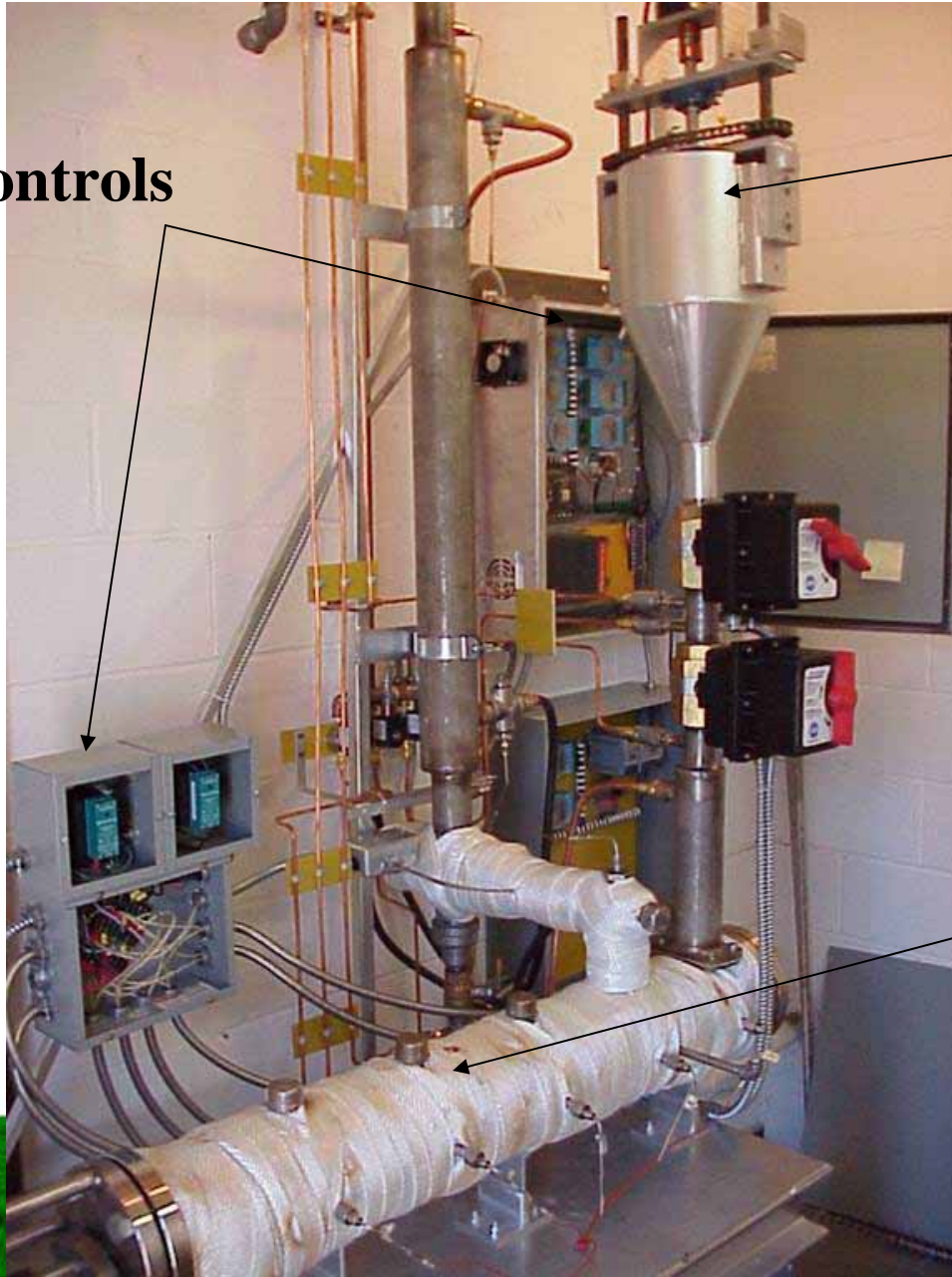
Under story vegetation

Pyrolysis Reactor for producing Bio-Oil

Computer controls

Feeder

Reactor, electric ring heaters and thermocouples



Biodiesel / Bio-crude Production

Biodiesel is the blending of diesel fuel with oil from biorenewable sources (soybean oil, waste food oil, lipids from microbes, etc).

Research topics include:

- feedstock development and evaluation
 - plants
 - agricultural wastes
 - microbial sources of lipids
 - sewage sludge
- process development
 - solid catalysts
 - emissions (NO_x, SO_x)



Sources of Oil for Biodiesel

Plant Oil

- Soybean
- Canola
- Cotton seed
- Rape
- Rice
- Corn
- Tree oils

Animal Fats

- Yellow grease (unused oils and fats)
 - rendering
 - direct process waste
- Brown grease (used oils and fats)
 - fry pit waste

Other

- Algae
- Lipids from waste treatment plants

Ethanol Production

Ethanol is blended with gasoline to reduce fossil fuel requirements.

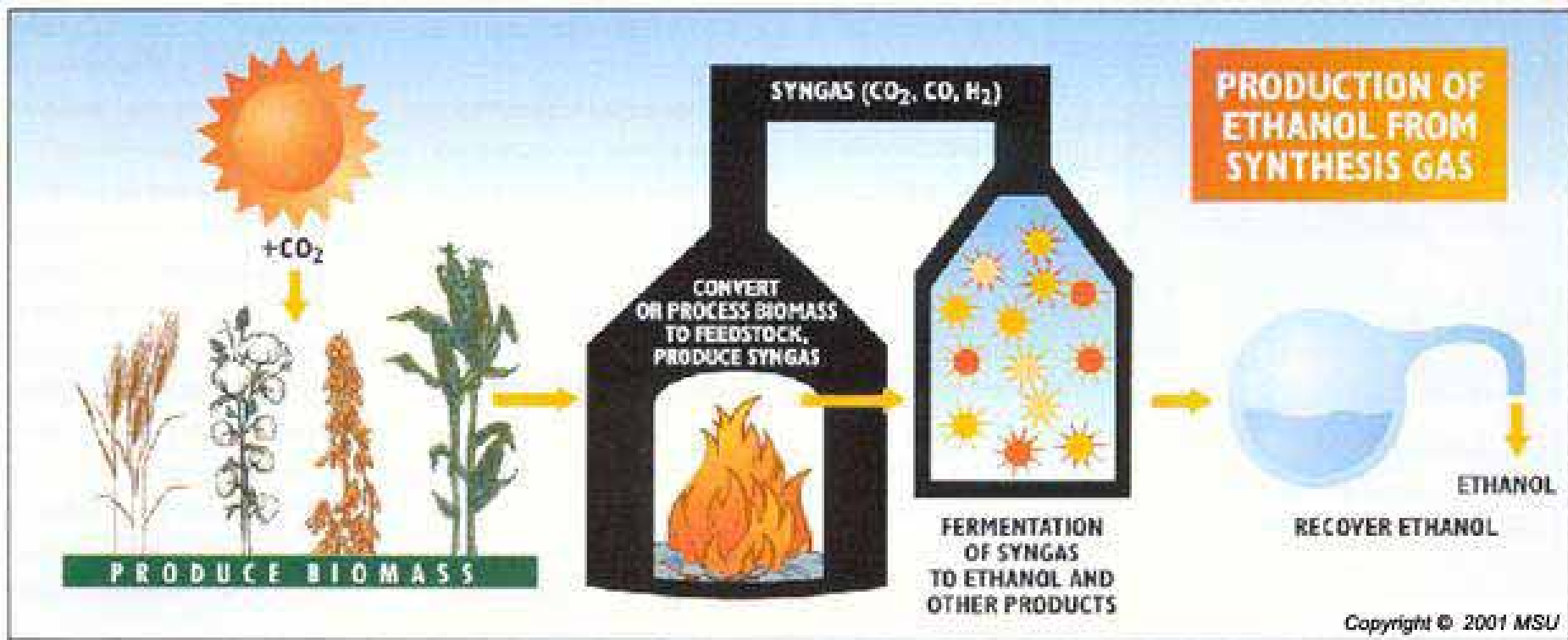
Ethanol derived from corn is a mature, commercial process, but lignocellulosic biomass is more abundant than corn in the Southeast.

Research topics include:

- improved process development for cellulose to ethanol conversion
- genetic improvement of microbes for fermentation



Production of Ethanol from Biomass



Syngas Production

Syngas is a carbon rich gas produced by burning biomaterials which can be converted to several energy sources.

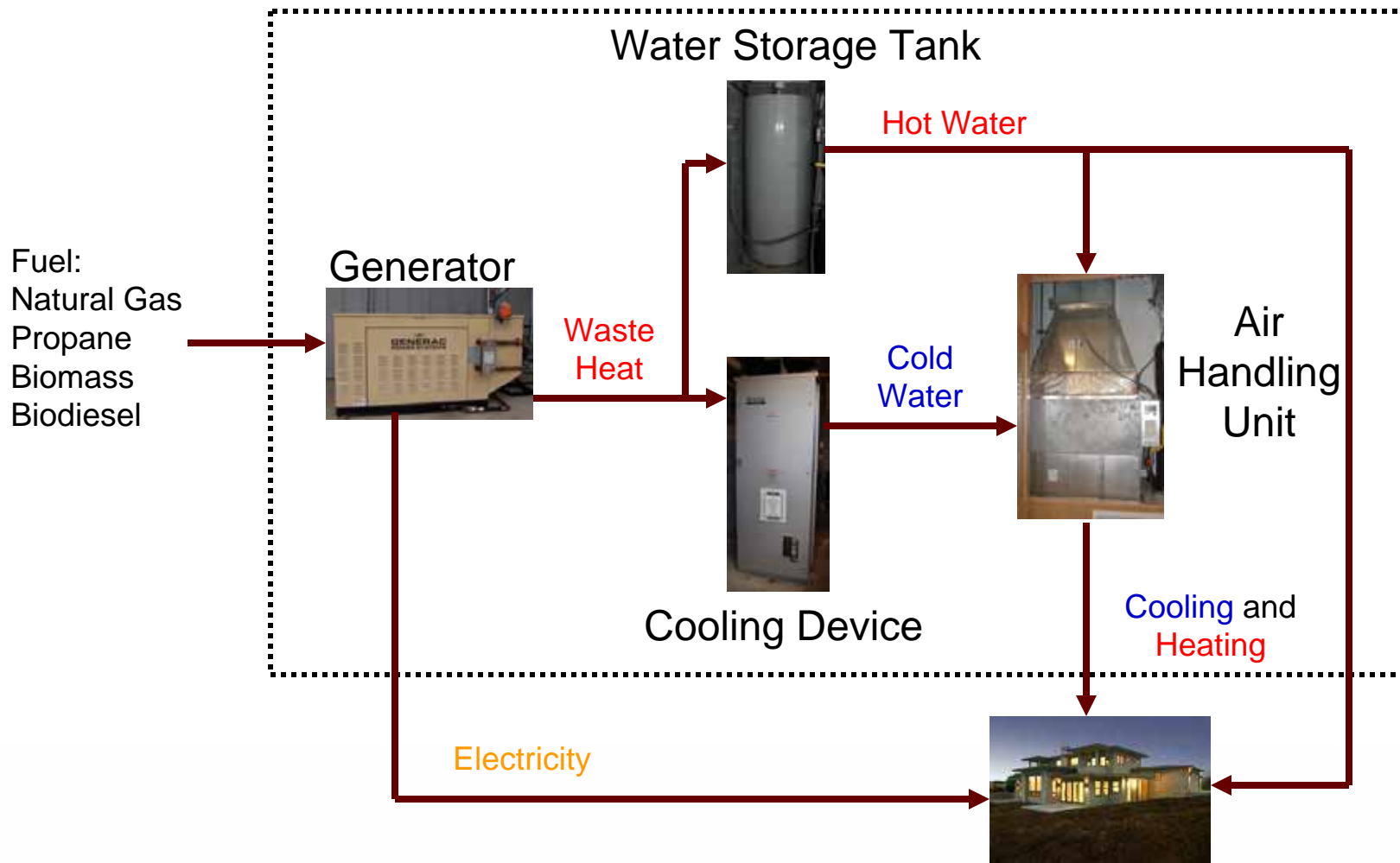
Research topics include:

- development of catalysts to convert syngas to gasoline
- development of methods to convert syngas to electricity
- evaluation of syngas production from several biomass sources
- improvement of efficiency in generating syngas

Syngas is important to Mississippi's renewable energy industry due to the abundance of biomass from agricultural and forest waste products in the state.



Compact CHP Systems



Final product will be a packaged system that can be commercialized, which will utilize different fuels and will provide the electricity, cooling, and heating for the home or small business.

Gasifier and Generator powered by a motor fueled with Syngas



Feedstocks

Sustainable cropping systems for production of lignocellulosic and oilseed renewable energy crops are needed to support biorenewable energy production.

Research topics include:

- characterize adaptation, yield potential, and important composition characteristics of candidate species in each major soil environment of Mississippi.
- characterize physiological limitations to increased biomass production
- modify plant cell walls for cost efficient bio-fuel production

Science-based recommendations on crop selection and management are needed to assist producers and energy manufacturers in the determination of the best cropping systems for each of Mississippi's diverse soil resources.

Mississippi Biomass feedstocks for Ethanol production

Crop Residues

cotton stalks

corn stover

wheat straw

rice straw

soybean stalks

sorghum stalks

Process Residues

cotton gin wastes

wood products
manufacturing

forest intermediate
crops and residues

chicken litter

Biomass Crops

switchgrass

elephantgrass

big bluestem

japanese foxtail

miscanthus

kenaf

Economics and Policy

The economic viability and sustainability of bioenergy fuels and products produced from a variety of selected biorenewable feedstocks must be determined. Also the social, political, and environmental policies that affect bioenergy processes must be considered.

Research topics include:

- produce **enterprise budgets** identifying the costs of producing, collecting, harvesting and transporting biomass feedstocks and of manufacturing biofuels and associated chemicals
- Identify **public policies** that influence feedstock production, location of bionewable processing plants, and uses of biofuels

SERC Accomplishments

- Patented process to make triglycerides from municipal waste
- Developed catalysts to convert syngas to gasoline
- Developed methods to make high quality bio-oil
- Identified microbes capable of producing 60-70% body weight as triglycerides
- Conducted statewide biomass survey
- Initiated statewide yield trials for several energy crops

Questions?

