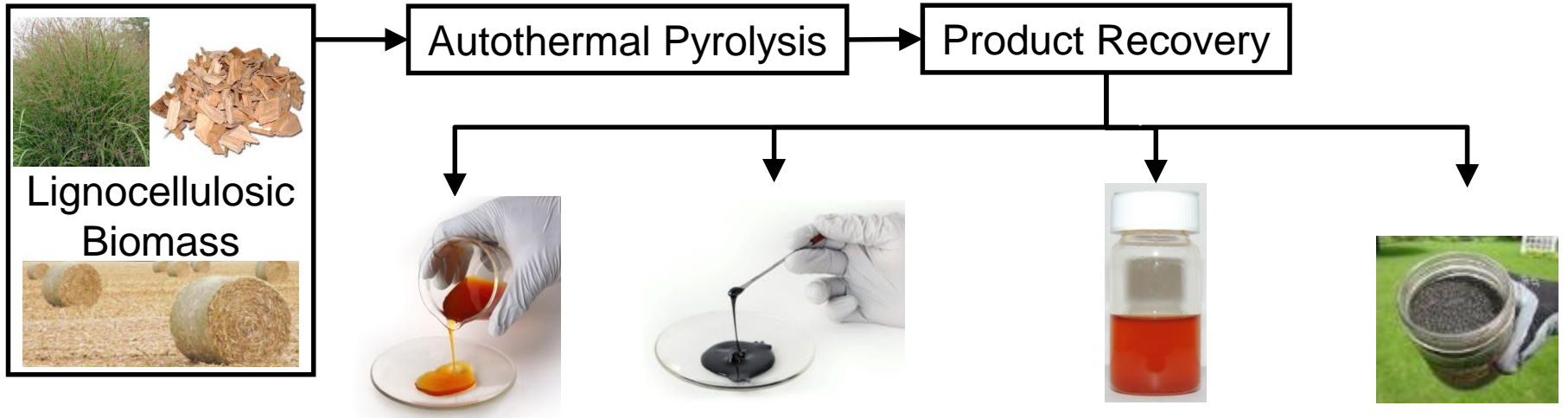


**Economic Development Case
Study on Pyrolysis
Demonstration Project**

Robert Brown

**MGA Biomass meeting
Iowa City, IA
October 11-12 , 2017**

Pyrolysis-based Modular Energy Production System (MEPS)



Unrefined Sugars

Phenolic Oil

Unrefined Acetate

Biochar

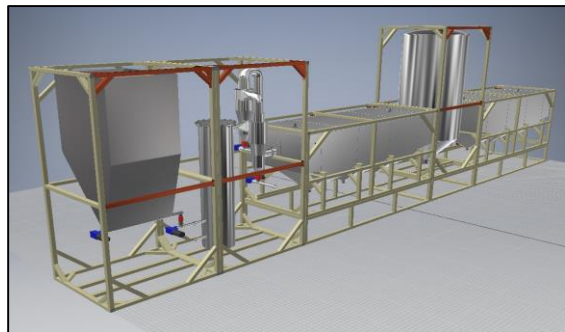
First Generation Products	-Ethanol -n-Butanol Acetone	Lignocol Boiler Fuel 	Renewable Natural Gas (RNG)	Soil Amendment
Potential Future Products	-Pharmaceuticals -Polymers -Solvents 	-Hydrocarbon Fuels -Carbon Fibers -Bio-asphalt -Chemicals 	-Acetone -Acetic Acid -Biocement -Alcohols 	Activated Carbon

First Demonstration Project

- Partnership with Easy Energy Systems (EES) and Stine Seed Company to commercialize Modular Energy Processing Systems (MEPS) based on ISU pyrolysis technology
- Demonstrate 50 tpd autothermal pyrolyzer in 2018
- Biochar used as for Carbon Farming, serving as soil amendment and carbon sequestration agent to achieve carbon negative fuels



Pilot plant used to design pyrolysis-based 50 tpd MEPS



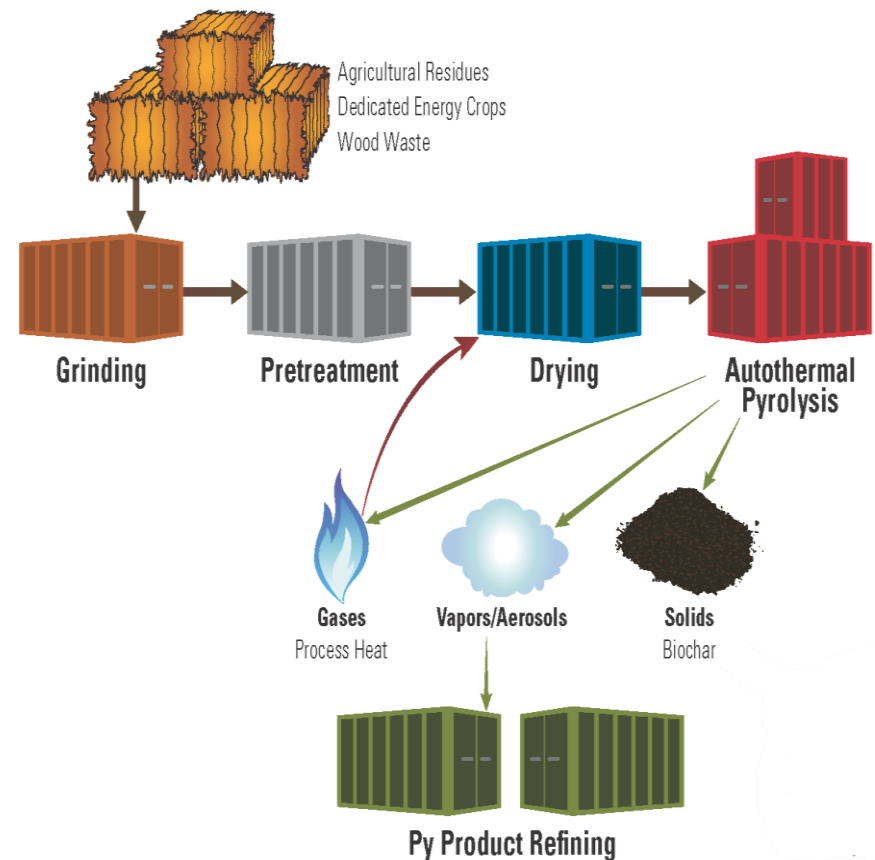
3D model of biomass feed, reactor, and intermediate collection modules being designed and constructed by EES



Carbon Farming

Modular Manufacturing of MEPS

- Subsystems fit into standard ISO shipping containers
- Factory-constructed modules shipped to construction site and assembled into a complete plant
- Lends itself to small plants that process dispersed feedstocks and/or manufacture products for local markets



Corn Stover vs Red Oak as Feedstock

(Acid Pretreatment and Autothermal Pyrolysis)

Yields of major products per MT of biomass

	Bio-oil yield (wt%)	Fractionated Bio-Oil			Biochar (kg)
		Sugar (kg, d.b.)	Phenolic oil (kg, d.b.)	Methane (L)	
Red oak	69	208	138	12,762	137
Corn stover	62	117	128	14,967	180



Depolymerized carbohydrate (mostly cellulose)



Depolymerized lignin



Assumes anaerobic digestion of light ends

Commercialization is being accelerated through recently announced DOE-funded RAPID Institute

- Industry/academic/national lab consortium in process intensification and modular manufacturing
- ISU co-leads the renewable bioproducts area
- \$150 Million in federal/state/private funding over 5 years
- Autothermal pyrolysis was selected as a “quick start” project in the RAPID Institute

