Economic Development Case Study on Pyrolysis Demonstration Project

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## Pyrolysis-based Modular Energy Production System (MEPS)

- **Lignocellulosic Biomass**
- **Autothermal Pyrolysis**
- **Product Recovery**

### Unrefined Sugars
- Ethanol
- n-Butanol
- Acetone

### Phenolic Oil
- Lignocol Boiler Fuel

### Unrefined Acetate
- Renewable Natural Gas (RNG)

### Biochar
- Soil Amendment

### Potential Future Products
- Pharmaceuticals
- Polymers
- Solvents
- Hydrocarbon Fuels
- Carbon Fibers
- Bio-asphalt
- Chemicals
- Acetone
- Acetic Acid
- Biocement
- Alcohols
- Activated Carbon

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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
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

<table>
<thead>
<tr>
<th></th>
<th>Bio-oil yield (wt%)</th>
<th>Fractionated Bio-Oil</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sugar (kg, d.b.)</td>
<td>Phenolic oil (kg, d.b.)</td>
<td>Methane (L)</td>
<td>Biochar (kg)</td>
</tr>
<tr>
<td>Red oak</td>
<td>69</td>
<td>208</td>
<td>138</td>
<td>12,762</td>
<td>137</td>
</tr>
<tr>
<td>Corn stover</td>
<td>62</td>
<td>117</td>
<td>128</td>
<td>14,967</td>
<td>180</td>
</tr>
</tbody>
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- Assumes anaerobic digestion of light ends.
- 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