Lowering the Cost of Bio-energy Feedstocks while Providing Environmental Services: A Win-Win Opportunity

Contract Number: RD3-1

*Project funding provided by customers of Xcel Energy through a grant from the Renewable Development Fund
Goal, Research Areas, and Objectives
Project Goal

• To develop an efficient system for the production, preprocessing and delivery of biomass feedstocks for energy production that minimizes feedstock cost for energy facilities while maximizing landowner income and the environmental benefits of biomass production.

Major Research Areas

• Biomass crop production field to farm gate
• Moving biomass from road/farm gate to facility
• Measure and value environmental benefits
• An integrated assessment of multiple environmental commodity market options
• Life cycle assessment of biomass to energy system
What was Accomplished
• Biomass crop production field to farm gate
  – Biomass establishment, weed control, productivity
  – Harvest timing
  – Impact of ash as fertilizer (based on lab scale study)
  – Landowner willingness to supply biomass to a facility
  – Guidelines for biomass production and harvest

• Measure and value environmental benefits
  – Impacts of biomass production on birds and small mammals
  – Impacts of biomass on water quality and quantity

• An integrated assessment of multiple environmental commodity market options
  – Completed review of for ecosystem/environmental services payments
  – Completed survey of consumer interest in environmental services
• Biomass from field/farm gate to facility
  – Analysis of costs and benefits of biomass production
  – Costs of transport and environmental impacts
  – Impact of a staging area for KODA Energy

• Valuation of ecosystem/environmental services
  – Based on current and potential markets
  – Included in analysis of biomass production options

• Leveraged funding
  – LCCMR funding for impacts of biomass harvest on wildlife
  – EPA 319 funding for Decision Support Tool
  – Met Council/Natn’l Agroforestry Center/UMN (IREE) funding for study of biomass crops
Results
Landowner Willingness to Supply

Percentage of Farmers, Farm, and Agricultural Land Willing to Grow Perennial Grasses

- Farmland Owners
- Farmland
- Total Agricultural Land

<table>
<thead>
<tr>
<th>Relative net Returns (per acre)</th>
<th>Percentage of Farmers</th>
<th>Farm</th>
<th>Agricultural Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>63%</td>
<td>18%</td>
<td>11%</td>
</tr>
<tr>
<td>$50</td>
<td>70%</td>
<td>21%</td>
<td>15%</td>
</tr>
<tr>
<td>$100</td>
<td>71%</td>
<td>20%</td>
<td>14%</td>
</tr>
<tr>
<td>$150</td>
<td>67%</td>
<td>20%</td>
<td>20%</td>
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<td>$200</td>
<td>79%</td>
<td>28%</td>
<td>22%</td>
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<tr>
<td>$250</td>
<td>82%</td>
<td>38%</td>
<td>81%</td>
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</table>
Lowering the cost of grassland biomass production - agronomics

• Plant materials
  – Selection of plant materials with high yield, adaptability, & pest resistance
  – Maximize returns, reduce cost per unit of production

• Landscape targeting
  – Many perennial crops are better suited to floodplain or depositional positions than annual crops such as corn.
  – Targeting perennial bioenergy crops to these landscape positions results in a reduced opportunity cost for the landowner
Lowering the cost of grassland biomass production – (continued)

- **Companion crops**
  - Establishing perennial herbaceous biomass crops with companion crops such as barley can increase establishment year income by providing grain and additional harvestable biomass

- **Biomass ash fertilizer**
  - Excellent source of P & K (supplemental N required)
  - Diversion of waste stream
  - Could reduce production costs depending on delivery cost
Lowering the cost of grassland biomass production – (continued)

• Delaying harvest until spring
  – Increased flexibility for producers
  – Better wildlife habitat
  – Reduced nutrient export
  – Better product quality, especially for gasification
Lowering Per Acre Costs

Input Cost Reduction
- Companion Crop (barley)
- Ash Credit
- Seed Costs (prairie cord grass)
- Transportation

Environmental Payments
- Water Quality
  - Nitrogen
  - Phosphorus
  - Sediment
  - Volume
- Carbon
  - Sequestration
  - Nitrous Oxide
- Pollination
Lowering the Cost per Ton of Biomass

Cost per Ton (delivered) for Three Herbaceous Bioenergy Crops

<table>
<thead>
<tr>
<th></th>
<th>Upland</th>
<th>Lowland</th>
<th>Marginal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>$150</td>
<td>$200</td>
<td>$120</td>
</tr>
<tr>
<td>Input Cost Reduction</td>
<td>$120</td>
<td>$150</td>
<td>$100</td>
</tr>
<tr>
<td>+ Environmental Trading Markets</td>
<td>$100</td>
<td>$120</td>
<td>$90</td>
</tr>
<tr>
<td>No Environ Markets + CRP</td>
<td>$80</td>
<td>$100</td>
<td>$80</td>
</tr>
</tbody>
</table>

Legend:
- Current
- Input Cost Reduction
- + Environmental Trading Markets
- No Environ Markets + CRP
Environmental Scores of Biomass - LCA

Figure 2. Overall environmental scores of biomass electricity pathways and conventional (hard coal and natural gas) electricity generation

Note: shorter bars indicate fewer impacts (prairie mixes had the lowest level of impacts)
Questions?