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Webinar Speakers

Shelly Peterson
Energy Office, Program Manager, Iowa Economic Development Authority

Mark Mba Wright
Associate Professor, Iowa State University

Bryan Sievers
Manager and Owner, AgriReNew; Chief Operating Officer, Sievers Family Farms

Val Stori
Project Director, Clean Energy States Alliance (moderator)
Iowa’s Biomass Potential

Billion Ton Report
https://energy.gov/eere/bioenergy/2016-billion-ton-report
Biomass Success

~3 on-farm digesters producing electricity from biogas
~12 wastewater treatment plants with CHP
~3 landfills with CHP from methane
~10 biodiesel refineries
~42 ethanol plants/3 cellulosic ethanol plants
Biomass as coal substitute at University power plant (CHP)

Miscanthus grass
Biomass Stakeholders

- 36 of the largest 100 food manufacturers and processors
- #1 in nation in corn, eggs and pork
- #2 in soybean and red meat production

- 21M hogs
- 4M head of cattle
- 16B eggs annually
Biogas Potential: Infrastructure

- Natural gas provides 20% energy needs
- No in state production or processing
- 4 natural gas storage fields
- 5 interstate pipelines cross state
- Transmission system is broad but some areas of state lack adequate distribution system
Energy Plans


2018

www.iowaenergyplan.org

2016

www.iowaenergyplan.org
Biomass Conversion Committee: Members

**State agencies**
- Iowa Utilities Board
- Department of Natural Resources
- Iowa Department of Agriculture and Land Stewardship

**Other**
- Municipal Wastewater Treatment
- Farmers/Digester Owner
- Agriculture Associations
- Utilities
- Ethanol producer/Co-op
- Consultants
- University
- Student
State Level Recommendations

- Optimize permitting/regulatory requirements
- Account for ecosystem services
- Develop distribution strategy
- Identify funding sources
- Create bioenergy information platform
- Optimize supply chain/resource utilization
- Establish state incentive program(s)
Federal & Regional Level Recommendations

- **Federal**: Support federal policy initiatives
- **Regional**: Align regionally to promote biomass conversion
Key Points from Biomass Committee

- Short and long term approaches may look quite different
- Success stories can drive change
- Layer existing programs (flood control, water quality, energy, economic development)
Contact Information

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Energy Team Program Manager
Iowa Economic Development Authority
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shelly.peterson@iowaeda.com
Iowa Biogas Assessment Model

A Life-Cycle Cost Assessment of Anaerobic Digesters

Mark Mba Wright
Mechanical Engineering
Iowa State University
Iowa Biogas Assessment Model

Inert Biogas Assessment Model (IBAM)

**Fixed Film**

<table>
<thead>
<tr>
<th>Anaerobic Digester</th>
<th>Fixed Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target After-Tax Equity</td>
<td>0.12</td>
</tr>
<tr>
<td>Biogas (Raw) Consumption</td>
<td>1,500.00 mmbtu/day</td>
</tr>
<tr>
<td>Pipeline Gas Price</td>
<td>4.3 $/mmbtu</td>
</tr>
<tr>
<td>Renewable Identification Number (RIN) Value</td>
<td>0.6 $/RIN</td>
</tr>
</tbody>
</table>

**Net Present Value** | $6,593,000
Capital Cost | $8,473,000
Pipeline Gas Production | 287,000 mmbtu/year

![Graph showing costs and revenues]

External link for Iowa Economic Development Authority, Energy Office, and are free and available for public use. Terms.
# Motivation

To support and engage Iowa stakeholders in the development of biogas

<table>
<thead>
<tr>
<th>Investors</th>
<th>Technology Leads</th>
<th>Policy Makers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Suitability</td>
<td>Energy Efficiency</td>
<td>Investment</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>Process Design</td>
<td>Incentives</td>
</tr>
<tr>
<td>Technology Development</td>
<td>Environmental Impact</td>
<td>Job Creation</td>
</tr>
<tr>
<td>Market Uncertainty</td>
<td>Infrastructure Requirement</td>
<td>Environmental Impact</td>
</tr>
</tbody>
</table>

Life-Cycle Cost Assessment

Process Design → Cost Analysis → Lifecycle Analysis
Anaerobic Digestion Process Design

- **BO Scenario**
  - Biomass
  - Water

- **Cattle Barn Manure**

- **BG Scenario**
  - Biomass
  - Glycerin
  - Water

- **Anaerobic Digester**

- **Recycled Process Water**

- **Power (950 kW)**

- **Solid Digestate**

- **Liquid Effluent**
Anaerobic Digestion Key Assumptions

- The model describes an on-farm digester
- Processes manure from 2400 head of cattle
  - Corn husk, rye, or wheat are mixed in at 5-26 wt.%
  - Glycerin is mixed in 10 wt.%
- The digester operates at mesophilic temperatures (20-40 °C)
- The gas turbine provides combined heat and power at 950 kWe capacity
- The solid and liquid digestate are recycled to offset nutrient costs
## Anaerobic Digestion Feedstock

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Moisture Content (%)</th>
<th>Volatile Solids (kg/kg)</th>
<th>HHV (MJ/ton)</th>
<th>Biogas Potential (m³/ton)</th>
<th>Methane Potential (m³/ton)</th>
<th>Carbon Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure</td>
<td>88</td>
<td>0.85</td>
<td>20000</td>
<td>333</td>
<td>200</td>
<td>0.39</td>
</tr>
<tr>
<td>Corn</td>
<td>60</td>
<td>0.94</td>
<td>18880</td>
<td>585</td>
<td>348</td>
<td>0.44</td>
</tr>
<tr>
<td>Rye</td>
<td>60</td>
<td>0.96</td>
<td>17020</td>
<td>387.5</td>
<td>232.5</td>
<td>0.49</td>
</tr>
<tr>
<td>Wheat</td>
<td>60</td>
<td>0.98</td>
<td>17678</td>
<td>405</td>
<td>243</td>
<td>0.43</td>
</tr>
<tr>
<td>Glycerin</td>
<td>-</td>
<td>1.00</td>
<td>16000</td>
<td>306</td>
<td>183.6</td>
<td>0.88</td>
</tr>
</tbody>
</table>
Total Capital Costs are estimated at $3.12 million ($0.44/kWhe).

Costs are based on assessments by the National Renewable Energy Laboratory.
## Operating Costs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity</td>
<td>40%</td>
</tr>
<tr>
<td>Plant Life</td>
<td>30 years</td>
</tr>
<tr>
<td>Construction Period</td>
<td>2.5 years</td>
</tr>
<tr>
<td>Depreciation Period</td>
<td>7 years, 200 DDB</td>
</tr>
<tr>
<td>Working Capital</td>
<td>15% of Fixed Capital Cost</td>
</tr>
<tr>
<td>Plant Salvage Value</td>
<td>0</td>
</tr>
<tr>
<td>Startup Time</td>
<td>0.5 years</td>
</tr>
<tr>
<td>Revenue &amp; Cost during Startup (% of Normal)</td>
<td>Revenue: 50%</td>
</tr>
<tr>
<td></td>
<td>Variable Cost: 75%</td>
</tr>
<tr>
<td></td>
<td>Fixed cost: 100%</td>
</tr>
<tr>
<td>Interest Rate for Financing</td>
<td>7.5%/year</td>
</tr>
<tr>
<td>Income Tax Rate</td>
<td>39%</td>
</tr>
<tr>
<td>Electricity Price</td>
<td>$0.064/kWh</td>
</tr>
</tbody>
</table>
Operating Costs

Key Assumptions
Manure Cost: $5.0/tonne
Biomass Cost: $20/tonne
Glycerin Cost: $0/tonne

Solids Credit: $35.2/tonne
Liquids Credit: 2.64/tonne

Power Sale: $0.067/kWh
Renewable Tax Credit: $0.015/kWh

Internal rate of returns varied between 3.51% and 5.56%.
**Lifecycle Analysis**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>GHG emissions (kg CO₂e/ kg input)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure</td>
<td>-0.0741</td>
<td>Gao et al. (2014)</td>
</tr>
<tr>
<td>Corn</td>
<td>0.0377</td>
<td>SimaPro (2008)</td>
</tr>
<tr>
<td>Rye</td>
<td>0.00685</td>
<td>SimaPro (2008)</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.0401</td>
<td>SimaPro (2008)</td>
</tr>
<tr>
<td>Glycerin</td>
<td>2.49</td>
<td>SimaPro (2008)</td>
</tr>
</tbody>
</table>
Lifecycle Analysis

Estimated emissions range between -82.6 and 498.5 g CO$_2$e/kWh.
<table>
<thead>
<tr>
<th>Variables</th>
<th>Pessimistic Case</th>
<th>Base Case</th>
<th>Optimistic Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Efficiency (%)</td>
<td>33.4</td>
<td>42</td>
<td>50.4</td>
</tr>
<tr>
<td>Operating Capacity (%)</td>
<td>68</td>
<td>85</td>
<td>102</td>
</tr>
<tr>
<td>Capital Cost ($MM)</td>
<td>3.75</td>
<td>3.12</td>
<td>2.50</td>
</tr>
<tr>
<td>Waste per cattle (tons/day)</td>
<td>0.028</td>
<td>0.035</td>
<td>0.042</td>
</tr>
<tr>
<td>Manure Price ($/ton)</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Solid Digestate Price ($/ton)</td>
<td>-28.20</td>
<td>-35.25</td>
<td>-42.30</td>
</tr>
<tr>
<td>Biomass Price ($/ton)</td>
<td>24</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Glycerin Price ($/ton)</td>
<td>-10</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Liquid Effluent Price ($/ton)</td>
<td>-2.11</td>
<td>-2.64</td>
<td>-3.17</td>
</tr>
<tr>
<td>Biomass Emission Factor (kg CO₂e/kg input)</td>
<td>*Varies by feedstock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycerin Emission Factor (kg CO₂e/kg input)</td>
<td>1.992</td>
<td>2.49</td>
<td>2.988</td>
</tr>
<tr>
<td>Organic Matter Emission Factor (kg CO₂e/kg input)</td>
<td>-0.006</td>
<td>-0.0075</td>
<td>-0.009</td>
</tr>
<tr>
<td>Manure Emission Factor (kg CO₂e/kg input)</td>
<td>-0.059</td>
<td>-0.074</td>
<td>-0.089</td>
</tr>
</tbody>
</table>
Sensitivity Analysis

Key economic factors:
1. Operating Capacity
2. Power Efficiency
3. Waste per Cattle

Key environmental factors:
1. Power Efficiency
2. Glycerin Emission Factor
3. Waste per Cattle
Uncertainty Analysis
Key Takeaways

• Iowa has various biomass resources that can be converted to biogas
• Anaerobic digestion can be profitable specially when co-located with a biomass resource
• Operating capacity and power efficiency are important factors
Acknowledgments

➢ Alvina Aui
➢ Bryan Sievers
➢ Shelly Peterson
➢ Iowa Economic Development Authority
➢ Bioeconomy Institute
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www.iowabiogasmodel.us

Spreadsheet: http://www.iowabiogasmodel.us/IEDA_Anaerobic_Digestion.xlsm
Recycling Farm Nutrients and Agricultural Processing Waste for Energy Generation, Water Quality, and Soil Health
The primary function of AgriReNew, located near Stockton, Iowa, is to recycle farm nutrients, biomass, and other carbon-based substrates for energy generation and odor control. Specifically, the business recycles beef cattle manure, waste from agricultural and food processing, and biomass (crop residues) through anaerobic digesters. This process will produce renewable biogas, recapture nutrients used to grow the corn fed to the cattle, and produce positive environmental results.
AgriReNew is a joint venture between Sievers Family Farms, LLC, Sievers Renewable Energy, LLC, and Davidson Renewable Energy, LLC. Sievers Family Farms and Sievers Renewable Energy are owned by Bryan and Lisa Sievers. Davidson Renewable Energy is owned by Dr. Bill Davidson III and his wife Judy.

AgriReNew owns all structures needed for the processing enterprise. Structures include two anaerobic digesters, effluent storage structures, separated solids storage structures, biomass storage structures, separators, dosing units, pumps, etc. The facility is located between Stockton and New Liberty, which is in the northwest corner of Scott County, Iowa.
Sievers Family Farms, LLC, established in February 2010 by Bryan and Lisa Sievers, owns the land where AgriReNew’s complete-mix anaerobic digesters and facilities are located. Structures owned by Sievers Family Farms include two 1200 head cattle barns, commodity storage structures, and livestock nutrient handling equipment.
Sievers Family Farms Junior Executives
Your Iowa Waste Reduction Center Staff...
Climate Change Mitigation - Food waste in landfills generates methane, a potent greenhouse gas. Diverting food waste from landfills to anaerobic digesters and wastewater treatment facilities allows for the capture of the methane, which can be used as an energy source. In addition to decreased methane emissions at landfills, there are greenhouse gas emissions reductions due to the energy offsets provided by using an on-site, renewable source of energy.

The anaerobic digestion of food waste has many benefits!
Why Food Waste?

Food waste is the second largest category of municipal solid waste (MSW) sent to landfills in the United States, accounting for approximately 18% of the waste stream. Over 30 million tons of food waste are sent to landfills each year. Of the less than 3% of food waste currently being diverted from landfills, most of it is being composted to produce a fertilizer.
Manure Varies from Site to Site
Off-Farm High Solids Feedstocks

- Soy-oil Waste
- Glycerin
- Animal Processing Waste
- Waste
Biomass from Cover Crops
Double crop soybeans following cover crop harvest as biomass for digesters
## AgriReNew

### Current Level of Energy Production

<table>
<thead>
<tr>
<th>Production</th>
<th>2016</th>
<th>2017</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMBTU (CH4)</td>
<td>58,909.80</td>
<td>97,517.69</td>
<td>65.54%</td>
</tr>
<tr>
<td>Electricity (kWh)</td>
<td>5,707,087</td>
<td>6,742,081</td>
<td>18.14%</td>
</tr>
</tbody>
</table>
## AgriReNew

### Current Level of Fertilizer Production

<table>
<thead>
<tr>
<th>Fertilizer product</th>
<th>2016</th>
<th>2017</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestate (gallons)</td>
<td>15,035,988</td>
<td>20,585,455</td>
<td>36.9%</td>
</tr>
<tr>
<td>Liquid Effluent (gallons)</td>
<td>12,329,510</td>
<td>16,880,073</td>
<td>36.9%</td>
</tr>
<tr>
<td>Bio fibers (pounds)</td>
<td>22,586,921</td>
<td>25,902,915</td>
<td>14.68%</td>
</tr>
</tbody>
</table>
An innovative way to capture the beneficial aspects of renewable energy generation from biomass conversion, beef cattle production, and agricultural processing waste.
Thank you for attending our webinar

Val Stori
CESA Project Director
val@cleanegroup.org

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@CESA_news on Twitter
Upcoming Webinars

Renewable Thermal in RPSs: Examples from New Hampshire, Oregon, and Vermont
*Thursday, November 29, 1-2pm ET*

Americans’ Changing Views of Renewable Energy Policies
*Tuesday, December 4, 1-2pm ET*

The Real Estate Industry and Selling Homes with Solar
*Tuesday, December 11, 1-2pm ET*

Read more and register at: [www.cesa.org/webinars](http://www.cesa.org/webinars)