

# Highmark Renewables Research

*Better bioFuels: Generation 1.9 BioFuels  
Production*



Growing Power.™

*June 29, 2009*

**EPAC 2009**

*Trevor Nickel*

## Presentation Overview

- Highmark Renewables Research
  - Who we are
  - What we do
- Increasing Efficiency - Comparative Cases
  - Stand Alone Ethanol
  - Ethanol with AD and nearby CAFO
    - Anaerobic Digestion Technology Features
- The Keys to Increased Efficiency
- Questions

## **Framing the Discussion:** **Highmark Renewables Research LP**

### **What we do:**

- **Technology Commercialization**
  - Portfolio including the market leading AD technology and most energy efficient bioFuel production technology
  - Placing our technology globally where it enhances our clients' economics and operations
- **Technology Development**
  - Strive to develop technologies that maintain our differential advantage in AD
  - Enhance the value proposition of technologies through integration

### **Who we are:**

- **Bern and Mike Kotelko**
  - Founders
- **Evan and Shane Chrapko**
  - CEO's
- **Dr. Xiaomei Li**
  - Chief Science Officer
- **Trevor Nickel**
  - Assistant General Manager in charge of Technology Commercialization
- **A growing team of business professionals, engineers and technologists**

# Increasing Efficiency

## Conventional bioFuel production and competitiveness

Why is an AD company talking to you today about better bioFuel production, specifically ethanol production?



# Increasing Efficiency

## Stand-Alone Ethanol Plant

Model plant:

- Located in Alberta

Produces

- 40 Million Litres/an fuel ethanol
- 40,000 tonnes/an DDGS

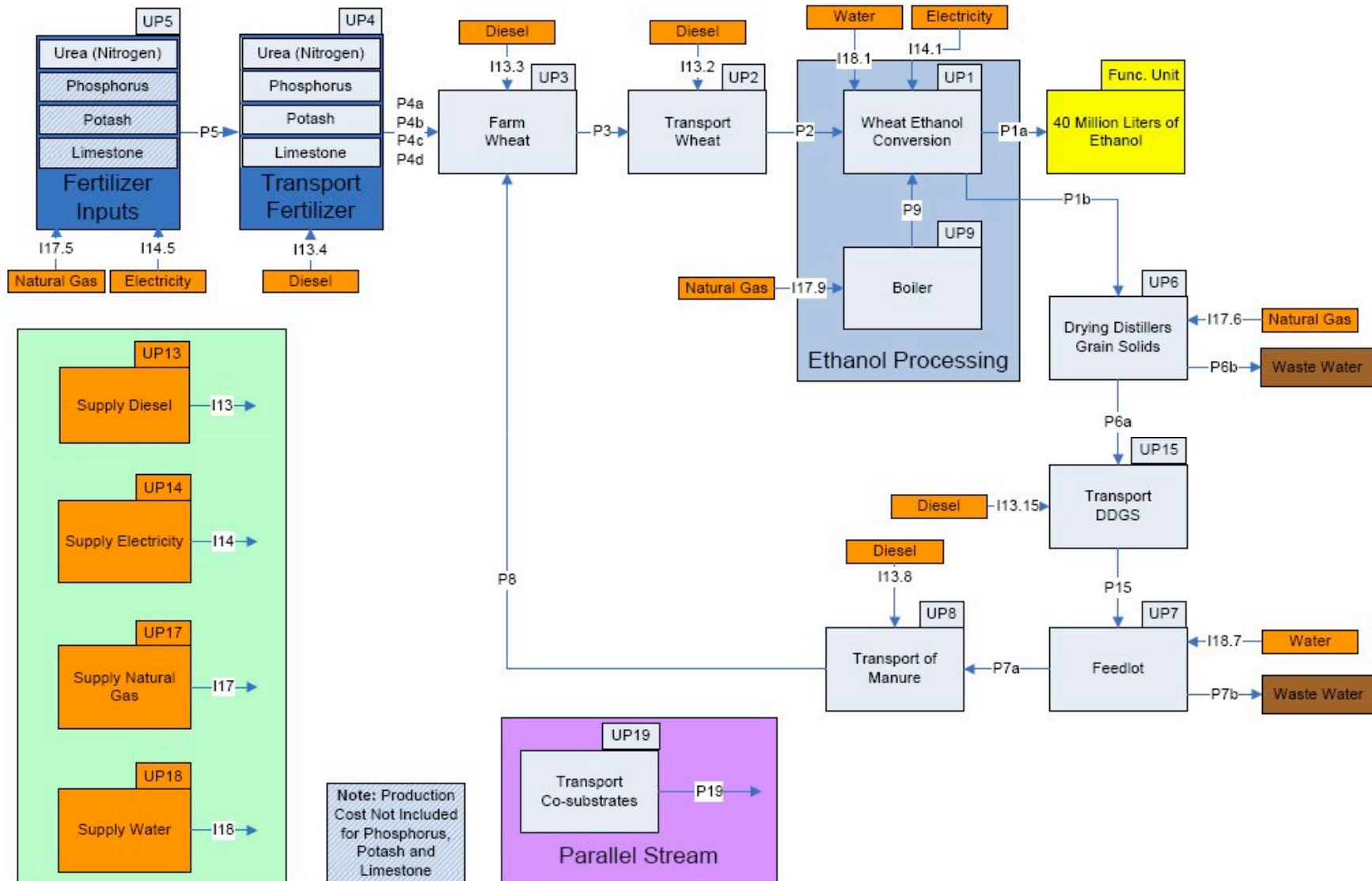
Uses

- 110 tonnes grain/an
- 863,694 GJ of fossil electrical and thermal energy/an
- Annual Energy cost approx \$3.2MM

Energy Balance

- Energy out:fossil energy in **1.10:1**
- Typical numbers 1.24:1 to 1.39:1 depending on vintage of facility
- Requires water, power, and natural gas services

# Increasing Efficiency Stand-Alone Ethanol Plant



# Increasing Efficiency

## Stand-Alone Ethanol Plant

	Volume	Price	Amount
Ethanol	40000000		
Denatured Ethanol	40800000	\$ 0.63	\$ 25,704,000.00
AB Ethanol Incentive	40800000	0.14	\$ 5,712,000.00
Federal Program	40000000	0.04	\$ 1,600,000.00
DDGS	34222	129.55	\$ 4,433,333.33
Chemical CO <sub>2</sub>	29820	0	\$ -
Electricity Sales	0	0.08	\$ -
GHG	43259.4	13	\$ 562,372.20
Tipping Fees	0	0	\$ -
BioFertilizer	0	0	\$ -
<i>Total Revenue</i>			\$ 38,011,705.53
Wheat	111111	\$ 160.00	\$ 17,777,777.78
Electricity Use	11076000	0.08	\$ 886,080.00
Heat	358800	6.5	\$ 2,332,200.00
Biogas incentive	0	0	\$ -
Denaturant@2%	800000	0.63	\$ 504,000.00
Enzymes	40000000	0.025	\$ 1,000,000.00
Labour	40000000	0.0255	\$ 1,020,000.00
Maintenance	40000000	0.0396	\$ 1,584,000.00
Misc	40000000	0.02	\$ 800,000.00
OH		0.2	\$ 2,421,529.55
<i>Total Cost</i>			\$ 28,325,587.33
EBITDA			\$ 9,686,118.20
Depreciation	20	\$ 55,000,000.00	\$ 2,750,000.00
Interest	50%	5%	\$ 1,575,000.00
EBT			\$ 5,361,118.20
Taxes	34%		\$ 1,822,780.19
<b>NI</b>			<b>\$ 3,538,338.01</b>

# Increasing Efficiency

## Stand-Alone Ethanol Plant

Approx \$3.2MM/an in energy costs

- At \$6.50/GJ
- At \$9.00/GJ; \$4.1MM
- Fully exposed to energy market variability

Distillers Grains

- More than 30% of the energy budget in plant goes to drying distillers grains
- Market for DDGs highly variable

Risks

- Responsible business must reduce risk
- Increased energy efficiency makes a significant impact



## Increasing Efficiency

### Ethanol with Anaerobic Digestion and a nearby CAFO

The ideal model for Energy Efficiency

- Gets rid of the dryer
- Energy is 100% renewable and has little ongoing cost
- Increases capital cost
- Increases revenue opportunity
- Dramatically decreases risk
  - No exposure to energy variability
  - Limited exposure to grain variability
  - No exposure to DDG market variability
- Increases access to market for ethanol
- **But is it technically feasible?**



## Anaerobic Digestion Technology Challenges

- Feedlot manure is NOT an easy substrate for AD
- Manures in general are POOR substrates for AD
- But, feedlot manure occurs in attractive quantity!
- Main R&D Breakthrough:
  - High-Solids Infeed System
- Subsequent breakthroughs:
  - Active Access
  - Clean Slate
  - Gas handling and cleaning
- Technologies near to market:
  - Phosphate Recovery
  - Nitrogen Recovery

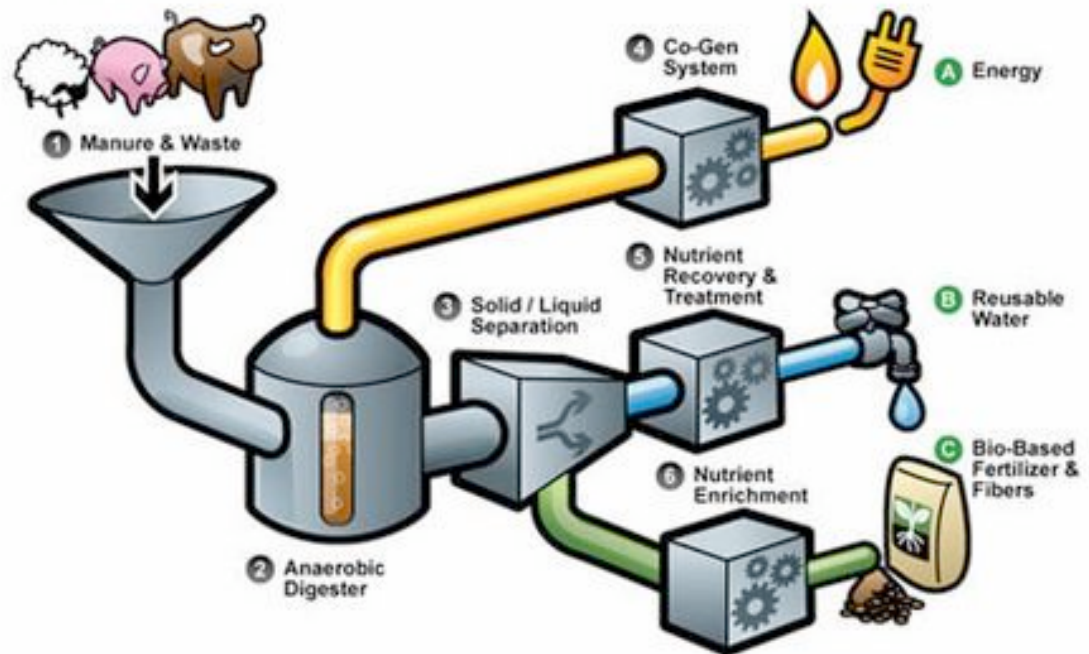


# Anaerobic Digestion Technology Features

## Growing Power Anaerobic Digestion (GPAD) Technology Package

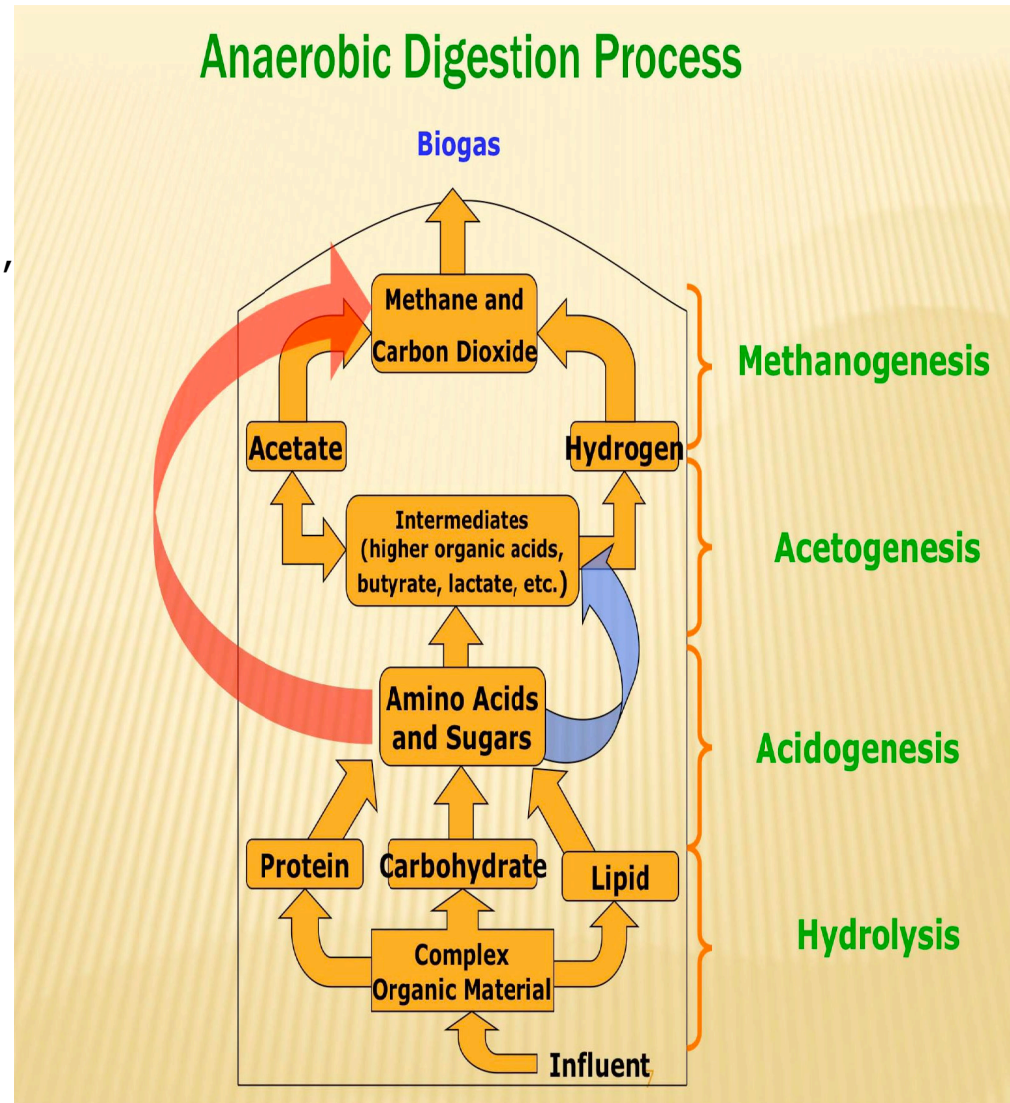
- Treats feedlot manure and other high-solids wastes
- Large scale; for feedlots, slaughter facilities and Integrated BioRefineries
- Produces renewable energy in the form of polished bioGas, which can generate heat and electricity
- Produces bio-based fertilizer
- Produces GHG emissions offsets
- Available, commercial technology, developed in Alberta, Canada, by Highmark Renewables Research for global implementation

### Overview



# Anaerobic Digestion Technology Features

- Waste material is broken down by the complex ecology within the anaerobic digesters
- In addition to the mechanical challenges, AD requires excellent biological management
  - Conditions for optimal growth of all organisms in the digesters
- Through the course of maximizing the growth on one ecology, all others are excluded, leaving a pathogen-free, weed-seed free, relatively odorless soil boosting product



# Anaerobic Digestion Recycling Soil Nutrients

## Bio-based fertilizer and soil amendment products

- Currently produce a solid product
- 3-2-2 (DM)
- Highly recalcitrant carbon (predominantly lignin residuals)
- Pathogen Free
- Weed Seed Free
- Good as mulch
- Good as soil amendment
- Excellent loose or densified



# Operating GPAD Plant at GPHH Site near Vegreville, Alberta, Canada

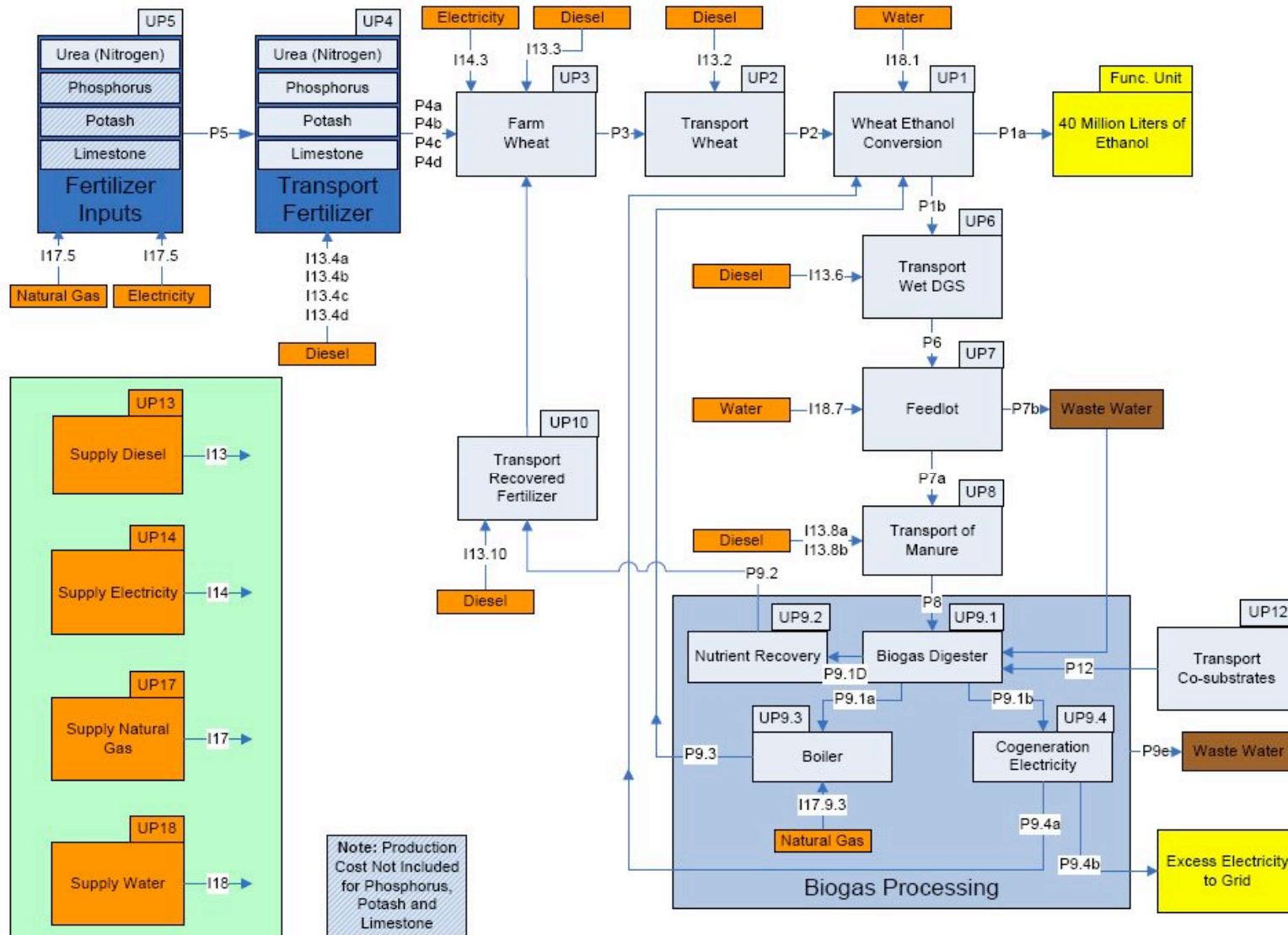
Commissioned in February 2005



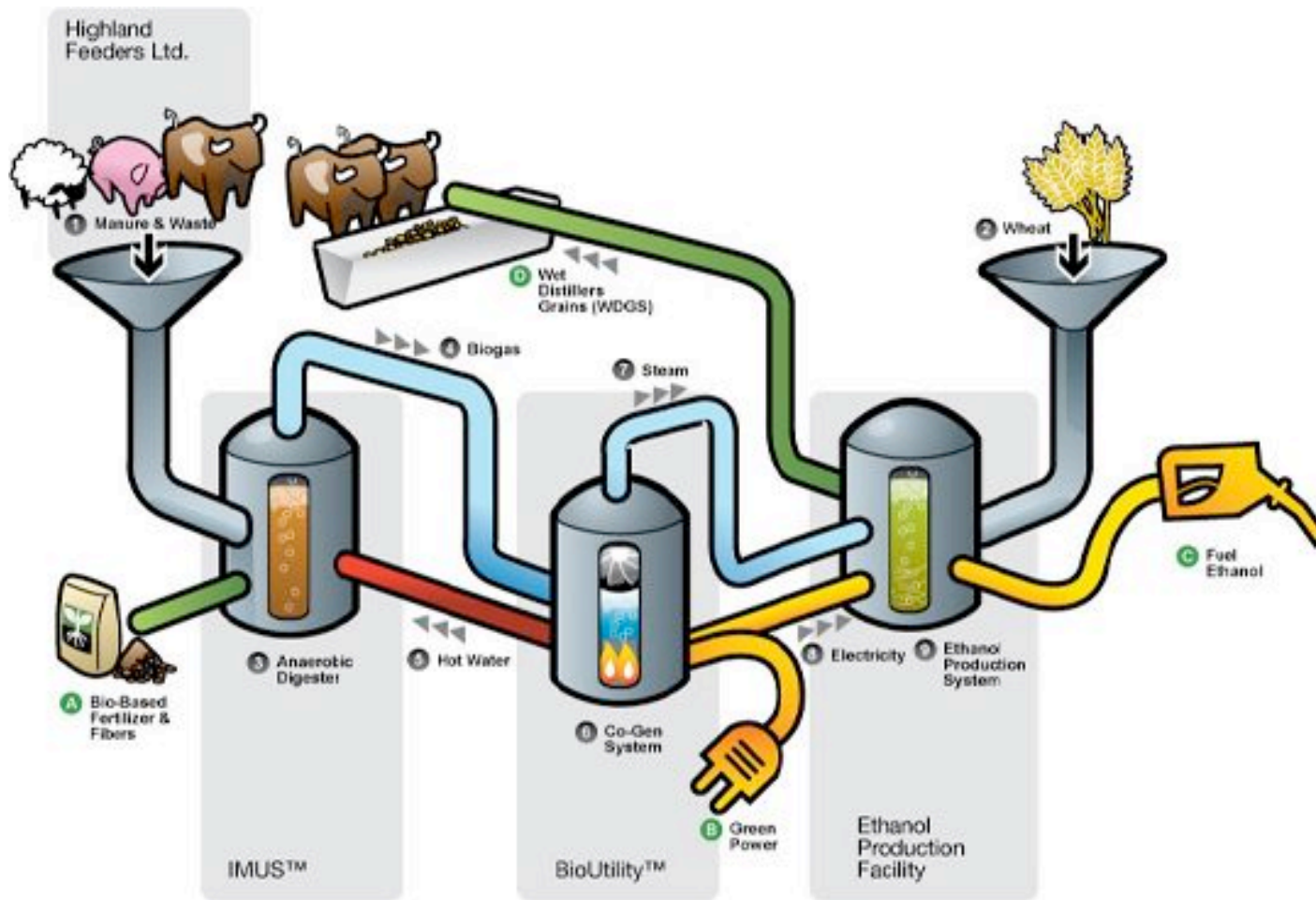
- Processes ~100 MT of high-solids feedlot manure and other waste daily
- Produces up to 1MW of continuous electrical output, biofertilizers, heat and reusable water.

# Increasing Efficiency

## Ethanol with Anaerobic Digestion and a nearby CAFO



# Increasing Efficiency Generation 1.9 Ethanol!



Integrated BioRefinery™ Overview

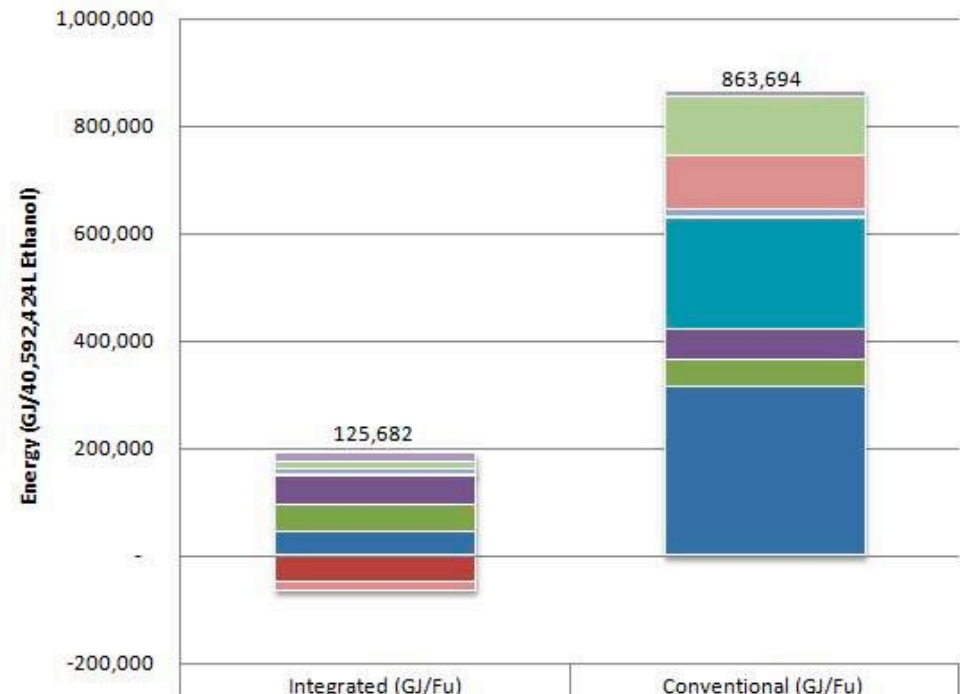
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# Increasing Efficiency

## Ethanol with Anaerobic Digestion and a nearby CAFO

### Energy Balance

- Conventional Ethanol (DDGs)
  - **1.1:1**
- Conventional (WDGs)
  - **1.45:1**
- Integrated Ethanol/AD/CAFO
  - **7.6:1**

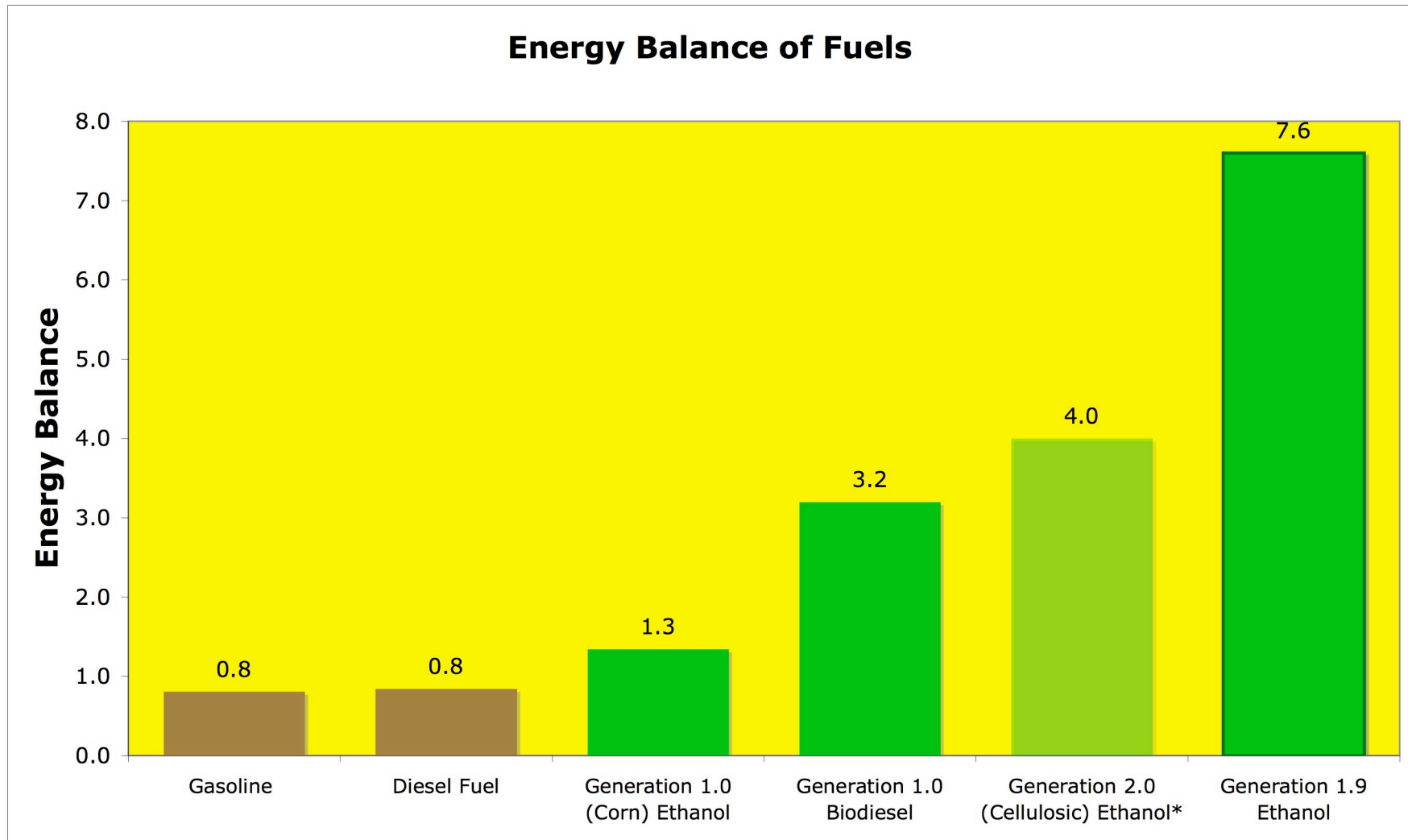


Each increment in energy efficiency can represent real savings in operating costs

	Integrated (GJ/Fu)	Conventional (GJ/Fu)
Other Transportation	15,005	7,499
Natural Gas Production	12,341	112,543
Electricity Production	-14,798	99,312
Diesel Production	12,677	11,833
Transport DGS	761	2,404
Drying DGS	-	209,243
Fertilizer Production	53,694	55,545
Wheat Farming	50,975	49,261
Biogas Processes	-49,887	-
Ethanol Production	44,914	316,054

# Increasing Efficiency

## Ethanol with Anaerobic Digestion and a nearby CAFO



# Increasing Efficiency

## Ethanol with Anaerobic Digestion and a nearby CAFO

	Volume	Price	Amount
Ethanol	40000000		
Denatured Ethanol	40800000	\$	0.63 \$ 25,704,000.00
AB Ethanol Incentive	40800000		0.14 \$ 5,712,000.00
Federal Program	40000000		0.04 \$ 1,600,000.00
WDGS	97778		45.34 \$ 4,433,333.33
Chemical CO <sub>2</sub>	29820		0 \$ -
Electricity Sales	3109800		0.08 \$ 248,784.00
GHG	131745.29		13 \$ 1,712,688.78
Tipping Fees	8875		20 \$ 177,500.00
BioFertilizer	30672		35 \$ 1,073,520.00
<i>Total Revenue</i>			\$ 40,661,826.11
Wheat	111111	\$	160.00 \$ 17,777,777.78
Electricity Use	19042200		0 \$ -
Heat	2760000		0 \$ -
Biogas Incentive	1		6.5 \$ (2,395,112.58)
Denaturant@2%	800000	\$	0.63 \$ 504,000.00
Enzymes	40000000		0.025 \$ 1,000,000.00
Labour	40000000		0.0268 \$ 1,071,000.00
Maintenance	40000000		0.046 \$ 1,821,600.00
Misc	40000000		0.02 \$ 800,000.00
OH			0.2 \$ 4,016,512.18
<i>Total Cost</i>			\$ 24,595,777.38
EBITDA			\$ 16,066,048.73
Depreciation	20	\$ 71,000,000.00	\$ 3,550,000.00
Interest	50%	5%	\$ 1,775,000.00
EBT			\$ 10,741,048.73
Taxes	34%		\$ 3,651,956.57
<b>NI</b>			<b>\$ 7,089,092.16</b>

**Advantage of \$0.09/L**

# Keys to Increased Energy Efficiency

## Balancing Risk-Reduction, Cost-Savings, and Capital-Costs

### Cost-Benefit Analysis

- Present value of savings less the increase in capital cost
- How much can be justified?
  - At 20% hurdle rate
  - Annual savings of \$3.2MM
  - **\$16MM**
  - \$21MM at 15% hurdle
- Value of reduced risk?
  - Difficult to quantify
  - Hedging costs reduced significantly
  - “Last plant standing”

### Keys to Success through Energy Efficiency Investment

- Balance the costs and benefits
- Reduce tangible risks
- Choose a technology suited to the location (and a location suited to the purpose)
- Remove large energy drains associated with risky products in design
- Right-size all processes
- Integrate, Integrate, Integrate

**Questions?**



## Increasing Efficiency Ethanol with a bioMass boiler

Ideal where feedstock for ethanol production comes with combustible waste product

- Largely removes Natural Gas exposure
- Still requires redundancy
  - Will equipment co-fire natural gas?
- Increases capital cost
- Adds supply risk
  - Especially if bioMass not linked with feedstock (straw)
  - Less risk in the case of sugar cane
  - Difficult to hedge the price of straw
- Increases freight costs for bringing in low-density bioMass
- Increases exposure to local crop failures
- Waste issues: what to do with the ash?
  - Ash is high in salts and phosphates, very limited use as a fertilizer



# Increasing Efficiency

## Ethanol with Anaerobic Digestion

AD converts non-woody organic matter to combustible biogas

- Removes Natural Gas exposure
- Still requires redundancy
  - No problem to co-fire with Natural Gas
- Increases capital cost
- Increases revenue opportunity
  - GHG credits
  - Bio-based fertilizers
  - Tipping fees
- Removes supply risk
  - If digesting stillage, trades potential revenue for reduced risks and costs
  - If digesting other material, may have some risks
- No waste issues
  - Effluent from AD is a stabilized, balanced fertilizer/soil amendment product

