

# Self-Generation

of Energy for Ethanol Production From  
Distiller's Grains Anaerobic Digestion

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# Drivers for DDGS to Energy

- Increasing price and volatility of natural gas
- DDGS production will increase to 30 million metric tons by 2010
- Aging electrical transmission system promoting distributed generation
- US EPA RFS rules promoting ethanol production from renewable energy
- Biogas Incentive Act of 2007

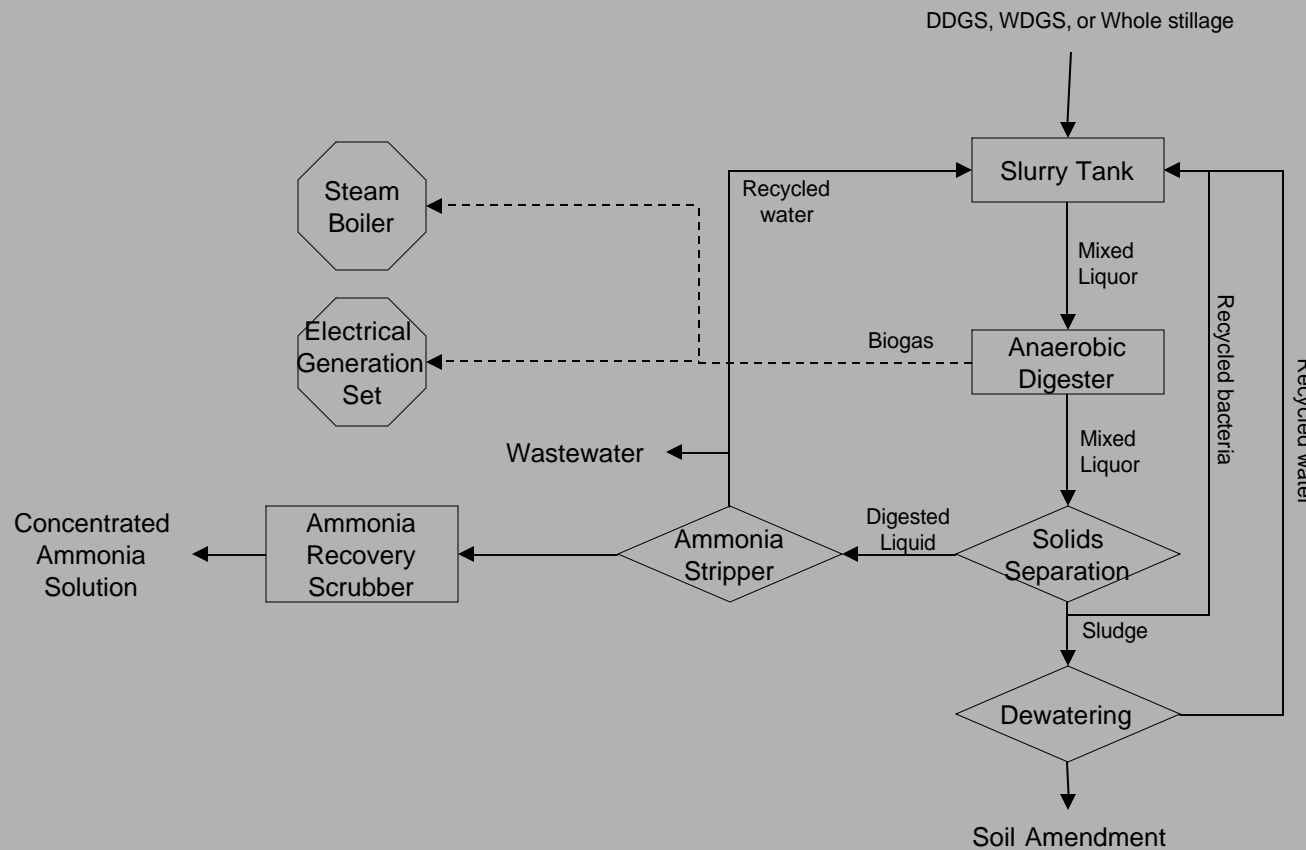
# Distiller's Grains

- **Moisture**
  - Whole stillage – 85%
  - Wet – 65%
  - Dry – 13%
- **Energy content**
  - **Direction combustion**
    - Dried – 14 mmBTU/ton
  - **Anaerobic digestion**
    - Whole stillage – 2.1 mmBTU/ton
    - Wet – 4.9 mmBTU/ton
    - Dried – 11.6 mmBTU/ton

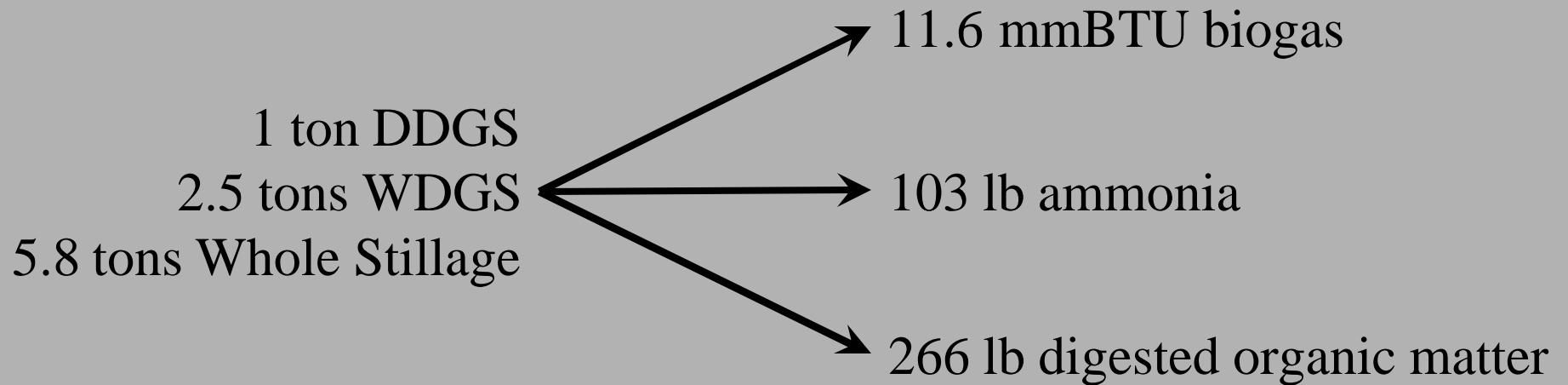
# Anaerobic Digestion of Distiller's Grains

- **Biological conversion of proteins, carbohydrates, and fats to biogas**
  - 70% methane
  - 30% carbon dioxide
- **Laboratory results show 11.6 mmBTU of biogas produced per ton of DDGS**
- **Bench scale reactor studies suggest solids retention times less than 10 days**

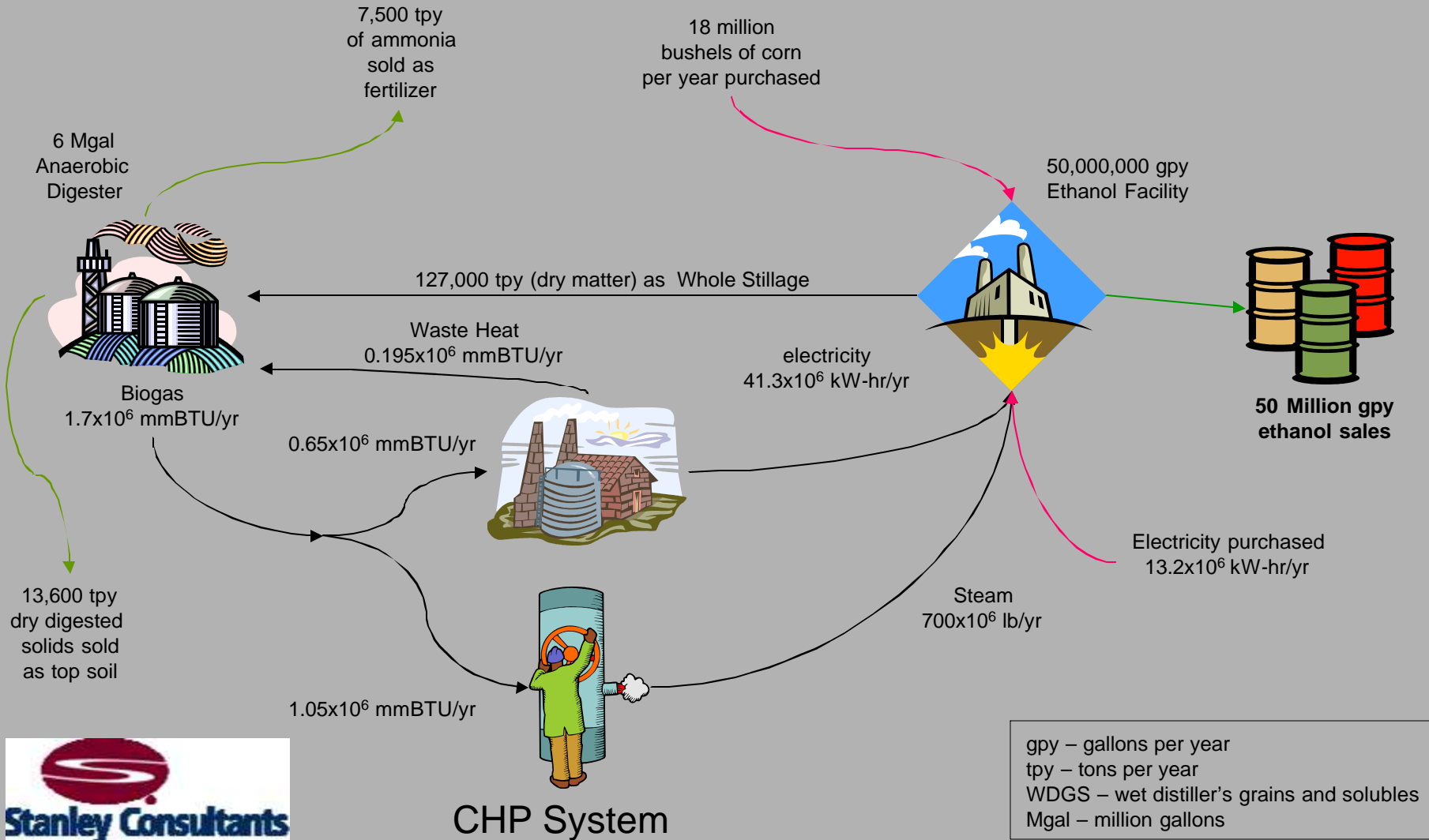
# Distiller's Grains to Energy Process



# Anaerobic Conversion of Distiller's Grains



# Ethanol Production with Energy Self-Generation



## Reasons to Consider Energy Self-Generation

- **Eliminate fossil fuel use**
- **Reduce energy purchase by 89%**
- **Increase the net energy value of ethanol from 5,880 BTU/gallon (Shapouri et. Al, 1995) to 55,000 BTU/gallon**
- **Reduce VOC emissions by 90%**
- **Obtain 'cellulosic' renewable identification number (RIN) for ethanol**



# Economic Evaluation

## Distiller's Grains Digestion

- **100 Mgal/year ethanol facility**
  - \$180 million capital cost
  - \$30 million O&M
    - Includes chemical and enzyme costs
- **Anaerobic digester system**
  - \$46 million capital cost
  - \$0.5 million O&M
- **50% debt at 9% interest rate**

# Economic Evaluation

## Distiller's Grains Digestion

			Energy Purchase	SECEF
Corn purchase	\$4.00	bu	(\$128,000,000)	(\$128,000,000)
Electricity Purchase	\$0.04	kW-hr	(\$4,352,000)	(\$528,000)
Natural Gas Purchase	\$8.00	mmBTU	(\$29,280,000)	\$0
Ethanol Sales	\$2.00	gallon	\$200,000,000	\$200,000,000
DDGS Sales	\$80.00	ton	\$23,360,000	\$0
Digested Solids Sales	\$15.00	ton	\$0	\$408,000
Ammonia Sales	\$300.00	ton	\$0	\$4,500,000
Net Revenue			\$65,388,000	\$76,380,000
10-yr IRR			26%	33%



# Economic Evaluation

## Distiller's Grains Digestion

- **What is the value of cellulosic RIN?**
  - Today's conditions
  - \$0.03 per gallon
    - Matches IRR
    - Generates \$67 million more in revenue
- **What is the value of the biogas tax credit?**
  - Today's conditions
  - \$1.00 per mmBTU
    - Matches IRR
    - Generates \$67 million more in revenue



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## Questions & Answers

