IDEA2015 | Inspiring the Next Generation
106th Annual Conference & Trade Show I Boston, MA I June 28 – July 1

Food Industry
Waste to Energy Case Study

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- ✓ Objectives
- ✓ Acknowledgements
- ✓ Existing Site Conditions
- ✓ Anaerobic Pretreatment
- ✓ Energy Recovery
- ✓ Project Execution
- ✓ Conclusions
- ✓ Questions

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CHP POWER GENERATION FUELED BY THE VERTICAL START-UP OF A 6.5MG ANAEROBIC REACTOR FOR INDUSTRIAL WASTEWATER PRETREAMENT IN THE FOOD SERVICE INDUSTRY

- ✓ Compliance with industrial pretreatment discharge limitations
- ✓ Elimination of off-site waste disposal
- ✓ Reduced energy & operating expenses for industrial pretreatment, energy generation, and heat recovery
- ✓ Use of design-build delivery method
- ✓ Securing of federal energy investment tax credit

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Acknowledgements

Presented by: Richard F. Rappa, PE, CEM ; J.S. Brown, PE

PROJECT TEAM

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* Kyle Schilling
* Brian Scott
* Ray Holland

* George Fertal
* Shawn Veltman, PhD, PE, BCEE
* J.S. Brown, PE

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Existing Site Conditions

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General Mills, Murfreesboro, TN

* Two operations on the same site
  - Pillsbury
  - Yoplait
* Historical Perspective
  - 605,000 gallons per day of process wastewater with a COD of approximately 3,400 mg/L pre-treated on-site with an activated sludge treatment system (aerobic) with large energy requirements for aeration
  - Off-site disposal of concentrated Ag waste and yogurt whey at considerable expense
  - Discharge to City of Murfreesboro or to golf course irrigation under an industrial discharge permit
  - Large energy consumer (>10 MW electric, >18 MMBTU/hr gas)

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Existing Waste Sources & Composition

- Pillsbury Wastewater
  - 80,000 gpd; COD =3,400 mg/L
- Yoplait Wastewater
  - 525,000 gpd; COD = 3,400 mg/L
- Ag waste
  - 24,000 gpd; COD = 57,500 mg/L
- Greek Yogurt Whey
  - 80,000 gpd; COD = 70,000 mg/L
- No sanitary waste admixture with process wastewater
- Pretreatment Limits
  - 250 mg/L COD; 250 mg/L TSS; 20 mg/L Ammonia

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Anaerobic Pretreatment

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Anaerobic Pretreatment

* 1 MG equalization/re-acidification tank
* 6.5 MG complete mix digester with an anaerobic DAF to separate the SRT and HRT (6-day HRT; 30-day SRT)
* No supplemental heating
* Waste gas flare for expected biogas generation of up to 700 scfm
* Designed to treat the full wastewater flow
* Related chemical feed systems for pH control, foam suppression, sludge conditioning and odor control
* Aerobic reactor reconfigured for polishing

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Pretreatment Results

- Lowered overall sludge production
- Average Effluent Quality
  - COD: 211 mg/L (250 mg/L)
  - TSS: 153 mg/L (250 mg/L)
  - Ammonia: 122 mg/L (20 mg/L)
- Gas Quantity & Quality
  - Average Flowrate: 450 scfm
  - Moisture Content: Saturated
  - CH_4 Content: 60-65%
  - H_2S: 400 ppmv (controlled by iron addition)
  - Total Siloxanes: <70 ppbv (very low)

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Energy Recovery

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Energy Recovery Evaluation

* Based upon proof of gas asset
* Alternatives considered
  - Direct Boiler Firing
  - Ice making
  - Electric generation using internal combustion engines with and without heat recovery
  - Grid sale of electric and net metering
* Alternatives evaluated using economic model to determine IRR
* A sensitivity analysis was performed to evaluate the impact of sensitive factors (electric rates, gas costs, ITC, heat recovery, on-line availability) on IRR

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Energy Recovery Plan

* Gas compression & drying at the digester site
* Gas transmission line: ± 3,200 ft.
* A single containerized engine-generator with provisions for an additional unit; Options Included:
  - 1.6 MW electrical production with potential grid sale to TVA under renewables standard offer that includes sale of RECs

    OR
  - 1.6 MW electrical production to off-set current site usage (Net Metering) and maintain the sale of RECs for GMI use at a later date

    AND
  - Engine jacket, oil cooler, and exhaust gas heat recovery (5.5 MMBTU/hr) via an FDA approved plate & frame heat exchanger (transfer from engine cooling circuit to Yoplait HTHW (high temperature hot water system)
* Excess biogas to flare or direct firing in a boiler for heat

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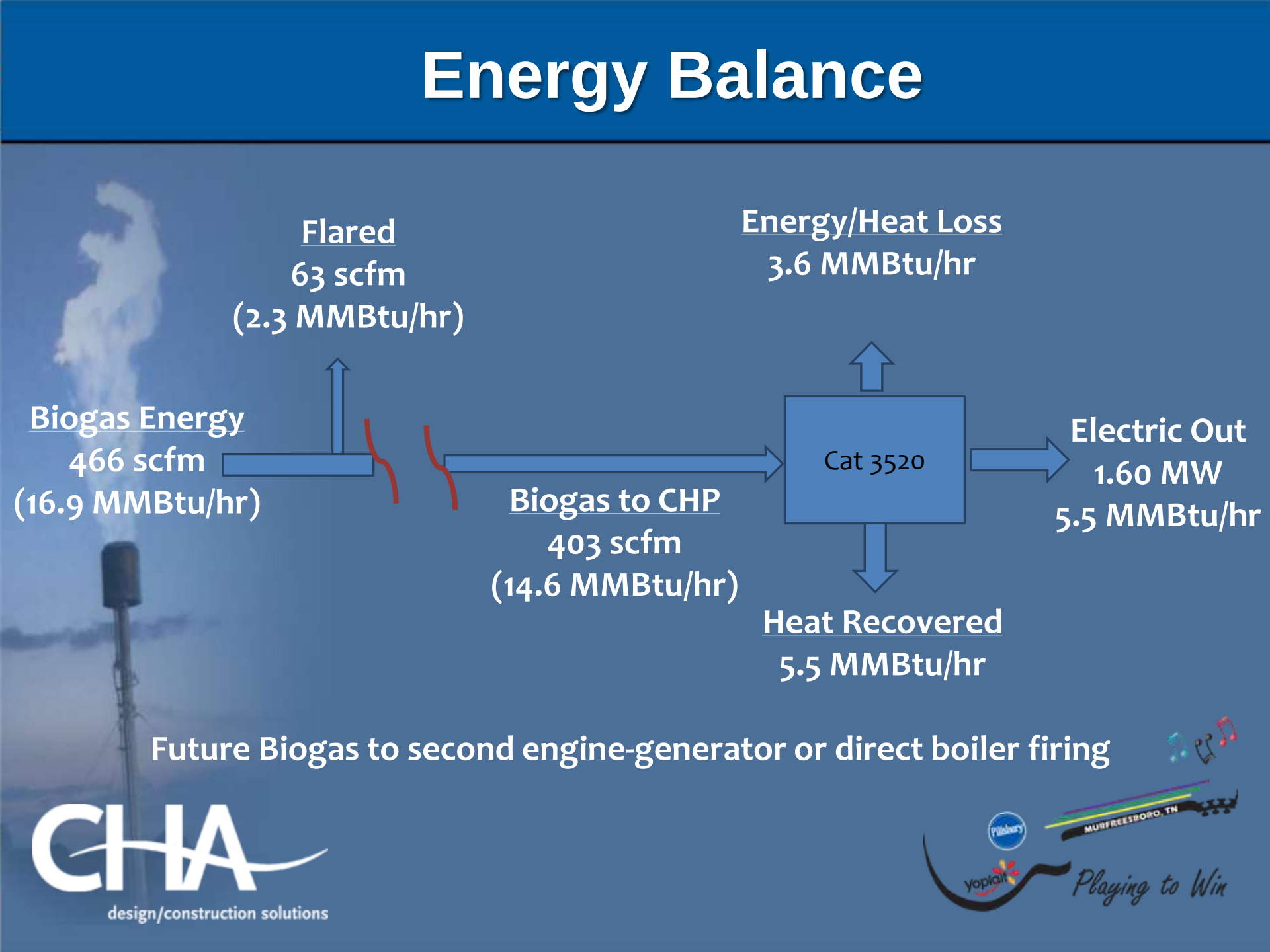
Energy Balance



Future Biogas to second engine-generator or direct boiler firing

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Project Execution

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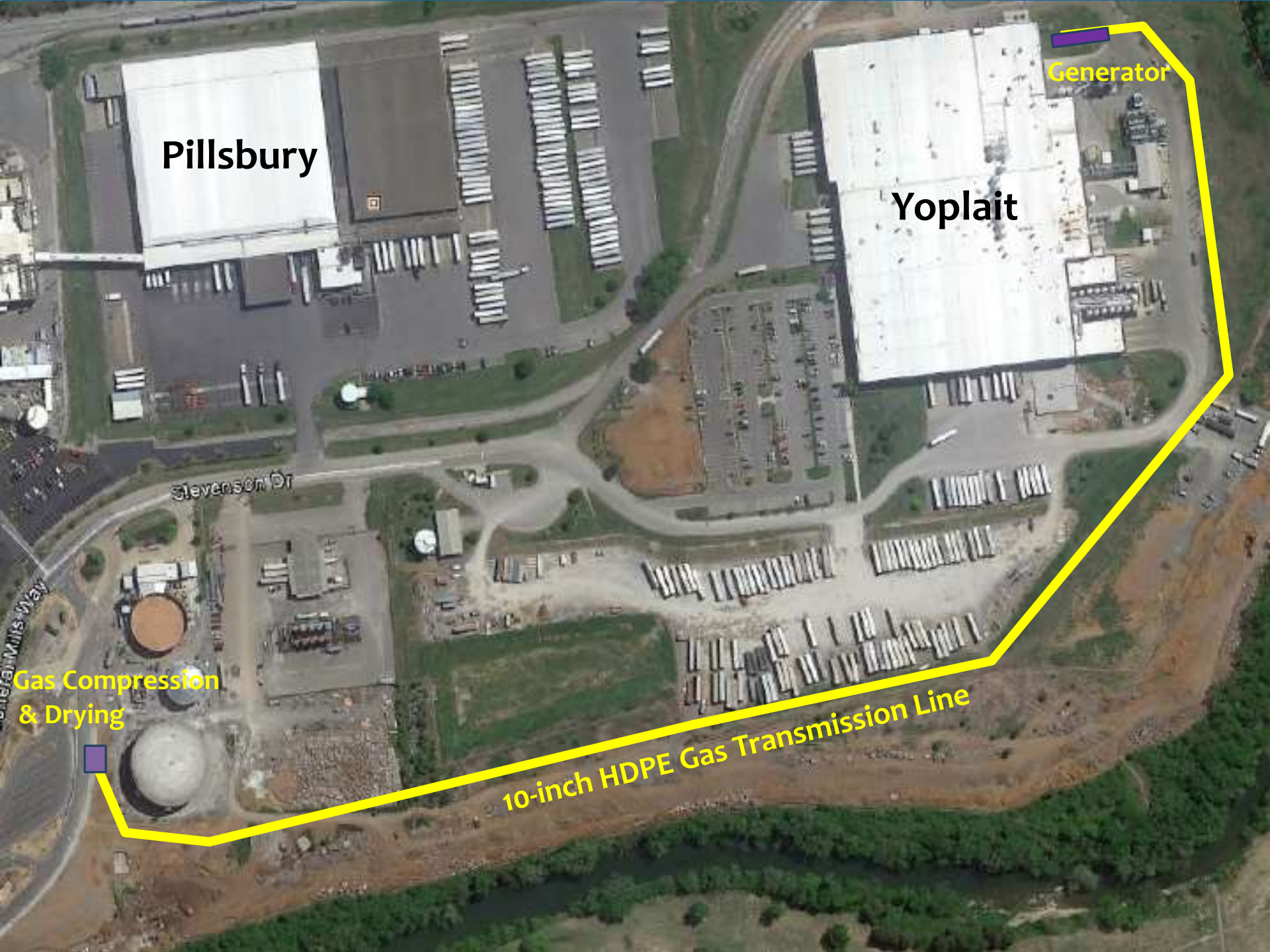
Pillsbury
Yoplait
Generator
Stevenson Dr
Gas Compression
& Drying
10-inch HDPE Gas Transmission Line

Gas Compression & Cleanup

General Equipment Arrangement:

- 2 – 50 HP 700 SCFM Centrifugal Blowers
- 1 – Biogas Demister / Particle Filter
- 1 – 700 SCFM Dual Core Heat Exchanger
- 1 – 2 HP 700 SCFM After Cooler
- 1 – 20T Air Cooled Glycol Chiller
- 1 – Gas Analyzer

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Engine Generator

General Equipment Arrangement:

- 1.6 MW CAT 3520 Containerized Engine-Generator
- 5.5 MMBTU/Hr (519GPM) Heat Recovery Loop

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HTHW Heat Recovery

Equipment Arrangement:

- 5.5 MMBTU/Hr Heat Recovery Loop
  - 1 – FDA compliant Plate & Frame HEX
  - 2 – 20 HP Circulating Pumps

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Pillsbury yoplait MURFREESBORO, TN Playing to Win

Current Status

- Corporate approval of $7.7 million digester and $5.4 million energy recovery facilities secured late 2014.
  - 30% ITC of approximately $4 million - a major factor in the economic evaluation
- Permitting (with TVA through Murfreesboro Electric Cooperative & Tennessee DEC) completed
- Design-Build Delivery Approach Selected
  - 100% design completed January 2015
  - Construction 95% complete with first power exported on 5/27/2015 (Placed in Service; 27 weeks from NTP)
  - System Training completed
  - Completing punch list items
  - Full power production July 2015

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Conclusions

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Conclusions

- ✓ Greater than 10% of power produced by Waste to Energy CHP plant
- ✓ Reduction of more than 10% of natural gas usage through heat recovery
- ✓ Reduction in 95,000 liters of diesel fuel annually
- ✓ 35 million gallons of water returned to watershed
- ✓ 2000 acres of farmland returned to normal ag use
- ✓ Reduction of 10,000 tons of CO_2 emissions
- ✓ In compliance with all regulatory standards
- ✓ Federal ITC approved
- ✓ 23.4% IRR; 4 year payback

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Questions

Contacts

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