Waste to Energy Opportunities in Wastewater Treatment Facilities utilizing Anaerobic Digester and CHP Concepts and Technologies

Webinar broadcast Tuesday, September 22, 2009

Combined Heat and Power (CHP) At Wastewater Treatment Facilities Case Studies

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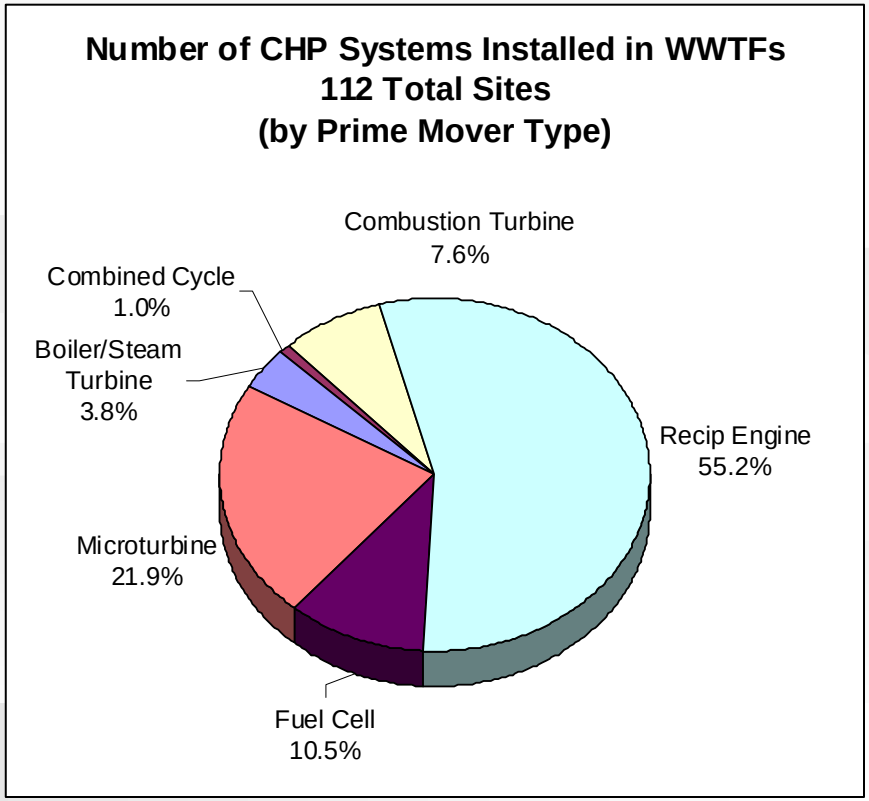
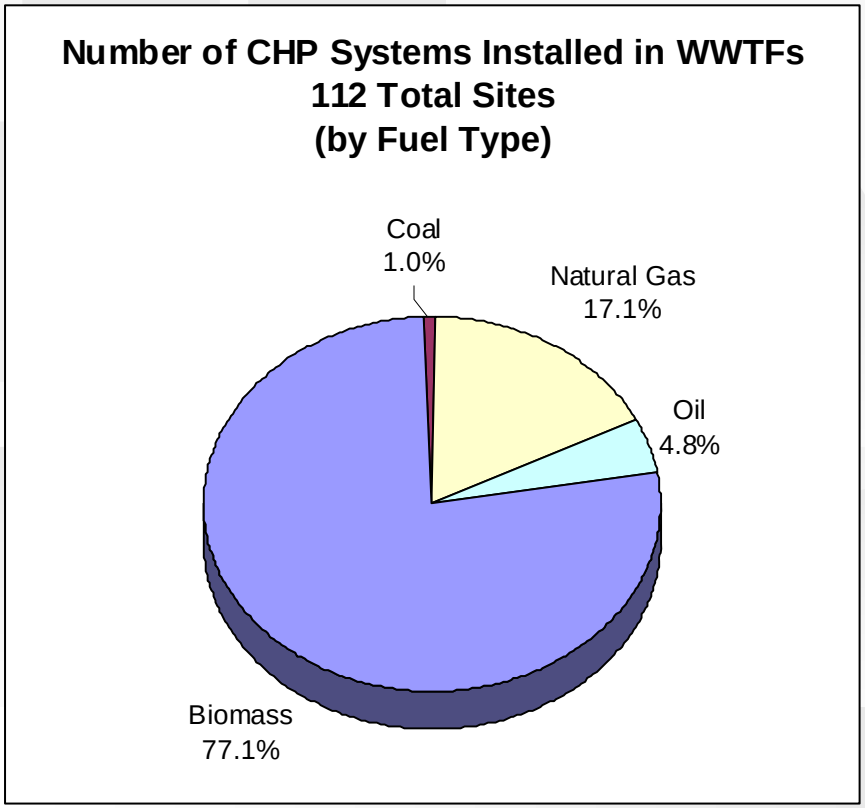
What Exists Today

- Wastewater Treatment Plants with CHP
  - 112 sites totaling Approximately 488 MW





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Topics Covered

- Two Case Studies:
  - City of Rochester, Minnesota Wastewater Reclamation Plant …..Chet Welle, Assistant Plant Manager
  - Cities of Gloversville & Johnstown Joint Wastewater Treatment Facility …. George Bevington, Plant Manager

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Rochester Wastewater Reclamation Plant

- Serves City of Rochester, Minnesota – Population of Approx. 100,000 People
- Residential, Commercial and some Industrial Customers
- Plant Capacity – Process Up to 24 MGD
- Solids Handling System Utilizes Anaerobic Digestion

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Biosolids Handling

- The Plant's Biological Treatment Process Produces Waste Activated Sludge (WAS)
- WAS is Thickened, Blended With the Primary Sludge and Introduced to the Anaerobic Digester System
- Produced Biogas is Approx. 66% Methane Gas
- Solids Removed from the Digesters (Biosolids) are Thickened, Stored, and then Trucked to Farm Lands (Applied as Fertilizer).
- Biosolids are High in Nitrogen and Phosphorous (low in odor and pathogens)

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Biogas Production and Use

- Two Continuous Complete Mix Digesters
  - Total Capacity 3.7 million gallons
  - 90ft Diameter Digesters with 10 Gas Cannons
  - Mesophilic (98°F) Digesters
  - Detention Time Approx 34 Days
  - Avg. Biogas Production 2007 – 338,000 cuft/day

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Combined Heat and Power System

- Two, 1,000 kW Engine Generator Sets with Full Heat Recovery
- Waukesha Lean Burn, Turbo Charged, Dual Fueled Engines, 20% More Effic. Than Original Engines
- 338,000 cuft/day Biogas (2007) Generates Approx. 700 kW to 850 kW Electric Power.
- All Electricity Generated is Utilized On-Site - Baseload

Waukesha Engine Generator Set

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Combined Heat and Power System

- Recovered Heat From Both the Engine Jacket Water and Exhaust
- 180ºF to 190ºF Hot Water Utilized Injected Into the Plant's Main Hot Water Loop and Digester Heating Loop
- Each Engine can Produce up to 4.46 MMBtu/hr
- Back up Dual Fueled Boilers also Available

Exhaust Heat Recovery Boiler

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Operating Strategy
(Largest Financial Returns)

- Due To Extremely Cold Minnesota Winters:
  - Utilize Biogas First in Existing Boilers and then in CHP System
  - Remaining Months, Operate CHP System at 700 kW to 850 kW with Full Heat Recovery
- 2007 Operation:
  - Produced About 2 million kWh of Electricity (11% of Electric Load)
  - Saved Approx. $564,000

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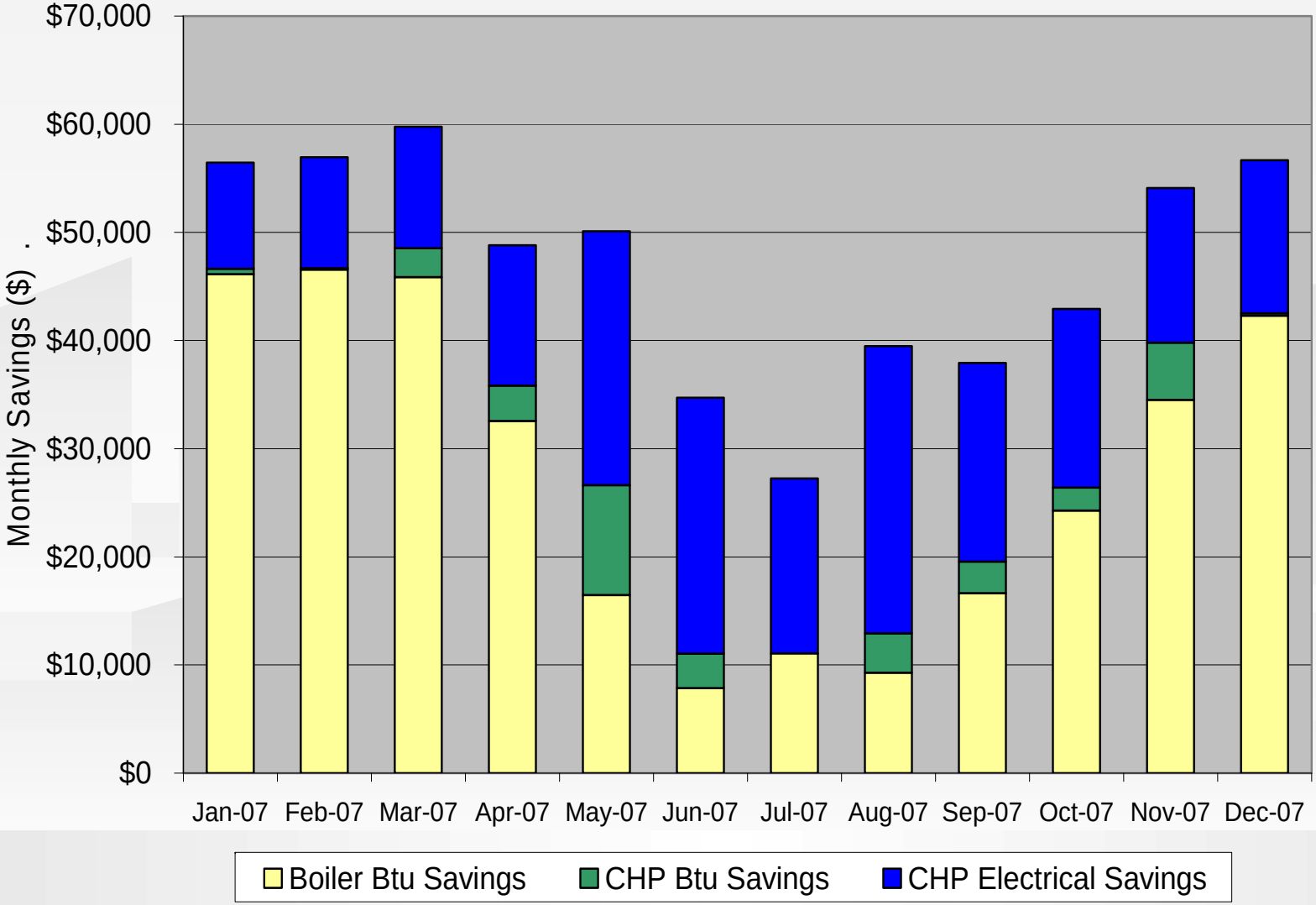
2007 Annual Savings ($564,000)



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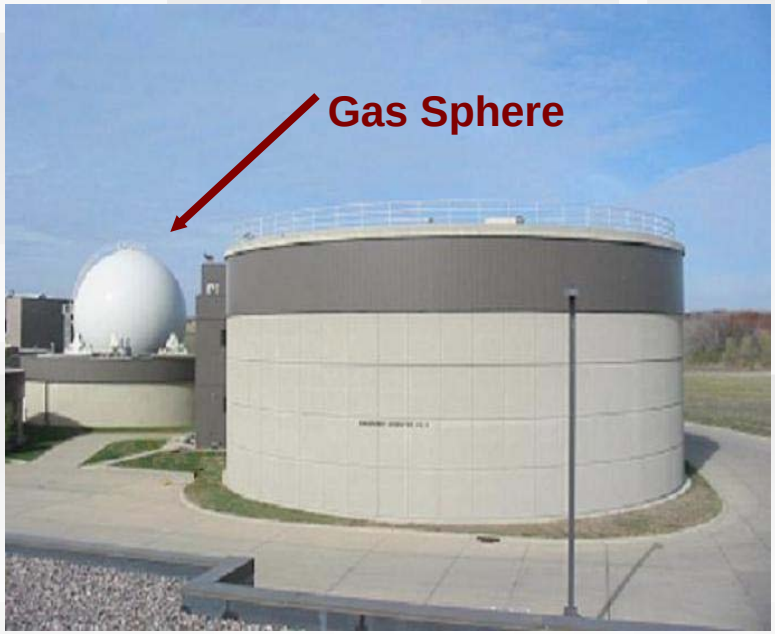
Digester Biogas Storage

- 50 ft-Diameter Gas Storage Sphere Stores Up To 208,000 cuft of Compressed (46 psig) Biogas
- Provides the Capability to Operate the Full 2 MW of Electric Power During Utility Outages and/or Utility On-Peak Periods



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Project Finances

- Purpose of the CHP Investment was to Provide Adequate Emergency Power for the Plant
- CHP System Provided the Added Benefit of Producing Base Load Electric Power and Recovered Heat
- Total Cost --- Approx. $4 million
- Projected Payback on the first 1,000 kW Engine Generator Set is 6 Years (with their cold climate operating strategy)
- No Direct Payback Expected on the Second 1,000 kW Unit Since It was Installed for Emergency Power.

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Plant Manager Quote

"We are very pleased with the operation of the CHP system. It allows the city to utilize the renewable biogas produced at the plant for energy cost savings while also providing a source of emergency power. The system is also environmentally friendly because it eliminates flaring of the digester gas to the atmosphere."

Chet Welle

Assistant Plant Manager

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Gloversville-Johnstown Wastewater Treatment Plant

- Serves Residential Load of 13.8 MGD Sanitary Sewage
- Also Treats a Large, Variable Industrial Load (Food Processing, Leather Tanning, Metal Finishing, Textile)
- Total Daily Peak Capacity Approx 30 MGD

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Plant Improvements 1999 - 2006

- Large Effort Took Place to Reduce Energy Costs:
  - Aeration System was Consuming Two-Thirds of Electricity Use. Beginning in 2002, a Number of Upgrades Reduced the Annual Energy Consumption by 30%
  - Anaerobic Digester System Upgraded, Increasing Biogas Production:
    - Installed 50,000 cuft Storage Sphere
    - Installed Advanced Gas Mixers
    - Installed 90,000 gallon equalization tank for high-strength wastes
  - Two 150 kW engine-generators (more than doubled electricity generating capacity)

Dual-Membrane Gasholder

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Results of Initial Improvements

- Cost ($3.5 million):
  - Aeration System Upgrades
  - Digester Process Improvements
  - Rebuild Engine generator Sets
- Annual Savings ($468,000)
  - Reduced electric usage by 50%
- Simple Payback: 7.5 Years

Rebuilt 150 kW Engine Gen Sets

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Cities' Energy Independence Strategy (2006)

Utilize CHP Technologies Integrated with Advanced Activated Sludge Systems to Achieve Energy Independence in the Facility by 2010

- Three Pronged Approach:
  - Pre-Treat the Food Manufacturers' Wastewater Before Sent to the Aerators. Allows handling Fats, Oils, and Greases (FOG)
  - Build on Previous Efforts to Increase Digester Efficiency and Biogas Output From Higher Strength Substrates
  - Replace Engines with Two 350 kW Units with Full Heat Recovery

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Energy Independence Finances

- Planned Investments (2009 – 2010)
  - Cost (Approx. $7.0 million)
    - US Economic Development Administration Grant - $2.2 Million
    - NYSERDA Grant - $1.4 Million
    - Cities Have Requested Stimulus (ARRA) Funding
    - Cities Arranged for a $7.0 Million Loan if Needed

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Plant Manager Quote

"If you can take wastewater nobody wants, effectively treat it, discharge it in a non-polluting way – and do it with no increase in purchased electricity – that's a pretty neat goal."

George Bevington

Plant Manager

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Additional Case Studies and Other Pertinent Information

- Visit:

www.chpcentermw.org

Click: Applications and Markets

Scroll: Anaerobic Digesters

Scroll: Where do A/D – CHP Projects Make Sense

Click: WWT Plants

Click: Case Studies

- Case Studies:

Albert Lea – MN – Microturbines

Chiquita – CA – Microturbines

Essex Junction – VT – Microturbines

Gresham – OR – Engines

Ina Road – AZ – Engines

Janesville – WI – Engines

Nashua – NH – Engines

Palmdale – CA – Fuel Cell

Columbia Boulevard – OR – Fuel Cell / Engines / Microturbines

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Lessons Learned

- CHP alone is not the answer to all your energy issues. Develop a comprehensive plan that combines other energy saving measures with CHP
- CHP technologies and systems are proven and reliable but complex. They require due diligence from design through operation:
  - Proper Sizing
  - Proper Control Strategies
  - Proper Training
  - Understanding Gas Quality
- Early coordination with local electric utilities (interconnection)
- Look for Funding Opportunities (federal, state, local)

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