Side Stream Treatment and Advanced Stabilization Technologies
## Overall Program Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Program Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:30 – 10:20</td>
<td>Biosolids Management / Regulatory Framework</td>
</tr>
<tr>
<td>10:20 – 10:30</td>
<td>Break</td>
</tr>
<tr>
<td>10:30 – 12:00</td>
<td>Biosolids Treatment Technologies</td>
</tr>
<tr>
<td>12:00 – 13:00</td>
<td>Lunch</td>
</tr>
<tr>
<td>13:00 – 13:30</td>
<td>Sidestream Treatment and Advanced Stabilization</td>
</tr>
<tr>
<td>13:30 – 14:30</td>
<td>Energy Management</td>
</tr>
<tr>
<td>14:30</td>
<td>Workshop Closure</td>
</tr>
</tbody>
</table>
SIDESTREAM TREATMENT
NITROGEN REMOVAL
Conventional nitrogen removal pathway is energy and carbon “intensive”

- **Nitratation**: NO$_3$-N → 25% O$_2$
- **Nitritation**: NO$_2$-N → 75% O$_2$
- **Denitratation**: NO$_3$-N → 40% BOD/COD
- **Denitritation**: NO$_2$-N → 60% BOD/COD
- **N$\text{H}_3$-N**: NH$_3$-N
- **N$_2$-gas**: N$_2$-gas
There are more energy and carbon efficient pathways for nitrogen removal.

- Shortcuts traditional nitrification and denitrification
- Stopping at nitrite rather than nitrate.
- Uses 25% less oxygen (theoretical)
- Uses 40% less carbon (theoretical)
Nitritation and Deammonification is an even more efficient N removal pathway.

• The most energy-efficient and low cost way to remove nitrogen
• Uses 62.5% less oxygen
• Does not require any supplemental carbon
• Utilizes annamox bacteria
SIDESTREAM TREATMENT
PHOSPHORUS REMOVAL
Uncontrolled Struvite formation after anaerobic digestion can be a problem.
OSTARA offers a “controlled” struvite recovery reactor system.
Multiform Harvest offers a competing controlled struvite recovery reactor.
OSTARA struvite recovery reactor system at the Nansemond WWTP.
OSTARA struvite recovery reactor system at the Nansemond WWTP.
Product quality can vary depending on the struvite recovery system installed.

OSTARA CrystalGreen Product

Multiform Harvest Product
Active learning exercise…

The two major constituents of concern in side stream from dewatering anaerobically digested sludge are:

1. __________________
2. __________________

What are the five chemical elements found in struvite:

1. ___________________
2. ___________________
3. ___________________
4. ___________________
5. ___________________
POST-DEWATERING TREATMENT TECHNOLOGIES
Composting can be utilized to achieve 40 CFR 503 “Class A” standards.

- Space intensive
- High odor potential
- Labor and equipment intensive for material handling
- Seasonal product demand
- Unique marketing and distribution challenges
Basic process configuration for composting unit treatment process.

Image: Inland Empire Regional Composting Authority
(http://www.ierca.org/process/compostprocess.html)
Alkaline stabilization can meet both “Class A” or “Class B” standards

- Calcium Oxide (Lime) is blended with dewatered cake
- Elevated pH can result in high ammonia odors release
- “Class A” achieved by:
  - pH + Temperature
  - Time + Temperature
- Finish Product used as Soil Conditioner
Fluid bed thermal oxidation is the current “standard” in incineration.
Thermal drying systems are “rated” by evaporation rate capacity
Rotary drum thermal drying is the most prominent technology for “large” systems.

Source: Andritz-Ruthner
South Cary WRF thermal drying facility
8,800 lb/hour evaporation rate capacity.
Compact rotary drum drying systems are available for “smaller” size systems.
Belt drying systems are a more recent addition to the sludge drying market.

Source: Andritz-Ruthner
Belt dryer installation in Biel, Switzerland with an evaporation rate 2,900 lb/hour.
Paddle dryers are the most common of the “indirect” dryer systems.

Source: Komline-Sanderson
Paddle drying system in Mason, OH with 6,500 lb/hour evaporation rate capacity.
Fluid bed dryers are not common in the North American market.

Source: Andritz-Ruthner
Fluid bed dryer in Houthalen, Belgium with evaporative capacity 8,000 lb/hour.
Biosolids gasification is an emerging technology for energy recovery.
Solar sludge drying beds can be covered to reduce seasonal impacts

Source: Veolia Water / Kruger
Automation can be applied to increase solids loading rates to reduce footprint.
Active learning exercise…

What are three major types of processes used for producing a Class A biosolids after dewatering:

1. ________________________
2. ________________________
3. ________________________
Active learning exercise…

What is the primary criteria used for sizing an thermal drying system?
What are the five major types of thermal drying systems on the market:

1. _________________
2. _________________
3. _________________
4. _________________
5. _________________
The big picture take away items...

• The “on-site” residuals stabilization and handling requirements are largely governed by the needs of the “off-site” residuals management program.

• Thickening, stabilization, dewatering, and post-dewatering treatment must work together as a system to effectively achieve residuals processing objectives.
Reference Materials

National Manual of Good Practice for Biosolids

Last Updated January 2005
View the Document Control Log for a Summary of Revisions
Reference Materials

Operation of Municipal Wastewater Treatment Plants

Volume I: Management and Support Systems
SIXTH EDITION

Water Environment Federation (WEF)

MANUAL OF PRACTICE No. 11

Design of Municipal Wastewater Treatment Plants

FIFTH EDITION

Volume 1: Planning and Configuration of Wastewater Treatment Plants

Water Environment Federation (WEF)
American Society of Civil Engineers (ASCE)
Environmental & Water Resources Institute (EWRI)

WEF MANUAL OF PRACTICE No. 8
ASCE MANUALS AND REPORTS ON ENGINEERING PRACTICE No. 76
Reference Materials

RECOMMENDED STANDARDS for WASTEWATER FACILITIES

POLICIES FOR THE DESIGN, REVIEW, AND APPROVAL OF PLANS AND SPECIFICATIONS FOR WASTEWATER COLLECTION AND TREATMENT FACILITIES

1997 EDITION
A REPORT OF THE WASTEWATER COMMITTEE OF THE GREAT LAKES – UPPER MISSISSIPPI RIVER BOARD OF STATE AND PROVINCIAL PUBLIC HEALTH AND ENVIRONMENTAL MANAGERS

MEMBER STATES AND PROVINCE
ILLINOIS                  NEW YORK
INDIANA                  OHIO
IOWA                     ONTARIO
MICHIGAN                 PENNSYLVANIA
MINNESOTA                WISCONSIN
MISSOURI

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Questions?

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Biosolids and Residuals Processing & Energy Management Workshop

December 12, 2013

Energy Management
Agenda

- Electric Utilities Overview
- Electric Billing
- Demand Management
- Resource Recovery
- Power Monitoring
- Typical Energy Efficiency Opportunities
Energy management is more than energy efficiency
Energy Management has potential savings of 10-40%
Energy Management is a Continuous Process

Energy Auditing

Education & Training

Implement

Monitor & Verify

Energy Management Program
Managing energy begins with an energy management program

- **Energy Modeling and Benchmarking**
- **Power Monitoring and Plant Control Capabilities**
- **Understand Utility Billing Rates and Configuration**
  - Understand Current and Future Energy Costs

- **Demand Management**
- **Process Optimization**
- **Lighting**
- **HVAC/Building Improvements**
- **Alternative Energy Utilization**
  - Energy Efficient Equipment
- **Process Upgrades**
- **Energy Efficient Equipment**

**Energy management program**

- **Moderate to Low Benefit Potential**
  - Low Capital Costs
- **High Benefit Potential**
  - Moderate to High Capital Costs
- **High Benefit Potential**
  - Low Capital Costs

**High Benefit Potential**

**Moderate to Low Benefit Potential**

**Low Capital Costs**
Electrical Utilities
Utility Distribution Systems

Electric Utility

Utility Grid

Electric Cooperative

Electric Utility Customers
Electrical Utility Billing

“How” you are charged for energy is just as important as “how much” energy you use.
### Utility Bill Example

<table>
<thead>
<tr>
<th>Rate Name</th>
<th>Service Period From</th>
<th>To</th>
<th>Meter Number</th>
<th>Reading Type</th>
<th>Meter Reading Previous</th>
<th>Present</th>
<th>Meter Constant</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPL</td>
<td>07/22/10</td>
<td>08/23/10</td>
<td>WF0036</td>
<td>Tot kWh</td>
<td></td>
<td></td>
<td>1</td>
<td>1,188,875.52</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pk kVA</td>
<td></td>
<td></td>
<td>1</td>
<td>1,860.9889</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Power Factor</td>
<td></td>
<td></td>
<td>1</td>
<td>0.9587</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Co Pk kW</td>
<td></td>
<td></td>
<td>1</td>
<td>1,784.16</td>
</tr>
</tbody>
</table>

### EXPLANATION OF CHARGES

- **LPL - Light and Power Large**
- **Contract Term Discount**
- **Contract Term Discount .04**
- **Contract Demand**
- **Standby Generation**
- **Contract Generator kW: 2700**
- **Parallel Gear Amt $ -500.00**
- **Customer Charge**
- **Demand 2025 KVA * 4.750000**
- **Energy Charge 506250 KWH * 0.036391**
- **Energy Charge 682626 KWH * 0.023891**
- **Discount**
- **SG Customer Charge**
- **Parallel Gear**
- **SG - Capacity Credit**
- **Fuel Charge 1188876 KWH * 0.025100**
- **Natural Disaster Reserve**
- **Tax Adjustment**
- **Utility License Tax**
- **EnergyDirect.com Premium**

### BILLING INFORMATION

- **Tot kWh**
- **Pk kVA**
- **Ratch kVA Cont**
- **Power Factor**
- **Bill Demand**
- **Generation Dem**

### HISTORICAL DATA

<table>
<thead>
<tr>
<th></th>
<th>Days</th>
<th>KWH</th>
<th>KWH/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>This Mth</td>
<td>32</td>
<td>1188876</td>
<td>37152</td>
</tr>
<tr>
<td>Last Mth</td>
<td>30</td>
<td>1114437</td>
<td>37148</td>
</tr>
<tr>
<td>1 Yr Ago</td>
<td>32</td>
<td>1327212</td>
<td>41475</td>
</tr>
</tbody>
</table>
Electrical utility bills are typically comprised of several “charges”.

- **Energy Usage Charge (kWh)**
  - Energy consumed during the billing period.
  - Typically “Flat Rate” or “Time of Use”.

- **Demand Charge (kW)**
  - Typically 15-30 minute peak power demand during a billing period

- **Fixed Charges**
  - Independent of demand or usage.
  - Facility charges
  - Minimum demand/energy charges
The demand profile establishes both “demand” and “energy usage”.

![30 Day Plant Demand Profile](image)

**Peak Demand (15-30 Min Average)**

**Average Demand**

**Area = Energy Usage (kWH)**
Demand ratchets can significantly impact electrical utility cost.
Demand ratchets can significantly impact electrical utility cost.

<table>
<thead>
<tr>
<th>RATE NAME</th>
<th>SERVICE PERIOD FROM</th>
<th>TO</th>
<th>METER NUMBER</th>
<th>READING TYPE</th>
<th>METER READING PREVIOUS</th>
<th>PRESENT</th>
<th>METER CONSTANT</th>
<th>USAGE</th>
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<td></td>
</tr>
</tbody>
</table>

**EXPLANATION OF CHARGES**

LPL - Light and Power Large 07/22-08/23

- Contract Term Discount
- Contract Term Discount .04
- Contract Demand
- Contract Demand: 2700
- Standby Generation
- Contract Generator kW: 2700
- Parallel Gear Amt $ -500.00
- Customer Charge 50.00
- Demand 2025 KVA * 4.750000 9618.75
- Energy Charge 506250 KWH * 0.036391 18422.94
- Energy Charge 682626 KWH * 0.023891 16308.62
- Discount -1776.01
- SG Customer Charge 620.00
- Parallel Gear -500.00
- SG - Capacity Credit -6237.00
- Fuel Charge 1188876 KWH * 0.025100 29840.79
- Natural Disaster Reserve 0.37
- Tax Adjustment -1916.14
- Utility License Tax 1159.78
- EnergyDirect.com Premium 50.00

**BILLING INFORMATION**

- Tot kWh 1,188,876
- Pk kVA 1,861
- Ratch kVA Cont 2,025
- Power Factor 0.959
- Bill Demand 2,025
- Generation Dem 2,700

**HISTORICAL DATA**

- This Mth 32 1188876 37152
- Last Mth 30 1114437 37148
- 1 Yr Ago 32 1327212 41475
“Time of Use” energy and demand billing is very common.

- 2.70¢/kWh from 1 AM to 10 AM
- 5.36¢/kWh from 10 AM to Noon and 9 PM to Midnight
- 13.13¢/kWh from Noon to 7 PM
Utility billing structures will vary significantly.
Energy efficiency benefit example: LED Lighting

- LED outdoor lighting reduces plant’s outdoor lighting demand by 50kW
- Annual Energy Savings - 175,000 kWh per year.
Energy efficiency benefit example: LED Lighting

So.....

175,000KWH X 8.5¢/KWH = ~$15,000/yr. of savings right?

Maybe not!.......

Energy efficiency benefit example: LED Lighting

SVEC Rate LP-10 - $17/kW any time, $0.041/KWH any time

- LED light demand offset - $10,400/yr,
- LED light energy usage offset - $7,100/year

LED Lighting Evaluation – Water Treatment Plant

50kW Peak Demand Reduction
Energy efficiency benefit example: LED Lighting

SVEC Rate LP-10 - $17/kW any time, $0.041/KWH any time

- LED light demand offset - $0
- LED light energy usage offset - $7,100/year

LED Lighting Evaluation – Wastewater Treatment Plant
“When” energy is used and “how much” energy is used determines the overall cost.
Demand Management

“Using Energy More Efficiently”
Common Demand Management Strategies

- Manage plant operations to reduce demand during on-peak hours
- Defer non-critical operations to off-peak hours
- Interlock intermittent loads
- Utilize on-site power generation capacity to manage plant demand
- Electric utility load response programs
Demand Management Strategies Will Depend on Multiple Elements

Electric Utility Billing Rate

DEMAND MANAGEMENT STRATEGY

Process Flexibility

Demand Profile
Plant demand profile impacts energy costs

![Graph showing energy usage](image)

- **Peak Demand** - 6500 kW
- **Peak Demand** - 3700 kW
- **Energy usage for both scenarios** - 2330400 kWh

**Days**

- Days 1 to 30

**Graph Legend**

- Red line: High Peak Demand
- Blue line: Low Peak Demand
Plant demand profile impacts energy costs

- Evaluate the energy costs for two demand profiles
  - Energy Charge – 3.0¢/KWH
  - Monthly Demand Charge - $10.00/kW

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Energy Usage</th>
<th>Energy Charge @ 3.0¢/KWH</th>
<th>Metered Demand</th>
<th>Demand Charge @ $10.00/KW</th>
<th>Total Charges</th>
<th>Average Cost per/KWH</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Peaking Scenario</td>
<td>2330400 KWH</td>
<td>$69,912</td>
<td>6500kW</td>
<td>$65,000</td>
<td>$134,912</td>
<td>5.8¢/KWH</td>
</tr>
<tr>
<td>Low Peaking Scenario</td>
<td>2330400 KWH</td>
<td>$69,912</td>
<td>3700kW</td>
<td>$37,000</td>
<td>$106,912</td>
<td>4.6¢/KWH</td>
</tr>
</tbody>
</table>
Case Study – Managing plant loads to reduce demand charges – HRRSA

- **Electric Utility Rate**
  - Demand charges - $17.33/KW (any 15 min period)
  - Energy Charges $0.041/KWH

- **Opportunity** – Stop non-critical mixing loads during each 20 min filter backwash cycle.
  - Filter backwash loads (~100hp)
  - Digester mixing loads (~85hp).

- **Annual benefit** - ~$10,000/year (@ 80% load factor) in demand savings
Case Study – Reduced demand charges through filter backwash timing

The Cause: Automatic Deep-bed filter backwash process during on-peak periods - ~150kW

The Response: Move timing to lower demand periods. Potential to save ~$1500 per month
Case Study – Managing demand during on-peak periods

Average On-Peak Demand – 437kW

On-Peak:
- $15/KW
- 5.7¢/KWH

Off-Peak:
- $1/KW
- 3.4¢/KWH

Problem: Stopping electric blowers 10 minutes after On-Peak period began. ~$20,000/Year in excess demand charges

Stop Electric Blowers and Start Engine Blowers

Optimum On-Peak Demand – 265kW
Demand Management Key Points

- **Demand Management primary objective is to lower energy costs.**

- **Demand Management strategies can be implement at a low or zero cost.**

- **Power monitoring and an understanding of the utility billing structure are key components to developing demand management strategies.**
Onsite power generation systems can be used to manage demand.

- Standby Power Generator Systems
- Biogas Fueled CHP Systems
## Average Fuel and Energy Costs

<table>
<thead>
<tr>
<th>Fuel Source</th>
<th>Average Fuel Cost ($/MMBTU)</th>
<th>Electric Energy Conversion Efficiency (%)</th>
<th>Cost of Electric Energy Generated ($/KWH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.2 Non-Road Diesel @ $3/Gal</td>
<td>$21.43</td>
<td>37.5%</td>
<td>$0.23*</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$7.70</td>
<td>37.5%</td>
<td>$0.088*</td>
</tr>
<tr>
<td>Electric Utility</td>
<td>$17.88</td>
<td>100%</td>
<td>$0.071**</td>
</tr>
</tbody>
</table>

* 2.0¢/KWH O&M costs included
** Does not include fixed charges

**On average, generating electric energy costs more than purchased electric energy**
Onsite Power Generation Systems – Peak Shaving

- Operate generators to reduce demand charges
- **This strategy can be risky!**
- EPA emission restrictions
- Better to defer load

![Demand Profile (30 Days)](image)

- 6500kW (Missed peak = no benefit)
- 5000kW

**Calculations:**

- 1500kW x $10.00 = $15,000
- 24hrs @ 1500kW -> $7,200 Fuel
- Net Benefit -> $7,800
Load management is valuable to electric utilities.

- Electric Utility
- Utility Grid
- Electric Cooperative
- Electric Utility Customers
Demand Response Programs

- End user’s ability to shed load is valuable to electric utilities.
- Many electric utilities will pay end users for “capacity”.
- Plant owner is compensated by the utility to have the standby power generators available in the event of an utility emergency.
- Generally less than 100 hours/year of operation.
EPA Emission Requirements

- EPA National Emission Standards for Hazardous Air Pollutants (NESHAP)
  - Regulates the Carbon Monoxide emissions for existing non-emergency engines
  - Regulations not applicable to emergency use application and biogas fueled CHP systems.

- EPA New Source Performance Standards (NSPS)
  - New non-emergency generators must meet stringent emission limits. Most applications require emissions after treatment for non-emergency applications

- Air Permitting
Resource Recovery
Energy Sources Available

- Biogas
- Thermal Energy
- Chemical Energy
- Hydraulic Energy
- Renewable Energy
Combined Heat and Power Generation Systems - CHP

Typical WW plant will support 15-30kW of generation capacity per MGD
Combined Heat and Power Generation Systems - CHP

- Building Heat
- Process Heat
- Thermal Energy 40%
- Engine
- Mechanical Energy 35%
- Biogas Fuel
- Anaerobic Digesters
- Sludge
- Generator Blower Pump
Biogas to energy systems have been around a while!

Boy haven’t we come a long way in the last 90 years....
Combined Heat and Power Generation Systems - CHP

- “Free” fuel source
- Generate an average of 20% to 40% of the electric energy usage.
- Considered renewable energy source.
- Generally feasible where energy costs are above 7.5¢/KWH
Combined Heat and Power Generation Systems - CHP

Microturbine

- Integrated Controls
- Heat Recovery
- Recuperator
- Synchronous Generator
- Combustor
- Turbine Engine

Reciprocating Internal Combustion Engine

Image Courtesy GE/Jenbacher Engines
<table>
<thead>
<tr>
<th>Prime Mover Technology</th>
<th>Common Size Range (kW)</th>
<th>Typical Electrical Efficiency (%)</th>
<th>Typical Thermal Efficiency (%)</th>
<th>Installed Cost ($/kW)</th>
<th>Gas Conditioning Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spark Ignited Reciprocating Engines</td>
<td>150-5000kW</td>
<td>35%-40%</td>
<td>25%</td>
<td>1500 - 2000 $/kW with Heat Recovery</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>45%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25% with exhaust heat recovery</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microturbines</td>
<td>30 – 250kW</td>
<td>30%</td>
<td>45%</td>
<td>2000-2500 $/kW with Heat Recovery</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Cells</td>
<td>100 – 250kW</td>
<td>50%</td>
<td></td>
<td>$5000+</td>
<td>Very High</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stirling Engines (New Technology)</td>
<td>~50kW</td>
<td>25%</td>
<td>45%</td>
<td>$2500+</td>
<td>Low</td>
</tr>
</tbody>
</table>
Waste Heat Recovery Systems

• Beneficial Uses of Thermal Energy
  ➢ Digester Heating (Most Common)
  ➢ Building Heat and Cooling (Absorption Chillers)
  ➢ Sludge Drying

Absorption Chiller Process Diagram
Combined Heat and Power Generation Systems - CHP

CHP systems can be used to drive process equipment

- Offset plants purchased power with mechanical energy
- Common applications are process pumping and aeration
- Benefit is dependent on the process demand.
Combined Heat and Power Generation Systems - CHP

CHP systems can be used to generate electricity

- Offset plant’s purchased power with electricity
- Benefit is not dependent on process demands.
- Possible to increase benefit by selling energy directly to the utility.
Energy generated from biogas can be sold directly to the utility or offset purchased utility power source.
Utility rates have a significant impact on CHP system benefit.

Plant Demand Profile with and without 1000kW CHP System

- CHP Downtime
- Peak Demand with 1 day of CHP system downtime
- Peak Demand with continuous CHP system operation

~1000kW demand loss with 1 day of CHP system downtime
### CHP System Benefit Analysis
**SVEC – Rate LP10**

<table>
<thead>
<tr>
<th>Electric Utility Cost</th>
<th>CHP Demand Offset @17.33/KW</th>
<th>CHP Energy Offset @ $0.041/KWH</th>
<th>CHP System Benefit</th>
<th>CHP System Operation % Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>No CHP</td>
<td>$164,000</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>1000kW Base Load – Continuous Operation</td>
<td>$119,200</td>
<td>$17,300</td>
<td>$27,500</td>
<td>$44,800</td>
</tr>
<tr>
<td>1000kW Base Load – 1 day CHP Down Time</td>
<td>$133,000</td>
<td>$0</td>
<td>$26,000</td>
<td>$26,000</td>
</tr>
</tbody>
</table>

- 3 day CHP peak period downtime resulted in a 40% loss of the CHP system benefit for the billing period.
- Demand ratchets can extend the loss for up to 12 months! – 80% 12 month ratchet could result in a loss of ~$170,000/year
Some utilities purchase renewable energy on a energy charge only rate.

Duke Energy (NC) Rate PP-N
Rate Option A
No Demand Ratcheting!!!!
Benefit may depend on renewable energy portfolio standards and goals. www.dsireusa.org
Power Monitoring
Power monitoring is key to energy management and optimization.
Benefits from incorporating energy usage data into process operations
Monitor individual loads as well as overall distribution equipment loads.
Power monitoring dashboard example

Energy Efficiency Monitor

- On Peak 30 Minute Demand: 2057.00 kW
- Off Peak 30 Minute Demand: 3526.30 kW
- Current 30 Minute Demand: 1050.00 kW
- Estimated Daily Demand Cost: 680.32 $

Today Electric Consumption: 15749.10 kWh
- Today Electric Cost: 8955.22 $

Yesterday Electric Consumption: 22136.40 kWh
- Yesterday Electric Cost: 4668.82 $

Today Gas Consumption: 140.60 kcf
- Today Gas Cost: 993.80 $
- Yesterday Gas Consumption: 218.13 kcf
- Yesterday Gas Cost: 2558.26 $

Today Water Consumption: 22230.24 gal.
- Today Water Cost: 98.33 $
- Yesterday Water Consumption: 30295.40 gal.
- Yesterday Water Cost: 159.33 $

Cost Analysis
- Water: 19%
- Gas: 27%
- Power: 54%

Power Consumption: 1.99 $/Ton
Natural Gas Consumption: 0.03 $/Ton
Water Consumption: 0.08 $/Ton
Total Production Cost: 2.25 $/Ton
Typical Energy Management Opportunities
The treatment process typically consumes 90% of the energy usage.
National Energy Benchmark Data

**Secondary Treatment**

- Activated Sludge with Advanced Treatment and Nitrification: 1,900 kWh/MG
- Activated Sludge with Advanced Treatment, No Nitrification: 1,600 kWh/MG
- Activated Sludge with No Advanced Treatment or Nitrification: 1,400 kWh/MG
- No Activated Sludge, Trickling Filter: 1,000 kWh/MG

*Source: WEF MOP-32*
Energy Optimization – Secondary Treatment Considerations

- Excessive operating units (too many tanks online)
- DO control (excessively high DO)
- Blower turndown limitations
- Over mixing
- Diffuser fouling
- Inefficient aeration equipment
- Primary clarifier efficiency
Damaged equipment

Damaged Diffuser
Aeration equipment can impact energy efficiency

- Conversion to fine bubble is not always cost effective.
- Have to make an economic case to change to fine bubble from surface aerators.
- Cost of energy impacts economic case.

### Aerator technologies oxygen transfer efficiencies

<table>
<thead>
<tr>
<th>Aerator Type</th>
<th>SAE lbO2/hp-hr</th>
<th>AE at 2 mg/L DO lbO2/hp-hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Aerators</td>
<td>1.5 – 3.2</td>
<td>0.7 – 2.5</td>
</tr>
<tr>
<td>Coarse Bubble</td>
<td>1 - 2.5</td>
<td>0.5 – 1.6</td>
</tr>
<tr>
<td>Fine Bubble</td>
<td>6 – 8</td>
<td>2.0 – 4.0</td>
</tr>
</tbody>
</table>
Questions?

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