Energy Audits
Waste Water Treatment Plants

Ohio Water Environment Association Conference
June 20, 2012

Presented by:
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CT Consultants, Inc.
World Energy Trend

Figure 15. World energy consumption by fuel, 1990-2035 (quadrillion Btu)

## US Total Energy Usage

<table>
<thead>
<tr>
<th>Category</th>
<th>Quadrillion BTU</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>22.2</td>
<td>23%</td>
</tr>
<tr>
<td>Commercial</td>
<td>18.2</td>
<td>19%</td>
</tr>
<tr>
<td>Industrial</td>
<td>30.1</td>
<td>31%</td>
</tr>
<tr>
<td>Transportation</td>
<td>27.5</td>
<td>28%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>98.0</strong></td>
<td></td>
</tr>
</tbody>
</table>
US Total Energy Usage Chart

Quadrillion BTU

- Residential: 22.2 Quadrillion BTU (23%)
- Commercial: 18.2 Quadrillion BTU (18%)
- Industrial: 30.1 Quadrillion BTU (31%)
- Transportation: 27.5 Quadrillion BTU (28%)

Total = 98 Quadrillion BTU
## US Electric Energy Usage

<table>
<thead>
<tr>
<th>Category</th>
<th>Quadrillion BTU</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>5.0</td>
<td>39%</td>
</tr>
<tr>
<td>Commercial</td>
<td>4.5</td>
<td>35%</td>
</tr>
<tr>
<td>Industrial</td>
<td>3.3</td>
<td>26%</td>
</tr>
<tr>
<td>Transportation</td>
<td>0.3</td>
<td>0.2%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>12.8</strong></td>
<td></td>
</tr>
</tbody>
</table>
US Electric Energy Usage Chart
Quadrillion BTU

Total = 12.8 Quadrillion BTU

- Residential: 5.0 (39%)
- Commercial: 4.5 (35%)
- Industrial: 3.3 (26%)
- Transportation: 0.03 (0%)

Residential
Commercial
Industrial
Transportation
Energy Benchmarking

- Commercial Buildings
  - Energy Star
  - DOE Commercial Buildings Benchmark
  - LEED
  - USGBC – US Green Building Council
  - ASHRAE
    - 90.1 Defines Minimum Energy Efficiency Standards
    - 189.1 Allows Adoption of LEED as Building Code
Energy Benchmarking

- WWTP – EPA Tools
  - Energy Star EPA Portfolio Manager – WTP & WWTP
  - EPA Energy Management Planning Self Assessment Worksheet
  - EPA Groundwater and Drinking Water Energy Use Assessment Tool
EPA Benchmarking Tools for WWTP

- EPA Energy Star Portfolio Manager
  - Performance Score Based on Energy Use per Unit of Flow / Effluent Quality / Treatment Type
  - Accessed On-line

- EPA Energy Use Assessment Tool
  - Drills Down to Equipment Level
  - Allows Utility Bill Analysis
  - Use Before Full Scale Energy Audit
Non-EPA Benchmarking Tools

- WERF Carbon Heat Energy Analysis Plant Evaluation Tool (CHEApet) – for WERF Members
  ---- Water Environment Research Foundation ----

- CEE Water and Wastewater Self-Audit Checklists
  ---- Consortium for Energy Efficiency ----

- NYSERDA Water and Wastewater Focus Program

- Various State Specific Measurement Tools
Electric Usage at WWTP and WTP

- 55 Billion Kilowatt Hours (kWh)
- $4 Billion Annual Energy Cost
- Equivalent to 45 Million Tons of Greenhouse Gas
- Represents 3% of US Electricity Use
- Accounts for 35% of Municipal Electric Use
- Preliminary Savings Estimates = 15% - 30%
WWTP Energy Use

- Over 15,000 Wastewater Treatment Plants
- Over 50,000 Water Treatment Plants
- WWTP Energy = 25% – 35% of Total Plant O&M
Why Reduce?

- Reduced Energy Costs
- Lower Operating Costs
- Save Water
- Reduced Carbon Footprint
  - Lower Greenhouse Gas Emissions
Reduce Carbon Footprint

- Saving 25% of WWTP Energy Equals
  - 9,500,000 Tons CO₂
  - 3,300,000 Tons Recycled Waste Instead of Landfill
  - 22,000,000 Million Barrels of Oil
  - 51,500 Rail Cars of Coal
  - 1,180,000 Homes
  - Carbon sequestered by 2,000,000 Acres Pine Forest
## Where Does the Energy Go

<table>
<thead>
<tr>
<th>End Use</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Sewage Pumping</td>
<td>12%</td>
</tr>
<tr>
<td>Aeration</td>
<td>55%</td>
</tr>
<tr>
<td>Anaerobic Digestion</td>
<td>11%</td>
</tr>
<tr>
<td>Clarifiers</td>
<td>3%</td>
</tr>
<tr>
<td>Solids Handling</td>
<td>8%</td>
</tr>
<tr>
<td>Buildings, HVAC, Lighting</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>5%</td>
</tr>
</tbody>
</table>
WWTP Energy Usage

- Raw Sewage Pumping: 12%
- Aeration: 55%
- Anaerobic Digestion: 11%
- Clarifiers: 3%
- Solids Handling: 8%
- Buildings, HVAC, Lighting: 8%
- Other: 5%
Types of Energy Audits

- Varying Level of Detail
- Varying Level of Costs
- ASHRAE Tiered Levels
  - Level 1 – Walk-Through Analysis, Low or No Cost
  - Level 2 – Energy Survey Req’d, Identifies Energy Conservation Measures with Cost Estimate & Payback
  - Level 3 – Detailed Analysis of Capital Intensive Improvements
Types of Energy Audits

- **ASHRAE Level I**
  - Walk-through Analysis Identifies Areas of Potential Energy Savings
  - Usually ½ Day or Less
  - Suggestions for Quick Payback Projects
  - Suggestions for Areas Needing Further Study
  - Often Performed for Little or No Cost
Types of Energy Audits

- **ASHRAE Level II**
  - May Require One or Two Days at Plant
  - Includes Interviews with Plant Personnel
  - May Require Two or More Weeks to Analyze Utility Data, Pump Curves, Aeration Processes, Other Processes
  - Identify Projects With Short Payback
  - Determine Savings, Costs and Payback Period
Types of Energy Audits

- ASHRAE Level III
  - May Require Three or More Days at Plant
  - Examines Energy Use in All Processes
  - Proposes Possible Design Modifications
  - Emphasis on Optimization
  - Detailed Cost Est. Often with Significant Investment
  - May Result in Major Energy Savings
Elements of Level II & III Energy Audit

- Examine and Analyze Utility Bill / Rate Structure
  - Electric, Gas and Water
  - Allocate Usage to Major Processes – *Energy Balance*
- Identify Cost Effective Equipment Efficiency Improvements
- Identify Cost Effective Operational Improvements
  - Often Find Controls Related Improvements (e.g. DO)
- Develop Cost Estimate and Energy Savings
- Determine Payback in Years
Work Product - Level II & III Audit

- Whole Plant Benchmark

- Energy Balance
  - Allocate Electric, Gas and Water to End Use
  - Include 24 Months Usage -- 12 Months Minimum

- Energy Conservation Measures
  - Cost of Implementation -- Level II vs. Level III
  - Energy Savings – Include Methods / Calculations
  - Calculate Payback

- Recommendations for Future Study
Energy Audit Focus

- HVAC / Mechanical Systems
  - Mainly in Administrative Buildings

- Electrical Systems
  - Lighting in All Buildings – Examine Efficiency / Consider Occupancy Sensors
  - Motor Efficiency (Premium Motor Efficiency Savings)
  - VFD’s (Frequent Savings Opportunities)
Energy Audit Focus

- **Aeration Systems**
  - Blower Efficiency
  - Blower Controls
  - Constant Speed, Throttling, VFD’s
  - Diffusers – Fine Bubble vs. Coarse Bubble
Energy Audit Focus

- Pumping Systems
  - Premium Motor Efficiency
  - Sizing
  - VFD’s

- Solids Handling
  - Varies by Plant
Energy Audit Focus - Equipment

- Equipment Assessment
  - Tour Facility
  - Review Plans & Specs
  - Meet with Operating Personnel
  - Understand Current Conditions
  - Discuss Alternatives to be Considered
  - Develop Payback for Each Alternative
Energy Audit Focus - Process

- Process Optimization
  - Review O&M Manual
  - Discuss Operating Techniques
  - Review / Discuss Regulatory Status
  - Consider Present & Future NPDES Discharge Limits
  - Examine Plant Loadings vs. Future Expansion
  - May Develop Computer Model - Benchmarking
Energy Audit Focus - Process

- Process Optimization Continued
  - Explore Revising Basic Plant Operating Methods
  - Analyze Process Configuration Changes
  - Calculate Capital Improvement Costs
  - Calculate Energy Savings
  - Determine Payback Period
  - Identify Other Benefits – Chemical Reduction, Sludge Removal, etc.
Energy Audit Focus – Utility Optimize

- Utility Optimization
  - Examine Utility Rate(s)
    - Consider Alternative Rate Structures - Case Study 2
  - Perform Energy Balance – End Use Allocation
  - Examine Incentives to Reduce Peak Demand
  - Evaluate Opportunities to Reduce Peak Demand
Energy Audit Focus – Buildings

- Building Auditing
  - Allocate Energy to End Use
  - HVAC
  - HVAC Controls
  - Lighting
  - Envelope
Auditor’s Tools

- eQuest
- Air Master +
- Motor Master +
- Pumping Assessment Tool (PSAT)
- Numerous Others
Analysis of Implementation Costs

- Auditor Must Help Explore Funding Opportunities
- Identify All Utility Incentive Programs
- Factor External Funding and Utility Incentives into Financial Analysis
- Consider Remaining Useful Life
  - Sometimes Overlooked in Energy Audit
  - Include in Capital Replacement Program
Best Savings Opportunities

- Aeration Blower Optimization
  - Control DO to Minimum Practical Value
  - Match Energy Input to DO – Via Throttling, Timers, Speed Control
  - Change Diffusers from Coarse Bubble to Fine
Best Savings Opportunities

- **Plant Pumping Systems**
  - Size for Efficient Operation at Average Conditions
  - Consider Entire System Design
  - Big Pipes and Small Motors - Not the opposite

- **Motors**
  - Premium Efficiency Motors
  - Apply Variable Speed Drives
Best Savings Opportunities

- Plant Anaerobic Digestion
  - Can Usually Reduce Mixing
  - Run Mechanical Mixers Intermittently
  - Consider Running Heater Recirculation Pumps Intermittently
  - Replace Recessed Biosolids Pumps with Semi-open Impeller Non-clogging Pumps
  - Shift Operations to Off-peak Times Where Possible
Best Savings Opportunities

- Lighting
  - Replace T12 Fluorescent and Incandescent
  - Add Occupancy Sensors
- HVAC in Administrative Buildings
- Water Heating
Case Study 1 – City of Canton Water Reclamation Facility
Case Study 1
Canton Water Reclamation Facility

- De-nitrification Activated Sludge Process
- 39 MGD
- Major Facility Improvement Project
- Install New MBR - Membrane Bioreactor System
- Convert Blowers From Activated Sludge Aeration to MBR Scour Operation
Case Study 1
Canton Water Reclamation Facility Aeration

- 4 – 800 hp Blowers and 1 – 500 hp Blower
- Centrifugal Blowers
- 4160 Volt Motors
- Common Air Header
- Inlet Valve Throttling
- Controlled by Header Pressure
Case Study 1 - VFD’s vs. Throttling

☐ Should VFD’s be Added?
☐ If Yes, How Many VFD’s? (1, 2, 3, 4 or 5)
☐ Blower Type: Centrifugal
☐ Blower Motors: 4160 VAC, 3570 RPM
☐ Blower HP: 4 – 800 hp + 1 – 500 hp
☐ VFD’s at 4160 volts Are Very Costly
☐ Involve Blower Manufacturer in Analysis
Case Study 1 – VFD’s vs. Throttling

- Required SCFM Based on Total Plant Flow (Q)
- Q - Determines Number of MBR Basins
- MBR Basins – 5 Minimum, 12 Maximum
- Developed Hourly SCFM Requirements
- 12,000 – 48,000 SCFM @Outlet Pressure = 7.1 psi
- Derived Number of Blowers for Each Air Flow
- Could Reach All Operating Points with 2 VFD’s
Case Study 1 – Fan Performance
Case Study 1 – Fan Laws

- Fan Air Flow Rate Varies with Fan Speed Ratio
  - \[ Q_2 = Q_1 \times \left( \frac{N_2}{N_1} \right) \]

- Fan Pressure Varies with Square of Speed Ratio
  - \[ P_2 = P_1 \times \left( \frac{N_2}{N_1} \right)^2 \]

- Fan Input Power Varies with Cube of Speed Ratio
  - \[ H_2 = H_1 \times \left( \frac{N_2}{N_1} \right)^3 \]
  - This 3\textsuperscript{rd} Law Answers Why Speed Control Saves So Much Energy
## Case Study 1 – HP vs. Blower Speed

<table>
<thead>
<tr>
<th>SCFM</th>
<th>RPM</th>
<th>HP</th>
<th>% Full RPM</th>
<th>% Full HP</th>
</tr>
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<tbody>
<tr>
<td>16,900</td>
<td>3,357</td>
<td>571</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>14,002</td>
<td>3,300</td>
<td>511</td>
<td>92%</td>
<td>90%</td>
</tr>
<tr>
<td>12,402</td>
<td>3,170</td>
<td>441</td>
<td>89%</td>
<td>77%</td>
</tr>
<tr>
<td>10,950</td>
<td>3,090</td>
<td>393</td>
<td>87%</td>
<td>69%</td>
</tr>
<tr>
<td>9,662</td>
<td>3,025</td>
<td>351</td>
<td>85%</td>
<td>62%</td>
</tr>
<tr>
<td>7,754</td>
<td>2,960</td>
<td>298</td>
<td>83%</td>
<td>52%</td>
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<tr>
<td>4,696</td>
<td>2,925</td>
<td>225</td>
<td>82%</td>
<td>39%</td>
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</table>

Source = Gardner Denver Fan Curves

7.1 psi
# Case Study 1 – Air Demand Profile

<table>
<thead>
<tr>
<th>Hours / Day</th>
<th>SCFM</th>
<th>Blower RPM</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td><strong>VFD’s</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Blower 1</strong></td>
</tr>
<tr>
<td>3</td>
<td>12,084</td>
<td>3150</td>
</tr>
<tr>
<td>2</td>
<td>22,472</td>
<td>3150</td>
</tr>
<tr>
<td>7</td>
<td>31,270</td>
<td>3225</td>
</tr>
<tr>
<td>12</td>
<td>48,336</td>
<td>2925</td>
</tr>
<tr>
<td>0.7</td>
<td>72,504</td>
<td>3560</td>
</tr>
</tbody>
</table>

500 HP Blower Not Shown
## Case Study 1 – Air Demand vs. HP

<table>
<thead>
<tr>
<th>Hours / Day</th>
<th>SCFM</th>
<th>HP per Blower</th>
<th>Total HP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>VFD’s</td>
<td>Constant Speed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blower 1</td>
<td>Blower 2</td>
</tr>
<tr>
<td>3</td>
<td>12,084</td>
<td>430</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>22,472</td>
<td>402</td>
<td>402</td>
</tr>
<tr>
<td>7</td>
<td>31,270</td>
<td>471</td>
<td>--</td>
</tr>
<tr>
<td>12</td>
<td>48,336</td>
<td>255</td>
<td>255</td>
</tr>
<tr>
<td>0.7</td>
<td>72,504</td>
<td>670</td>
<td>670</td>
</tr>
</tbody>
</table>

500 HP Blower Not Shown
# Case Study 1 – Annual Energy Cost

<table>
<thead>
<tr>
<th>Month</th>
<th>kWh</th>
<th>Energy Cost</th>
<th>kWh</th>
<th>Energy Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Inlet Valve Throttling</strong></td>
<td></td>
<td><strong>2 VFD’s</strong></td>
</tr>
<tr>
<td>January</td>
<td>807,025</td>
<td>$60,285</td>
<td>736,681</td>
<td>$55,030</td>
</tr>
<tr>
<td>February</td>
<td>727,650</td>
<td>$54,355</td>
<td>663,726</td>
<td>$49,580</td>
</tr>
<tr>
<td>March</td>
<td>807,814</td>
<td>$60,344</td>
<td>737,711</td>
<td>$55,107</td>
</tr>
<tr>
<td>April</td>
<td>779,434</td>
<td>$58,224</td>
<td>710,886</td>
<td>$53,103</td>
</tr>
<tr>
<td>May</td>
<td>879,286</td>
<td>$65,683</td>
<td>709,436</td>
<td>$52,995</td>
</tr>
<tr>
<td>June</td>
<td>851,698</td>
<td>$63,622</td>
<td>688,436</td>
<td>$51,426</td>
</tr>
<tr>
<td>July</td>
<td>880,038</td>
<td>$65,739</td>
<td>711,262</td>
<td>$53,131</td>
</tr>
<tr>
<td>August</td>
<td>878,834</td>
<td>$65,649</td>
<td>708,340</td>
<td>$52,913</td>
</tr>
<tr>
<td>September</td>
<td>851,071</td>
<td>$63,575</td>
<td>686,914</td>
<td>$51,312</td>
</tr>
<tr>
<td>October</td>
<td>878,784</td>
<td>$65,645</td>
<td>708,218</td>
<td>$52,904</td>
</tr>
<tr>
<td>November</td>
<td>778,714</td>
<td>$58,170</td>
<td>709,946</td>
<td>$53,033</td>
</tr>
<tr>
<td>December</td>
<td>804,657</td>
<td>$60,108</td>
<td>733,593</td>
<td>$54,799</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>9,925,005</strong></td>
<td><strong>$741,398</strong></td>
<td><strong>8,505,147</strong></td>
<td><strong>$635,334</strong></td>
</tr>
</tbody>
</table>

**Annual Savings with 2 VFD’s**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1,419,858</strong></td>
<td><strong>$106,063</strong></td>
<td></td>
</tr>
</tbody>
</table>
## Case Study 1 – Study Results

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blower Curves Defined Operating hp and kW</td>
<td></td>
</tr>
<tr>
<td>Cost per kWh</td>
<td>$0.075</td>
</tr>
<tr>
<td>Energy Cost Inflation</td>
<td>4%</td>
</tr>
<tr>
<td>Install Cost of Two VFD’s</td>
<td>$497,000</td>
</tr>
<tr>
<td>Annual kWh with Throttling</td>
<td>9,946,000</td>
</tr>
<tr>
<td>1st Year Energy Cost with Throttling</td>
<td>$742,000</td>
</tr>
<tr>
<td>Annual kWh with Two VFD’s</td>
<td>8,512,000</td>
</tr>
<tr>
<td>1st Year Energy Cost with Two VFD’s</td>
<td>$635,000</td>
</tr>
</tbody>
</table>
Case Study 1 – Study Results

- 1st Year Gross Energy Savings Using 2 VFD’s
  - 1,434,000 kWh
  - $106,000
  - 14% Reduction

- VFD Rejected Heat at Full Load = 63 mBTU

- 1st Year Cooling Costs for VFD’s
  - 107,015 kWh
  - $8,782
Case Study 1 – VFD’s vs. Throttling

- 1st Year Net Savings
  - 1,326,985 kWh
  - $97,218
  - 13% Reduction
  - Equivalent to 915 Metric Tons of CO₂ Emissions
Case Study 1 – Payback Calculation

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment Less Savings + 5% / yr.</th>
<th>Electric Savings + 4% / yr.</th>
<th>Balance End of Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$497,000</td>
<td>$97,282</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>$521,850</td>
<td>$101,173</td>
<td>$420,677</td>
</tr>
<tr>
<td>2</td>
<td>$441,711</td>
<td>$105,220</td>
<td>$336,491</td>
</tr>
<tr>
<td>3</td>
<td>$353,316</td>
<td>$109,429</td>
<td>$243,887</td>
</tr>
<tr>
<td>4</td>
<td>$256,081</td>
<td>$113,806</td>
<td>$142,275</td>
</tr>
<tr>
<td>5</td>
<td>$149,389</td>
<td>$118,358</td>
<td>$31,031</td>
</tr>
<tr>
<td>6</td>
<td>$32,583</td>
<td>$123,092</td>
<td>($90,510)</td>
</tr>
</tbody>
</table>

Payback Period is 5.3 Years
Case Study 1 – Conclusion

- VFD’s vs. Inlet Valve Throttling
  - VFD Speed Control is Economically Justified Even If Inlet Valve Throttling Already Installed
- Blowers Operate Closer to Surge Line
- Savings Produces $100,000 + Every Year After Year 6
- Savings Calculated Without Utility Incentive
Case Study 2 – City of Willoughby WWTP

- Conventional Activated Sludge Process
- 9 MGD
Case Study 2 – City of Willoughby WWTP

- Performed a Level 1-1/2 Audit
  - Three Hour On-site Visit
  - No Cost to Client
  - Palmer Conservation Consulting & CT
- Looked for Readily Apparent Savings Opportunities
- Developed Some ECM and Calculated Payback
  - Not Normally Part of Level 1 Audit
Case Study 2 - Opportunities

- Savings Opportunities
  - Lighting and Lighting Controls Throughout Plant
  - Administrative Building HVAC Roof Top Units
  - Administrative Building HVAC Controls
  - Power Distribution - Utility Electric Service
    - Secondary Metering to Primary Metering
  - Aeration Blower Dispatch with DO Monitoring
Case Study 2 - Lighting

- Lighting Upgrade
  - Plant Previously Replaced 50% of T12 Fluorescent
  - Replace Remaining T12’s with T8’s
  - Applied Utility Incentive -- Minimal
  - Calculated 6 Year Payback

- Lighting Controls
  - Occupancy Sensors with Manual Override
  - Calculated 6 Year Payback
Case Study 2 - Buildings

- HVAC in Administrative Building
  - Replace Singular RTU with Two Separate Units to Serve Areas of Different Needs
  - Replace Building Controls
  - Approximately $60,000 in Cost
  - Calculated 10 Year Payback
Case Study 2 – Electric Rate Schedule

- Existing Electric Utility Service
  - 13.2 kV Service from Utility
  - 13,200 – 480 volt Transformers
  - Billing Metering CT’s on 480 volt Bus (Secondary)

- Proposed Service
  - Purchase Transformer from Utility Company
  - Move Metering to 13.2 kV Bus (Primary Metering)
  - Savings Due to Lower Electric Rate Schedule
Case Study 2 – Electric Rate Schedule

- Primary Metering Rate is Lower but Has Risks
- Cost to Purchase Transformer and Primary Metering CT’s & PT’s
  - $189,000
- Annual kWh Savings = 0
- Annual Electric Cost Savings = $25,000
- Simple Payback = 7.6 Years
### Case Study 2 – Energy Conservation Measures

<table>
<thead>
<tr>
<th>Energy Conservation Measures</th>
<th>Cost</th>
<th>Annual Savings</th>
<th>Payback – Yrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting</td>
<td>$25,100</td>
<td>$4,200</td>
<td>6.0</td>
</tr>
<tr>
<td>HVAC Modifications</td>
<td>$43,200</td>
<td>$4,300</td>
<td>10.0</td>
</tr>
<tr>
<td>HVAC Controls</td>
<td>$27,000</td>
<td>$2,500</td>
<td>10.8</td>
</tr>
<tr>
<td>Power Distribution</td>
<td>$189,000</td>
<td>$25,000</td>
<td>7.6</td>
</tr>
<tr>
<td>Other</td>
<td>$27,000</td>
<td>$1,000</td>
<td>27.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$311,300</strong></td>
<td><strong>$37,000</strong></td>
<td><strong>8.4</strong></td>
</tr>
</tbody>
</table>

**Future Study**

DO Controls / Aeration Blower Controls
Case Study 2 – Future Study

- Aeration Blower Dispatch Optimization
- 4 – 200 hp Turbo Blowers
- Manual DO Readings
- Manual Dispatch of Blowers

Question – If 160% of Blower Capacity is Needed, What is Optimum Configuration?
- 2 Blowers @ 80% or 1 Blower @100% + 1 @ 60%
- Other Combination(s)?
Renewable Energy

- Consider Renewable Energy Alternatives
  - Co-Generation
  - Photovoltaic
  - Wind Turbine

- Usually Requires Outside Funding
  - Often Partially Available

- City of Delphos WWTP
  - Installed 83 kW Photovoltaic - 100% Outside Funding
Summary

- Energy Costs Will Continue to Increase
- Perform Level II or Level III Audit
- Make Energy Conservation an Integral Part of Plant Operations and Future Planning
- Select Efficient Equipment
- Install Energy Monitoring Equipment
- Savings Opportunities Exist
Thank You