Smart Water Management & Modeling for Optimizing Energy Use & Reducing Costs for Water Distribution Systems

September 17, 2014
Agenda

- Water Distribution and Energy Management
- Electric Utilities and Energy Billing Overview
- Opportunities to Reduce Energy Costs
- Case Studies
- Energy Markets
“Multiple Opportunities”

- Pumping Efficiency
- Conservation
- Infrastructure Repairs and Improvements
- Automation and Control
- Energy Procurement Strategies
Water Treatment and Distribution Energy Optimization

• Use Less Energy
  – Pumping efficiency optimization
  – Water usage conservation
  – Variable speed systems

• Energy Recovery
  – Hydraulic energy recovery
  – Renewable energy systems

• Manage Energy Costs
  – Demand Management
  – Coordinate billing rates
  – Potential for Low or No cost opportunities
Water Modeling is an Effective Energy Management Tool

System Modeling + Energy Management = Energy Savings

Use Less Energy + Energy Cost Management + Energy Recovery = $\text{Energy Savings}$

System Modeling can be a very effective tool to identify energy optimization opportunities.
Managing Energy Costs

- Leveraging water storage Leverage operations and utility billing rates to control energy costs
- Peak load management
- Load curtailment programs

*Water Treatment/Distribution Facilities have multiple opportunities to reduce energy costs*
Utility Billing

System Modeling + Utility Billing Modeling

Demonstrate how system modeling and energy management were used to identify opportunities to reduce energy costs
Typical industrial electric utility billing charges

• Fixed Charges
  – Independent of demand or usage.
  – Facility charges.

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

• Energy Usage Charge (kWh)
  – Energy consumed during the billing period.

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**EXPLANATION OF CHARGES**

LPL - Light and Power Large
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
Demand 2025 KVA * 4.750000
Energy Charge 56250 KWH * 0.038391
Energy Charge 882626 KWH * 0.023891
Discount
SG Customer Charge
Parallel Gear
SG - Capacity Credit
Fuel Charge 1183876 KWH * 0.025100
Natural Disaster Reserve
Tax Adjustment
Utility License Tax
EnergyDirect.com Premium

**BILLING INFORMATION**

<table>
<thead>
<tr>
<th>RATE NAME</th>
<th>SERVICE PERIOD</th>
<th>METER NUMBER</th>
<th>READING TYPE</th>
<th>METER READING PREVIOUS</th>
<th>METER READING PRESENT</th>
<th>METER CONSTANT</th>
<th>USAGE</th>
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<tbody>
<tr>
<td>LEV</td>
<td>07/22/19-08/23/19</td>
<td>WFO016</td>
<td>Tot kWh</td>
<td>1</td>
<td>1,188,875.52</td>
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<td>1,188,875.52</td>
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<td></td>
<td></td>
<td></td>
<td>Pk kVA</td>
<td>1</td>
<td>1,860,988</td>
<td>1</td>
<td>1,860,988</td>
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<td></td>
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<td>Power Factor</td>
<td>1</td>
<td>0.959</td>
<td>1</td>
<td>0.959</td>
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<td></td>
<td></td>
<td></td>
<td>Co Pk kWh</td>
<td>1</td>
<td>1,784,116</td>
<td>1</td>
<td>1,784,116</td>
</tr>
</tbody>
</table>

**HISTORICAL DATA**

Current KWh: 311108976
Current KWH/day: 37312

Last Month: 301104437
KWH/day: 37148

1 Yr Ago: 311327212
KWH/day: 41475
Demand charges are based on peak metered demand.

### Plant Demand Profile
(15 Minute Interval Data)

- **Peak Demand** – 7500KW
- **Average Demand** – 2700KW
Demand ratchets and minimum billing demand charges can increase energy costs

90% Annual Demand Ratchet Example

- Peak
- Minimum Demand Charge
- Excess Demand Charges
“Time of Use” Billing

• Energy & Demand costs change with the time of day.
• On peak periods can change seasonally
• Very Common

“When” energy is used and “how much” energy is used determines the overall cost.
Demand Profile Will Impact Energy Costs

- Peak Demand – 6500kW
- Energy usage for both scenarios – 2330400 kWh
- Peak Demand – 3700kW
“When” energy is used and “how much” energy is used determines the overall cost.
Case Studies
Case Study – Davidson Water Energy Optimization

- 58,000 customers in Central North Carolina
- 10MGD average flow
- 23 pumping stations
- 12 pressure zones
Project Scope

• Develop a long term CIP master plan
• Forecast demands to identify facilities for future improvements
• Identify near term and long term energy management opportunities
Power Bill Review

Pump Station Energy Usage (KWh)

- Hyattown: 195,932
- Hwy 52: 11,185
- Kennedy: 20,344
- Hwy 109: 5,113
- Lower Hasty: 3,837
- Gumtree: 2,674
- Ridge Road: 16,363
- Hwy 8: 6,508
- Belmont: 2,224
Power Bill Review
Average Energy Cost ($/KWh)
Hyattown Pump Station

- Evaluate opportunities to reduce energy charges.
- Pumps 2-75hp, 4-150hp, 2-200hp (Constant Speed)
# Hyattown Pump Station Billing Rate

**Duke Energy OPT-G (Time-of-Use)**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Energy Rate</th>
<th>Demand Charge</th>
<th>Economy Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer Months</strong></td>
<td>6.13¢/KWH</td>
<td>$15.72/KW</td>
<td>$1.16/KW</td>
</tr>
<tr>
<td><strong>Winter Months</strong></td>
<td>6.13¢/KWH</td>
<td>$9.26/KW</td>
<td>$1.16/KW</td>
</tr>
</tbody>
</table>

### Summer Months Energy Rate (June 1 thru Sept 30)
- **On-Peak Monday-Friday**
- **Demand Charges Established During This Time Period**
- **Economy Demand**
- **Demand Charge**

### Winter Months Energy Rate (Oct 1 thru May 31)
- **On-Peak Monday-Friday**
- **Demand Charges Established During This Time Period**
- **Economy Demand**
- **Demand Charge**
Hyattown Pump Station – Existing Operations

- Maintain Tank Level
- On-Peak pumping operations resulting in elevated energy costs

Energy Usage: 1472 MWH/YR
Peak Demand: 232 KW
Yearly Utility Cost: $68,487

Power Demand Profile:
- Off Peak Demand: $1.16/KW, Energy: $0.035/KWH
- On Peak Demand: $15.72/KW, Energy: $0.061/KWH
Hyattown Pump Station – Demand Management

- Minimize Pumping Operations During On-Peak periods

Energy Usage- 1491MWH/YR
Peak Demand 75KW*
Yearly Utility Cost $44,445

Hyattown Pump Station Power Demand Profile

- Off Peak
  - Demand $1.16/KW
  - Energy $0.035/KWH

- On Peak
  - Demand $15.72/KW
  - Energy $0.061/KWH
Hyattown Pump Station – Demand Management and Piping Modifications

- Piping Modifications to reduce pumping head

Energy Usage- 1400MWH/yr
Peak Demand 75KW*
Yearly Utility Cost $40,424

![Graph showing power demand profile with Off Peak and On Peak demand and energy costs.]

- Off Peak Demand $1.16/KW
  - Energy $0.035/KWH
- On Peak Demand $15.72/KW
  - Energy $0.061/KWH
Hyattown Pump Station Operations Optimization

• ~$15,000/year of energy cost savings at **Zero Capital Cost**

• Minimum billing demand limited additional demand reduction from piping modifications.

![Hyattown Annual Energy Costs Summary](chart)

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>Demand Management</th>
<th>Demand Management &amp; Piping Modifications</th>
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<tbody>
<tr>
<td>Energy Costs</td>
<td>$80,000</td>
<td>$70,000</td>
<td>$60,000</td>
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<tr>
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<td>$20,000</td>
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<td>$0</td>
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<tr>
<td></td>
<td>$0</td>
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</table>
Hwy 8 Pump Station Billing Rate

Lexington Utilities Small Commercial Service (Schedule SC)

<table>
<thead>
<tr>
<th>For Billing Months Energy</th>
<th>Rate</th>
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<tbody>
<tr>
<td>Basic Facilities Charge</td>
<td>$64.20</td>
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<td>Minimum Charge: Basic Facilities Charge</td>
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<table>
<thead>
<tr>
<th>Demand Charge:</th>
<th>Summer</th>
<th>Non-Summer</th>
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<tbody>
<tr>
<td>First 10 kW</td>
<td>$6.24 per kW</td>
<td>$6.24 per kW</td>
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<tr>
<td>All Over 10 kW</td>
<td>$12.91 per kW</td>
<td>$12.91 per kW</td>
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</table>

<table>
<thead>
<tr>
<th>Energy Charge:</th>
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<tbody>
<tr>
<td>First 100 kWh Billing Demand Per Month</td>
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<tr>
<td>First 3,000 kWh</td>
<td>$.1134 per kWh</td>
<td>$.1064 per kWh</td>
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<td>All Over 3,000 kWh</td>
<td>$.0825 per kWh</td>
<td>$.0755 per kWh</td>
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<td>Next 200 kWh Billing Demand Per Month</td>
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<td>All kWh</td>
<td>$.0787 per kWh</td>
<td>$.0715 per kWh</td>
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<tr>
<td>All Over 300 kWh Billing Demand Per Month</td>
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<tr>
<td>All kWh</td>
<td>$.0678 per kWh</td>
<td>$.0606 per kWh</td>
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Demand based on 30 interval anytime during billing period
Hwy 8 Pump Station Billing Analysis

Average Energy Costs - 13¢/KWH
Average Load Factor – 38% (low)
Hwy 8 Pump Station Optimization

- Downstream piping improvements caused existing pumps to operate inefficiently

- Reduced pump size to gain efficiency and reduce demand charges

### Hwy 8 Pump Station Power Demand Profile

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>20</td>
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<tr>
<td>4</td>
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<td>10</td>
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<td>12</td>
<td>10</td>
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<td>16</td>
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<td>20</td>
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<tr>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>24</td>
<td>20</td>
</tr>
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</table>

### Existing Power Demand vs. Optimized Time of Day Power Demand

<table>
<thead>
<tr>
<th></th>
<th>Peak Demand</th>
<th>Energy Usage</th>
<th>Annual Cost</th>
<th>Load Factor</th>
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<tbody>
<tr>
<td>Existing</td>
<td>24.5</td>
<td>10400KWH/Yr</td>
<td>$13,828</td>
<td>38%</td>
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<tr>
<td>Pumping Optimization</td>
<td>6.5</td>
<td>57000KWH/Yr</td>
<td>$5,787</td>
<td>69%</td>
</tr>
</tbody>
</table>
System Automation & Monitoring

• Some opportunities may require a high level of management
• Operations Automation
• System monitoring and performance verification
• “Self-management” vs 3rd party software
Future Energy Markets/Billing

United States transmission grid
Source: FEMA
Energy Market Trends

- Future concerns over transmission and distribution capacity
- Time of use and demand based rates gaining popularity
- Increase in load curtailment programs
Energy Market Trends

• Ability to manage/defer loads will increase in value.
• Water utilities can benefit from this trend by utilizing water storage and demand forecasting.
• On-site power generators can also be used to generate an revenue stream.