Energy Efficiency Best Practices for Drinking Water Utilities

2010 GWPC Water/Energy Sustainability Symposium

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The Cadmus Group, Inc.
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RESEARCH PROJECT

• Water Research Foundation Project #4223
  – Project Manager, Linda Reekie
• Co-funded with NYSERDA
  – Kathleen O’Connor
• Research Team
  – PI, Vanessa Leiby, The Cadmus Group, Inc.
  – Subcontractor, Michael Burke, CH2M Hill
• PAC Members: Richard Metzger, MVWA; Kevin Fisher, LVVWD; and Steve Conrad, Simon Fraser University
• International Research Project headed by GWRC
  – North America, Asia, Europe, South Africa, and Australia
GOALS AND OBJECTIVES

• Compile successful strategies to help water utilities reduce energy consumption
  – Reduce energy costs for individual utilities
  – Reduce GHG emissions that contribute to climate change

• Develop a compendium of best practices and case studies
  – Report
  – Searchable database
  – Presentations
CASE STUDY LOCATIONS
CASE STUDY UTILITIES

- American Water, NJ
- Ann Arbor Water Treatment Services, MI
- Austin Water Utility, TX
- Cedar Rapids Water Department, IA
- Cleveland Water Division, OH
- Columbus Water Works, GA
- Las Vegas Valley Water District, NV
- Metro Vancouver / Greater Vancouver Water District, BC, CN
• Mohawk Valley Water Authority, NY
• Monroe County Water Authority, NY
• New Jersey American Water, NJ
• Queensbury Water District, NY
• Suffolk County Water Authority, NY
• Village of Waterloo, NY
• West Basin Municipal Water District, CA
BACKGROUND

• $4 billion spent annually in U.S. in the water sector on energy

• 3% of U.S. energy consumption

• 56 billion kilowatt hours (kWh)

• 44.8 million tons greenhouse gas
• DW and WW treatment consume 30 – 60% of energy used by municipalities

• 80 – 90% of water treatment plant energy consumption goes to pumping

• Energy efficiency could be improved by 10 – 30%
AVERAGE ENERGY CONSUMPTION

Typical energy breakdown for urban drinking water supply (AwwaRF 2008)

Source → Treatment → Distribution → Tap

100 kWh/MG → 250 kWh/MG → 1,150 kWh/MG
ENERGY COSTS ARE INCREASING

- Installing new technologies
- Drought and climate change
- Aging infrastructure
- Growth and system expansion
- Increased demand
BENEFITS OF ENERGY EFFICIENCY

• Reduced GHG emissions
• Less strain on current energy grid
• Meet new state energy reduction targets
• Financial savings/reinvestment
  – New/better treatment
  – Distribution system/infrastructure upgrades
• Environmental stewardship
• Improved customer relations
POTENTIAL ENERGY SAVINGS

• Potential savings of 10-30% are readily achievable

• Water facilities can save
  – 10-15% through load shifting
  – 5-15% through VFDs and premium efficiency motors
  – 10-20% through process optimization and SCADA

• Installing meters and monitoring systems can save 10% of energy costs through behavioral changes and improved O&M
POTENTIAL BARRIERS

• Operational barriers
• Institutional barriers
• Political barriers
• Regulatory barriers
• Financial barriers
BEST PRACTICES

- Management Tools
- Plant Improvements and Operational Changes
- Water Treatment
- Water Distribution
- Water Conservation
- Alternative / Renewable Energy Sources
- Financial Assistance
- Partnerships
MANAGEMENT TOOLS

- Benchmarking
- Energy Audits
- Energy Management Systems
- EWQMS
PLANT IMPROVEMENTS AND OPERATIONAL CHANGES

- Lighting & HVAC
- SCADA
- Forecasting & Load Demand Profiles
- Long-range Planning
- Rate Structures
- Fuel Efficient Vehicles
<table>
<thead>
<tr>
<th>WATER TREATMENT</th>
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<tr>
<td>River Bank Filtration</td>
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<td>Slow Sand Filtration</td>
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<tr>
<td>Direct Filtration</td>
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<tr>
<td>Conventional Filtration</td>
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<tr>
<td>Diatomaceous Earth Filtration</td>
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<tr>
<td>Hydraulic Flocculation</td>
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<tr>
<td>Polyaluminum Chloride</td>
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<td>Air Stripping</td>
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<td>Membranes</td>
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<td>Ozone</td>
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<td>Ultraviolet Disinfection</td>
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<td>Desalination</td>
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WATER DISTRIBUTION

Hydraulic Modeling

Post Flocculation

Distribution System Piping

Pumps

Motors

Variable Frequency Drives

PRVs & Inline Turbines
WATER CONSERVATION

• **Supply Side**
  – Leak Detection
  – Metering
  – Alternate Supply

• **Demand Side**
  – Water Loss Audits
  – EPA’s WaterSense Program
  – Metering
  – Water Efficient Devices
  – Commercial and Industrial Efficiency
  – Alternate Supply
  – Conservation Rate Structure
ALTERNATIVE/RENEWABLE ENERGY SOURCES

- Solar Power
- Wind Turbines
- Geothermal
- Lake / Ocean Water Cooling
- Micro-Hydro Generation
FINANCIAL ASSISTANCE

- DWSRF and CWSRF
- ARRA-GPR
- Financial Incentives
  - State programs
  - Electric and power utilities
- State Funding Programs
- Energy Performance Contracting
PARTNERSHIPS

• Federal Government
• State Governments
• Universities
• Energy and Water Providers
• Trade Associations and Other Business Networks
STEPS FOR ENERGY PROGRAM

1. Commit
2. Baseline
3. Identify
4. Evaluate
5. Change
6. Quantify
7. Promote
BEST ENERGY PRACTICES: MANAGING ENERGY DEMAND

- Know your energy bill - work with energy provider, negotiate rates
- Add / use water storage to take advantage of TOU energy rates
- Pump during off-peak hours
- Demand forecasting
- Install renewable energy on-site
- Contract for guaranteed power (3rd party provider of solar/wind)
BEST ENERGY PRACTICES: HVAC

- Greatest opportunities at design phase - latest systems can reduce energy use 10-40%
- High efficiency AC can reduce cooling loads by 30-40%
- Controls can reduce energy use by 10-20%
- Regular cleaning of air filters can lower energy use by as much as 20%
- Programmable thermostats, ventilation fans, insulated building, low-emittance windows, reflective coating on building roof
BEST ENERGY PRACTICES: LIGHTING

- Lighting accounts for 35-45% of a building’s energy use; uses 2% of a plant’s total electricity load.
- Occupancy sensors can reduce lighting 10-20% with average payback period of 1 year.
- Upgrade incandescent lights with fluorescent systems – last 10x longer, 3x more effective, use 20-30% less wattage than conventional.
- Replace T-12 with T-8 lamps which are up to 34% more energy efficient.
- Replace mercury lights with metal halide or high-pressure sodium – yield 50% energy savings.
<table>
<thead>
<tr>
<th>BEST ENERGY PRACTICES: PROPER EQUIPMENT SIZING</th>
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<tr>
<td>Match pumps to intended duty</td>
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<tr>
<td>Design systems with lower capacity and total head requirements</td>
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<td>Where pumps are dramatically oversized, reduce speed with gear, belt drives, or slower motor speed</td>
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<td>Use two smaller pumps instead of one larger pump so excess pump capacity can be turned off</td>
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<tr>
<td>Use VFDs to match speed to load requirements for pumps</td>
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<tr>
<td>Correctly size pipes</td>
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<td>Automate controls</td>
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**BEST ENERGY PRACTICES: PUMPS, MOTORS, AND VFDS**

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<tr>
<th>Variable frequency drives (VFDs) can offer motor energy savings between 10-50% with payback of 1-8 years</th>
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<tr>
<td>Eliminate pump discharge throttling – savings can be as great as 50% of pumping energy</td>
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<td>Collect proper data and create a pump curve, properly maintain pumps</td>
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<td>Motor maintenance savings can range 2-30% of total motor system energy</td>
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<td>Replace standard efficiency motors with premium efficiency motors when standard are 5+ years old and run 75% of time</td>
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<tr>
<td>Premium efficiency motors are 2-10% more efficient than standard motors</td>
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<td>Water saved is energy saved</td>
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<tr>
<td>Average water loss 10-20%</td>
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<tr>
<td>Leak detection &amp; repair/replacement</td>
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<td>Accurate metering</td>
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<tr>
<td>Promoting conservation with consumers (rebates, home audits, etc.)</td>
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<td>Manage high-volume users</td>
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Available at the end of this presentation

- Web sites
- Resources
- Tools
QUESTIONS?

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RESOURCES

• Water Research Foundation  http://www.waterresearchfoundation.org/
• NYSERDA  http://www.nyserda.org
• EPA ENERGY STAR®  http://www.energystar.gov
• EPA Green Power Partnerships  http://www.epa.gov/greenpower
• EPA WaterSense  http://www.epa.gov/watersense
• AWWA WaterWiser  http://www.awwa.org/Resources/Waterwiser.cfm?navItemNumber=1516
• Consortium for Energy Efficiency  http://www.cee1.org
• California Energy Commission  http://www.energy.ca.gov/reports/efficiency_handbooks/index.html
• Alliance to Save Energy  http://www.ase.org
RESOURCES

• Alliance for Water Efficiency
  http://www.allianceforwaterefficiency.org
• California Urban Water Conservation Council
  http://www.cuwcc.org
• National Regulatory Research Institute
  http://www.nrri.org
• Electric Power Research Institute
  http://my.epri.com/portal/server.pt?
• DOE’s Energy Efficiency and Renewable Energy Clearinghouse
  http://www.eere.energy.gov
• USGBC and LEED program
  http://www.usgbc.org;
RESOURCES

• EPA Climate Leadership Partner Program  
  http://www.epa.gov/stateply
• EPA Drinking Water State Revolving Fund  
  http://www.epa.gov/safewater/dwsrf
• American Water Works Association (AWWA)  
  http://www.awwa.org
• Database for State Incentives for Renewables and Efficiency (DSIRE)  
  http://www.dsireusa.org
• Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities, USEPA  
  http://www.epa.gov/waterinfrastructure/pdfs/guidebook_s_i_energymanagement.pdf
• U.S. Department of Energy  http://www.doe.gov
RESOURCES

- Iowa Association of Municipal Utilities http://iamu-is-svr01.iamu.org/ww-cat
- Pump System Improvement Modeling Tool http://www.pumpsystemsmatter.org
- USEPA region 9’s website: http://www.epa.gov/region09/waterinfrastructure/benchmark.html
- Lean and Energy Toolkit http://www.epa.gov/lean
RESOURCES

- EPA Portfolio Manager

- DOE information on various alternative fuels
  http://www.fueleconomy.gov and
  http://www.eere.energy.gov/afdc/fleets/index.html

- DOE free software program, the Pumping System Assessment Tool (PSAT)
  http://www.pumpsystemsmatter.org/content_detail.aspx?id=112

- DOE 1*2*3 Approach to Motor Management resource tool to assist with motor repair / replace decisions
  http://www.motorsmatter.org/
RESOURCES

• DOE’s Motor-Master+International program
http://www.eere.energy.gov/Industry/bestpractices/software.html

• DOE factsheet Determining Electric Motor Load and Efficiency
http://www1.eere.energy.gov/industry/bestpractices/pdfs/10097517.pdf

• AWWA and International Water Association free water audit software program
http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511&navItemNumber=48158

• AWWA’s third edition M36 publication, Water Loss Control
http://www.awwa.org
RESOURCES

• DOE Save Energy Now Program
  http://www1.eere.energy.gov/industry/saveenergynow/assessments.html

• Energy Efficiency and Conservation Block Grant Program (EECBG)
  http://www.eecbg.energy.gov/

• USDA Rural Development
  – Rural Energy for America Program Grants/Energy Audit and Renewable Energy Development Assist
    http://www.rurdev.usda.gov/rbs/busp/9006loan.htm
  – Rural Energy for America Program Guaranteed Loan Program (REAP LOAN)
    http://www.rurdev.usda.gov/rbs/busp/REAPEA.htm

• U.S. DHHS Rural Assistance Center (RAC)
  http://www.raconline.org/funding/