# ENERGY EFFICIENCY STRATEGIES FOR WATER AND WASTERWATER UTILITIES

By
Nithiya Saravanan
Allison Harris
**EcoWorks, June 2017**

This report was prepared by EcoWorks with funding from C.S.Mott Foundation

# INTRODUCTION

Providing safe drinking water and reliable wastewater services is highly energy intensive in North America with estimates of $4 billion spent annually in the U.S. for energy in the water sector. EPRI estimates that 3% to 4% of U.S. energy consumption is used for drinking water and wastewater services. (EPRI, 2002)

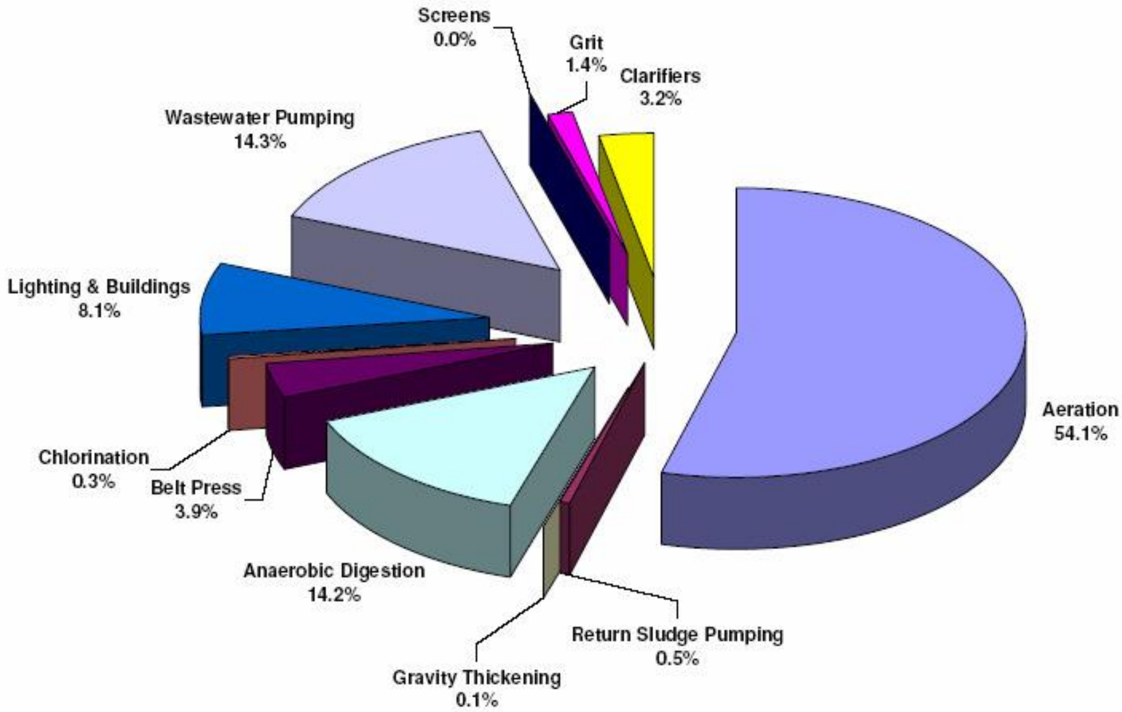
However, water and wastewater treatment systems have the potential to save significant amounts of energy, largely through replacing aging infrastructure of the industry with more efficient equipment. The utilities can reduce their annual energy costs by an average of 10% or more, freeing up resources for additional investments in energy efficiency and other priorities. (EPA)

Further, rising energy costs, combined with state initiatives to reduce energy consumption and Greenhouse gas emission reductions, makes this the best time for utilities to learn about and take steps to reduce their energy consumption.

This report provides information and resources to assist water/wastewater treatment facilities to reduce their energy consumption.

# OVERVIEW

For wastewater utilities, as illustrated in the below figure, the primary area to target improvement is aeration. Aeration electric demand could be reduced by using fine-pore




**Electricity Requirements for Activated Sludge Wastewater**

Derived from data from the Water Environment Energy Conservation Task Force *Energy Conservation in Wastewater Treatment* diffused air systems, turbo blowers and aeration process controls as detailed later in this report.

For drinking water utilities, the primary area to target improvements is pumps and motors since pumping accounts for 80 percent of the energy used at most water utilities (EPRI 2002). This may include pump rehabilitation, pump optimization, correctly sizing pumps, and use of variable frequency drives (VFDs). More details on key technologies are included in the pages that follow.

**Benchmarking** and conducting energy audits can help a utility define its current energy usage and establish a baseline from which to measure and track changes and reductions in consumption over time as energy improvements are implemented. This does not have to be complicated or overwhelming. For small systems, in particular, USEPA's ENERGY STAR® *Portfolio Manager* is free tool that can be used to establish an energy use baseline and even compare consumption with other utilities nationwide.

**Funding** is available to utilities to implement energy efficiency options. Beginning in 2009, State revolving funds (SRFs) now include a requirement for the states to allocate 20 percent of the capitalization grant to "green projects." For utilities, this includes funding for on-site production of power, energy audits, equipment upgrades, leak detection equipment, meter installation, and installation of water efficient devices. Other funding & financing resources are listed in Appendix A.

# ENERGY EFFICIENCY RECOMMENDAITONS/MEASURES

This section summarises the identified energy efficiency recommendations for water and wastewater utilities. The recommendations have been divided into the following sub sections

1. **Equipment upgrades**
   1.1 Variable Frequency Drives (VFD)
   1.2 Pump optimization
   1.3 High efficiency motors
   1.4 Turbo blowers*
   1.5 Fine bubble diffusers*
   1.6 Automatic continuous DO control*
2. **Operational changes**
   2.1 Anaerobic digestion & cogeneration*
   2.2 Data monitoring and automated controls
   2.3 Pollutant Emission and Pump Station Optimization (PEPSO)
3. **Facility upgrades**
   3.1 Facility energy audit
   3.2 Lighting, HVAC and Building envelope
   3.3 System leak detection & repair
   3.4 Demand side management
   3.5 Energy Education – Facility Personnel

*applicable only for wastewater treatment plants

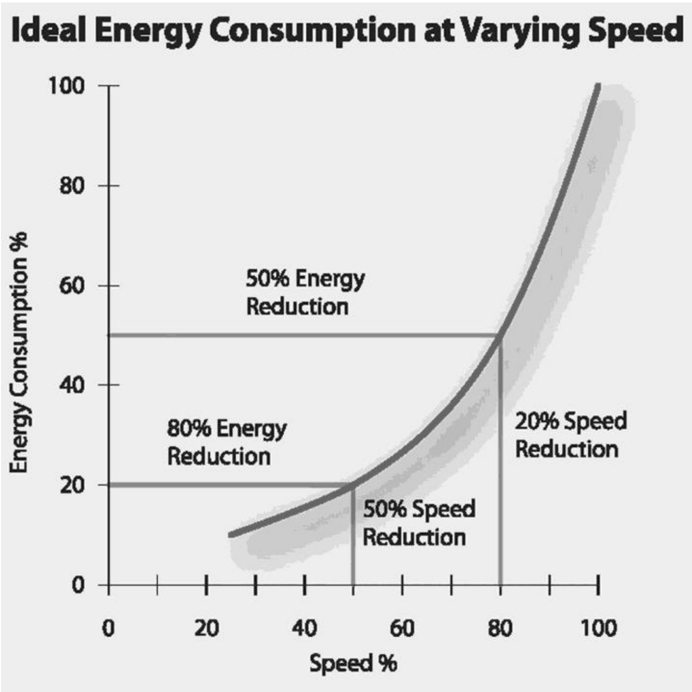
# 1. EQUIPMENT UPGRADES

## 1.1 Variable Frequency Drives (VFD) - Pumping, Aeration

Variable frequency drives (VFDs*)* match motor output speeds to the load requirement and avoid running at constant full power, thereby saving energy.

**Process/area of application:** VFDs apply to all pumps/blowers in a water/wastewater system. But it is most effective for pumps/blowers running 24 hours a day such as raw sewage pumps, aeration blowers.

**Economic Benefit:** VFD costs range from $100 to $500 /hp. Payback is typically from six months to five years (WERF, 2010)




**Energy Saving:** Savings range from 10% to 50% depending on the type of application.

### Additional Benefits

- Reduces starting current of motor
- Longer motor life due to reduction of thermal and mechanical stresses on motors and belts during start
- Better process control and regulation

## 1.2. PUMP OPTIMIZATION

Pump optimization can be achieved by changing operation processes such as adding multiple smaller pumps to an application to meet changing flow demand, resizing impellers(if pumps are over sized ), changing from fix-speed to variable-speed drives on pump motors, and establishing a regular pump maintenance and efficiency evaluation

**PROCESS/AREA OF APPLICATION**: All pumps in treatment and distribution systems

**ENERGY SAVING:** Energy savings range from 15% to 25% of pumping energy costs**.** For a motor or pump that is running constantly, efficiency increases of a few percent can result in large energy savings.

**ECONOMIC BENEFIT:** Many pump optimization options have a relatively short payback when incorporating savings from maintenance and energy costs.

## 1.3. HIGH EFFICIENCY MOTORS

Replace existing motors with new high efficiency motors. This practice is implemented when an existing motor is replaced or needs to undergo major repairs. However, in certain situations, such as high annual hours of operation, it may be financially beneficial to replace a working motor before the end of its useful life.

**PROCESS/AREA OF APPLICATION**: Can be applied to all electric motors in the plant, especially on well and booster pumps for water systems, and on those wastewater facility motors with high annual operating hours and those that operate during peak demand, e.g., aeration blowers, disinfection systems (seasonal), pumps and clarifiers.

**ENERGY SAVING:** Savings will vary, but should be at least 5% to 10% of the energy used by the lower efficiency motor to be replaced.

**ECONOMIC BENEFIT:** The simple payback is generally short, often less than two years, if the motor operates continuously.

## 1.4. Turbo Blowers

When compared to traditional blowers, direct-drive turbo blowers have demonstrated significant savings in power consumption and a comparison of typical blower efficiencies is given below.

Blower Type Typical Efficiency Range

| | |
|---|---|
| Single-stage Centrifugal Blowers | 65% to 80% |
| Multi-stage Centrifugal Blowers | 60% to 75% |
| Positive Displacement Blowers | 45% to 60% |
| Turbo Blowers | 70% to 85% |

Gearless high-speed turbo-blowers are a currently available retrofit technology for positive displacement blowers and multi-stage centrifugal blowers.

Turbo blowers are now offered by K-Turbo, Neuros, Turblex, HSI, ABS Group, Atlas Copco, and Piller TSC.

**Process/area of application**: Aeration tanks (Activated Sludge Treatment Facilities), Aerobic Digesters

**Energy Saving:** Energy savings range from 25% to 30%

### Additional Benefits

- Compact, lightweight and minimal installation requirements
- Low noise and require minimum maintenance.

## 1.5. Fine Bubble Diffusers

Fine bubble diffusers increase oxygen transfer and treatment efficiency more than coarse bubble diffusers. Because fine bubble diffusers transfer more dissolved oxygen into the water than coarse versions, less oxygen needs to be introduced, lowering the energy required to drive dissolved oxygen compressors.

| Aerator Type | Aeration Efficiency, kg $O_2$/kWh (lb $O_2$/hp hr) | |
|---|---|---|
| | **Standard Conditions** | **Field Conditions** |
| Fine pore aeration | 5 – 6.5(8.2 – 10.7) | 2.5 – 3.5 (4.1 – 5.8) |
| Coarse bubble aeration | 2.5 – 3.5 | 1.0 – 2.0 |

**Process/area of application**: Aeration tanks (Activated Sludge Treatment Facilities), Aerobic Digesters

**Energy Saving:** Energy savings range from 20% to 75% of the aeration or aerobic digestion unit's energy consumption. When operating at peak efficiency, the energy cost of fine pore aeration would be 40% to 50% less than for coarse bubble or mechanical aerators. (NYSERDA)

**Economic Benefit:**

For WWTPs with a flow of one MGD or less, the cost is about $35,000 per year per MGD.

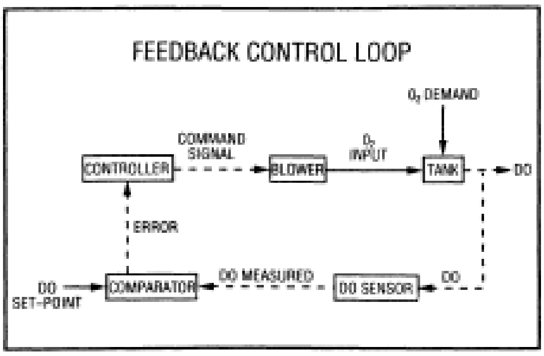
For the larger plants with capacities of five MGD or more, annualized capital costs are reduced to $10,000 to $11,000 per MGD. The higher cost per MGD for the smaller WWTPs is due to a higher fixed percentage of total construction cost. (NYSERDA)

Payback for replacing coarse-bubble with fine-pore aeration is five to seven years for most WWTPs. If mechanical aeration is removed to install a fine-pore system, the payback period drops to four to five years.

As noted previously, smaller WWTPs have a much higher specific cost for installing fine pore aeration compared to larger plants, resulting in a payback period two to three times as long.

## 1.6. Automatic continuous DO Control

Automated control of the aeration process can save a utility considerable energy by quickly adjusting to variable conditions within the basin. This maintains a DO concentration that matches the demand of biological activity.




**Process/area of application**: Aeration tanks (Activated Sludge Treatment Facilities), Aerobic Digesters

**Energy Saving:** Compared to manually controlled aeration systems, automatic DO control systems conserve 20-40% of aeration energy. (NYSERDA)

**Economic Benefit:**

Automated continuous DO control usually proves cost-effective for new activated sludge installations. Life-cycle cost assessment is recommended when modifying existing systems.

Payback periods for control systems installed at a one-MGD plant are 5 to 12 years depending on the type of aeration system.

For smaller WWTPs with less than one MGD of flow aeration system controls will probably not be economical.

For larger plants with capacities of five MGD or more, payback from energy savings of one to three years is possible for coarse-bubble aeration with controls, and two to four years with fine-pore control systems.

# 2. OPERATIONAL CHANGES

## 2.1. Anaerobic Digestion & Cogeneration

For larger, more dramatic savings, anaerobic digestion can be considered in place of aerobic digestion.

**Anaerobic Digestion**

Anaerobic digestion is used to produce biogas, which is utilized for on-site power generation. Anaerobic digestion is commonly used in medium to large WWTPs. The process is used to stabilize sludge, inactivate pathogens, produce biogas and reduce odour. Anaerobic digesters are typically temperature-controlled to grow mesophilic organisms and usually require supplemental heating.

Burning biogas produces thermal energy that can be wasted (flaring), used for heating (boilers), used for electricity (generation), or can simultaneously produce electricity and provide heating (cogeneration).

**Cogeneration**

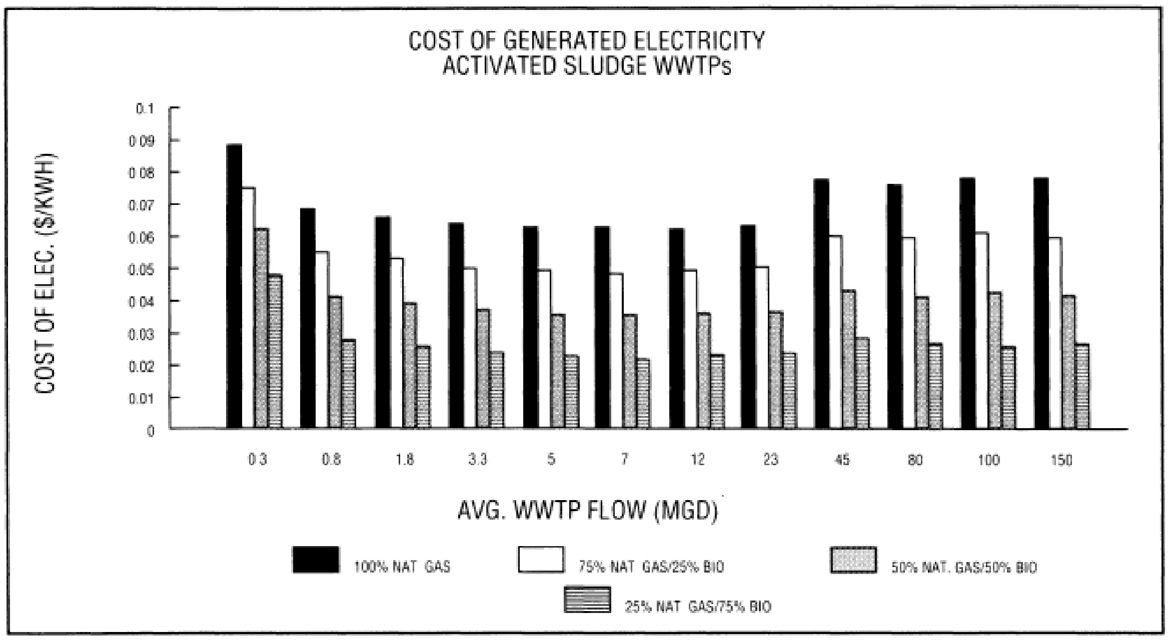
Cogeneration is typically the most energy-efficient use of the biogas because both heat and electricity are utilized locally. Electrical energy can be used internally in the plant or be exported to the electrical supply grid. Thermal energy could be used to heat digesters, dry sludge, or heat buildings.

The gas from anaerobic digesters varies in quality because of operating conditions and the composition of the digester influent. To increase the energy capacity of a system, the biogas could be supplemented with natural gas, if available.

IC engines and gas turbines are used to generate electricity from biogas

Internal combustion engines are commonly used with digester gas. Installations of 1,000 kW or less generally use engine-generators; gas turbines are preferred for capacities of 6,000 kW or more.

**Process/area of application**: WWTP Digesters




**Graph shows the costs of electricity provided by onsite cogeneration for a range of activated sludge treatment plant sizes using various combinations of natural gas and biogas fuels**.
Source: Energy Efficiency in Municipal Wastewater Treatment Plants, NYSERDA

**ENERGY SAVING:** Approximately 40-50% of the facility's electrical demand can be offset by power generated by the cogeneration system.

**ECONOMIC BENEFIT:**

Payback will be around 10 years (based on electric energy savings calculated at USD$0.075/kWH). Digester and cogeneration systems approximately cost $3 million. These systems become cost-effective at WWTP capacities of approximately 20 MGD and larger. (WERF, 2010)

## 2.2. Data Monitoring and Automated Control

Automatic data collection and computerized monitoring and control systems, such as Supervisory Control and Data Acquisition (SCADA), can track energy use, and improve overall system efficiencies by automatically controlling equipment operations, flow rates, and pressure based on real-time data.

SCADA and other electronic monitoring and reporting systems can significantly enhance a utility's ability to coordinate, track, and manage energy-related decisions and operational changes.

**Process/area of application**: SCADA systems are versatile and include multiple applications and can be set up to automatically monitor and control a single component of the water facility or all aspects of the water facility such as wells, pump stations, valves, treatment plants, storage facilities, etc. Additionally, water utilities can install SCADA systems in a step-by-step manner over time which allows the water utility to use the automatic control in areas that will provide the most benefit.

**Energy Saving:** The range of energy savings is typically 10% to 20%.

**Economic Benefit:** Payback is variable.

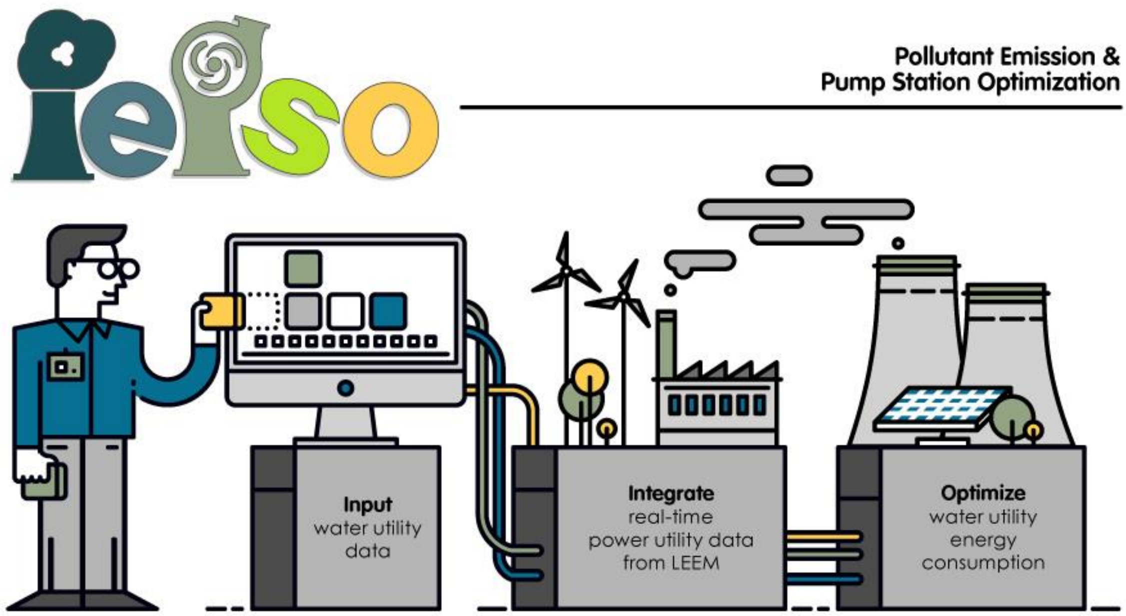
### ADDITIONAL BENEFITS

- SCADA also monitors equipment efficiency, detects leaks, performs meter reading, and can sound necessary alarms when operations are out of "normal" range.
- SCADA optimizes the complete system and provides cost savings through reduced operation and maintenance needs
- SCADA provides useful operation information for analysis of the facility's processes, energy use, and benchmarking comparisons.

## 2.3. PEPSO

PEPSO (Pollutant Emission and Pump Station Optimization) is a software package that performs optimization of large water distribution systems. It is a computational tool that allows near real-time targeted reductions of energy consumption, cost, and/or environmental footprint of water network operation.

More information is available at
http://engineering.wayne.edu/wsuwater/hydraulics/pepso.php
https://www.awwa.org/resources-tools/water-and-wastewater-utility-management/water-utility-energy-challenge/tools.aspx




**PROCESS/AREA OF APPLICATION**: All pumps in treatment and distribution systems.

**ENERGY SAVING:** Energy savings will vary depending on the level of optimization.

**ECONOMIC BENEFIT:** The modifications are generally procedural and do not have significant costs.

# 3. FACILITY UPGRADES

## 3.1. FACILITY ENERGY AUDIT

This document presents a number of opportunities for energy savings, but if you are interested in a more in-depth, holistic view of your facility, a trusted energy manager can perform an in-depth audit. Energy audits help a utility define its current energy usage and determine opportunities to improve energy efficiency. This does not have to be complicated or overwhelming. Audits can take 2 – 3 weeks and costs vary but expect to pay a few thousand dollars.

There are a number of management tools available to utilities to better understand their energy consumption, determine the most energy intensive areas of their system, define goals and energy conservation measures, develop a plan of action, and monitor progress.

USEPA's ENERGY STAR® *Portfolio Manager* - Free tool that can be used to establish an energy use baseline and even evaluate carbon emissions. This is a benchmarking & data management tool but cannot do the audit. More information is available at http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager.

**PROCESS/AREA OF APPLICATION**: Entire facility, with emphasis on major energy consuming processes such as pumping, aeration.

**ENERGY SAVING:** Energy savings identified will vary depending on the existing equipment and the opportunities identified. Savings range from 10% to 50% of the total energy consumption.

Note that the audit identifies opportunities for savings but doesn't actually implement them.

**ECONOMIC BENEFIT:** Payback period will vary with the complexity of the modifications and the required capital investment.

## 3.2. Lighting, HVAC & Building envelope

An integral part of a utility's facility energy improvements include the evaluation of potential benefits from upgrading the lighting, HVAC and the building envelope at the facility. Retrofitting with new lighting, HVAC technologies, insulation and windows and implementing maintenance programs have the potential to produce significant energy reductions and efficiency improvements.

**Lighting**

Advances in lighting systems provide water and wastewater utilities with opportunities to reduce energy consumption by retrofitting or providing lighting that are more efficient.

- Fluorescent lighting upgrades such as compact fluorescent lamps
- Light-emitting diode array upgrades
- Fixture upgrades
- High-intensity discharge lighting upgrades
- Occupancy sensor installation
- Scheduling controls installation

**HVAC**

New high-efficiency HVAC systems can reduce energy use as compared to conventional systems from 10 to 20 years ago. Air conditioning systems include roof top units, heat pumps, and chilled water systems. The energy efficiencies are associated with improved compressors, high-efficiency motors, and better insulation incorporated into the HVAC units.

**Building Envelope**

Building envelope upgrades aid in the reduction of energy costs. It is important to seal any breaches in the envelope that may compromise building performance. The physical components of the envelope include the foundation, roof, walls, doors and windows. Some of the upgrades are

- Air-sealing all wire, conduit and pipe penetrations to exterior of building
- Seal around doors and overhead door trims at cracks and mortar joints
- Replace caulking around any exposed areas of building and around all windows
- Window upgrades
- Exterior insulating wall systems

Note that we advise for a whole building approach, so if, for example, the building is better sealed & insulated then the new HVAC system may be reduced in size for the new building performance.

**Energy Saving:** Energy savings range from 20% to 40% of lighting and HVAC's energy consumption

**Economic Benefit:** Payback is variable

## 3.3. System Leak Detection & Repair

Identifying and fixing leaks can reduce a water system's real water losses and decrease pumping energy requirements. A leak can occur at any point in a water system because of a variety of causes including pipe age, pipe material, corrosion, freeze-thaw cycle, ground settlement, and surface loads.

**Process/area of application**: All distribution systems.

**Energy Saving:** Potential energy savings will vary with number and severity of leaks, and with system pressure.

**Economic Benefit:** Payback varies considerably depending on the size and complexity of the distribution system and the extent of any required repairs. Payback periods tend to be longer than for many energy efficiency projects since the energy savings may be small compared with the cost to repair the leak. The economics should also consider the value of lost water.

## 3.4. Demand Side Management

Management of peak demand (shifting to off-peak or shaving peak power usage) can substantially lower energy costs. The following can be done to optimize power use and reduce Electric Peak demand:

• Assess the typical and peak operation of your water and wastewater system to identify areas where peak power demand can be trimmed or shifted.

• Develop an operation strategy that meets overall system demand and minimizes pumping and specific treatment processes during peak power demand periods. Consider adding storage capacity or simply delaying the time of operation.

**Process/area of application**: All energy-using components of water and wastewater systems. Candidates for off peak operation in wastewater include bio-solids management (operate sludge presses in off-peak demand times); shifting recycling to off–peak periods; loading or feeding anaerobic digesters off-peak so supernatant does not recycle on-peak; operating mixers or aerators in aerobic digesters off–peak; and accepting or treating hauled in wastes during off–peak.

**Energy Saving:** These strategies do not necessarily minimize the energy consumption, but do minimize energy cost. We advise the cost savings be held in a separate account and used to fund energy conservation measures.

**Economic Benefit:** Paybacks are typically less than a year because the modifications are generally procedural and do not have significant costs.

## 3.5 Energy Education – Facility Personnel

All water and wastewater system personnel should understand the relationship between energy efficiency and facility operations.

**Process/area of application**: This practice focuses on personnel, especially those who make both long- and short-term decisions that affect energy use (including Board or Council members). It is useful to establish an annual schedule for energy training to keep facility management and personnel up to date on available technology and management practices.

**Energy Saving:** The energy savings for this practice will vary substantially depending on what measures are implemented.

**Economic Benefit:** The return will be a function of actual process changes made in response to recommendations.

# APPENDIX A: FINANCING RESOURCES

The main ways to finance energy efficiency projects are:

## Self –Financing

If your agency has sufficient internal funds, you may want to consider self-financing to avoid interest costs. Funds might come from your annual operating budget or may be borrowed internally from enterprise accounts. These accounts can be repaid from the project savings.

Self-financing may be the lowest cost option for financing your energy project and has the following benefits: 1) funds are immediately available, allowing for quick project implementation and early realization of the energy cost saving benefits and 2) internal funds have no points, fees or other transaction costs associated with them.

Alternatively, we encourage the establishment of a separate energy fund where 80% of savings are set aside in a revolving fund to help fund future investments.

## Loans – Public Agencies

**State Revolving Fund** (SRF), is a low-interest loan (2.5% for 20-year loans and 2.75% for 30-year loans in fiscal year 2017) financing program that assists wastewater treatment energy efficiency improvements.
For more information on state revolving fund see website at
http://www.michigan.gov/deq/0,4561,7-135-3307_3515_4143---,00.html

**Drinking Water Revolving Fund** (DWRF), is a low-interest loan (2.5% for 20 and 30-year loans in fiscal year 2017) financing program that assists water treatment energy efficiency improvements.
For more information on drinking water revolving fund see website at
http://www.michigan.gov/deq/0,1607,7-135-3307_3515_3517---,00.html

## Third-party financing

**Michigan Saves** is a non-profit organization that offers low-interest loan financing programs to Consumers energy & DTE energy commercial and municipal customers for energy efficiency improvements.
For more information on Michigan saves programs see website at
http://michigansaves.org/

**PACE**
Property-Assessed Clean Energy program is a revolutionary new financing tool that enables investment in comprehensive energy efficiency, water efficiency and renewable energy projects. The cost of the project is repaid via a special assessment on the property over a period of years. By financing such projects through PACE, businesses can eliminate the need for upfront capital and spread the costs over 15 or 20 years so that the savings generated

from the project are greater than the annual PACE loan repayment – generating immediate positive cash flow.

For more information on PACE see website at
https://energy.gov/savings/lean-and-green-michigan-pace
http://leanandgreenmi.com/index

**ESCO**
Energy performance contracting (EPC) can be used to finance energy efficiency improvements. Properly structured performance contracts can be considered in the utility's operating budget instead of as a capital expense.

Energy Services Company (ESCO) usually develops and manages EPCs, manages a wide range of tasks (audit, financing and implementation steps of energy management program) and assumes some or most of the technical and performance risk associated with the project. Examples include energy service provider-based financing and tax exempt lease-purchase agreements.

ESCO contracts should be vetted carefully with someone knowledgeable about energy services to protect the assets and interests of your organisation.

See the National Association of Energy Service Companies (NAESCO) website at http://www.naesco.org/ for more information and a list of service providers in your area.

**Energy Rebates**
Most Utilities including DTE and Consumers Energy provide substantial rebates to energy customers who make energy efficient upgrades. These rebates maybe available to water utilities also. For more information see website at
https://www.newlook.dteenergy.com/wps/wcm/connect/dte-web/home/business#

# APPENDIX B: STORIES OF ENERGY SAVING UTILITIES

**36 MGD ENCINA Wastewater Treatment Plant** (Activated Sludge with cogeneration)

Encina Wastewater Authority implemented the following energy efficient strategies:
Use cogeneration to produce on-site electricity and thermal energy
Use fine-bubble diffusers for aeration
Enact Electric Peak reduction strategies
Pump water more efficiently with variable-frequency drives
Upgrade standard motors to energy-efficient motors

### BENEFITS
### Cogeneration
Encina's cogeneration facility produces 80% of on-site power and provides heat to digesters and HVAC applications that would otherwise operate solely on purchased natural gas and electricity. As it currently operates, the system produces about 8 million kilowatt hours per year.

### Aeration
When expanding their plant, Encina chose fine-bubble diffusers over the less-efficient coarse-bubble versions previously used. The fine-bubble diffusers are estimated to save about 2,920,000 kilowatt hours per year. San Diego Gas & Electric financed 25% of the installation cost.

### Electric Peak Reduction
Encina adopted San Diego Gas & Electric's seasonally adjusted time-of-use rate. By shifting treatment process times, they were able to reduce their peak electricity demand.

Pumping off-peak has also produced savings. Equalization storage of process flows allows Encina to postpone disposal pumping until off-peak hours, at cheaper rates. Because the disposal pumps use 200 horsepower motors, savings can be considerable.

## Energy Efficiency Improvement Annual Estimated Savings

| **Estimated Total Annual Savings** | **$611,000** |
|---|---|
| Cogeneration | $300,000 |
| Fine-Bubble Diffusers | $225,000 |
| Electric Peak Reduction (off-peak pumping) | $50,000 |
| Variable-Frequency Drives | $21,000 |
| Energy-Efficient Motors | $15,000 |

Annual System wide Purchased Electricity after upgrades: **$174,300 (2.2 million kilowatt hours)**

# APPENDIX C: REFERENCES/RESOURCES

American Council for an Energy Efficient Economy (ACEEE)
http://www.aceee.org

American Water Works Association (AWWA)
www.awwa.org

California Energy Commission (CEC)
http://www.energy.ca.gov/reports/efficiency_handbooks/
http://www.energy.ca.gov/process/water/index.html

Consortium for Energy Efficiency (CEE)
http://www.cee1.org/

Environmental Protection Agency
www.epa.gov
Energy Efficiency for Utilities
https://www.epa.gov/sustainable-water-infrastructure/energy-efficiency-water-utilities

Focus on Energy, Wisconsin
https://www.focusonenergy.com/business/water-wastewater

New York State Energy Research and Development Authority (NYSERDA)
https://www.nyserda.ny.gov/

Energy Efficiency in Municipal Wastewater Treatment Plants (pdf)
https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/Energy-Efficiency-Municipal-WWTP.pdf

Pump Systems Matter (Hydraulic Institute)
http://www.pumpsystemsmatter.org/

U.S. Department of Energy – Best Practices (USDOE)
https://energy.gov/eere/office-energy-efficiency-renewable-energy

Water Environment Federation
www.wef.org

Water Environment Research Foundation
www.werf.org

Energy efficiency in wastewater treatment in North America, 2010(pdf)
Energy efficiency Best Practices for Drinking water utilities, 2011 (pdf)
http://www.waterrf.org/Pages/Projects.aspx?PID=4223