Energy Use Assessments at Water and Wastewater Systems Guide

A means of assessing your system's baseline energy consumption and costs in order to identify areas for improved energy efficiency and operational savings

Using the Energy Use Assessment Tool

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Abbreviations and Common Terms

Amp	Amperage
Energy Baseline	An energy baseline is developed by measuring and documenting your energy usage and costs at a specific time. This establishes a reference point for evaluating the effectiveness of future changes in process and equipment.
FLA	Full Load Amperage
Hp	Horsepower output
HVAC	Heating, Ventilation, and Air-Conditioning
W	Watts
kW	Kilowatts

Introduction

Energy use assessments can help water and wastewater utilities identify energy and cost savings. This booklet contains practical direction on how to begin an assessment as well as potential steps that systems could take after an assessment is completed.

EPA's Energy Use Assessment Tool is available to address areas where utilities tend to get stuck and is meant to guide them through the process. Some commonly seen issues are:

Trouble Establishing an Audit/Baseline

- Utilities tend to stop even before they start because of the cost of hiring third-party energy auditors.
- Most facilities do not have extra personnel with the energy expertise to diagnose areas of improvement

Where to begin

- Utilities may not be able to appropriately identify or prioritize projects (or operational modifications).
- Utilities may not be able to compare energy impacts of current technologies versus more efficient technologies.
- They may be unfamiliar with funding opportunities for energy efficiency.

This booklet will discuss how to establish an energy baseline using the Energy Use Assessment Tool, the next steps and the resources available to help along the way.

Benefits of Improved Energy Efficiency

Reduced operating costs

With energy costs rising, increasing energy efficiency can reduce the impact on your operating budget.

Opportunity for financial savings reinvestment back into the system

Many systems have not received upgrades because of budget limitations. Additional room in the budget from monthly energy savings can be used to make updates and repairs where they are needed.

Less pressure on freshwater resources

A nexus exists between the amount of energy consumed and the use of freshwater resources.

Less strain on current energy grid

With the rise in electric consumption, energy grids are being strained. More efficient large scale consumers can help reduce that grid strain.

Less greenhouse gas emissions

Reducing energy use results in less greenhouse gas emissions.

Environmental stewardship

Reducing energy use, and thus freshwater use, ultimately conserves the overall environmental quality and resources that we all need.

There is a Nexus between Water and Energy

Processing drinking water and wastewater is an energy intensive activity. It accounts for a large portion of a municipality's energy needs. For drinking water systems, energy is typically needed for raw water extraction and conveyance, treatment, water storage and distribution. Energy usage can vary based on water source, facility age, treatment type, storage capacity, topography, and system size, which encompasses volume produced and service area.

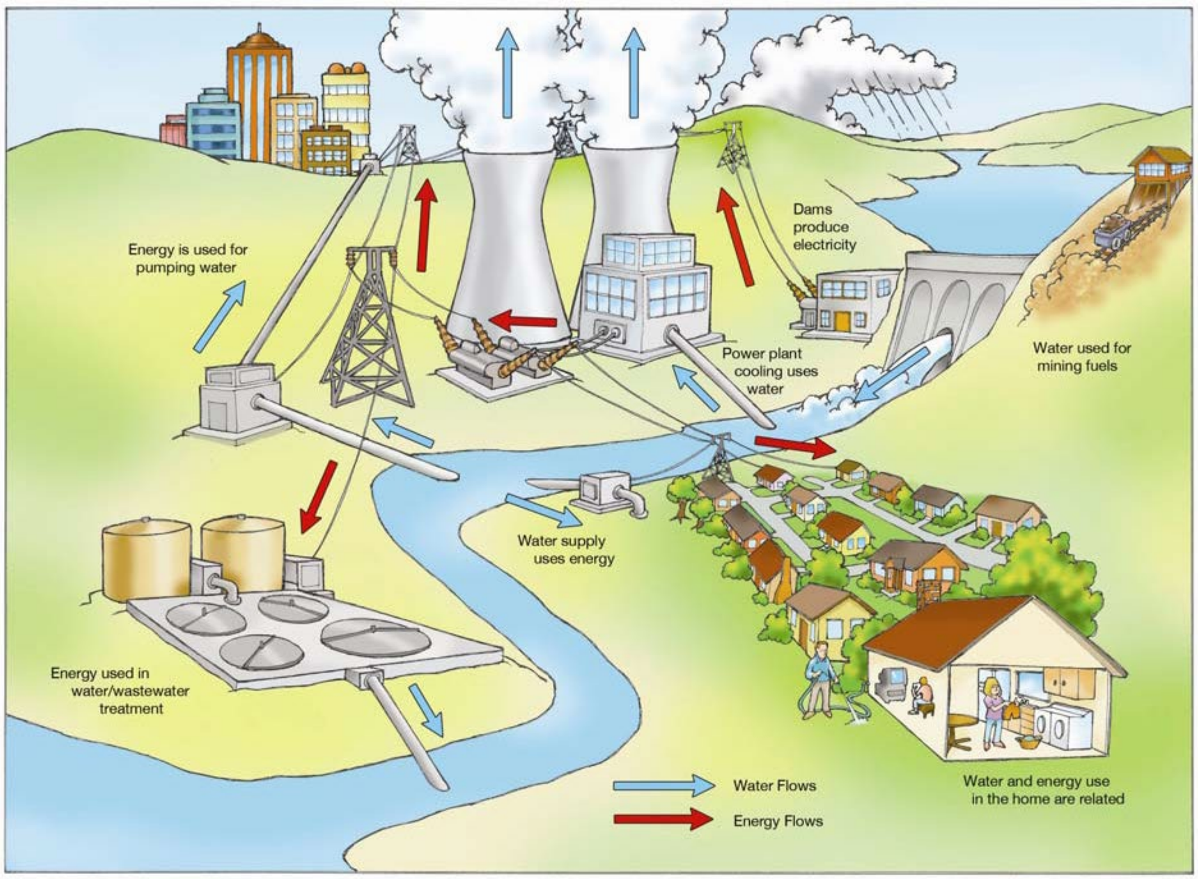


Image from "Energy Demands on Water Resources," U.S. Department of Energy, 2006 (pg. 13)

Producing energy needs water.

Extracting, treating and distributing water needs energy.

Conserving one reduces both.

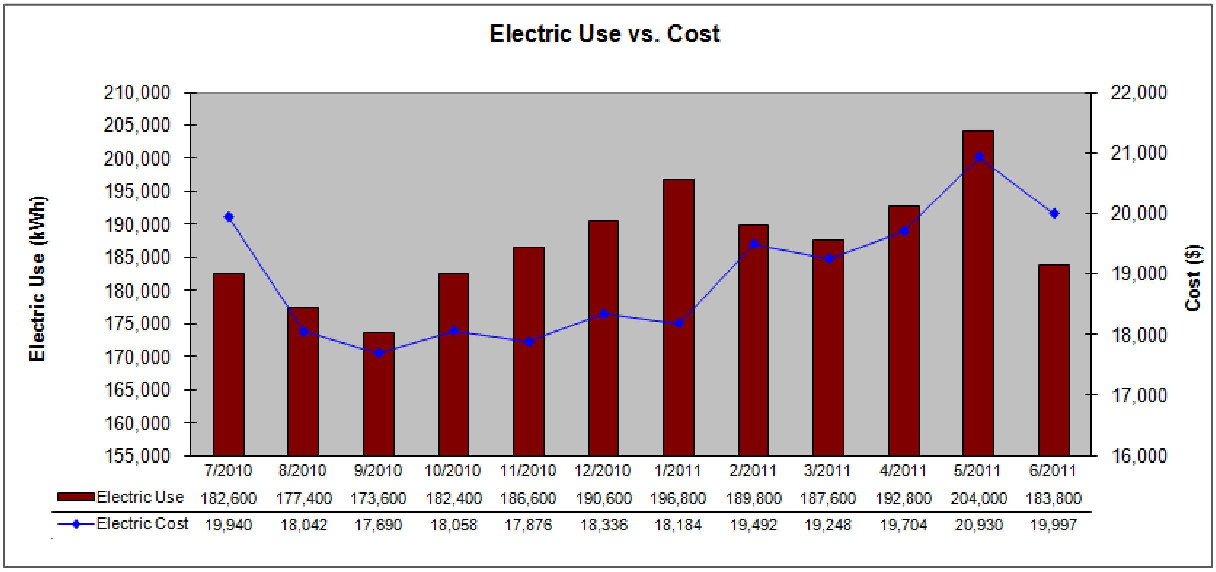
Energy Use Assessment Tool

Download the Energy Use Assessment Tool and User's Guide:

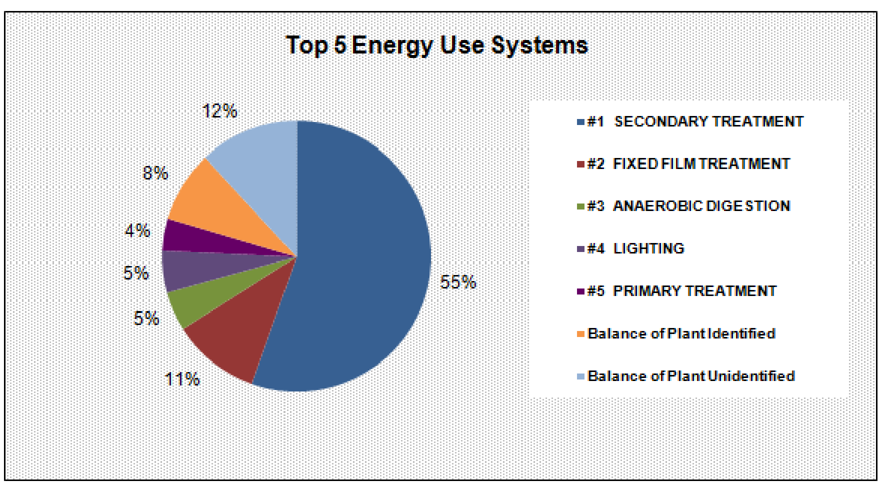
http://water.epa.gov/infrastructure/sustain/energy_use.cfm

The Energy Use Assessment Tool can be a key step in analyzing and ultimately reducing the energy usage at a small or medium sized water/wastewater system. The Tool helps to create an individual energy and cost baseline which can provide a utility an organized overall look at their facility's current energy usage.

This free, downloadable, Excel-based Tool helps to highlight areas of inefficiency that utilities may find useful in identifying and prioritizing energy improvement projects.



DISTRIBUTION OF ELECTRICAL ENERGY USE & COST BY MAJOR PROCESS FOR 7/2010 - 6/2011



Energy Use Assessment Tool

The Tool allows entry of up to five years of utility data. The Tool organizes the last five years of utility bills giving a clear look at how use and costs are trending. Use trends can show performance of existing or new equipment. It is recommended to enter more than just 12 months of data to develop useful trend comparisons.

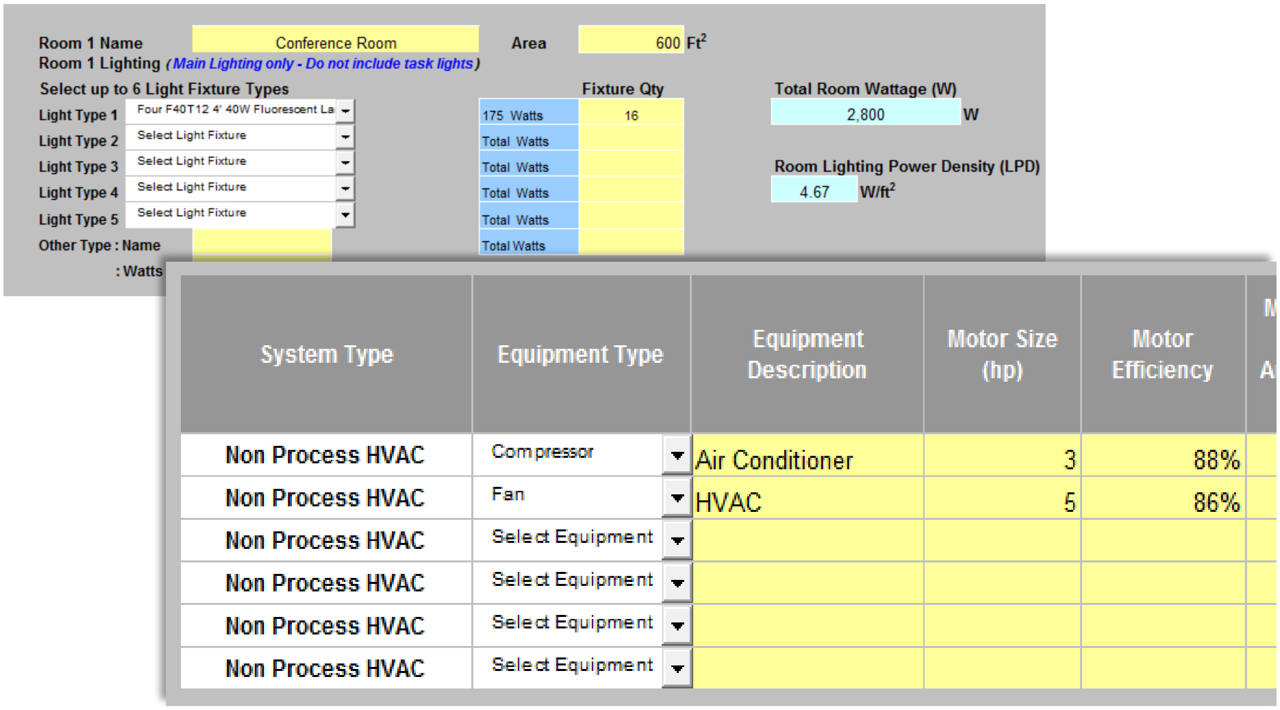
2011

Electric ($/kWh) $0.1018 Natural

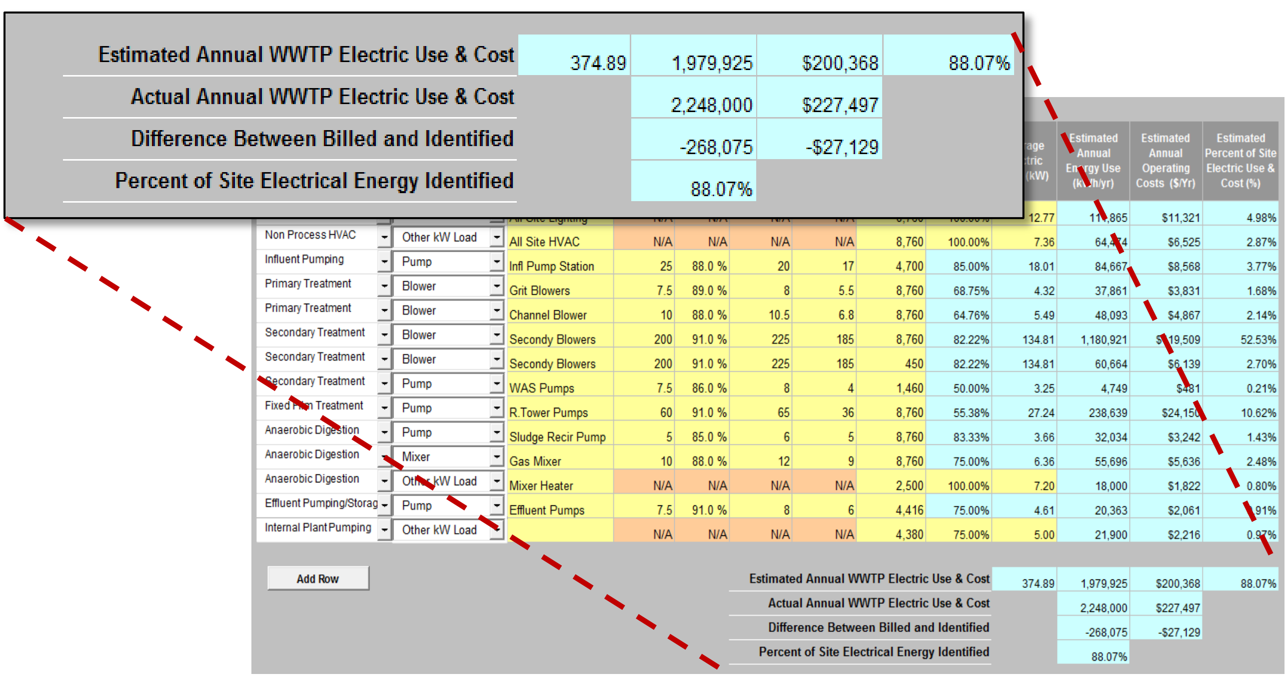
2011	January	February
Electricity Cost ($) 2011	$18,184.32	$19,492.46
Consumption (kWh) 2011	196,800	189,800
Natural Gas Cost ($) 2011	$6,146.54	$5,556.68
Consumption (CCF) 2011	5,276	4,782
No 2 Fuel Oil Cost ($) 2011	$16,231.03	$11,166.71
Consumption (CCF) 2011	14,260	10,279
Water & Sewer Cost ($) 2011	$12,320.06	$12,320.06
Consumption (GAL) 2011	2,210,986	2,210,986
Alternative Energy Cost ($) 2011	$1,914.90	$2,035.80
Consumption (CCF) 2011	1,473,000	1,566,000
Other - Propane Cost ($) 2011	$1,070.30	$1,535.60
Consumption (GAL) 2011	973,000	1,396,000
Total Utility Cost 2011	$55,867.15	$52,107.31
Treatment Volume (MGAL) 2011	112.240	107.500
Utility Cost/Treatment Volume ($/MGAI	$497.75	$484.72
Electric Utilization (kWh/MGAL) 2011	1,753.39	1,765.58

Energy Use Assessment Tool

The Tool also assists in detailing lighting and HVAC in each building. Comparison of lighting density may highlight areas of energy inefficiency.



Compiling the data of motor sizes, efficiencies and operating schedules into one place gives systems the ability to quickly assess opportunities for energy management of each area of the plant and determine whether it is more appropriate to replace equipment with newer technology or to instead change specific operational features of particular equipment.



Establish an Energy Baseline

An energy baseline is developed by measuring and documenting your energy usage and costs at a specific time. This establishes a reference point for evaluating the effectiveness of future changes in process and equipment.

To establish a baseline you will collect utility bills and the operating data of process equipment, HVAC equipment and lighting.

The more information that's collected will produce a better baseline, but do not get frustrated "completing" the baseline because you do not have everything collected. What is a good amount to cover?

- **One to two years of utility bills are a good start for an initial baseline.** If more can be provided (up to five years), additional opportunities can be discovered in repeating bill trends.
- **Accounting for 80-90% of the electric load is ideal**, after totaling each piece of equipment's electric energy.
- **An operation schedule is just as important as energy use and efficiency data.** If possible capture daily information about how long and at what times the equipment is operated. Also note what factor(s) may influence the schedule (e.g., is it driven by demand, the process or an arbitrary schedule? Are these factors adjustable?)

Tips to Establish a Baseline

Break the process up into palatable slices ahead of time.

- Evaluate a new room or process every couple of days.
- **Focus on the big energy users first: motors 10 hp or greater, major HVAC equipment and significant groups of lighting.**
- After filling out equipment information in the Tool you will see what percentage of the billed energy usage you have documented.
- If this percentage is low or you have more time, go through and evaluate smaller equipment until you have reached a percentage you are comfortable with.
- Again, check the percentage of the billed energy usage you have accounted for prior to running the numbers.

What Exactly Am I Collecting?

You will be collecting the operating data of the facility's equipment to feed into the Energy Use Assessment Tool.

Motors –
horsepower output (hp),
motor efficiency (%),
full load amperage (FLA)

Electrical equipment –
watts (W) or
kilowatts (kW)

Energy Load & Operating Schedule

You want to collect the energy load and the operating schedule for major equipment to determine its energy consumption.

Sub-metering

If your facility has sub-metering after the initial utility company meter, collect this information to quickly identify where your energy is being used.

Equipment Consumption

To estimate equipment energy consumption you will collect equipment **nameplate data.** The Tool will show you how to easily calculate energy consumption.

The Tool will estimate your plant's electricity consumption from motors by utilizing their current operating load as compared to its rated load.

Collect the nameplate Full Load Amperage (FLA) information. If a motor does not have this information, the Tool will estimate its energy from its horsepower.

If your site has trained and authorized personnel, have them **measure the current** with an amperage (Amp) meter.

- Note that this reading may fluctuate slightly throughout the day from varying loads.
- A motor typically operates at a current (i.e., amperage) lower than its rated FLA.
- If an amperage reading is not available, then the Tool will use a default 75% load factor as an acceptable estimate.

Note: To save you time, the Tool will only estimate electric use for motors based on horsepower or current load factors. The Tool does not include voltage and power factor as these values typically do not vary and the additional time and effort to collect and enter this information is not required for entry in the Tool.

Review Your Calculated Metrics

As you are filling out your baseline pay attention to a couple of metrics which will be calculated by the Tool:

- Note the **percentage consumption for each system** compared to the site's total energy. (The WTP Energy Usage tab or the WWTP Energy Usage tab)
- Note the utility's **monthly energy consumed per gallon of water or wastewater treated**. This is your plant's energy utilization. (Summary Report tab)
- Note that a utility that has equipment which is rightly sized for its treatment flows will tend to have fairly consistent energy utilizations from month to month.
- Note that utilities which have opportunities for improved equipment sizing may have greatly varying utilization from month to month.

The point of the initial audit/baseline is to get a general understanding of what the big energy consumers are.

Identify the areas where you can get good value for making improvements by:

- **Focusing on assets consuming the most energy.** It is important to not get lost in the little things when developing the initial baseline. You can spend incredible amounts of time trying to capture every tiny piece of equipment and every little detail of each piece of equipment, but a perfect model of your facility is not the goal of the baseline.
- The point of the baseline involves working in some generalities, rough numbers, industry averages and rules of thumb. As you gain more experience the generalities become more evident, but realize **you want quality numbers, but you do not need to waste time chasing perfection**.

After "completing" the initial baseline, keep it up to date.

If you make equipment or process improvements or changes, make the quick update to the baseline. This will avoid large future updates when you need to evaluate a new situation.

Baseline Evaluation

Which systems are dominating your energy consumption?

The results can sometimes be surprising. Assets that you did not expect to be a large energy user may be identified as top energy use systems. This may be due to a large number of smaller assets with long operating hours. Examples include lighting or ventilation equipment. These can collectively contribute to a larger than expected percentage of energy usage.

Where should I focus my improvement efforts first?

Systems that consume a large percentage of the total energy consumption are those you want to initially focus your improvement efforts. If a vendor is recommending higher efficiency equipment, you can use the Tool's electrical balance to compare and contrast the potential impact to the site.

Will an improvement actually affect my bottom line?

Consider a scenario, a vendor approaches you with a 20% more efficient pump, which sounds great, but do you use that pump enough for the efficiency increase to save you energy and money? Once a baseline is developed then you will be able to more easily determine if an energy savings idea will actually affect the bottom line.

Energy bill usage trends can also provide opportunities for improvement.

Seasonal increases are expected, but drastic swings could point to a greater issue in HVAC or process design.

Increases in energy use per gallon of water or wastewater treated can show that aging major equipment is oversized or becoming ineffective.

What Will a Baseline Ultimately Do?

Having an organized baseline laid out in front of you can cause obvious improvements to become apparent that you may have never considered.

You may be shocked by what percentage of your energy use is consumed by lighting, digester pumps, etc.

A baseline allows you to quickly see the impact of changes to your budget.

Modifying your baseline to include new equipment being installed as part of a new process or expansion will quickly allow you to see the impact on the annual operating budget beyond the initial installation costs.

You are converting a garage to a chemical storage area, but it needs heat and ventilation. What is the potential impact of this change to your annual operating budget? You can use the Tool to enter the cut sheet data for the exhaust fan and electric unit heaters with expected run hours per year to determine the potential energy cost impact per year.

Having a baseline will help make day-to-day decisions easier.

The baseline can quickly be changed to see how replacing a piece of equipment may affect operating costs. It may be cheaper in one year’s time to buy and install a new premium efficiency motor than to operate and maintain an older unit.

If the modified baseline shows a savings, use it as documentation to get approval for purchasing the new equipment.

Next Steps — Opportunities for Improvement

1. Prioritize further investigation of opportunities to reduce your energy use.

With energy evaluations the first goal is to find the “low hanging fruit.” These are the changes to your operations or equipment that are cheap and/or quick to implement.

At first, focus on discovering opportunities for energy savings on the assets with the largest energy consumption; that is where your biggest savings can be made.

Once you have entered your information to a reasonable accuracy and create your energy usage baseline, you can identify where the majority of energy is being used.

As time permits, work down to progressively smaller assets until you have the “Balance of Plant Unidentified” as low of a value as possible. Focus on assets that run for long hours.

Next Steps — Opportunities for Improvement

Do not ignore lighting and HVAC as these areas have had recent technological improvements. Even an one-for-one replacement can provide great energy savings, sometimes at very low payback costs. Also, compare room lighting power densities as a first step to potentially identify where areas of the plant may be over lit.

Look to make operational changes before capital changes as these can often be at no cost.

Sometimes simple operation or technological changes can greatly reduce run time and cut large portions of energy consumption.

2. Determine operational improvements to reduce energy use.

Time is money when it comes to energy consumption and run time is a large factor in the amount of energy an asset uses. Changing operational procedures and schedules could reduce overall costs.

Shutting equipment down rather than leaving it idle during long periods of inactivity is an easy operator or programming change. Look for process equipment that is left on during non-processing periods or lighting and heating that are left on when a building is vacant.

Making these changes can provide great savings at little to no cost.

Ask yourself if you can operate this equipment during non-peak electricity hours when the $/kW or $/kWh is lower?

Next Steps — Opportunities for Improvement

Stagger equipment startup and the number of large pieces running simultaneously to avoid costly demand charges.

Electrical bills typically have Peak Demand charges which can be 25-50% of the plant's total electric bill. That means the more electric load the site consumes at one time, the larger the fee. Such peak demand is often carried over for months or years after it occurs. Starting or running multiple pieces of large equipment simultaneously multiplies the demand spike and your electricity bill.

Therefore, staggering equipment (such as those with cyclical operation) may reduce the system's peak demand and greatly reduce electrical fees.

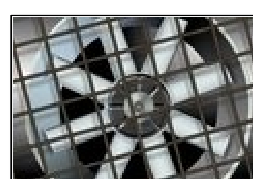
Consult your utility rate schedule and/or utility representative to determine your plant's demand interval (e.g., 15 minutes, 30 minutes) to be sure you are making adjustments within the necessary time periods required by your rate schedule.

3. Determine equipment improvements to reduce energy use.

What technology is being used currently versus new alternatives that are available?

Do we need new equipment or can we retrofit existing equipment?

For buildings with no to low occupancy, lighting may be retrofitted with motion sensors. Also, depending on area ventilation requirements, ventilation fans may be retrofitted with controls that turn them down based on occupancy sensor or timer based devices.



Next Steps — Opportunities for Improvement

Compare current technology and equipment to alternatives that are higher efficiency. Ask yourself, what is the opportunity cost?

Lighting upgrades can result in large increases in efficiency. Payback results can be under a year or two.

Lighting and HVAC can often be oversized for the plant; however, it is important to consult an engineer who is an expert in regulations and safety before making fixture, lamp, ballast, quantity, heating, cooling, ventilation or control changes.

Should you get new equipment?

Gather capital, operating, and maintenance costs for new equipment and compare that to your existing operating costs. This is where you want to double check that you are accurately evaluating your existing equipment's energy usage.

- Don't get overly confident in theoretical claims. Actual results may not fully reach their manufacturer's claimed efficiencies.
- Replacing equipment that runs continuously will generally pay back faster than intermittently used equipment.
- Remember that you can have two identical pumps but different motors and net energy consumption. (The motors may be of different ages or different efficiencies.)
- Once high energy use equipment is identified, then analyze its efficiency.
- Can you turn existing waste into profit (e.g., Can digester gas be utilized for fuel in your boilers or a micro turbine)?
- See if there any local or federal programs that will assist in funding capital improvements for increasing your energy efficiency.
- Determine if your buildings and outdoor equipment are properly insulated. Improving insulation thickness, type and condition can dramatically decrease energy waste.

Next Steps — Opportunities for Improvement

4. Use the Tool to compare and contrast energy impacts (reductions or increases) from contemplated equipment upgrades or technology changes.

Save another copy of the Energy Use Assessment Tool to alter for hypothetical site changes. Change the baseline equipment listed in the Tool with different lighting types, more efficient equipment, or different operating schedules to see the possible yearly savings instantly. Note that these are estimates and there will always be differences in the actual utility savings.

Equipment Inventory: Breakdown of Electrical Energy Use for Major / Energy Intensive Equipment

Major Process/Top Energy Use Systems	Motor Efficiency (%)	Efficiency Rating	Electric Energy Use (%)	Electric Energy Use (kWh)	Electric Energy Cost ($)
Chemical Mix and Feed					
Blower - Blower 1	65	Low	0.29%	6,427	$650.42
Blower - Blower 2	65	Low	0.29%	6,427	$650.42
Clarification					
Mixer - Rapid Mixer	78	Low	2.12%	47,566	$4,813.71
Mixer - Tk Mixers Summer	9.6	Low	11.69%	262,707	$26,585.93
Decarbonation					
Mixer - Decarb Mixer 1	88	Medium	1.13%	25,364	$2,566.84

5. Use the Tool to confirm energy impacts (reductions or increases) as operational or equipment modifications or replacements are completed.

Keep the Energy Use Assessment Tool up-to-date as changes are made to the system and see the impact to utility consumption and provide a baseline for further work.

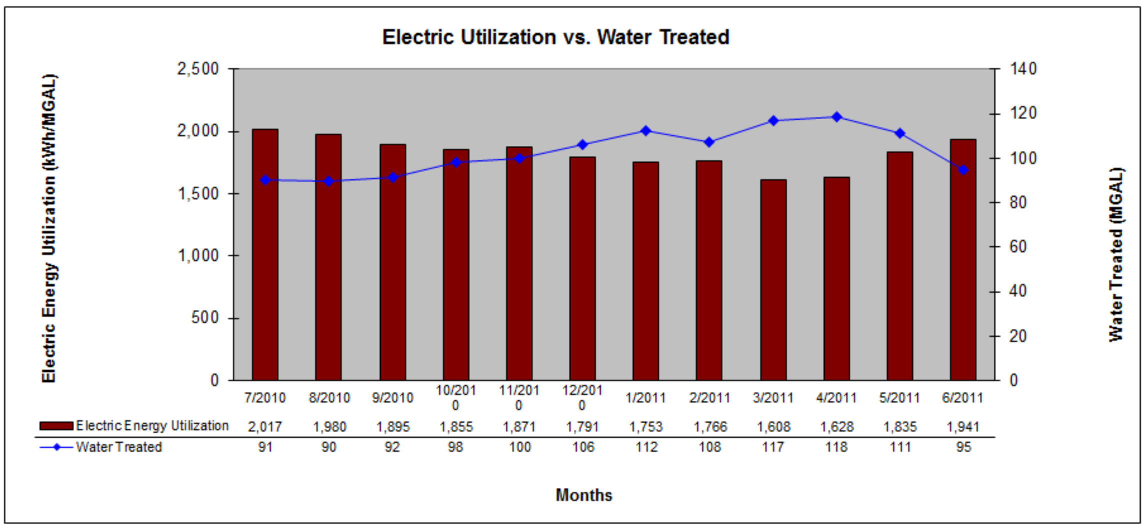
Next Steps — Opportunities for Improvement

6. Seek detailed engineering insight.

Process opportunities might exist beyond improving motor efficiencies and one-for-one upgrades. Seeking a detailed engineering analysis of the system's largest energy consuming processes could reveal new technologies or alterations to the original design that can reduce energy consumption.

7. Utilize the Summary Report.

- Provide a focused snapshot of the past and current energy utilization at the plant each month.
- Review trends to compare and contrast energy use and costs from month to month, season to season, and year to year.



8. Use the Tool to track site energy.

- Confirm use and cost impacts from operational and equipment improvements (and make sure these savings are captured each month).
- Identify quickly when use and/or costs have increased.
- Show where there may be system limitations at the plant requiring further analysis (e.g., where equipment is oversized and doesn't allow the plant to right size energy use as treatment volumes increase and decrease).

Resources

Getting Through an Energy Audit

EPA's EnergyStar Portfolio [www.energystar.gov/benchmark]

Understanding Your Electric Bill
[http://water.epa.gov/infrastructure/sustain/upload/Understanding-Your-Electric-Bill.pdf]

How to Hire an Energy Auditor
[www.energy.ca.gov/reports/efficiency_handbooks/400-00-001C.PDF]

Energy Action Plans and Request for Proposals (RFPs)

EPA's Ensuring a Sustainable Future: Energy Management Guidebook for Wastewater and Water Utilities
[www.epa.gov/waterinfrastructure/pdfs/guidebook_si_energymanagement.pdf].

Consortium for Energy Efficiency RFP Guidance for Water-Wastewater Projects
[www.cee1.org/ind/mot-sys/ww/rfp/index.php3]

5 Steps to Successful Energy Performance Contracting
[www.energyservicescoalition.org/resources/5steps.htm]

Best Practices

Water and Wastewater Energy Best Practice Guidebook
[www.werf.org/AM/Template.cfm?Section=Home&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=10245]

NYSERDA Water & Wastewater Energy Management Best Practices Handbook
[www.nyserda.ny.gov/Page-Sections/Commercial-and-Industrial/Sectors/Municipal-Water-and-Wastewater-Facilities/~/media/Files/EERP/Commercial/Sector/Municipalities/best-practice-handbook.ashx]

Saving Water & Energy in Small Water Systems
[http://watercenter.montana.edu/training/savingwater/default.htm]

Resources

A Closer Look at Pumps

Pump System Assessment Tool (PSAT)
[www1.eere.energy.gov/industry/bestpractices/software_psat.html]

Pump System Improvement Modeling Tool (PSIM)
[www.pumpsystemsmatter.org/content_detail.aspx?id=110]

Improving Pump System Performance: A Sourcebook for Industry
[www1.eere.energy.gov/industry/bestpractices/pdfs/pump.pdf]

A Closer Look at Motors

DOE factsheet Determining Electric Motor Load and Efficiency
[www1.eere.energy.gov/industry/bestpractices/pdfs/10097517.pdf]

U.S. DOE Motor Challenges Program
[www1.eere.energy.gov/industry/bestpractices/techpubs_motors.html]

Water Efficiency

U.S. EPA WaterSense [www.epa.gov/watersense]

American Water Works Association (AWWA) Water Audit Software
[http://www.awwa.org/resources-tools/water-knowledge/water-loss-control.aspx]

Green Energy

U.S. EPA Green Power Partnerships [www.epa.gov/greenpower]

U.S. DOE Energy Efficiency and Renewable Energy Clearinghouse [www.eere.energy.gov]

Saving Water & Energy in Small Water
[http://watercenter.montana.edu/training/savingwater/default.htm]

Resources

Funding

DWSRF Green Project Reserve Guidance [www.epa.state.il.us/water/financial-assistance/publications/green-project-reserve-guidance.pdf]

DWSRF Contacts by State [www.epa.gov/ogwdw/dwsrf/nims/dwagency2.pdf]

Database of State Incentives for Renewables & Efficiency (DSIRE) [www.dsireusa.org]

Federal Energy Management Program (FEMP) [www1.eere.energy.gov/femp/financing/energyincentiveprograms.html]

U.S. Department of Energy

- ✓ **Save Energy Now Program** is an initiative to reduce industrial energy intensity. Companies can participate in no-cost energy assessments. [www1.eere.energy.gov/industry/saveenergynow/assessments.html]
- ✓ **Energy Efficiency and Conservation Block Grant Program** (EECBG) [www1.eere.energy.gov/wip/eecbg.html]

U.S. Department of Agriculture (USDA)

- ✓ **Rural Energy for America Program Grants/Energy Audit and Renewable Energy Development Assist** (REAP/EA/REDA) [www.rurdev.usda.gov/rbs/busp/REAPEA.htm].
- ✓ **Rural Development through the Rural Energy for America Program Guaranteed Loan Program** (REAP LOAN) [www.rurdev.usda.gov/rbs/busp/9006loan.htm]

U.S. Department of Health and Human Services - Rural Assistance Center (RAC) [www.raconline.org/funding]

Questions?

Contact us at

EnergyUseTool@epa.gov

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