ENERGY AUDITS: BENEFITING YOUR DRINKING WATER AND WASTEWATER TREATMENT FACILITY

Energy accounts for about one third of the operating budget for drinking water and wastewater systems. It's a facility's largest controllable budget item so it's a logical place to look for savings.

The most important step in reducing energy costs is to have a good understanding of where the energy is being used in the facility. The first step is to conduct an energy audit to: evaluate possible operational adjustments and concepts; conserve energy and save money; and maintain or improve facility performance.

Generally, an energy audit is a component of an overall energy management program. Similar to a periodic maintenance program, an energy management program (focusing on energy conservation) is a continuous process. A detailed audit is only helpful if there is an ongoing strategy for implementing the recommended upgrades. Having an "energy champion" responsible for monitoring and meeting energy management program goals and also the authority to implement operational changes is critical.

What is an Energy Audit?

An energy audit is an inspection and analysis of the energy usage of your facility. The end product is the identification of energy conservation measures (or energy saving projects) that reduce the total energy consumed without impacting the final product. Energy audits are conducted by professionals who have experience in energy management and drinking water and wastewater treatment plant operations. Audits can range from a simple walk through to a more comprehensive, customized effort involving review of plans and specifications, evaluation of the efficiency of equipment (e.g. pumps, blowers, and motors), and review of capital improvement and long term plans. Through an audit, wasteful situations like excessive leakage from a pump (e.g. worn impeller) or operating conditions that are stressing motors unnecessarily (e.g. valve throttling) will be identified. Also, other energy wasting practices, as simple as lighting, heating, and air conditioning usage, are noted.

The majority of potential energy saving measures are process optimization and equipment upgrades. A fundamental process example is over aeration. If activated sludge is over aerated, there is a potential for the sludge not to settle well. By controlling the dissolved oxygen at an ideal set point, the sludge settling may improve and the facility will save energy. Immediate paybacks may be achieved from process adjustments, similar to dissolved oxygen control, and changes in daily procedures that impact energy usage, such as adjusting building temperatures or shifting operations to off peak hours. Capital improvements, such as energy efficient motors, may accomplish significant energy reductions with paybacks of 3-5 years (20% - 30% Return on Investment).

Audit Options

There is a range of energy audit options from preliminary (walk through) to very detailed audits. Detailed audits take much more time and effort, depending on the size and type of treatment plant and the number and complexity of potential energy saving measures to be evaluated. If uncertain on whether to have a full scale audit conducted, it is suggested that a preliminary audit be scheduled, taking from a day to two weeks. The time is generally spent interviewing operators, taking photos, and walking the plant identifying pieces of equipment and/or process upgrades that warrant further investigation. The deliverable for this type of audit is a report detailing the opportunities for conserving energy with very rough cost estimates. At this point the auditor should be able to advise whether a full scale audit is likely to identify significant energy saving opportunities. A preliminary audit generally costs around $1,000 to $5,000.

A detailed audit, on the other hand, may take several weeks to several months to complete. During this time, auditing staff may be on-site intermittently. Auditors may set up metering equipment to track pump run times and electric usage to calculate pump efficiencies and replacement equipment paybacks. Detailed audits typically range from as low as $10,000 to as high as $100,000 with deliverables varying from technical memos to multi-volume reports.

To receive meaningful and appropriate recommendations that are within the budget, it is critical to clearly define the scope of work and to communicate expectations and desired outcomes. An option is to focus on one process, such as aeration, to keep the cost down.

A factor that influences costs is the level of detail requested regarding implementation costs i.e. rule of thumb estimates, desktop (RS Means) calculation, or actual vendor quotes. An audit could consider electrical rate structures and renewable energy alternatives as well as energy efficiency measures.

Tip: State and local environmental and health agencies and energy companies often offer free energy audits. Although likely a basic audit, it is a step in the direction of becoming more energy efficient and boost morale. It is recommended to also inquire whether these same agencies/companies fully or partially fund energy projects. The U.S. Environmental Protection Agency's (EPA) premiere funding source for drinking water and wastewater improvement projects is the State Revolving Fund (SRF) Program. The SRF program promotes the funding of green projects. Check with your state agency for the availability of low interest loans.

Homework in Advance of an Audit

Prior to conducting an energy audit, there is some homework involved. Knowing how your facility is performing in terms of energy efficiency, relative to other similar facilities, is valuable information. The EPA Energy Star Portfolio Manager web site has an energy benchmarking tool that is easy to use. Inputs to this on-line tool include the facility's annual energy use, treatment processes, and average influent and effluent water quality. The tool generates an output 'score' between 0 and 100, where 0 represents the least energy efficient facility and 100 represents the most energy efficient facility. The majority of plants score between 40 and 60. Typically plants with scores below 65 have easily identifiable energy saving opportunities. This confidential tool is also used to track energy usage, flow, and green house gas production. (Energy Star Portfolio Manager: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager)

Depending on the level of energy audit conducted, the energy auditor may request information on the plant's existing equipment, processes, operation and energy use. This information could include: asbuilt/record drawings; original basis of design reports; operator logs; operation and maintenance manuals; at least two years of energy bills; and equipment maintenance history. Ideally, the energy auditor will meet with and interview plant operators and other staff.

When to Conduct an Audit?

An ideal time to conduct an energy audit is prior to a facility upgrade, since some energy saving measures may be economically unfeasible on the basis of energy savings alone. As an example, it may not be feasible to replace a very inefficient pump motor if it only runs a few hours a day. However, as part of an upgrade, replacement of the motor with a more efficient, maintenance-friendly motor might be cost effective. Consequently, an upgrade presents a unique opportunity to invest in energy efficient equipment. Otherwise, it is a good practice to replace a piece of equipment or treatment process when it has failed or is reaching the end of its useful life with an energy efficient replacement.

Due to system changes, new technology innovations, and varying energy costs, it is recommended that energy audits be repeated every three to five years or before a major project.

Auditor Qualifications

When selecting an auditor, seek a firm with a history of successful audits in the industry. Consider asking other neighboring utilities about their experience or references to contact. It is important that the energy auditor be an expert in energy management and drinking water and/or wastewater facility operations and design.

The auditor should be able to look at lighting, air conditioning (HVAC), pumps and motors, and they should also have experience working in both the liquid and solids phases of the treatment process. A skilled drinking water or wastewater treatment plant energy auditor will be able to identify not only typical commercial-building

energy upgrades (lighting, motors, HVAC), but also process equipment changes and/or process upgrades with reasonable paybacks.

Along with a good background in drinking water and wastewater operations, there are two certifications an auditor may have. The Association of Energy Engineers (AEE) administers certification programs for Certified Energy Managers (CEM) and Certified Energy Auditors (CEA). These are helpful and comprehensive certifications, but are not specific to drinking water and wastewater treatment and pumping facilities.

Request for Proposals and Request for Qualifications

The procurement method to obtain the services of an energy auditor may vary depending state and local regulations. One possible option is to draft and advertise a Request for Proposal (RFP). An RFP is generally solicitation made by a utility interested in the procurement of a service.

When preparing an RFP, consider asking that the audit report include estimated payback times, a prioritized list of suggested capital expenditures, and specify that any recommendations relating to process changes should be consistent with performance requirements of the facility. A good RFP must clearly define the scope of work, the level of detail required for the evaluations, and the breadth and depth of the deliverable. A thorough RFP also includes a section on financing options, e.g. potential grant and funding programs that could help offset energy saving measure implementation costs.

Rather than soliciting a detailed pricing and project scope, an option is to select an auditor based on qualifications by soliciting for a Request for Qualifications (RFQ). A RFQ allows for communication and planning with a selected contractor. Together, plant needs are identified, plant processes understood, and a comprehensive list of upgrades that meet the current and future needs of the plant, while staying within budget, is developed. It is suggested that a RFQ request information on:

- Past experience with drinking water / wastewater treatment plants
- Specific upgrades identified, installed and guaranteed in previous projects
- The process used to develop energy projects in general, and at wastewater treatment plants in particular
- Typical methods for demonstrating ongoing energy savings (measurement & verification methods)
- Individuals who will perform the audit and their experience
- Individuals who will manage the long-term energy savings, and their location i.e. are they local?
- Financial capability of the company
- A sample completed energy audit
- A sample contract for a project

Before issuing a request for a RFQ or RFP, the facility must be ready, willing, and able to move forward in implementing a project if the audit shows that the desired economic and operational outcomes can be achieved.

Minimizing Risk Through Performance Contracting

A possible option for cash strapped facilities to implement energy saving measures is through the issuance of a RFP for Energy Service Companies (ESCOs) to provide Performance Contracting services. Similar to a detailed energy audit, the ESCO identifies potential energy saving measures including energy, chemical, operational and maintenance savings as well as increases in revenues and avoided capital costs and quantifies the costs and benefits of each. The ESCO also finances and provides the actual upgrade/energy saving measure, with input from plant staff on products and vendors selected, for projects determined to be 'economically feasible'.

Energy Performance Contracting is a practical way for a facility to undertake expensive or complex energy savings projects. With the information gathered, an ESCO provides the utility with a proposed energy savings project with guaranteed monthly savings.

Through an agreement between the ESCO and the utility, the utility pays the ESCO a portion of the energy savings over a period of time, which allows the ESCO to recover its costs and to make a profit. In most cases the utility takes on the debt to pay for the upgrade, since they are usually able to take advantage of tax breaks. This debt service may be secured by the Energy Saving Contract with the ESCO. The ESCO is held accountable for the measures outlined in the Guaranteed Energy Saving Contract. This allows a facility to complete capital, "paid-from-savings" projects that can be implemented on a cash-flow neutral basis, with savings that are guaranteed for the life of the project. Paybacks achieved depend on the specific processes and operating costs of the facility.

Another consideration using a Performance Contract is the possibility of bundling, no capital outlay, shorter payback improvement measures with longer-payback upgrades that do not explicitly save energy e.g. bar screen replacement, SCADA expansion. The performance contracting language in some states allows municipalities to enter contracts up to 20 years in length so that they can implement projects with longer paybacks that are critical to the effective treatment of the drinking water or wastewater and help the plant run more efficiently. After implementation of a performance contracting project is completed, the ESCO typically returns each year of the project term to measure and verify the energy savings realized.

The National Association of Energy Service Companies (NAESCO) provides accreditation to Energy Services Companies. (NAESCO website: http://www.naesco.org/). Similar to auditor certifications, the focus is on energy upgrades to traditional commercial and institutional buildings, rather than drinking water or wastewater process facilities.

Lessons Learned

Some examples of lessons learned from an energy audit include:

- Premium motors are not economical in some applications; run time is a significant variable in determining whether or not an energy saving measure has an acceptable payback period;
- Where low run times make a measure unfeasible, it is recommended that the equipment be replaced with the most efficient available when the equipment/lighting is being replaced;
- If the treatment facility pays a demand charge, pumps should be timed so that they do not run simultaneously. For drinking water treatment plants, schedule backwashing during low-peak periods;
- Lighting replacements and energy efficient motors are generally the least costly to implement, which when evaluated individually, have favorable payback periods;
- Upgrade one of two pieces of equipment and then run the upgraded equipment the majority of the time;
- A plant that is well maintained is more energy efficient than a plant that does not keep up with regular maintenance. Qualified O&M staff is critical to the performance of drinking water and wastewater systems;
- To make the greatest impact, implement energy efficiency measures for the largest energy users (i.e. aeration, pumping, solids handling);
- The installation of variable frequency drives (VFDs) does not always guarantee energy savings – especially if you are replacing another, older variable pumping drive or if the majority of total pumping head is static, not dynamic;
- VFDs rarely save energy when used on centrifugal blower applications (because the blower curves are relatively 'flat');

- Process design can limit energy savings opportunities. For example, it is important to understand that a minimum level of mixing is required in process tanks in order for the solids to stay suspended;

- Although most renewable energy projects have longer than expected payback periods, they pay for themselves within their useful life. A benefit of these is that the cost of electricity remains constant (i.e. cost of debt service for the upgrade / kWhs generated) such that a facility's budget is unaffected if the cost of conventional purchased power increases

The Cost of Delay

A thorough energy audit gives plant operators the data needed to make informed decisions as to whether a measure should or should not be implemented. Follow-through to project implementation can reduce energy costs and make funds available for other needed facility improvements. The benefits of doing energy efficient projects sooner rather than later are numerous. A decision to install more efficiency energy equipment and implement related energy-saving measures is a decision to save money and environmental resources.

Additional references:

US Environmental Protection Agency (EPA): Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities
http://www.epa.gov/owm/waterinfrastructure/pdfs/guidebook_si_energymanagement.pdf

EPA Region 3 website - Road to Net Zero Energy:
http://www.epa.gov/reg3wapd/infrastructure/EnergyEfficiency/index.html

Rural Community Assistance Partnership (RCAP) – Energy audit webcast for small drinking water utilities:
http://www.rcap.org/energyauditswebinar

National Rural Water Association: Paper titled Small System Electric Power Use – Opportunities for Saving:
www.nrwa.org/benefits/whitepapers/risks/2008papers/regnier%20SMALL%20SYSTEM%20ELECTRIC%20POWER%20USE%206.doc

AWWA Water Audit Software:
http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=47846&navItemNumber=48155

EPA: Control and Mitigation of Drinking Water Losses in Distribution Systems
http://water.epa.gov/type/drink/pws/smallsystems/upload/Water_Loss_Control_508_FINALDEc.pdf

New York State Energy Research and Development Authority (NYSERDA) website:
– Various tools: http://www.nyserda.ny.gov/en/Commercial-and-Industrial/Sectors/Municipal-Water-and-Wastewater-Facilities/MWWT-Tools-and-Materials.aspx

US Department of Energy - Motor Master:
http://www1.eere.energy.gov/manufacturing/tech_deployment/software_motormaster.html

US Department of Energy - Pump System Assessment Tool:
http://www1.eere.energy.gov/manufacturing/tech_deployment/software_psat.html

US Department of Energy - Savings Performance Contracting webpage:
http://www1.eere.energy.gov/wip/solutioncenter/financialproducts/espc.html

New York State Energy Research and Development Authority (NYSERDA) - basic self assessment checklist: http://www.nyserda.ny.gov/en/Commercial-and-Industrial/Sectors/Municipal-Water-and-WastewaterFacilities/MWWT-Tools-and-Materials.aspx

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