Roadmap to Energy Efficiency

for

Water and Wastewater Utilities

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INTRODUCTION

Everyday, utilities are confronting an increasingly complex array of regulatory and internal mandates and stakeholder demands for developing and integrating "green" practices and services into their businesses. Simultaneously, they are feeling equal pressure to become more efficient and reduce their cost of service. Further, the options for integrating "green" practices and services can be overwhelming and the metrics for success can be difficult to determine. As a result, leading utilities are faced with the need to develop a comprehensive strategy for selecting the sustainability program that is the best case for their situation. At R. W. Beck, we help our clients implement a comprehensive strategic approach or an "Enterprise Sustainability Leadership Program" that aligns the economic, social and environmental impacts of the Program to deliver "Triple Bottom Line" results.

A comprehensive "Enterprise Sustainability Leadership" approach encompasses a variety of tactics. These typically include a combination of internal efficiency programs, best practices for encouraging customer conservation and, in appropriate circumstances, facets such as reclaimed water use for non-potable applications. Programs for best practices to promote customer conservation often include features such as an inverted rates structure that increases unit volume price as customer consumption increases or, if smart metering is available, rates that could include time-of-use factors or leak detection; incentives such as rebates for installing low water use fixtures; and low or no-cost water use audits for customers. Water reclamation or reuse is also frequently used to offset or reduce peak irrigation demands on potable water systems. Initiating a reuse water program can be capital intensive, since separate transmission and distribution systems are required. As a result, they are often implemented to supply new large residential, commercial and industrial developments rather than as retrofits in established residential, commercial and industrial areas.

Demand management strategies can be very useful in reducing the cost of service as they can delay the need for capital expenditures for new facilities and new water supply development. However, internal efficiency programs addressing energy conservation, water loss, and waste minimization that focus on water and wastewater utility assets such as treatment plants, water distribution, and wastewater collection networks also represent vital tactics in an overall sustainability program. These strategies provide Triple Bottom Line benefits because they align environmental and social policy goals for resource conservation, waste minimization and energy efficiency with cost of service reduction objectives.

The purpose of this paper is to describe one aspect of a sustainability program, an approach to energy conservation programs that water and wastewater utilities should consider when looking to implement internal efficiency programs to reduce their costs or to become more sustainable.

INTRODUCTION TO AN ENERGY SAVINGS PROGRAM

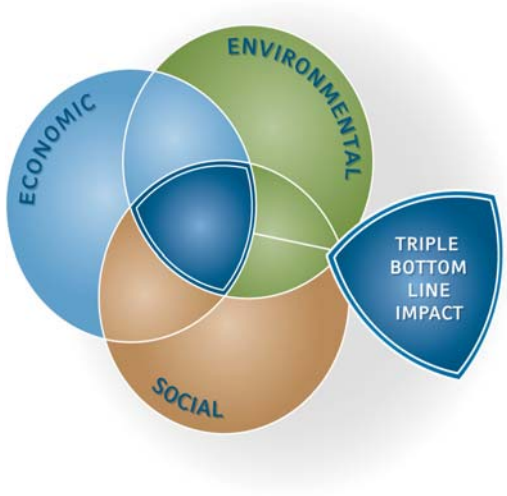
Water and wastewater utilities need large amounts of energy to deliver their services. After labor, energy costs are generally the second highest annual operating and maintenance line item in a utility's budget. Further, water industry case histories have demonstrated that energy savings of 20 to 35 percent and more have been achieved when an effective enterprise-wide energy savings program has been implemented.[1]

[1] Judith A. Barry; February 2007, Watergy: Energy and Water Efficiency in Municipal Water Supply and Wastewater Treatment, Cost-Effective Savings of Water and Energy; Alliance to Save Energy.

Concerns about greenhouse gas (GHG) emissions have made energy consumption a focus of intense public interest and legislation nationwide. As a result, energy conservation is more than a good business practice. It is a public responsibility. While reducing energy consumption provides an opportunity to lower the cost of service, it also reduces a utility's carbon footprint, and enhances its image as a responsible public partner and a steward of public interest from both an external and an internal stakeholder prospective. Implementing an energy savings plan has the social benefit of supporting energy independence. Best practices in fact are evolving toward a Triple Bottom Line focus, one that takes economic, environmental and social considerations into account. Considered on these terms, these programs provide far-reaching paybacks.

Figure 1, depicts the Triple Bottom Line effect. As shown, the synergy of the economic, environmental and social benefits compounds the payback.

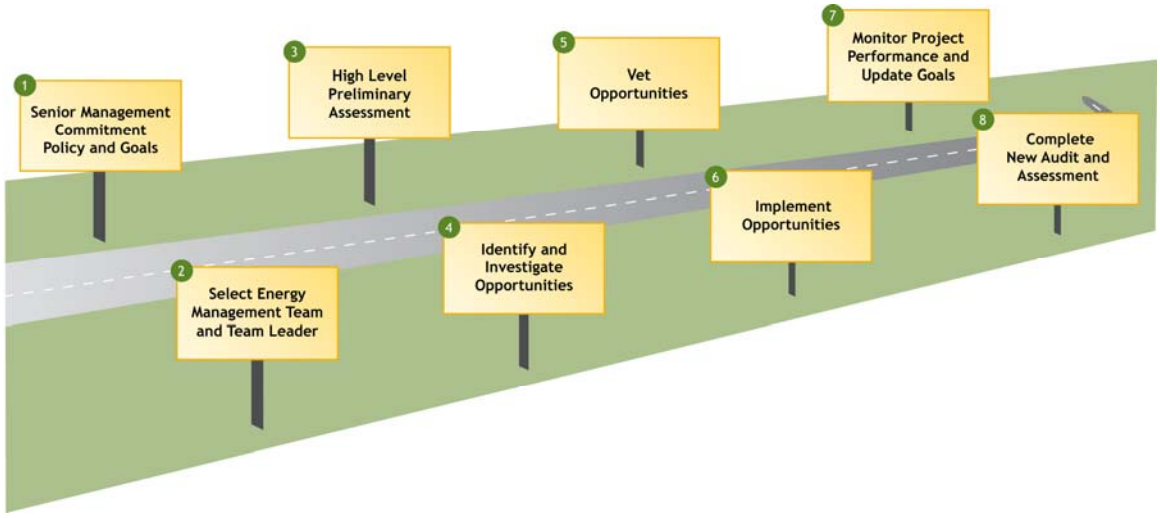
Figure 1
Triple Bottom Line Effect



Elements of an Effective Energy Savings Program

There are a several components of an effective energy savings program. These components include a management commitment; goal setting; baseline audit, a focused approach with a logical plan of action; program identification, analysis and prioritization; employee involvement; goals and metrics for program performance tracking; and adequate resources. The analysis and prioritization steps are key program aspects to achieve a "next best dollar spent" goal for both operation and maintenance (O&M) practice changes and equipment upgrades. Figure 2, illustrates the roadmap for a typical energy reduction program in a water/wastewater municipal utility.

Figure 2
Energy Reduction Program Roadmap

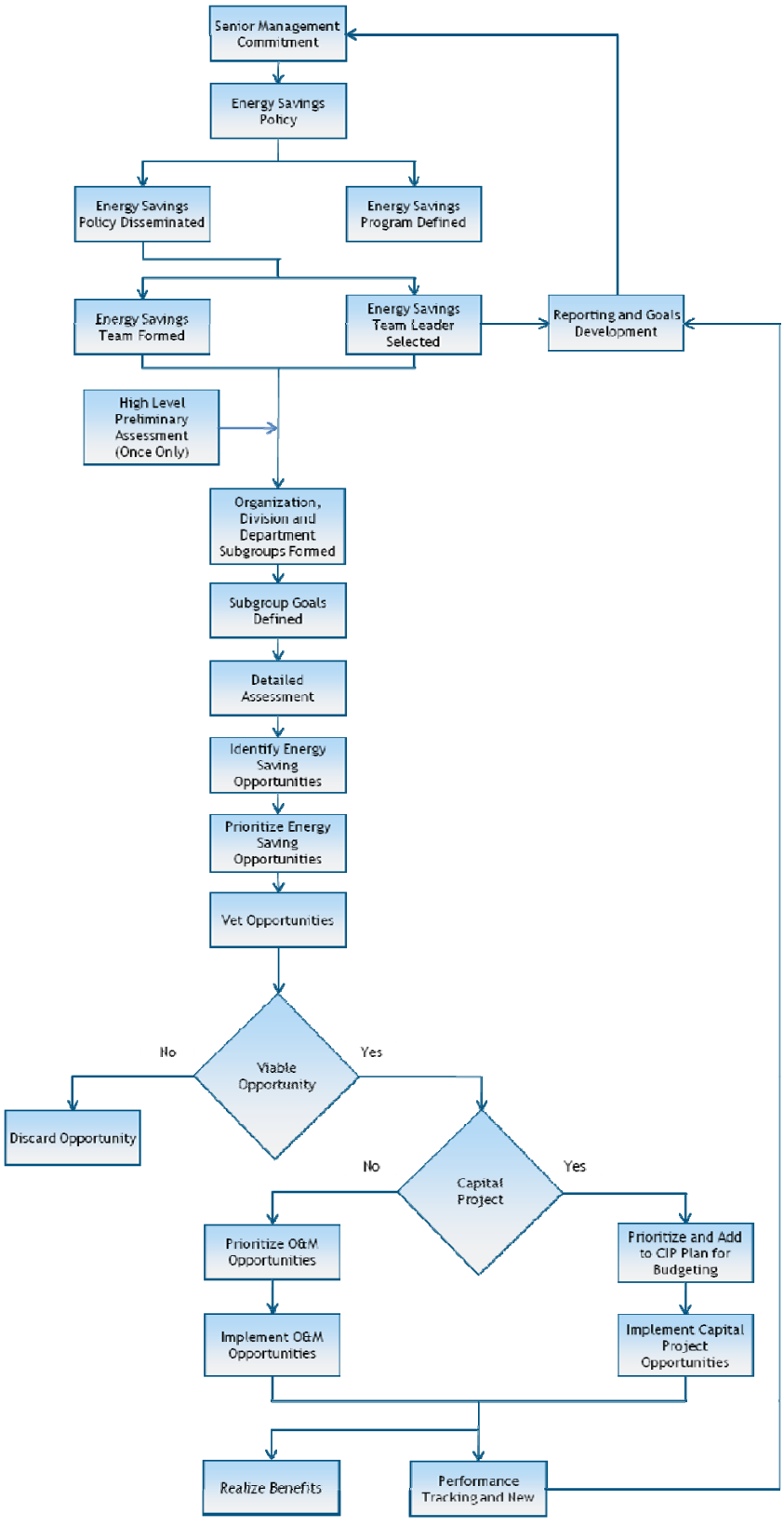


Senior Management Activities

The first step requires a firm and consistent commitment from senior management for energy conservation. This is a key prerequisite for initiating and implementing the program. The importance of developing an energy savings policy, codifying it as a policy statement and clearly communicating to all utility personnel that energy savings is an important priority that cannot be overstated.

After the policy has been developed, an energy savings team needs to be formed and an Energy Program Manager needs to be designated. Once the team is in place, measurable goals and metrics are necessary. These should be developed such that there is an overall corporate goal that cascades down through each organization, division and department in the utility in the form of measurable goals for each organization and department. Then when performance is measured, achievements in each department are rolled up to the department level, department level accomplishments are rolled up to the organizational level and organizational level information is consolidated to determine if the enterprise-wide goal has been met. Thus, the program performance tracking process provides recognition of successes, establishes accountability, and serves to assure senior management that the resources invested in the program have been wisely used and provide sufficient payback. The first set of goals usually consists of preliminary targets that will be adjusted based on the findings of the team. Then monthly reports are usually augmented with periodic meetings (quarterly or otherwise) to update senior management. Figure 3, shows the steps in the program.

Figure 3
Energy Savings Program Steps



Program Approach

Once preliminary goals have been set and the team is in place, an initial baseline audit and a high-level preliminary assessment should be conducted. The audit should encompass, but not be limited to factors such as unaccounted for water; sewer infiltration; O&M practices; employee awareness and behavior patterns about energy conservation; equipment use patterns; and bills, rate structures, and purchase contracts for electricity; as well as traditional process and treatment information like pump sizing and efficiency, motor efficiency, aeration steps, and filter backwash processes, etc. For example, when viewed holistically, the information about O&M practices and bills for electricity could facilitate savings opportunities that take advantage of the time-of-use component of rates for electricity or lower power demand charges.

After the baseline audit and preliminary evaluation are complete, the team members should be tasked to investigate specific areas identified by the study such as high energy use areas. Typically, these will provide the most promising energy consumption reduction targets.

It is important to note that the entire utility does not have to be evaluated at the same time. This can make the time commitments for utility personnel more manageable. For example, the older portions of the utility's assets can be analyzed first. These often provide opportunities for some of the largest gains in energy use reduction.

There are two broad categories of energy conservation upgrades. The first category involves operational and/or employee behavior changes and requires minimal capital funding. The low cost behavior change techniques often require organizational culture changes and can have a very high payback. However, employees need to understand how these can benefit the utility and utility employees. Consequently, desired behavior must be encouraged, recognized, and rewarded.

The second category involves equipment upgrades and system modifications and requires moderate capital funding. These projects should be carefully vetted. Once the team has developed a concept for a specific energy reduction project and quantified the projected savings, the project should undergo the utility's typical engineering development and justification process. If vetting shows the project is suitable for implementation, it should then be added to the Capital Improvement Program (CIP) for prioritization, funding and implementation. Once implemented, performance tracking to verify energy savings should be conducted. Thus, these energy savings steps will provide an orderly implementation and management control process.

The energy savings program should be an iterative process. Once the team has completed the process, it conducts another audit to identify new opportunities for savings. Thus, the program becomes institutionalized and ingrained in employee thought processes and can be incorporated to daily activities.

To minimize costs, the utility could use its own staff to gather and help analyze data. Then, the utility could augment its personnel as required if additional expertise or staff is needed for the program. Alternatively, the audits and initial evaluations may be more effective or performed quicker if conducted by an outside party; utility staff may be more willing to provide information if they can do so anonymously. This is important in the beginning until employees understand that their ideas are welcomed.

Further, a facilitator for the energy savings team is useful to keep the team focused and working efficiently. The facilitator can also assist the Energy Program Manger by tracking team member

assignments, progress reporting, providing goals status updates, and, if necessary coordinating external support. This arrangement is very useful if the team manager has other responsibilities.

Energy Savings Team Structure

The members of the team should include representatives from all utility water and wastewater operating areas and also include engineering, buildings services, logistics, and accounting. One of the key team members is the executive sponsor. The team should then be divided into smaller mini-teams for each operating department for the purposes of focusing team member efforts in the area that they know best. For example, when focused appropriately, treatment plant operators and engineering staff will likely have an understanding of where opportunities for energy savings due to pumping inefficiencies, process upgrades, unaccounted for water, and sewer infiltration, etc. are most viable; where to get the data required for evaluating energy use, understand the utility's capital authorization and CIP process. Similarly, logistics and/or accounting personnel can assist with the evaluation of item such as contracts, rates, and bills for electricity.

Organizational Alignment

Employee involvement and management commitment are essential for success. Otherwise, their buy-in for operational changes and behavioral changes and their commitment to finding energy saving opportunities will not be obtained. Further, to sustain their buy-in and commitment, they will need to see their ideas evaluated in good faith and that worthy projects are implemented; and that employees are recognized for successes. Competitions for highest energy savings levels, formal recognition, social events such as recognition dinners, and bonuses for outstanding ideas or savings achievements are frequently part of a structured recognition program. Utilities generally have staff that can design and implement such employee recognition programs.

Adequate resources in terms of staff and funding are also critical. Senior management needs to assure these resources are available in both the short term when the program is initiated and the long term so that the gains are consistent and progress continues. Sufficient resources are also vital to assure buy-in from the energy savings team and other utility employees.

First Steps

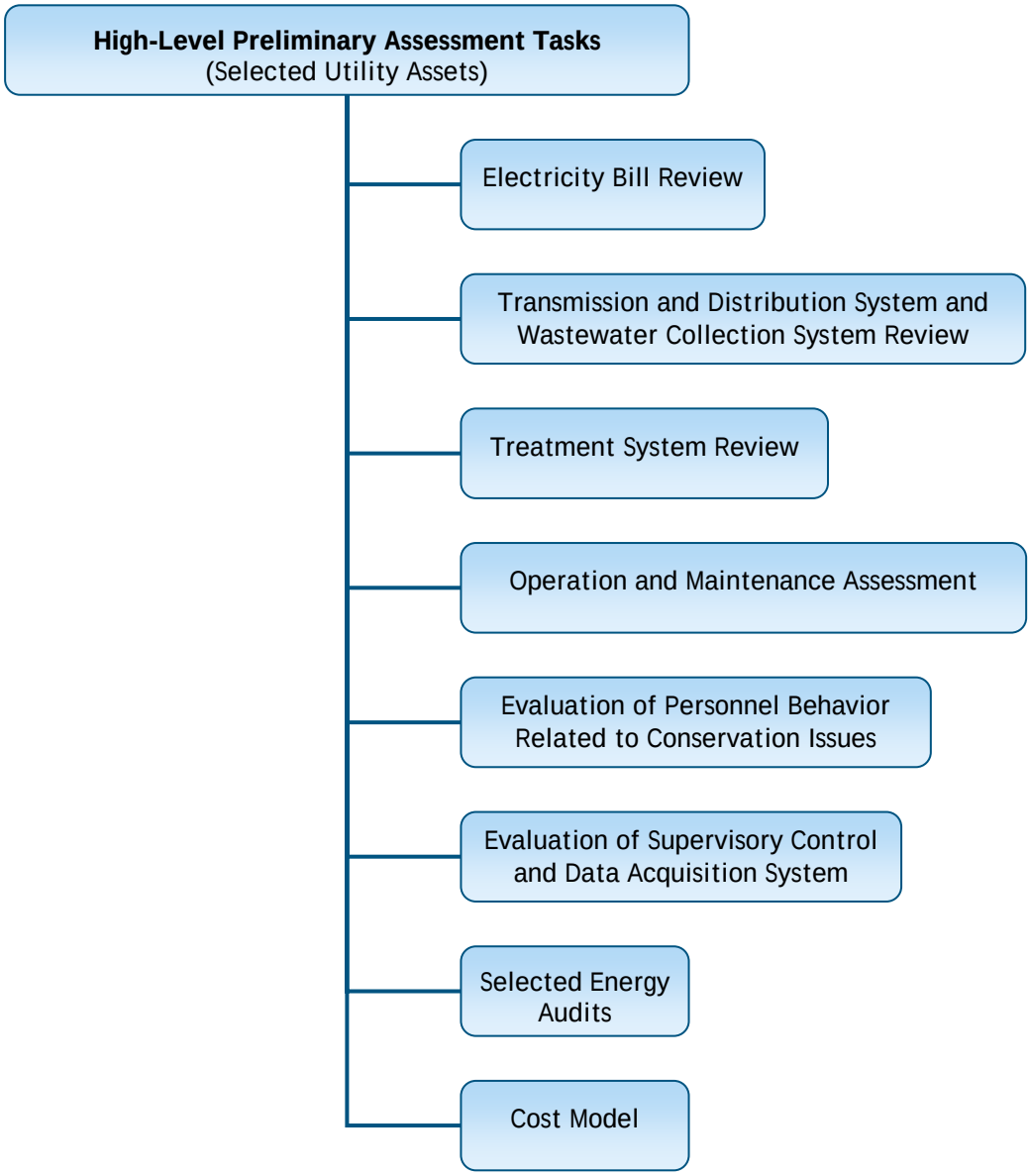
The first steps include creation of an energy savings policy, an energy savings team, and a team leader to serve as the principal advocate within the utility. Then, as explained above in the description of the program approach, we recommend a high-level, preliminary assessment of the energy savings potential of selected utility water and wastewater assets. Based on the opportunities revealed by this initial work, the utility can make an informed decision where to find its best opportunities. The objective should be to establish a clear and distinct, but achievable challenge goal.

The high-level, preliminary assessment would have three major goals:

- Establish the current energy conservation-related practices of the utility;
- Estimate the potential savings from the program so that preliminary goals could be set; and
- Prioritize the initial targets for the program.

Figure 4, shows the tasks that could be included in the high-level preliminary assessment. These would be tailored to fit specific utility preferences.

Figure 4
High-Level Preliminary Assessment Tasks



Each task is described in more detail, below.

- **Electricity Bill Review.** This task will encompass a review of a representative sampling of the water/wastewater utility's electric bills to gain an understanding of the construct of the charges. Once appropriate facility boundaries have been selected for this aspect of the study, the investigation will evaluate the key areas of potential savings revealed by the evaluation of the electric bills. For example, the review will identify the portion of the cost for energy consumption (kWh) versus peak power demand (kW) and how the demand charges are linked to

the highest power draws. An assessment of the terms of available rates for electricity will also be conducted to identify the opportunities for saving resulting from switching to different rates. After understanding the electric bill components, billing categories and billing rates, the potential for savings through O&M practice modifications, equipment changes, and billing rate options selection can be assessed.

Further, an investigation of whether potential savings from high electricity demand response opportunities are feasible will be conducted. The first step will be to determine if there would be incentives for water and wastewater operations responses to high demand events and, if so, to identify the specific conditions for obtaining such incentives. Then, an assessment of the practicality of meeting the conditions necessary to obtain the incentives will be carried out. If practical, the utility could then develop a plan of action to be implemented if the electric supplier declares a high electricity demand event.

- **Transmission and Distribution System Review.** A representative sampling of transmission and distribution system and wastewater collection and transmission system elements such as: pumps, piping systems, valves, prime movers, end-use equipment, and capacity/quantity of generators will be studied. The evaluation will include energy losses due to unaccounted for water and from wastewater infiltration in addition to assessing traditional factors such as pumping energy and motor efficiency. Unaccounted for water and wastewater infiltration are key components for improving efficiency because they inflate treatment and pumping costs.

  One common efficiency issue frequently cited by water and wastewater utilities is that equipment and pumping systems have been oversized and over-designed. This results in wasted energy. Consequently, the assessment will identify evidence of inefficient pumping systems and corrective measures for saving energy without sacrificing performance or redundancy. In addition, the feasibility of employing various energy recovery devices will be studied. For the purpose of minimizing the cost of the assessment, previous energy and water conservation audits will be used where available.

- **Treatment System Review.** A representative sampling of water and wastewater treatment plant system elements such as: treatment process equipment, pumps, piping systems, valves, prime movers, end-use equipment, and capacity/quantity of generators will be evaluated. As in the assessment for transmission and distribution systems described above, the water treatment equipment and pumping systems will be considered in a holistic manner. Factors such as aeration rates, filter backwash flows, will be reviewed against typical industry practices. Inefficiencies in these processes often result in wasted water and/or energy. Further, the feasibility employing various energy recovery devices will also be studied. For the purpose of minimizing the cost of the assessment, previous energy and water conservation audits will be used where available.

- **Operation and Maintenance Assessment.** An O&M evaluation will be performed as it relates to the various water and wastewater system processes. A representative sample of the processes will be studied to identify any changes in standard operating procedures to reduce energy use. The goal of the O&M assessment is to develop a list of low-cost improvements or changes to O&M practices that can be put in place quickly and economically to immediately begin saving costs. Payback guidelines associated with O&M improvements are typically six months to a year.

- **Evaluation of Staff Awareness and Procedures.** Energy use investigations have shown that increasing staff awareness and altering procedures/behavior is a very cost-effective technique for saving energy that is frequently under-utilized. In fact, case study data has shown modifying the attitudes and behavior of administration and staff toward energy conservation has reduced energy consumption by up to 10 to 20 percent with little or no capital expenditure[2;] this is largely due to increased awareness and understanding of the positive impacts that can accrue. A selected sample of the O&M staff will be interviewed to ascertain their normal work habits, their attitudes regarding energy conservation, their suggestions of altering the operation of various treatment systems to save energy. In addition, their thoughts about a utility-wide program for energy reduction will be solicited.
- **Evaluation of Current Supervisory and Data Collection System.** Energy consumption and demand data is essential for the program. Utility instrumentation and control personnel will be interviewed to determine the capabilities of the current Supervisory Control and Data Acquisition (SCADA) system to monitor real-time energy use in amps, kW, kVA, power factor, kWh and demand. Based on the review, recommendations will be offered for improvements to the SCADA system to monitor the energy use of the treatment and transmission/distribution system on a long-term basis.
- **Energy Audits.** Energy audits are an integral part of all energy savings programs. Therefore, if one is not available, a baseline audit for the selected sampling of the water and wastewater facilities will be performed. Otherwise, if the information in the existing baseline audit for these selected facilities and water distribution and wastewater collection systems is satisfactory, it will be used as a basis for assessing initial conditions.
- **Develop a Cost Model.** The information obtained in the tasks above will be used to produce a cost model for the energy improvements identified in this study. An estimate of the potential energy savings for the samples of the selected facilities and water distribution and wastewater collection systems will be developed. Using realistic assumptions, the estimate will then be extrapolated as a planning level estimate for the utility's entire water and wastewater operations to facilitate the utility's assessment of the benefits of a comprehensive energy savings program.

CONCLUSIONS

Conservation programs promoting internal efficiency provide water and wastewater utilities with win-win opportunities. These programs lower the cost of service, enhance the utility's image, and provide environmental and social benefits. Further, they use sound, proven management and engineering techniques to tap the creativity of utility staff and cost-effectively elevate utility performance.

These programs need to be implemented in a systematic and logical manner to be an effective tool. The elements of the program include a management commitment; goal setting; baseline audit; a focused approach with a logical plan of action; program identification, analysis and prioritization; employee involvement; goals and metrics for program performance tracking; and reporting and

[2] Karen Ehrhardt-Martinez, November 2008, Behavior, Energy, and Climate Change: Policy Directions, Program Innovations, and Research Paths

tracking for management control. To maximize program effectiveness, the analysis, prioritization and vetting steps are vital components for incorporating a "next best dollar spent" approach for O&M practice enhancements and for equipment upgrades.

Once a management commitment has been implemented and a policy has been developed, preliminary goals should be set and a team with a leader should be designated. Then, an initial baseline audit and a preliminary assessment should be conducted. The baseline audit and a preliminary assessment can then be used to identify opportunities to improve efficiency.

The programs should be iterative. After the team has used the baseline audit and the preliminary assessment to complete the process, another audit and assessment should be conducted to identify new opportunities. With this approach, the program becomes institutionalized and ingrained in employee thought processes and thereby can be incorporated to daily activities.