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IDENTIFICATION OF BARRIERS TO ENERGY EFFICIENCY AND SOLUTIONS TO PROMOTE THESE PRACTICES

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ABSTRACT AND BENEFITS

Abstract:

Successful deployment of energy efficiency initiatives may be increased by recognizing barriers and advancing strategies that overcome them. A national survey recently collected input on barriers from more than 110 wastewater service utilities. A concurrent utility focus group process captured detailed experiences.

Motivation is a crucial precondition for energy efficiency. The utilities reported that the strongest motivators for utility staff are reductions in energy expenditures and prioritization by utility management.

The project identified the following key barriers:

- **Capital projects.** Economic barriers dominate: inadequate financial feasibility, lack of funding, and resource competition with other organizational priorities.
- **Operations optimization.** Operational conservatism (desire for a margin of safety for permit compliance) is the strongest barrier to implementing operating changes that conserve energy.
- **Maintenance for energy efficiency.** Many utilities have not optimized maintenance intervals for energy efficiency because they prioritize more pressing maintenance activities.

The barriers considered by this research include both internal and external challenges. Internal challenges are mitigated by well-developed energy programs, as gauged by the level of implementation of the approaches outlined in the Water Environment Federation (WEF) Energy Roadmap. Utilities with well-developed programs perceive barriers as being lower. External challenges are reduced for water resource recovery facilities (WRRFs) in states with well-funded and accessible energy incentive programs and less-inhibitive energy policies.

Benefits:

- Assesses the significance of various barriers to energy efficiency for capital projects, operational optimization, and maintenance practices to maintain efficiency.
- Presents utility experiences with strategies to address barriers.
- Compares the energy policies in three states that encourage or inhibit the implementation of three relevant types of WRRF energy projects: major capital projects to improve process efficiency, biogas utilization projects, and onsite solar energy generation.
- Showcases facilities that have made significant or unique efforts in energy efficiency.

Keywords: Energy efficiency, organizational approaches, operations and maintenance optimization, biogas utilization, renewable energy, case studies.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACEEE	American Council for an Energy Efficient Economy
ARRA	American Recovery and Reinvestment Act
CASA	California Association of Sanitation Agencies
CEC	California Energy Commission
CEO	Chief executive officer
CEPT	Chemically enhanced primary treatment
CHP	Combined heat and power
CIP	Capital improvement plan
CNG	Compressed natural gas
CO_2	Carbon dioxide
COO	Chief operating officer
CPUC	California Public Utilities Commission
CSO	Combined sewer overflow
Cx	Commissioning
DAF	Dissolved air flotation
DO	Dissolved oxygen
DOE	U.S. Department of Energy
DSIRE	Database of State Incentives for Renewables and Efficiency
EEPS	Energy Efficiency Portfolio Standard
EERS	Energy efficiency resource standards
EPRI	Electric Power Research Institute
ESCO	Energy service company
FEMA	Federal Emergency Management Agency
GESP	Guaranteed Energy Savings Program
GHG	Greenhouse gas
GPSC	Georgia Public Service Commission
HMGP	Hazardous mitigation administration grant funds
hp	Horsepower
HRSD	Hampton Roads Sanitation District (Virginia Beach, VA)
HSW	High-strength waste

HVAC	Heating, ventilation, and air conditioning
IC	Internal combustion
IEEE	Institute of Electrical and Electronics Engineers
I/I	Infiltration/inflow
IOU	Investor-owned utility
IRP	Integrated resource planning
kW	Kilowatt(s)
kWh	Kilowatt-hour
LED	Light-emitting diode
LRAM	Lost revenue adjustment mechanism
MACT	Maximum Achievable Control Technology
MCES	Metropolitan Council Environmental Services (Minneapolis/St. Paul, MN)
MCRT	Mean cell residence time
mgd	Millions of gallons per day
MMSD	Milwaukee Metropolitan Sewerage District
MOU	Memorandum of understanding
M&V	Measurement and verification
MW	Megawatt(s)
MWBE	Minority-/Women-owned Business Enterprise
MWRA	Massachusetts Water Resources Authority
MWRD	Metro Wastewater Reclamation District (Denver, CO)
MWS	Metro Water Services (Nashville, TN)
N/A	Not applicable
NACWA	National Association of Clean Water Agencies
NPDES	National Pollutant Discharge Elimination System
NYC DEP	New York City Department of Environmental Protection
NY EFC	New York Environmental Facilities Corporation
NYPA	New York Power Authority
NYSEG	New York State Electric and Gas
NYSERDA	New York State Energy Research and Development Authority
NYWEA	New York Water Environment Association
OCGA	Official Code of Georgia Annotated

O&M	Operations and maintenance
PGE&E	Pacific Gas and Electric
PM	Preventive maintenance
PPA	Power purchase agreement
PSC	Public service commission
PSE	Puget Sound Energy
PUC	Public utilities commission
PV	Photovoltaic
QECB	Qualified Energy Conservation Bond
R2E2	Resource Recovery and Electrical Energy
R&D	Research and development
REC	Renewable energy credit
REV	"Reforming the Energy Vision"
RFP	Request for proposals
RG&E	Rochester Gas and Electric
RIN	Renewable identification number
ROI	Return on investment
RPS	Renewable portfolio standards
R&R	Rehabilitation and replacement
SBC	System benefits charge
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric
SEPA	State Environmental Policy Act
SERP	State Environmental Review Process
SEU	Sustainable Energy Utility
SGIP	Self Generation Incentive Program
SIR	Standard Interconnection Requirements
SOGR	State of Good Repair
SREC	Solar Renewable Energy Certificate
SRF	State revolving fund
SRT	Solids retention time
SSI	Sewage sludge incinerator

SSO	Source-separated organics
TRA	Trinity River Authority
UOSA	Upper Occoquan Service Authority
URC	Utility regulatory commission
USDA	U.S. Department of Agriculture
U.S. EPA	United States Environmental Protection Agency
UV	Ultraviolet
VFD	Variable-frequency drive
VOS	Value-of-solar
VVWRA	Victor Valley Wastewater Reclamation Authority
WEF	Water Environment Federation
WERF	Water Environment Research Foundation
WLSSD	Western Lake Superior Sanitary District (Duluth, MN)
WRA	Water Reclamation Authority (Des Moines, IA)
WRF	Water reclamation facility
WRRDA	Water Resources Reform and Development Act
WRRF	Water resource recovery facility

EXECUTIVE SUMMARY

ES.1 Purpose

The Water Environment Federation (WEF) Energy Roadmap (WEF, 2013) established six interrelated energy management topic areas, and proposed a series of practical approaches and levels of progression to be used to prioritize actions to take toward energy sustainability. The investigation presented in this report is intended to build on the Roadmap framework by tracing the path of a successful energy program and identifying the barriers and strategies that promote progress along that path.

ES.2 Methods

A voluntary national survey collected input on energy efficiency programs and barriers from more than 110 wastewater service utilities. A concurrent focus group process convened four groups of 10-12 wastewater utility representatives to discuss the issues raised in the survey in a more in-depth format, capturing detailed experiences and impressions that provide real-world context to the raw data from the survey. This process identified barriers for various types of energy efficiency initiatives, as depicted in Figure ES-1.

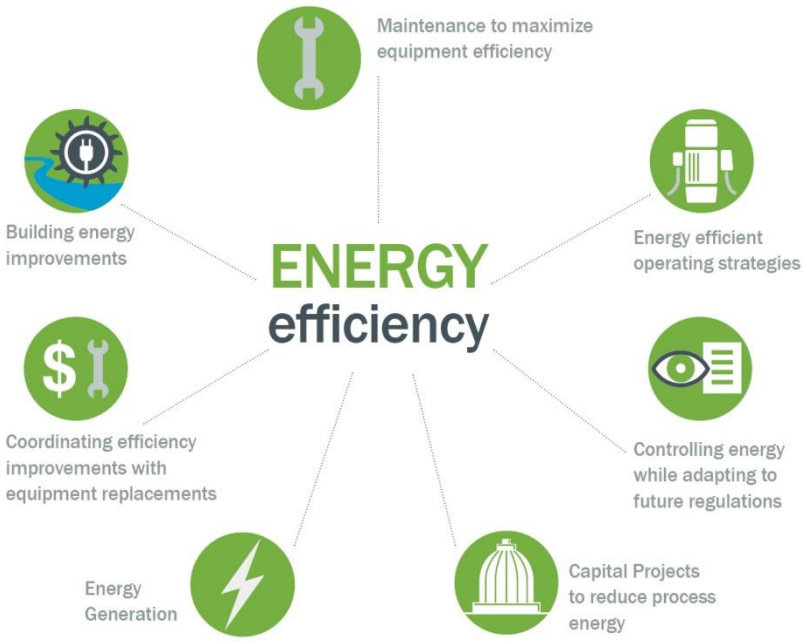


Figure ES-1. Universe of Energy Efficiency Focus Areas.

The online survey also asked respondents about their experience with a representative selection of 25 of the Roadmap organizational approaches, such as forming energy teams, setting goals, and providing staff training in energy. The survey asked whether each approach had been implemented at the respondent's utility, and how effective each implemented activity was in achieving significant, measurable energy reductions. In order to gauge the perceived level of development of each survey respondent's energy program, a simple scoring system was

developed based on how many of the identified approaches each respondent reported as being implemented at his or her utility.

ES.3 Findings

Because the project survey and focus group input regarding barriers to energy efficiency and strategies to overcome them was dominated by utilities that are progressive in their approach to energy, the research was able to compile a good picture of the characteristic experiences of these utilities. From this picture, it is clear that these progressive approaches are accessible to a wide range of utility sizes and types.

Although progress is being made by many of these progressive utilities, it is clear that energy efficiency efforts are pushing against stiff headwinds, many of which cut across the various focus areas presented in Figure ES-1:

- **Low cost of energy.** In most parts of the country, energy rates are fairly low, and it can be tough to make the case for energy efficiency initiatives on a purely financial basis. Multiple benefits, such as replacing aging equipment, may be required to provide sufficient project justification.
- **Competing organizational priorities.** Wastewater utilities are fundamentally water-quality-based organizations and water quality compliance is their core business objective. This organizational orientation affects the prioritization of all types of energy efficiency initiatives, from minor operating changes to major capital projects.
- **Appropriate financial bar.** It is important to set an appropriate financial "go" threshold that captures the long-term value of the project, as well as the value of non-monetary benefits. The financial feasibility evaluation must realistically consider all variables that could affect financial feasibility in order to maintain the credibility of the energy program, including the likelihood of increasing project costs during detailed design.
- **Less-developed asset management.** Asset management practices provide a good platform for energy efficiency because they can highlight opportunities for efficient equipment replacement, detect abnormal operating conditions that increase energy use, and support intelligent maintenance practices to maintain efficiency levels. Conversely, plants that struggle to keep equipment operating reliably find it extremely difficult to make resources available for energy initiatives.
- **Unreliable process control and performance.** Optimization efforts and energy-efficient retrofits may have the effect of reducing the available margin of operating error in wastewater processes. For plants without predictable operations based on robust process controls, this reduction in margin is less likely to be accepted by plant staff.

Specific findings relative to capital projects, operations and maintenance (O&M) initiatives, organizational approaches, and state policy impacts are discussed in the following sections.

ES.4 Capital Projects

The funding phase was identified as the most likely project phase to bog down or stop an energy project, although barriers exist throughout the project, as summarized in Table ES-1. Funding and resource issues arise if the project is not about the utility's core mission—clean water. Often, a kick-starter of some type is needed and many energy efficiency projects may not have sufficiently compelling financial benefits for such benefits alone to be the kick-starter. Integrated strategies become crucial to energy efficiency success, including seed funding (e.g., grants), energy metrics, energy efficiency culture, connecting to community values, and efforts to overcome tactical barriers (such as those listed in Table ES-1).

A key element of integrated energy strategy is building energy consumption into project evaluation criteria used in the capital planning process. Including energy efficiency in the project ranking system can advance energy efficiency in both "pure" energy projects and other projects that have energy reduction as part of their justification. For example, equipment condition projects may replace aging equipment with more efficient equipment, so the project ranking criteria would reflect both asset management and energy benefits.

Table ES-1. Significant Barriers.

Project Phase	Likelihood of Stopping Projects	Most Significant Barrier
Identifying Opportunities	Low	Innovation and change create angst
Feasibility Study	High	Financial viability
Project Approval and Capital Improvements Planning	High	Competition with clean water business objective Difficulty selling a project not required by capacity of condition
Funding	Very High	Lack of grant funding[a] Competition with other water-quality-related projects
Design Initiation	Low	Lack of energy guidelines and procedures
Procurement	Low	Sole source issues
Construction Commissioning and Continued Operations	Very Low	Lack of factory testing and onsite commissioning Equipment complexity, staff training

[a] For projects that do not proceed.

ES.5 O&M for Energy Efficiency

The project identified the following key barriers to O&M practices that reduce energy consumption:

- **Operations optimization.** Operational conservatism (desire for a margin of safety for permit compliance) is the strongest barrier to implementing operating changes that save energy.
- **Maintenance for energy efficiency.** Many utilities have not optimized maintenance intervals for energy efficiency because they prioritize more pressing maintenance activities. Identifying the optimum maintenance interval and approach for activities such as diffuser cleaning can also be challenging.

Based on survey data, small plants appear to have similar barriers to operational initiatives to those facing larger plants, with slightly more significant barriers related to lack of energy data and technical support, as shown in Figure ES-2. Similarly, Figure ES-3 shows that a lack of technical support for maintenance planning was a more significant barrier for small utilities.

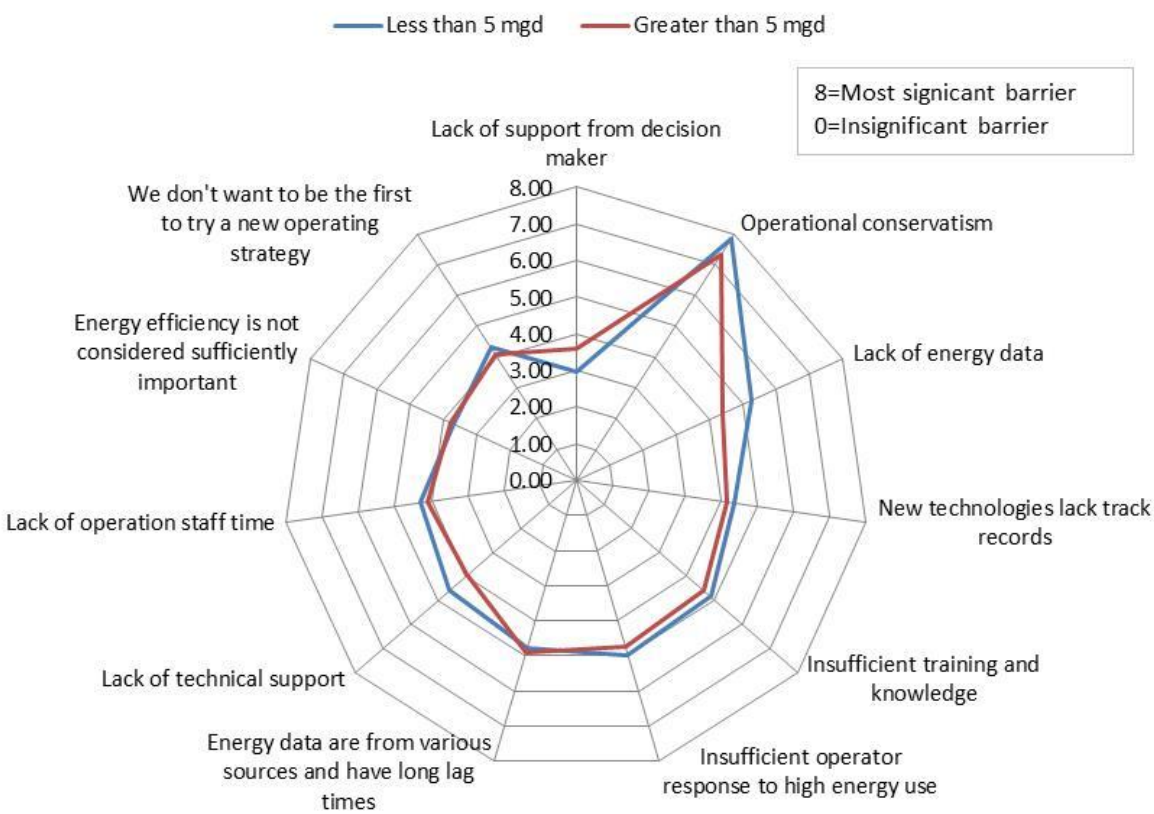


Figure ES-2. Comparison of Barriers for WRRF Sizes Greater Than and Less Than 5 mgd.

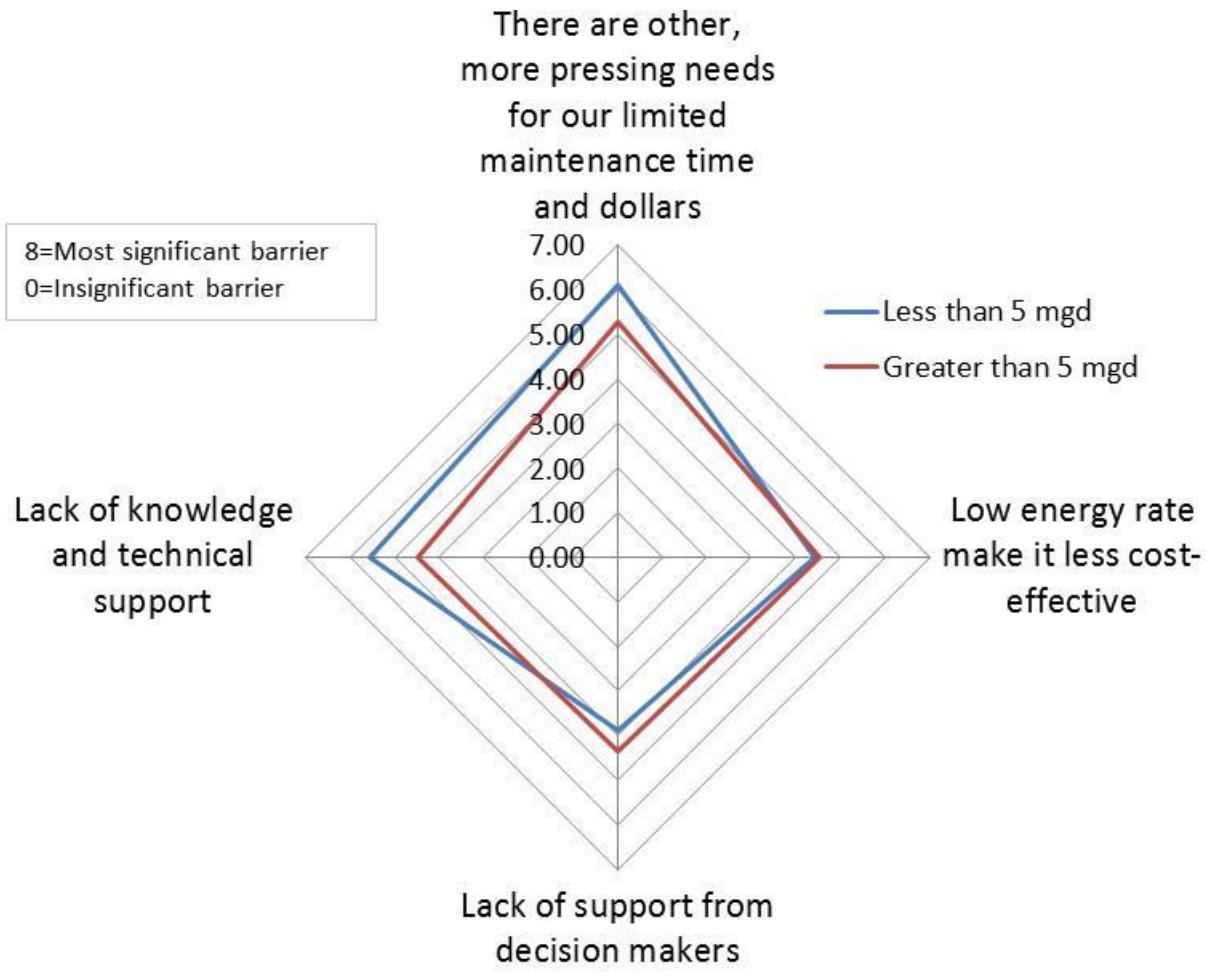


Figure ES-3. Comparison of Barriers to Maintenance for Energy Efficiency for WRRF Sizes Greater Than and Less Than 5 mgd.

ES.6 Assessing Organizational Strategies

Several survey findings point toward the importance of creating organizational cultures within wastewater utilities that support and foster energy initiatives. The organizational approaches proposed by the WEF Energy Roadmap were found to have a significant effect in lowering the perceived significance of many barriers to energy efficiency. Figures ES-4 and ES-5 illustrate the relatively high level of barrier strength perceived by survey respondents with less-developed programs.

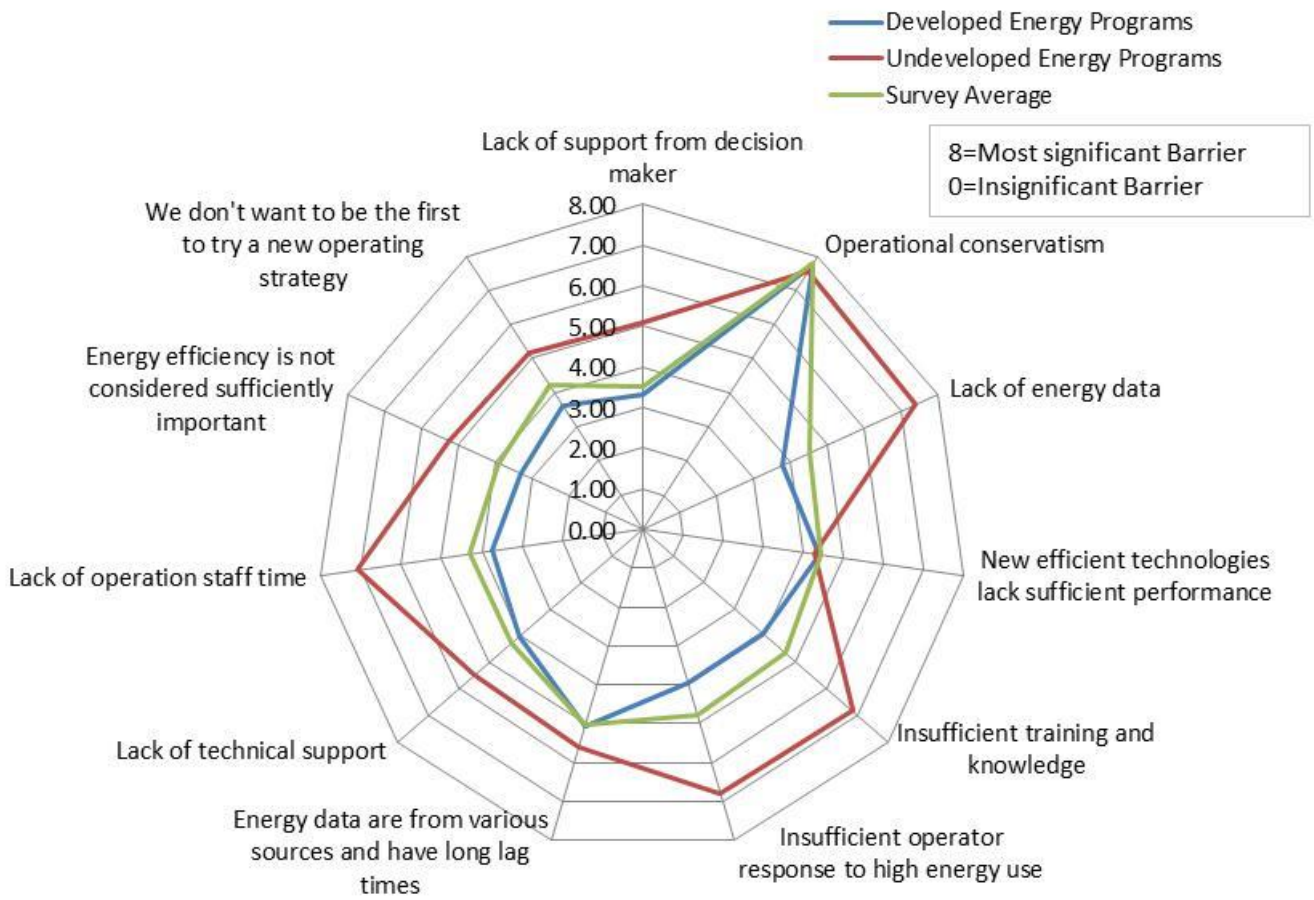


Figure ES-4. Effect of Energy Program Development Level on Barriers to Optimizing Operations for Energy Efficiency.

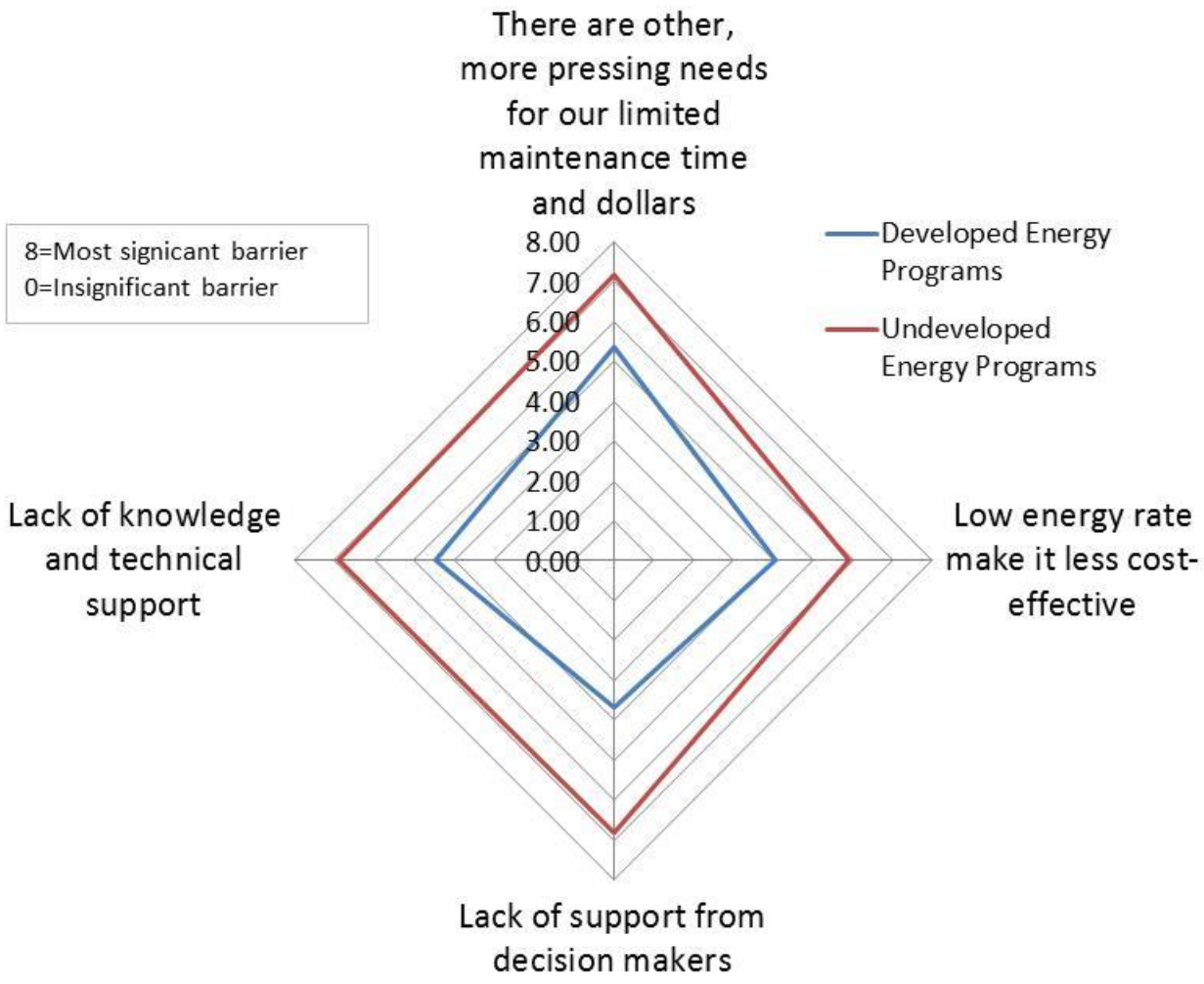


Figure ES-5. Effect of Energy Program Development Level on Barriers to Optimizing Maintenance Practices for Energy Efficiency.

ES.7 Barriers and Incentives Related to Electric Utility Legislation

As noted in Table ES-1, funding and perceived financial viability are prominent potential barriers to energy efficiency projects. Local policy and energy market conditions such as electrical rates, outside funding support, and availability of low-cost technical assistance can play a significant role in addressing these barriers.

By comparing the energy policies of three states (California, Georgia, and New York) as they applied to three representative types of energy projects common to wastewater treatment plants, key policies were identified that either supported or hindered energy projects. Table ES-2 highlights selected policies for each project type.

Table ES-2. Barriers Related to Electrical Utility Legislation.

Project Type	Key State Incentives	Example Policy Impairments
Energy efficiency	CA and NY: Generous funding of energy efficiency programs public benefit funds to meet Energy Efficiency Resource Standard goals. CA and NY: Rebates for process efficiency projects (not just conventional lighting, motors, etc.).	GA: No Energy Efficiency Resource Standard and low levels of funding for energy efficiency programs.
Biogas CHP	CA and NY: Grant funding for biogas CHP to meet state renewable portfolio standards (RPS). RPS includes biogas projects.	NY: No net metering for wastewater biogas projects. GA: No renewable portfolio standards.
Onsite solar	NY and CA: Support for renewables to achieve aggressive state portfolio standards. GA: Large voluntary solar portfolio initiative.	GA: Solar development at WRRFs by private solar developers not allowed, reducing access federal tax advantages for solar that are not available to municipal entities.

CHAPTER 1.0

INTRODUCTION

1.1 Research Context

While some wastewater utilities are implementing process and equipment innovations that enable them to use less energy and generate their own power, many utilities face tradeoffs, hurdles, or barriers to maximizing operations for energy efficiency and in creating the net environmental benefit from wastewater operations. The purpose of this research is to increase successful deployment of energy efficiency initiatives by identifying barriers and advancing strategies that overcome the barriers.

The Water Environment Federation (WEF) Energy Roadmap (WEF, 2013) established six interrelated energy management topic areas, and proposed a series of practical approaches and levels of progression to be used to prioritize actions to take toward energy sustainability. The Roadmap framework is summarized in Figure 1-1. The investigation presented in this report is intended to build on the Roadmap framework by tracing the path of a successful energy program and identifying the barriers and strategies that promote progress along that path. Key aspects of this investigation include:

- Identifying the most compelling motivators for initiating efforts to reduce utility energy use.
- Gauging the importance of internal challenges that impede energy initiatives within the wastewater utility organization.
- Investigating external challenges such as legislated energy policies and electrical utility market conditions.
- Developing a metric that benchmarks energy program "development status" based on each utility's progression along the framework in Figure 1-1.
- Testing the impacts of energy program development status on the perceived significance of barriers.
- Assessing how progression affects the number of successfully completed energy initiatives.
- Prioritizing the action items listed in the Roadmap based on utility staff perceptions of each item's relative importance in reducing purchased energy use.

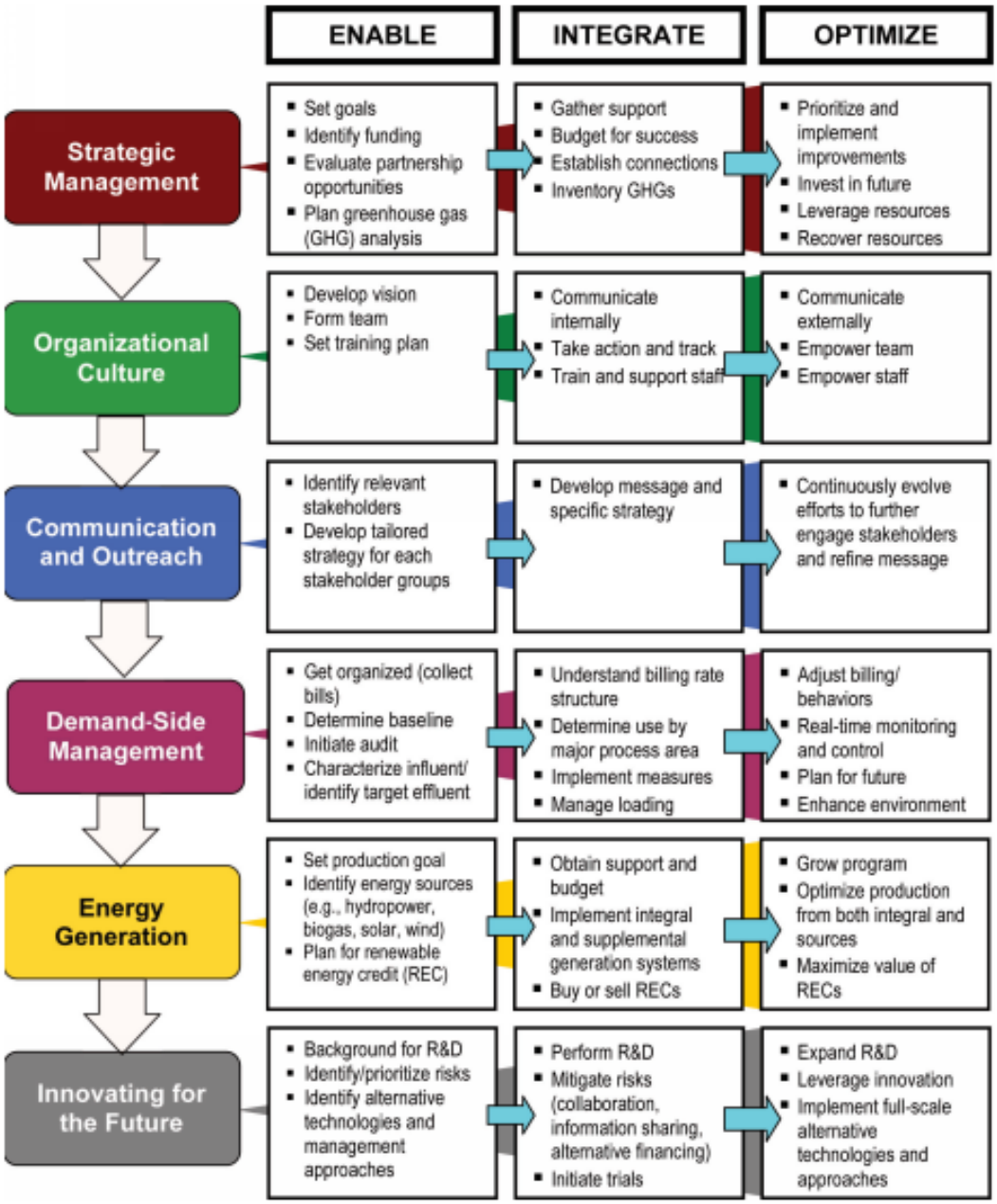


Figure 1-1. Framework for Organizational Approaches to Energy Management.

Source: *The Energy Roadmap: A Water and Wastewater Utility Guide to More Sustainable Energy Management,* 2013

1.1.1 Universe of Energy Efficiency

Energy efficiency is a complex subject because it touches virtually all wastewater utility assets and cuts across all organizational function groups. The focus areas depicted in Figure 1-2 were used by this research to define the scope of the investigation and explore energy efficiency barriers within specific contexts.

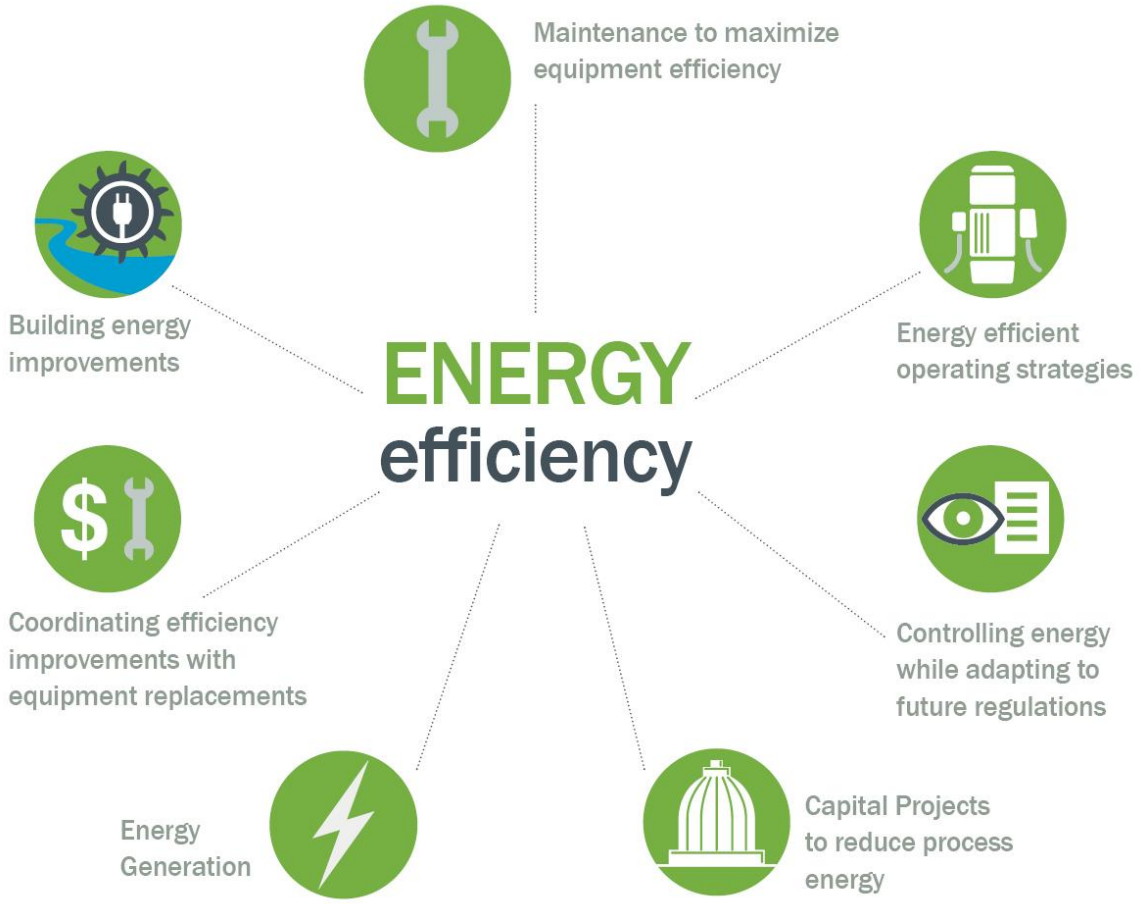


Figure 1-2. Universe of Energy Efficiency Focus Areas.

For purposes of this report, these seven focus areas were grouped under three main categories: capital projects, optimization of existing equipment via energy efficient operating strategies, and performing maintenance at intervals to optimize energy efficiency. Capital project categories in the energy "universe" include:

- **Building energy improvements.** Many utilities begin their energy program with building and site-related energy improvements, such as lighting retrofits and heating, ventilation, and air conditioning (HVAC) improvements. These projects have several inherent advantages: no risk to wastewater process performance, support from established electrical utility incentive programs, use of well-established technologies, and often improved illumination or personnel comfort.
- **Coordinating efficiency improvements with equipment replacement.** It is sometimes difficult to justify energy efficiency projects purely on economic or environmental criteria. Seizing the opportunity to improve efficiency in rehabilitation and modification projects can

be a particularly effective method for advancing energy efficiency because these projects typically have multiple drivers (e.g., equipment condition or capacity concerns), not just energy.

- **Energy generation.** Energy generation, including biogas utilization, incineration heat recovery, and onsite wind and solar systems, are not, strictly speaking, "energy efficiency" measures. However, energy generation is a large part of many wastewater utility energy programs and shares many barriers with other energy efficiency capital projects. While previous Water Environment Research Foundation (WERF) research has focused specifically on barriers to biogas utilization (Willis et al., 2012), this research treats energy generation projects somewhat generically with regard to barriers and strategies to overcome them.

- **Capital projects to reduce process energy.** Because lighting and building energy has been estimated to account for only 4-5% of typical water resource recovery facility (WRRF) energy use (Burton, 1997), significant energy reduction programs must include energy projects that improve efficiency in large process equipment, such as aeration blowers and major oxygen transfer, pumping, and mixing systems.

Equipment optimization was divided into two categories:

- **Maintenance to maximize equipment efficiency.** Maintenance activities, such as fine-bubble diffuser cleaning, dissolved oxygen (DO) probe calibration, and pump clearance adjustments, can keep energy use from increasing over time, but these activities often compete with other priorities for scarce resources.

- **Energy-efficient operating strategies.** Many utilities have challenged themselves to look for large and small operating changes that can save energy. These plant-initiated strategies include measures such as reducing DO set points or fine-tuning the mixing energy used in digestion.

Finally, energy efficiency can be a key component of strategic infrastructure planning, especially when it comes to utility initiatives to meet increasingly stringent regulations related to nutrient limits, odor control, incineration air emission controls, and collection system overflow reduction. The last focus area straddles the previous three categories:

- **Controlling energy while adapting to future regulations.** While providing significant environmental benefits, these increased standards often trigger additional aeration, pumping, or fan energy inputs. Examples of energy efficiency in this context might include watershed-based nutrient trading or removal using natural systems in lieu of energy-intensive mechanical wastewater treatment processes.

1.1.2 Efficiency Opportunities

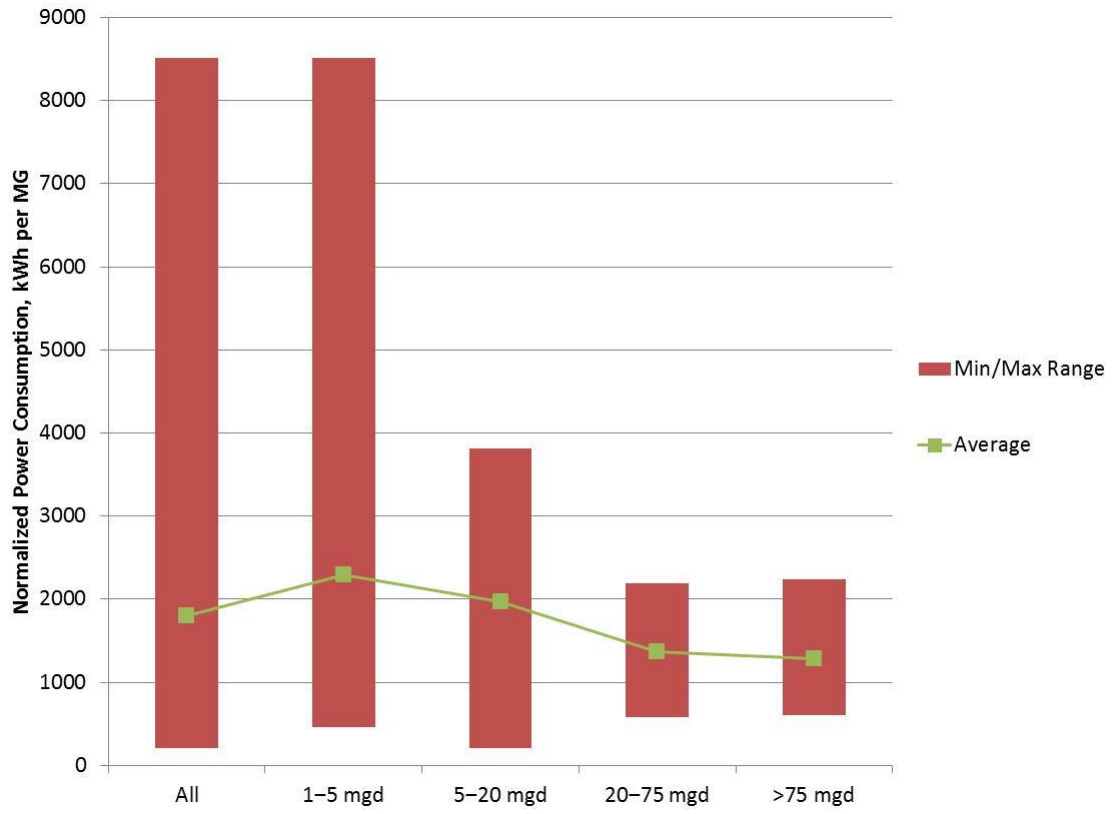
The opportunity has been recognized as a priority by the wastewater facilities, and more recently by the federal government. Diana Bauer, co-chair of the Department of Energy (DOE) Water-Energy Tech Team characterizes her agency's interest by stating, "*Energy efficiency and energy recovery contribute to the possibility of energy-positive wastewater treatment facilities. Such facilities can both save energy and improve water infrastructure resilience*." Although the opportunity is well recognized, the magnitude of potential opportunities for energy efficiency is difficult to gauge because of the complexity of the energy picture as described in the preceding section.

One measure of the potential magnitude of energy efficiency opportunities can be inferred from energy reduction goals set by various utilities. A sample of the energy goals established by various utilities is presented in Table 1-1. Although each utility has taken a different approach to the structure and nature of its goals, it is clear that these highly motivated utilities were able to envision and achieve improvements that exceed the EPRI benchmark.

Table 1-1. Energy Goal Programs Example.

Utility, State	Energy Program Baseline Year	Goals(s)
MCES, MN	2006	15% by 2010 (achieved) 25% by 2015 (on track) 50% by 2020
NYC DEP, NY	2005	30% reduction in City agency GHG emissions by 2017
Thousand Oaks, CA	2010	Net Zero Energy
Littleton/Englewood, CO	2014	Maintain energy intensity below 3,471 kWh/MG 2% energy reduction in biosolids program
Vancouver, WA	2009	10% by 2011 (achieved) 20% by 2016
MMSD, Milwaukee, WI		Meet 80% of MMSD's energy needs with renewable by 2035

Another gauge of the potential for improvements in energy efficiency is the range of normalized power consumption observed in various wastewater facilities. Figure 1-3 presents the minimum, maximum, and average energy intensities of 60 NY plants (net of onsite power generation) (Andrews et al., 2015). Figure 1-4 presents similar data by level of nutrient treatment. While these intensity values are imperfect measures of plant performance because they do not consider differing site conditions, it is clear that some plants have been able to achieve much lower than average energy intensity, through efficiency optimization measures, inherently efficient treatment technologies, or significant onsite power generation.



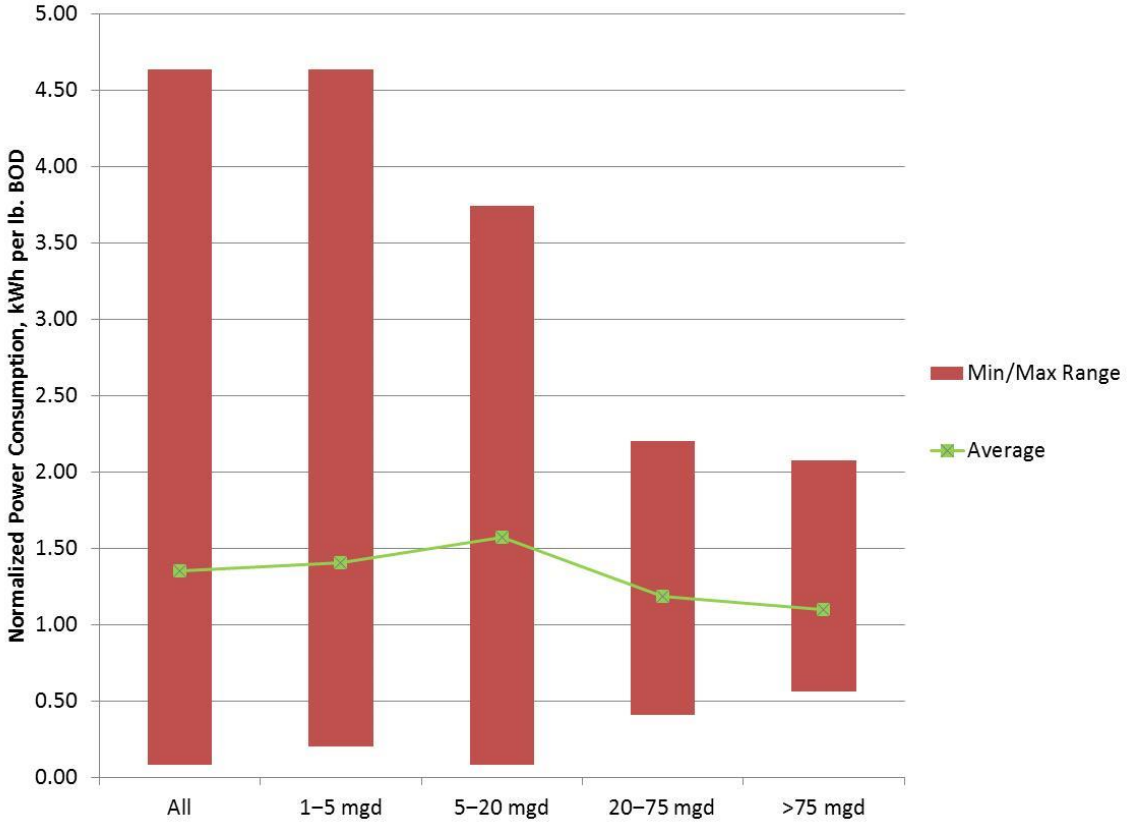


Figure 1-3. Normalized Power Consumption Ranges (minimum/maximum/average) for New York State WRRFs.

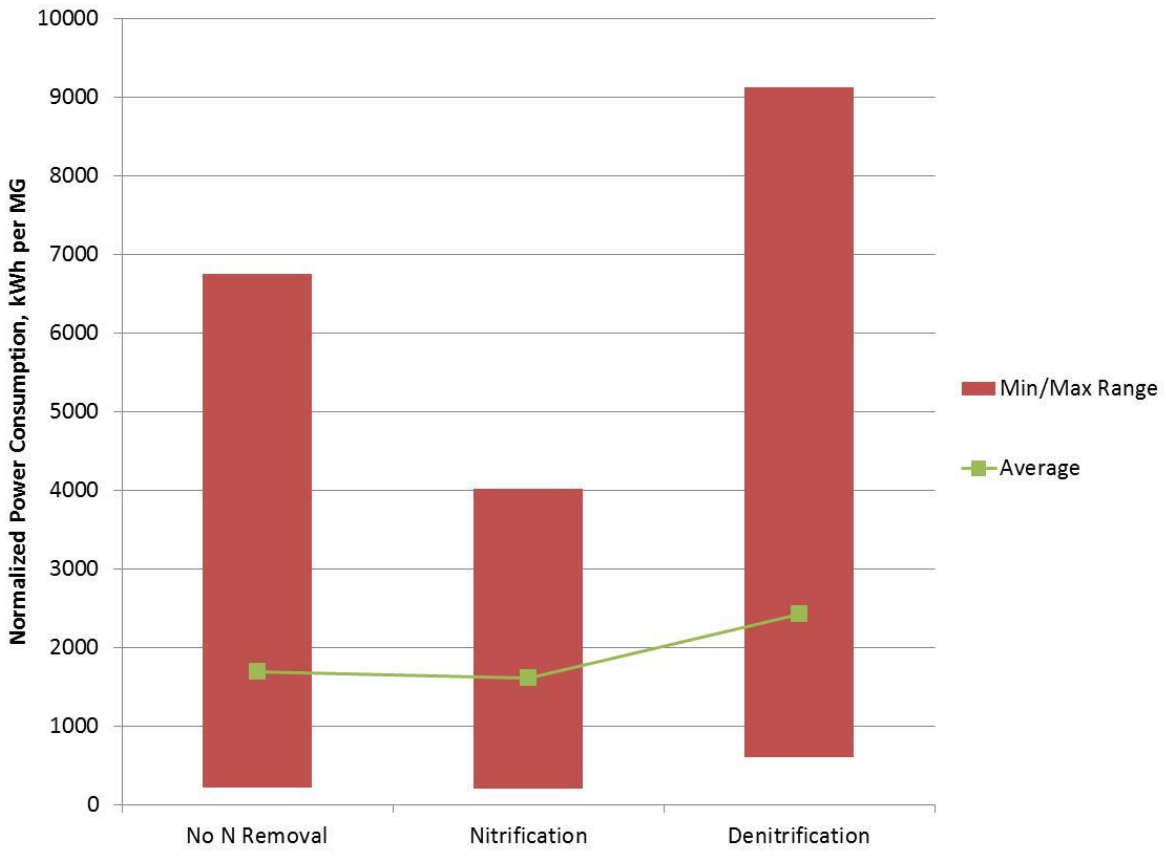


Figure 1-4. Normalized Power Consumption by Level of Treatment (minimum/maximum/average) for New York State WRRFs.

On the other hand, it must be noted that energy efficiency progress can be offset by increasing treatment demands. For example, a recent report published by the Electric Power Research Institute (EPRI, 2013) study estimated that national wastewater energy use increased by 15% over a 15-year period because of more stringent regulations, wider use of secondary treatment, and the wider embrace of additional technologies like odor control and ultraviolet (UV) disinfection, despite the continued deployment of more efficient treatment technology such as fine-bubble diffusion over the same time period and concerted efforts to optimize the additional technologies during commissioning.

1.2 Project Overview

This section presents the research objectives, scope, and approach of this project.

1.2.1 Research Objectives

WERF and the New York State Energy Research and Development Authority (NYSERDA), in conjunction with Brown and Caldwell and other project team members, led a research project to determine the following:

- What are the barriers to energy efficiency?
- Which barriers are most significant and how do they vary by size of facility?
- What strategies are available to overcome identified barriers?

- What is the effect of state legislation, public utility commissions, and power companies on energy efficiency and energy recovery?

Two related research projects will be published in separate WERF publications:

- The energy position of New York State wastewater facilities, including an examination of trends in energy use over the past 10 years and the underlying factors driving these trends.
- Evaluation of the maturity of new technologies with the potential to reduce wastewater energy use.

1.2.2 Research Scope and Approach

This report synthesizes information from over 100 utilities of varying sizes (less than 1 mgd to well over 100 mgd). Some of the participating utilities have been emphasizing energy efficiency for many years, and others are just beginning to prioritize energy reduction as a performance metric. The project team used an online survey and focus groups to gather utility staff perceptions and experience. The case studies found in Appendix A highlight the experiences of utilities that have made significant progress in incorporating energy efficiency into their utility culture.

Each utility's experience with energy efficiency is also played out against a backdrop of local energy pricing conditions and state regulatory programs that incentivize energy efficiency to varying degrees and in varying formats. Energy utility regulations vary from state to state in response to varying political climates and energy agendas. As a complement to the investigation of internal wastewater utility energy efficiency barriers, Chapter 10.0 of this report considers the effect of state-specific energy policies on three prototypical energy projects: 1) a high-efficiency blower retrofits, 2) a biogas combined heat and power (CHP) installation, and 3) an onsite solar photovoltaic (PV) installation; in three states (New York, California, and Georgia).

Related research on the energy position of New York WRRFs and the likely role of future technologies in reducing WRRF energy use are summarized and published in separate reports available through WERF.

1.3 Report Organization

This report is divided into the following chapters that document the methodology used to collect data and the findings in various focus areas:

Chapter 1.0: Introduction
Chapter 2.0: Online Survey and Focus Group Methodology
Chapter 3.0: Motivation and Communications
Chapter 4.0: Capital Projects
Chapter 5.0: Capital Funding Options
Chapter 6.0: Optimizing Operations
Chapter 7.0: Optimizing Maintenance
Chapter 8.0: Assessing Organizational Strategies
Chapter 9.0: Small Plants and Small Utilities
Chapter 10.0: Barriers and Incentives Related to Electric Utility Legislation
Chapter 11.0: Conclusions and Recommended Next Steps

CHAPTER 2.0

ONLINE SURVEY AND FOCUS GROUP METHODOLOGY

The researchers used a combination of online survey deployment and focus groups to gather real-world wastewater utility experience. The online survey allowed the project team to gather input from a large cross-section of utilities and staff functions. The focus groups were used to validate and refine survey results and to obtain a more complete contextual understanding of the operating conditions and associated barriers that WRRFs encounter as they pursue energy efficiency initiatives.

2.1 Survey

The following sections provide an overview of the survey process, including the overall structure, major topic areas, and relevant characteristics of the survey respondents. A copy of the online survey, including questions and response options, is included in Appendix B.

2.1.1 Respondents

More than 170 survey entries were received from utility respondents across the country, representing 104 different wastewater utility organizations of various sizes (Table 2-1). Survey respondents associated with a single plant within a larger utility were directed to indicate their own plant size, so this size distribution is an amalgam of utility and plant sizes. The survey data also include the perspective of several different job categories (Figure 2-1).

Table 2-1. Survey Respondents: Utility Size Distribution.

Utility/Plant Size Range	Number of Survey Respondents
0–1 mgd	5
1–5 mgd	19
6–100 mgd	106
> 100 mgd	39

Figure 2-1. Survey Respondents Included a Cross-Section of Wastewater Utility Staff Functions.

Respondents were more likely to indicate that their energy performance was equal to or better than that of their peers, as shown in Figure 2-2. And almost 80% of respondents indicated that they had achieved some level of reduction in purchased energy over the past 10 years, as shown in Figure 2-3. It was concluded that the survey results reflect the behavior of utilities currently achieving "above-average energy performance," and the results to certain survey questions are characteristic of the self-selecting nature of this survey, as anticipated in any voluntary survey of this type. Surprisingly however, 10-15% of respondents did not know enough about their energy performance to answer these questions, suggesting a need for continued benchmarking initiatives and employee awareness regarding trends in plant energy use.

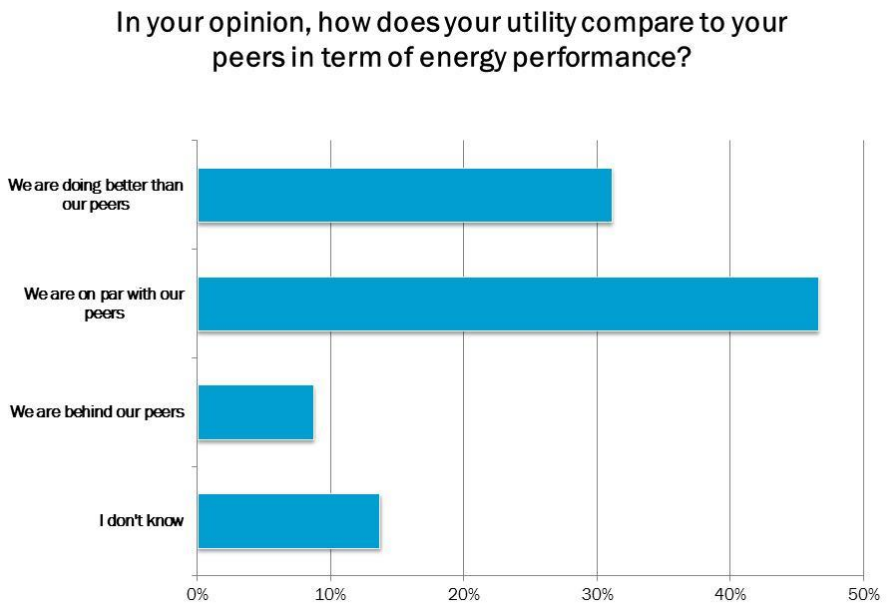


Figure 2-2. Most Survey Respondents Consider Themselves at Least on Par With the Energy Performance of Their Peers.

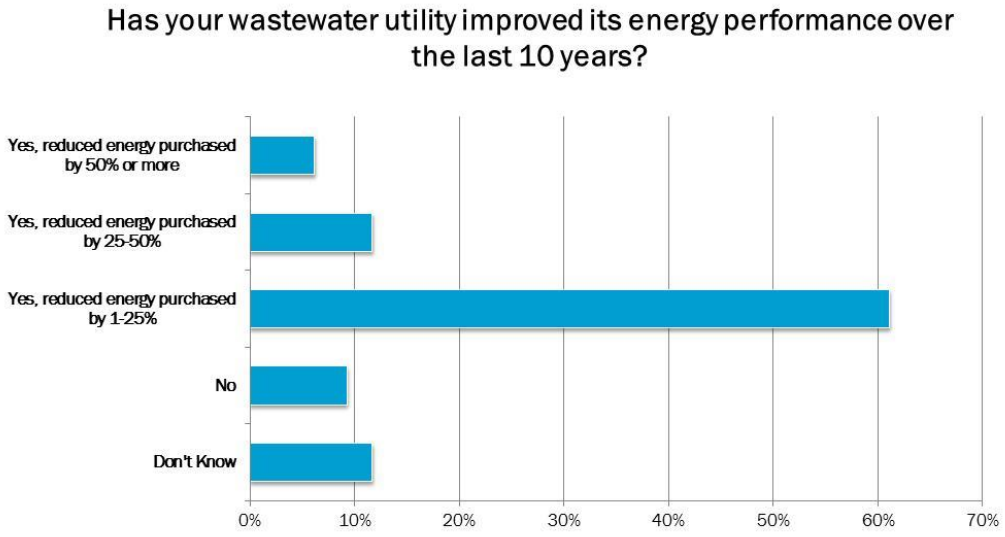


Figure 2-3. Most Survey Respondents Reported Achieving Reductions in Energy Purchases Over the Last 10 Years.

2.1.2 Overview and Methodology

The survey was conducted over a period extending from June through October 2014. A parallel WERF/NYSERDA survey was conducted of New York State wastewater plants. These data sets are also referenced where they provide relevant adjunct data.

The survey was structured according to the major components depicted in Figure 1-1 in order to explore the universe of energy efficiency focus areas in a systematic way. Key aspects of this survey design included the following:

- Questions about utility experience in each of the energy efficiency focus areas were used to orient the respondents to the types of projects to be included in each area.
- The survey was structured to illuminate project phases and factors that derail or slow energy capital projects. The utility experience questions asked whether the projects were completed, derailed, or not considered. Barrier questions were then posed in the context of either completed projects or projects that did not proceed.
- Questions related to the organizational "developmental status" of utility energy programs were grouped based on topic areas in the WEF Energy Roadmap, which encompass various strategies such as goal setting, leadership, staff energy training, communications, onsite energy generation, and innovation. These questions were intended both to establish the development status of the respondent and to highlight Roadmap strategies that appear to be the most significant.

2.1.3 Barrier Identification and Ranking

Respondents were asked to agree or disagree with a number of statements developed by the project team regarding barriers to energy efficiency within the three focus areas of operations, maintenance, and capital projects. Respondents were also asked to rank the level of agreement with statements tailored for each focus area. Respondents were given the option to strongly or somewhat agree or disagree, to neither agree nor disagree, or to consider the statement not applicable (N/A) as shown in the sample survey question (Figure 2-2).

The questions varied in terms of direct or inverse orientations to keep respondents from responding in a rote manner. For example, the first question in Figure 2-4, "We can get the decision maker's support needed for this kind of project," is an inverse barrier question because agreement signifies that the barrier is somewhat minor. Conversely, agreement with the second question in Figure 2-4, "We operate conservatively to ensure that our NPDES permit limits are met," indicates that this barrier is significant. Survey scores were adapted so that higher scores always indicate a barrier with higher significance. In other words, the raw survey scores were applied to the direct barriers statements and the scoring was reversed for inverse barriers statements.

49. Please rate your degree of agreement to the following barriers and motivators to the implementation operational energy projects (e.g. dissolved oxygen control optimization).

	Strongly Agree 10	9	8	7	6	5	4	3	2	Strongly Disagree 1	Not Applicable
We can get the decision makers support needed for this kind of project.											
We operate conservatively to ensure that our NPDES permit limits are met.											
We have sufficient "actionable" energy data collection and analysis dashboards to make timely decisions to reduce energy use.											

Figure 2-4. Example Survey Questions and Barrier Statements.

2.2 Focus Groups

A series of four focus group meetings were held to gather additional wastewater utility experiences with barriers to energy efficiency. The findings of these focus groups are highlighted in the subsequent sections of this report. Each focus group included 6-12 utility representatives. Focus group participants are listed in the Acknowledgements page at the beginning of this report.

Each focus group began with a brief presentation from each utility about its energy program and achievements. Following these presentations, the meeting facilitator led discussions on specific focus topics as summarized below.

WEF Residuals and Biosolids 2014 (May 21, 2014, Austin, TX). Utility participants in this focus group were selected based on their significant experience in initiating energy efficiency programs. This experience was used to develop online survey concepts and terminology, including:

- Feedback on the proposed structure and terminology used to delineate energy efficiency focus areas (e.g., Figure 1-2).
- Significant challenges to energy efficiency.
- Critical success factors and innovative strategies used to overcome energy efficiency barriers.

WEFTEC 2014 (October 1, 2014, New Orleans, LA). This meeting focused on the following areas:

- Motivations for energy efficiency, especially motivators for utility management.
- Financial barriers and strategies to overcome them.

Web Conference (November 13, 2014). This meeting focused on the following areas:

- Maintenance practices to improve energy efficiency.
- Operator "conservatism" as a barrier to operational changes to save energy.
- Financing alternatives: barriers and strategies.

New York Water Environment Association (NYWEA) Energy Conference (November 21, 2014, Albany, NY). This meeting focused on state-specific barriers and financing issues. Key topics included:

- The role of grant funding in advancing energy efficiency.
- Loans and financing alternatives.
- Barriers to increased deployment of solar generation at WRRFs.
- Electric utility relationships.

CHAPTER 3.0

MOTIVATION AND COMMUNICATIONS

The first step toward progress in energy efficiency in a wastewater utility context is elevating the priority assigned to reducing purchased energy use. This first step can be challenging given the wastewater industry's competing focus on water quality, permit compliance, increasingly stringent regulatory requirements, and ongoing management of aging infrastructure. This chapter explores which factors are the strongest motivators in elevating the priority of energy initiatives and which communication strategies establish and maintain motivation.

3.1 Findings

The most compelling motivator among survey respondents was operating cost reduction, as shown in Figure 3-1. This finding was echoed by focus group participants, who raised the following points about the cost reduction motivator:

- Utilities are compelled to be responsive to constituents who want to maintain low rates, including the perceived positive effect of low rates on economic development. Reductions in purchased energy costs can help to minimize operating budgets and control sewer rate increases.
- Energy projects with financial incentives from outside sources can be a source of positive public relations. "Big cardboard checks" and other public events can be used to promote projects.
- In addition to reducing costs, there is value in making the energy portion of utility operating budgets more predictable. This motivation is particularly relevant to renewable energy projects.
- It is not always possible to justify energy projects solely on an operating cost savings basis, so multiple outcomes may be used. In other words, it is important to identify all aspects of the "value added" in an energy initiative and build the program around these concepts. As an example, St. Petersburg, FL moved forward with aeration and biosolids projects that will have energy benefits, but that were also required because of equipment condition. The concept of multiple outcomes is reflected in the third-most important motivator in Figure 3-1, "Capacity or regulatory-driven capital projects provide opportunity to make energy efficiency upgrades."

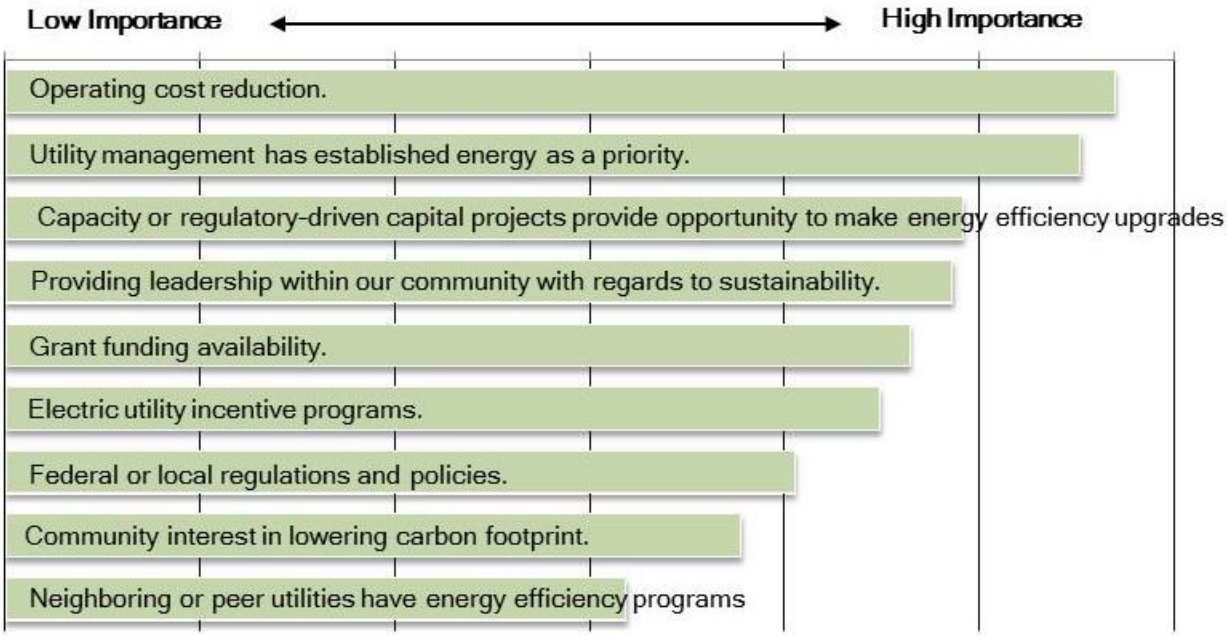


Figure 3-1. Motivators for Implementing Energy Projects, Ranked by Importance.

3.2 Management View and Community Engagement

As noted in Figure 3-1, "utility management has established energy as a priority" was also a very strong motivator for energy projects, begging the question, "what motivates utility leaders?"

3.2.1 What Motivates Utility Leaders and City Officials?

Focus group participants overwhelmingly cited cost reduction as the primary driver motivating utility management, echoing the overall motivator findings above.

Community interest in being good environmental stewards was also cited as a motivator for utility management. For example, Iowa City, IA noted that there is community "cultural pressure," in part because it is a college town. A community-wide sustainability assessment and greenhouse gas (GHG) report found that city utilities are a big part of the city energy picture. This information helped to frame the discussion with the city council on energy efficiency at the wastewater facility.

The Western Lake Superior Sanitary District (WLSSD) in Duluth, MN also operates in a community that places a high priority on environmental issues, including energy. The District has publicly communicated its biogas plans to local news outlets and produced a compelling "Roadmap to Sustainability" document outlining its energy program to its ratepayer community: http://wlssd.com/uploads/WLSSD_Energy__White_Paper__final_revised_for_web_2014_1.pdf.

Codifying support for energy efficiency can provide additional weight to programs. For example, Kitsap County, WA has a general ordinance with goals for energy reduction and

generation, although there are no metrics or timelines. The WRRF has been able to refer to the ordinance to gain approval for energy-related capital projects.

The Victor Valley Wastewater Reclamation Authority (VVWRA) (Victorville, CA) general manager enthusiastically captured VVWRA's community involvement philosophy:

> "Utilize public speaking opportunities to utility constituencies. Once utility managers see the support shown by the community for these types of projects, they in turn support them when it is time to make a decision. Be passionate and have fun. We are not here just to collect a paycheck; we are here to identify value-added opportunities for our ratepayers."

3.3 Communications

This section outlines efforts to communicate energy efficiency to senior leadership, staff, and stakeholders.

3.3.1 Promoting Benefits of Energy Conservation to Senior Leadership

Given the key role of motivating utility leadership, the online survey gathered input to the question, "How can senior leadership (e.g., Director of Public Works, Mayor or Commissioners, Office leaders) be best informed of the benefits of energy conservation and/or recovery at your facility and support further energy conservation efforts?" As might be expected, many of these responses related to the core issue of cost reduction, including sharing electrical and natural gas bills and trends, energy grant opportunities, and life-cycle savings (or return on investment, ROI). One respondent succinctly stated this point: "Results prove the case and open the door for more improvements." More broadly, these informational strategies can reinforce the prominence of energy goals and objectives among utility priorities.

Survey responses recommended regular face-to-face interactions between staff responsible for energy and senior leadership, usually monthly, to encourage open communication and understanding. Several organizational management practices and sample responses are quoted below, reflecting a range of individual perspectives:

- Engage plant staff and management by providing regularly scheduled updates of operations, and a summary of how those operations impact ongoing energy use (and costs).
- Communicate the opportunities and current achievements in saving energy. Periodically update leadership with energy reports, including recommendations for improvement needed to achieve goals. If an Energy Master Plan has been completed, track progress toward plan recommendations.
- Understand industry trends (e.g., attend WEF and WEF member association conferences, read white papers and case studies to be more informed). The Green Communities Act in Massachusetts has been the driving force to inform and encourage one utility's chief executive officer (CEO) and chief operating officer (COO) of the benefits of energy conservation efforts.
- Make energy efficiency on par with water quality requirements for wastewater treatment (e.g., "Our main objective is to put out the highest-quality effluent that we can while considering energy second. When we can show them that both will be better on paper, it is a win-win.")

- Set goals with senior leadership and provide tools to improve energy efficiency advocacy/leadership. Publicize metrics and increase awareness throughout the organization.
- Network with and tour other progressive peer facilities and utilities that have implemented successful energy programs and new, efficient technologies.
- Report cost savings and ROIs for energy efficiency measures and installations.
- Assign a senior manager to the energy team to be an advocate for implementing strategies and goals.
- Report energy savings/improvements through a well-accredited third party.
- Make additional staff resources available that are specialists in both energy and wastewater treatment, who can develop and communicate plans specifically tailored to our plant's specific wastewater treatment processes and objectives.
- Generate performance summaries with graphics or dashboards.
- Share information about ongoing efforts and a true reporting of the executive decisions affecting best practices, long-term goals, O&M staff buy-in, versus focusing solely on short-term cost savings.

Other respondents suggested that simply informing leadership does not provide adequate organizational motivation to move energy initiatives ahead. Economic challenges and other factors are evident in the following responses:

- Information is not the problem. The problem is the negative ROI of energy projects in a low energy cost state.
- [Senior managers] know benefits. They don't outweigh costs though.
- Need to implement energy savings projects with strong measurement and verification (M&V) and commissioning (Cx) protocols to clearly demonstrate energy savings objectives and results achieved.
- There are diminishing returns on energy efficiency projects.
- Management wants risk-free energy projects – including both financial and operations risks.

As these two sets of comments suggest, communications with senior leadership can be an important, positive aspect of providing continued momentum in energy programs. However, the message needs to be realistic and balanced in acknowledging economic challenges.

3.3.2 Promoting Benefits of Energy Conservation to Staff and Stakeholders

Communications processes are key to identifying and overcoming barriers within the organization, as well as fostering support with other stakeholders. Utilities noted that background information is important in fostering support from actively engaged governing bodies and citizens: "People don't want to spend money on things they don't understand." Similarly, employees may be reluctant to spend time on things they do not understand clearly. The WEF Energy Roadmap established Communications and Outreach as one of the key areas of progression for energy programs in response to the need to inform constituencies to foster buy-in.

For this project, survey respondents were questioned about their experience with communicating with different constituencies. Specifically, the survey asked respondents to rank their impression of the effectiveness of the following communications strategies in achieving significant, measurable energy reductions:

- Communicating energy program goals, vision, and achievement to your customers directly, or via media outlets.
- Communicating energy program goals, vision, and achievement to board members, local elected officials, and other civic leaders.
- Communicating energy program goals, vision, and achievement to employees.
- Collaborating with environmental advocacy groups and regulators.

As shown in Figure 3-2, survey respondents considered communications with employees to be the most effective and most widely implemented of these four communications channels. Communications with board members and local officials was similarly viewed as effective.

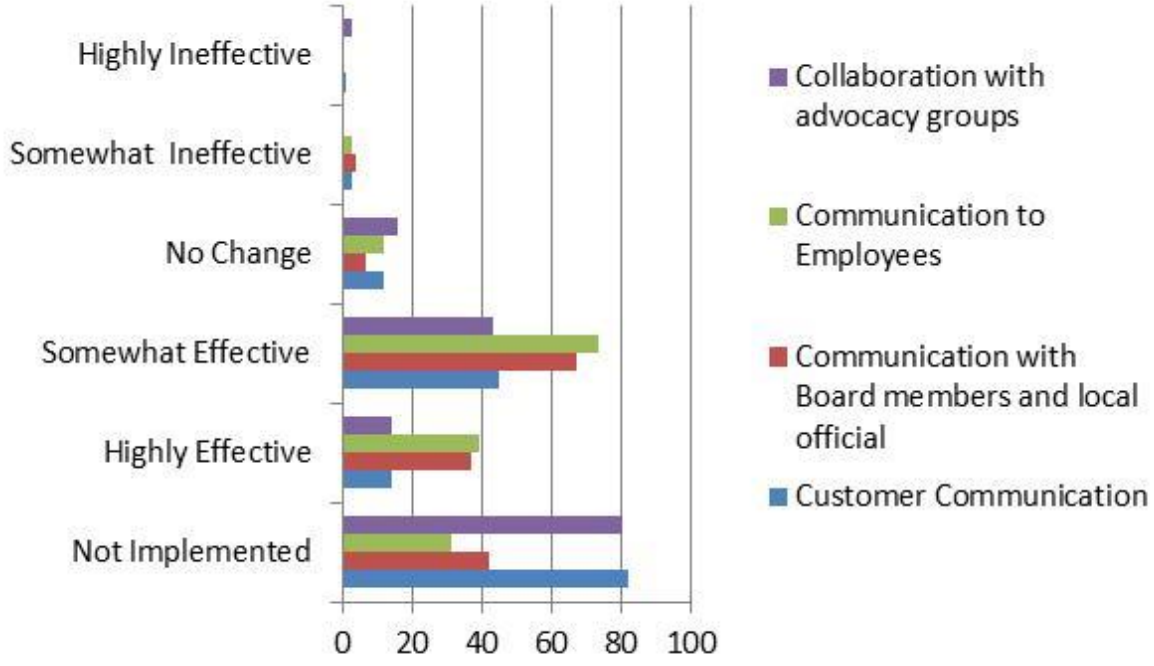


Figure 3-2. Number of Respondents Implementing Various Communications Strategies.

Some respondents emphasized the role of leaders in communicating with employees. For example, Denver (CO) Metro Wastewater Reclamation District (MWRD) staff noted that "upper-level management provides the voice that conveys the work under way and completed and the success of staff in an effective and productive manner."

One survey respondent noted, "As a bare minimum include power consumption as part of standing discussions/meetings; many staff and even some superintendents do not ever even see the power bill." The VVRA survey respondent also emphasized informal personal coordination

and communications over formal reporting: “We are acting and doing rather than writing and preparing.”

3.3.3 Organizational Buy-In

One focus group participant aptly described organizational communication as “*Redefining what is important and* **why.**” Participating utilities offered several strategies for increasing buy-in:

- **Routine energy-focused staff gatherings.** The Des Moines, IA Water Reclamation Authority (WRA), energy program hosts an annual energy awareness breakfast to communicate the energy program goals and recent project results in a positive setting.
- **Keeping the right people engaged.** For utilities with multi-department energy programs, it is important to organize the program to keep the right people engaged, providing technical and leadership support in critical areas.
- **Fostering staff interactions.** Metropolitan Council Environmental Services (MCES) (Minneapolis/St. Paul, MN) has found that specialized energy staff can support department managers and directors on energy initiatives, especially if office proximity nurtures interactions between energy, engineering, and finance staff.

3.3.4 Community Communications

Focus group members discussed the role of energy projects in building positive engagement with their local industries. For example, high-strength waste (HSW) co-digestion programs can provide a revenue source for the wastewater utility, as well as a service to local industries. In the case of the Des Moines WRA, local industry also serves as a customer for biogas produced at the WRRF. Likewise, WLSSD is hoping its future digester feedstock program will have synergy with its joint mission as the local solid waste authority and food waste collection program.

Other utilities cited a need for “multifaceted” internal and external communications. As an example, the NEW Water “Resource Recovery and Electrical Energy (R2E2)” biosolids and energy project in Green Bay, WI included extensive communications with community members to explain the costs and benefits. Additional information on this project is provided in the NEW Water case study in Appendix A.

The LOTT Clean Water Alliance, WA, opened its “WET Center” educational facility to increase awareness of utility operations, including energy initiatives. LOTT staff believe that community outreach makes the rate-paying public more inclined to support “any good project.”

CHAPTER 4.0

CAPITAL PROJECTS

Capital projects that are driven by energy savings encounter a range of barriers as they progress from concept through execution and ongoing operations. This chapter includes the following sections:

- Survey respondent's level of experience with various types of capital projects.
- Identification of the most problematic project phases.
- Assessment of significant barriers for each project progression phase.
- Potential strategies to address capital project barriers.

Because barriers associated with the project funding phase are somewhat unique and often involve outside entities, financing and funding options for capital projects are examined separately in Chapter 5.0.

4.1 Experiences With Energy Efficiency Capital Projects

Overall, 91% of survey respondents reported that their utilities had implemented capital projects to reduce grid energy use. As noted in Chapter 1.0, four types of capital projects were considered:

- Process improvements to reduce energy.
- Building-related energy improvements.
- Coordinating efficiency improvements with equipment replacements.
- Energy generation.

Table 4-1 summarizes survey data on representative energy efficiency projects that were most frequently considered and implemented. The survey also allowed respondents to list other energy projects that they had completed. These "other" projects provide useful examples of the wide range of possible energy projects and are itemized in Appendix B.

Among the overall list of representative project types in Table 4-1, lighting retrofits were by far the most widely pursued project type. For process-related improvements, diffuser retrofits, pump optimization, and high-efficiency blower projects had the highest levels of implementation.

The number of respondents pursuing energy generation projects was comparable to the process improvement and building categories. In addition to biogas utilization, a significant number of respondents indicated that they had wind/solar projects under way or completed, although many respondents indicated that wind/solar projects had not been pursued because of insufficient life-cycle savings.

Outside the fenceline projects take a broader view of energy efficiency by considering initiatives outside the plant boundaries that can reduce WWRF energy consumption or increase renewable energy use, sometimes in conjunction with achieving other treatment goals. For example, many respondents indicated that infiltration/inflow (I/I) reduction was in progress, although this is likely to be a case of regulatory pressure or multiple benefits, with energy as a secondary driver.

It is interesting to note that, with the exception of wind/solar and hydropower, “other factors” appear to be more likely to derail energy projects than insufficient life-cycle cost savings.

Table 4-1. Number of Respondents That Have Experience With Representative Types of Energy-Related Capital Projects.

Process Improvements	Not Considered	In Progress	Completed	Considered, but Not Pursued Because of Insufficient Life-cycle Cost Savings	Considered, but Not Pursued Because of Other Factors
Pumping optimization	15	63	62	7	9
High-efficiency blowers	18	55	53	14	17
Diffusers retrofit to improve air transfer efficiency	27	40	74	5	10
Low energy thickening/dewatering	57	36	34	8	14
Energy-efficient UV disinfection system	49	38	34	8	28
Low-energy mixing	60	23	34	13	19
Building Improvements					
High-efficiency lighting	6	73	71	3	5
HVAC Improvements	22	69	53	6	8
Reduced winter ventilation rates	80	32	24	1	10
Energy Generation					
Biogas utilization (beyond boiler use)	26	59	54	7	13
Co-digestion	50	39	25	12	27
Heat recovery from incineration	94	21	6	11	21
Effluent heat recovery (heat pump)	76	18	9	25	26
Wind/solar	38	23	27	38	28
Hydropower	71	7	9	38	27
Outside the Fenceline					
Water conservation (or I/I reduction) to reduce pumping energy	41	77	24	3	10
Adaptive management/nutrient trading: meeting nutrient or other regulatory goals with less energy	89	41	8	1	13
Purchase of third-party renewable energy	103	11	19	4	16

4.2 Project Progression Stages

Figure 4-1 illustrates the sequential progress of energy projects. This figure includes some of the project team's original hypotheses regarding barrier types and solutions to illustrate the correlation between project phase and barriers.

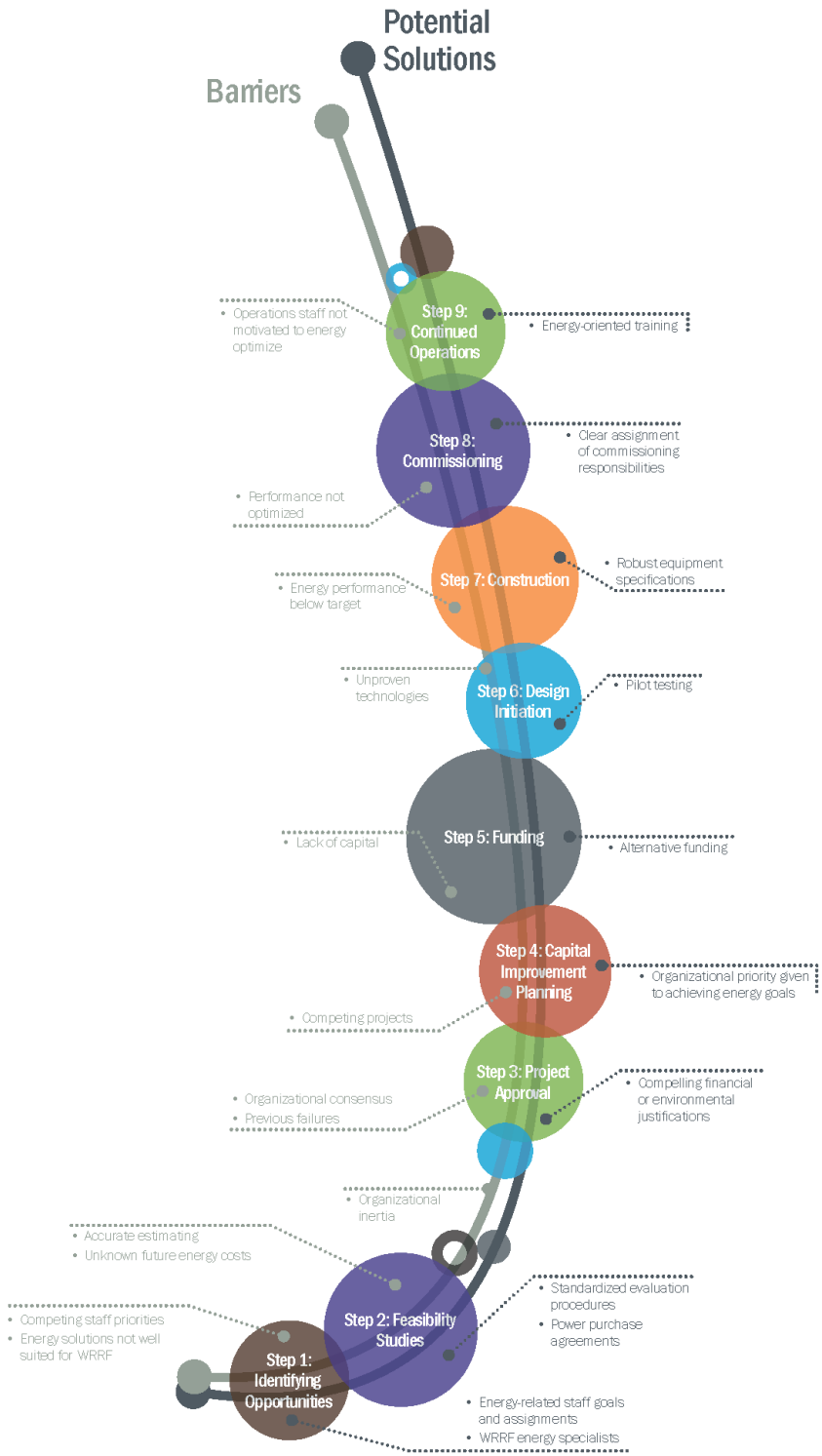


Figure 4-1. Project Progression Steps With Example Barriers and Strategies.

4.3 Problematic Progression Stages

The survey asked respondents to think of their projects that did not get off the ground and to identify which of the project phases were most likely to have "bogged down" or kept these projects from proceeding. As shown in Figure 4-2, the Funding stage was considered to be the biggest hurdle, followed by the Feasibility and Project Approval stages.

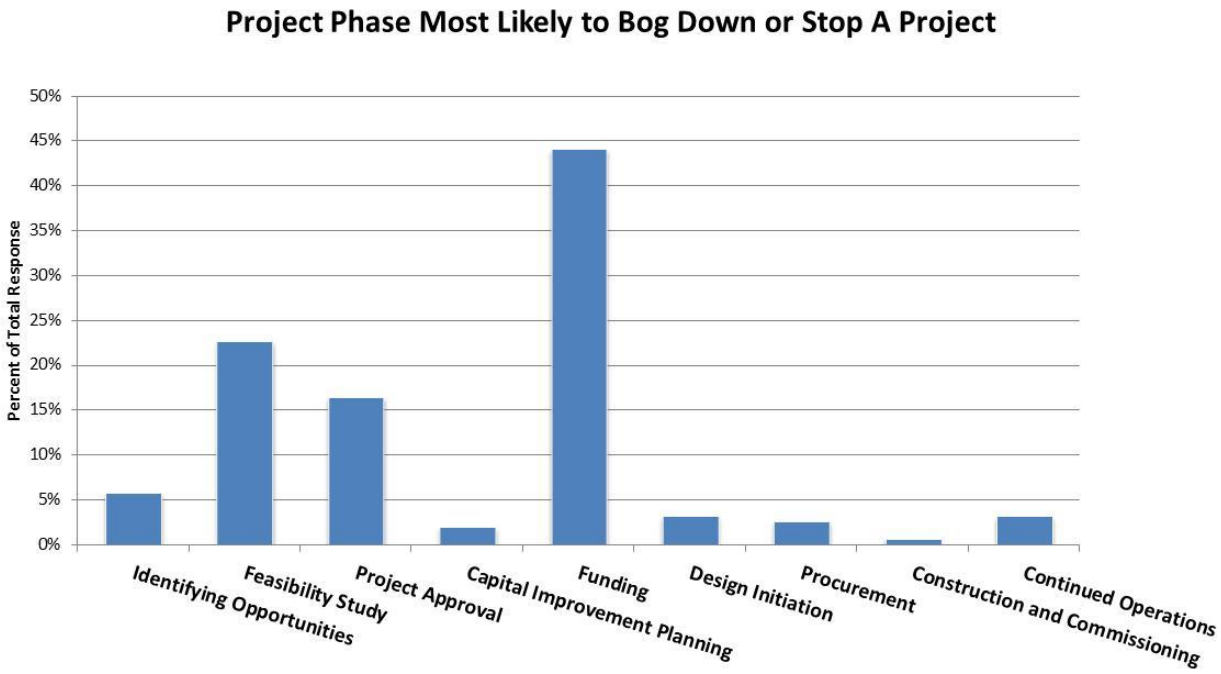


Figure 4-2. Most Problematic Project Phases.

4.4 Barriers and Solutions by Project Stage

The following sections use the organizational framework of these project phases to explore the findings regarding the most significant barriers and potential strategies.

In reviewing the survey results regarding barriers, it is useful to bear in mind the progressive orientation of this self-selecting survey group, including the relatively high reported level of energy achievement noted in Section 2.1. For most of the surveyed barriers, many respondents did not consider the hypothesized barriers to be significant. Because many respondents are affiliated with organizations that have placed a high priority on energy efficiency, the wastewater community as a whole would likely perceive these barriers to be stronger.

For each project phase, the survey asked respondents to agree or disagree with three to five barrier statements. As noted previously, the survey included both "direct" and "inverse" questions. In the following sections comparing the significance of various possible project phase barriers, the original survey statements have been reworded so that they all appear as direct

barrier statements. In other words, agreement with a statement always suggests a potential barrier, and disagreement always indicates that the barrier is not considered significant.

Respondents were first asked to react to barrier statements in the context of a project that did not proceed, and only for potential barriers in the project phase that were most problematic. These questions were intended to discern the types of barriers that are likely to completely stop a project. Respondents were then asked about energy projects that were implemented. In the context of implemented projects, respondents ranked the significance of barriers faced in all project stages.

This approach yielded a larger response set for barriers in the context of implemented projects. Data presented in the figures below are based on this larger data set, with commentary describing how survey responses differed when respondents were asked to think about projects that did not proceed.

Survey responses are summarized in bar charts that indicate the distribution of responses, including the strength of agreement or disagreement with each barrier statement. It is interesting to note in these figures that there is both strong agreement and disagreement on most barrier topics. As discussed further in Chapter 8.0, this divergence may be at least partially attributable to the degree of energy program development in various utilities, with effective energy programs devising methods that have reduced the barriers considered in the survey, for their particular context.

4.4.1 Identifying Opportunities

Over 75% of respondents indicated that they had performed energy audits or similar studies over the last five years, suggesting that most utilities are actively engaged in identifying energy opportunities.

Two-thirds of the utility respondents reported receiving technical assistance from various sources to identify efficiency opportunities, as shown in Figure 4-3.

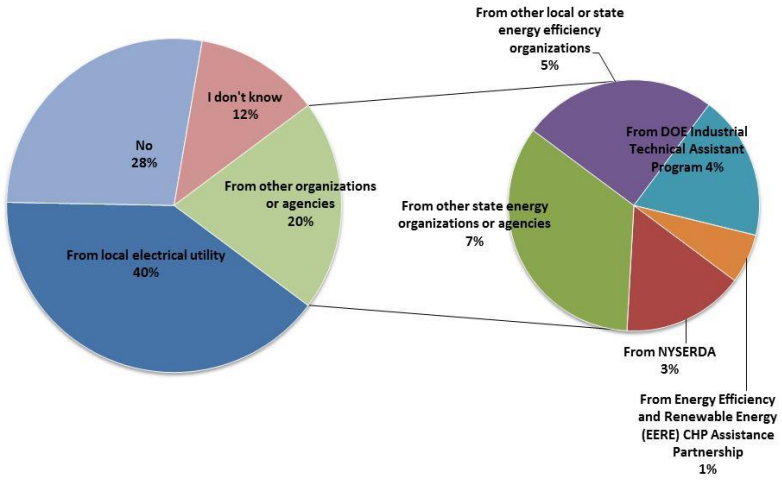


Figure 4-3. Utilities that Have Obtained Technical Assistance and Organizations Providing Assistance.

Barriers. The results of the survey of potential barriers in the "Identifying Opportunities" project phase are summarized in Figure 4-4. The surveyed barriers for this phase were found to be fairly weak. Key findings include:

- 70% of survey respondents believed that their utility staff's knowledge was not a significant barrier.
- For both projects that were implemented and projects that did not get off the ground, over two-thirds of respondents did not believe that there were insufficient resources for energy audits and studies.
- Respondents were split on whether angst surrounding innovation and change was a significant barrier in projects that were successfully implemented, with a slightly greater number stating that innovation and change concerns were not significant in the context of projects that were implemented. When survey respondents were asked about projects that did not proceed, several respondents strongly agreed that this was a barrier.

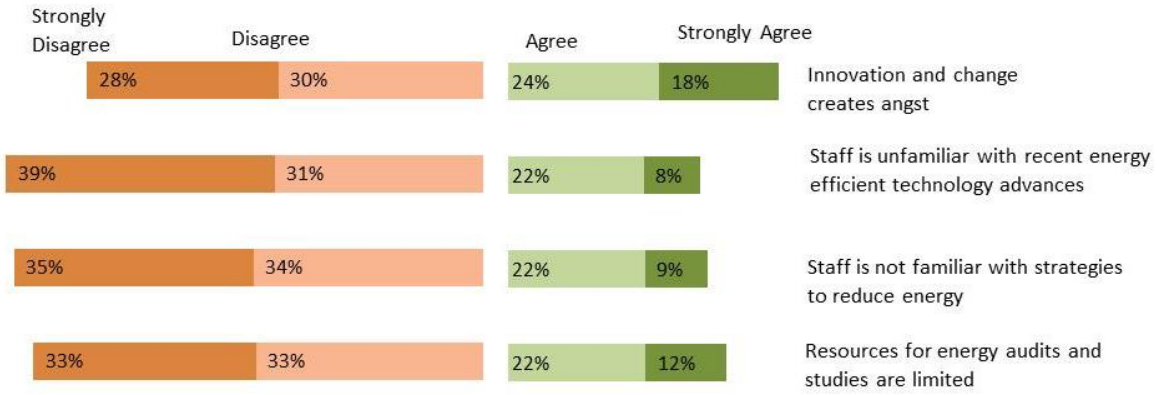


Figure 4-4. Barriers Associated With "Identifying Opportunities" Project Phase.

Strategies. With regard to innovation and change creating angst, each wastewater utility has a different culture regarding technology risks, especially in adopting approaches that are new or not widely implemented in North America.

AlexRenew's focus group representative stressed the importance of advanced planning for project technology risks, including identifying contingency plans to address potential technology failure modes or operating problems.

City of Austin, TX staff suggested increased use of pilot and demonstration projects to showcase performance for a new technology. This approach provides an opportunity for the utility to try out new approaches. On the other hand, the extra staff and financial resources for a pilot facility must be justified as part of a larger vision or mission.

4.4.2 Feasibility Studies

Barriers. The dominant barrier in the Feasibility Study phase is financial viability (Figure 4-5). This survey did not gather data on the financial viability metrics used by various utilities to approve projects, so this finding does not discern how high the bar is set by the respective respondents.

Financial viability appears to be the dominant factor contributing to this phase being the second-most problematic project phase in Figure 4-2. For projects that did not get off the ground, financial viability was by far the most significant barrier.

Many respondents indicated concern with issues related to independent reviews and project savings uncertainty. These issues have significance because they are often more malleable to change than poor financial viability.

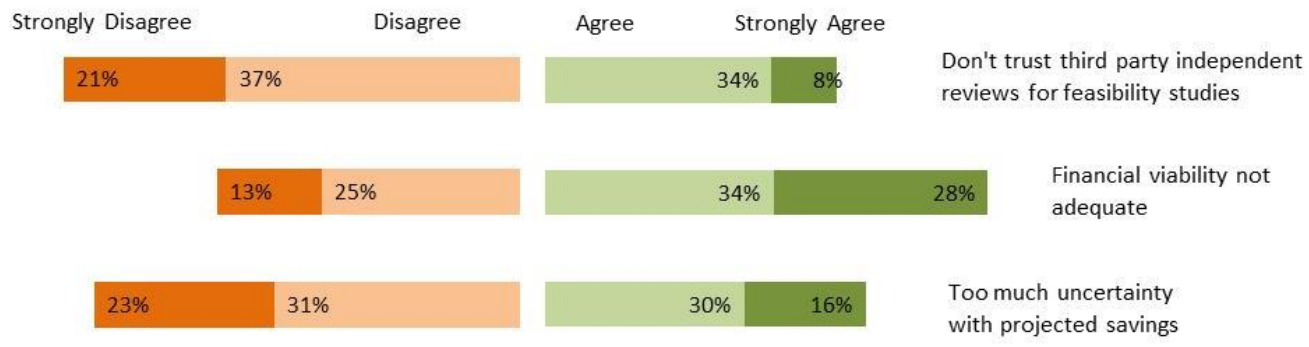


Figure 4-5. Barriers Associated With "Feasibility Study" Project Phase.

Strategies. Focus group members emphasized that good energy projects should have a "strong story line" with realistic goals and financial risk assessments. The Feasibility Study phase is crucial for developing this story and establishing a credible financial evaluation that will build organizational trust. Denver MWRD staff noted the risk of overestimating savings and having to "eat your words." Other focus group participants mentioned the importance of investigating the potential impact of electrical tariff details (e.g., demand charges, standby fees) on project economics. Participants also noted that it is important to ensure that the cost of doing nothing is adequately represented as part of the project economic evaluation, including future maintenance or capital expenses associated with the status quo approach.

Distributed generation such as biogas CHP or renewables are particularly susceptible to rate issues that diminish savings. For example, the Albert Lea (MN) WRRF considered installing wind power, but found that it could not get savings in demand charges. When these and other barriers arise in working with electrical utilities, focus group participants encouraged other utilities to not take "no" for an answer; challenge these "can't do" answers from your power provider.

In some cases, "lack of financial viability" is not the actual barrier. The barriers can be related to a failure to correctly analyze financials, or to take advantage and/or negotiate hard for fee structures or other financial dimensions that will make a project financially viable. In other words, while financial viability is crucial, a distinction must be made between underlying actual financial problems and failure to identify alternatives to improve viability.

4.4.3 Project Approval and Capital Improvement Planning (CIP) Phases

Barriers. Project Approval was the third-most problematic project phase in Figure 4-2. The CIP phase was not considered to be particularly problematic, perhaps because it was seen as a formality following Project Approval. These two phases are discussed in tandem because both phases relate to organizational approval gates for energy projects.

Survey respondents strongly agreed that their utility's core business objective is to produce clean water and comply with their National Pollutant Discharge Elimination System (NPDES) permit (Figure 4-6). Although this sentiment is not explicitly a barrier to energy projects, it suggests that projects that enhance liquid and solids treatment may have priority over energy projects.

Answers to other barrier questions suggest that the water quality business objective is not necessarily an insurmountable barrier to energy project approval for projects that were implemented. While 86% of respondents agreed (or strongly agreed) with the core business objective statement, two-thirds of the respondents believed that they could still get support for energy projects, even if the improvements are not tied to condition or capacity.

Survey results for projects that did not get off the ground also found agreement regarding the core business objective of clean water. However, in this context the related barriers to selling a project that is not required by capacity and condition drivers were most prominent.

Survey results for the CIP project phase tell a similar story (Figure 4-7), with over two-thirds of respondents indicating that energy projects do not have reduced priority relative to other capital projects, especially because of lack of specific energy goals.

Most respondents do not believe that they need to wait until equipment is fully depreciated to pursue energy projects, but that is not always the case. The Trinity River Authority (TRA), TX focus group representative observed that a tendency toward a "wear it out, use it up" approach. This mentality can lead to institutional inertia that slows energy-efficient upgrades to equipment.

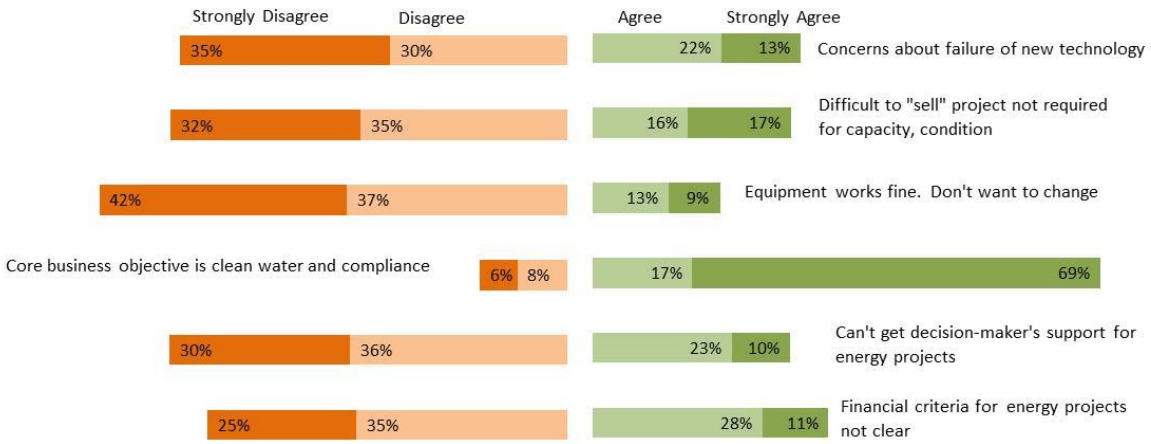


Figure 4-6. Barriers Associated With "Project Approval" Project Phase.

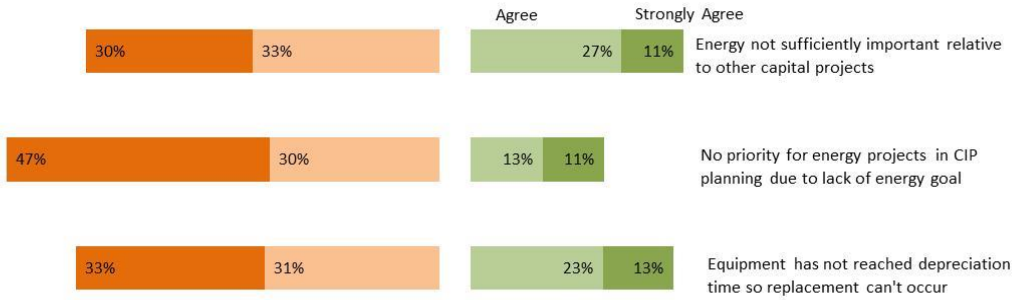


Figure 4-7. Barriers Associated With "Capital Improvements Planning" Project Phase.

Strategies. In the focus group discussion, the utility representative from the City of Fort Worth, TX suggested that the industry needs to redefine its core business in order to overcome resistance to projects that are not directly associated with traditional concepts of wastewater utility "core business" areas. Similarly, the Water Resource Utility of the Future report (NACWA, 2013) makes the case for a new business approach that recognizes WRRF inputs are valuable resources.

Focus group participants also offered their experience with approaches to reducing barriers to internal project approval and incorporation into capital plans.

- **Energy master planning.** The capital planning process has historically been focused on capacity drivers, regulatory compliance upgrades, and projects to address equipment condition needs. These projects are often identified in various master planning processes. Many utilities, including Nashville (TN) Metro Water Services (MWS), have recently conducted energy planning to support a programmatic approach to larger energy investments in its long-term capital planning. MWS's initial energy capital program includes $2.5 million allocated to identifying energy projects and beginning those improvements.

- **Procedures for prioritizing energy projects.** King County, WA has developed a capital project scoring process using weighted criteria that determines the priority level for potential projects. This scoring process has been adapted to provide credit for energy reduction, both for projects that are strictly energy-related and other capacity, condition, and level-of-service projects that have secondary energy benefits.
- **Project acceptance criteria.** The project approval process can be expedited by establishing a project acceptance criterion that all stakeholders agree on. As an example, MCES has established a criterion of net present value (NPV) greater than zero for energy projects and has found this criterion to be a political safe harbor between rate stability and sustainability goals.
- **Energy opportunities in other projects.** Many projects have multiple benefits. These projects may not meet an established project acceptance criterion based on energy savings alone and project approval will depend on the aggregate benefits.
- **Dedicated funding.** Representatives from the LOTT Clean Water Alliance, WA, reported that their organization has a dedicated funding allotment for energy projects.
- **Engaging project engineering staff.** Some utilities are integrating energy efficiency into the capital projects engineering design process via guidelines and energy reviews. Refer to the New York City Department of Environmental Protection (NYC DEP) case study in Appendix A for details of one such program.

4.4.4 Funding Phase

As noted previously, the funding phase was identified as the project phase most likely to bog down or stop a project. Refer to Chapter 5.0 for a discussion of funding barriers and alternatives, including survey and focus group findings.

4.4.5 Design Initiation Phase

The Design Initiation phase was considered to have relatively few significant barriers. However, this is the phase when many project details are established and many hidden issues can emerge, often causing project costs to escalate, and creating management and stakeholder concern regarding whether the project is still justified. As an example, one utility indicated that it had not implemented heat recovery from its incinerator because of lack of space in the incinerator building after finding that an air pollution upgrade would be required to comply with the Maximum Achievable Control Technology (MACT) Sewage Sludge Incinerator (SSI) rule (as well as concerns about life-cycle cost savings).

As shown in Figure 4-8, over 40% of the survey respondents reported that they had encountered site-specific issues such as space limitations, noise concerns, or emissions regulations during the design phase. In addition, half of the survey respondents believed there was a lack of guidelines and procedures for integrating energy efficiency into capital projects during the design phase.

Focus group participants also observed that they have encountered a pinch point in capital projects' staff capacity, specifically availability of engineering staff to implement energy upgrades. Often this situation arises in response to competition with large initiatives (e.g., consent decree requirements, new plant construction). The bottleneck can slow the progress of energy projects in some organizations. However, in light of opportunity costs; even though

energy projects might have attractive life-cycle cost savings, there is an opportunity cost if resources (staff or financial) are being diverted from other high-priority initiatives.

Figure 4-8. Barriers Associated With "Design Initiation" Project Phase.

Strategies. Focus group participants discussed concerns about O&M complexity and suggested that design-phase decisions must include features to streamline O&M requirements in order to ensure that plant staff will accept the project and operate it as intended.

4.4.6 Procurement Phase

Barriers. Barriers associated with the Procurement phase for successfully completed projects are summarized in Figure 4-9. The most prominent potential procurement-phase barrier in the survey was meeting sole-source criteria when limited suppliers of specialized equipment are available. Many survey respondents also believed that the procurement process was lengthy.

Some utilities have found the normal design/bid/build procurement process to be difficult for innovative energy projects because of unforeseen issues with suppliers of new technology equipment. However, a strong majority of survey respondents did not perceive the conventional procurement process as a significant barrier for successfully completed projects.

In survey results for projects that did not get off the ground because of procurement issues, the lengthy procurement process and sole-source issues were both prominent barriers.

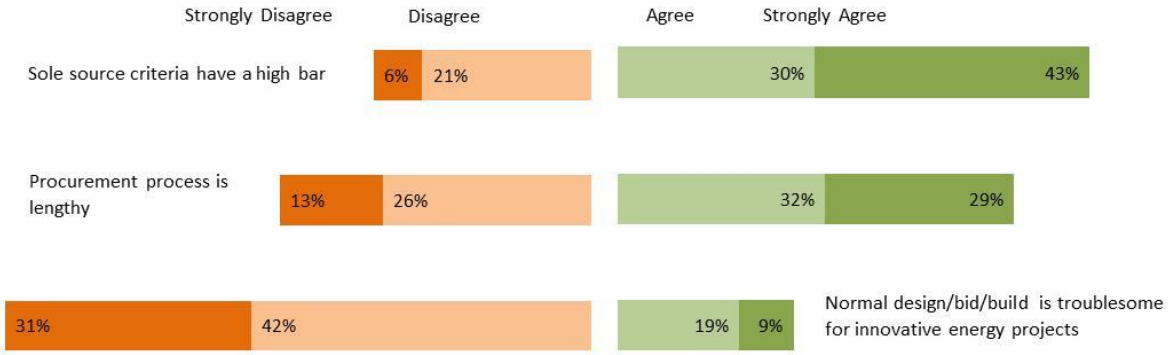


Figure 4-9. Barriers Associated With the "Procurement" Project Phase.

Strategies. Some utilities have used non-traditional procurement options to address issues with lengthy procurement, performance risk, vendor selection, and even to gain earlier-than-design/bid/build bid-day price certainty:

- **Energy service companies (ESCOs).** Focus group participants generally looked to ESCOs to have single-point responsibility for project outcomes. For example, the Upper Occoquan Service Authority (UOSA) used an ESCO agreement to install an 850 kW CHP system, high-efficiency blowers, and ammonia-based aeration control. UOSA's focus group representative emphasized that the project specification must include good "front-end" contractual language to make sure that the performance guarantee is enforceable. UOSA further recommends retaining a project specialist in this area to monitor the contracting process. Once the contract is in place, the project needs to be administered in a way that does not degrade the enforceability of contract performance provisions.
- **Life-cycle bid awards.** Life-cycle bid awards can be used to award a contract to a higher-capital-priced bidder based on documented life-cycle savings. Bid forms must clearly state the assumptions to be used in the bid evaluation.
- **Bidder qualifications.** Tighter specification language can be considered to increase the qualification requirements, especially for "riskier" and specialty energy projects.
- **Best-value request for proposals (RFP).** Similar to life-cycle and bidder qualified approaches, the best value contracting approach is a hybrid bid-RFP method that identifies the chosen bidder based on a weighted evaluation of price and other selection criteria. The criteria used for best-value procurement may include the quality and timeliness of the vendor's or contractor's performance on previous projects, as well as technical capabilities. This approach may allow wastewater utilities to improve the success of specialized energy projects (e.g., biogas utilization projects) by justifying the selection of a more highly qualified bidder.
- **Used or surplus equipment.** Suitable used or secondary market equipment can sometimes reduce project costs. For example, connections with equipment suppliers or peer utilities can sometimes lead to opportunities to purchase equipment from canceled orders or equipment that becomes available through other specialized circumstances.

4.4.7 Construction, Commissioning, and Operations Phases

Barriers. The Construction, Commissioning, and Operations project phases are the crucial final steps of the project that ensure that the projects meet their performance objectives and can be operated and maintained by utility staff without compromising efficiency. In some cases, this phase can be short-changed because of a lack of remaining resources at the end of a project.

Similar to barrier findings in earlier phases, lack of trained staff and equipment complexity was not considered to be a significant barrier by most respondents for projects that were fully implemented (Figure 4-10). However, in the survey results for projects that did not proceed, respondents who considered the Operations phase to be most problematic did identify these issues to be barriers. These two findings imply that, while staff training issues and equipment complexity are most often adequately addressed by successful projects, equipment complexity and insufficient training has contributed to the failure of at least a few projects.

Survey results suggest that factory testing and onsite commissioning may be an area for potential improvement (Figure 4-10).

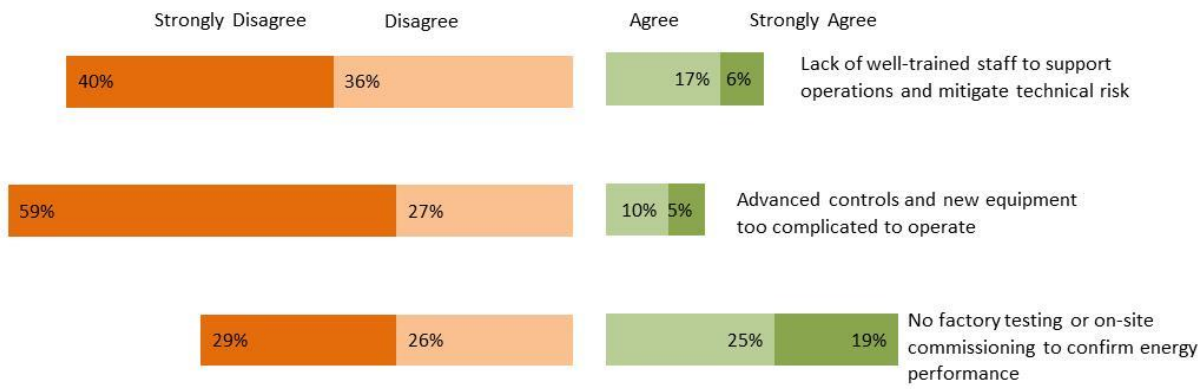


Figure 4-10. Barriers Associated With "Construction, Commissioning, and Operations" Project Phases.

Strategies. Advance planning for factory testing and onsite commissioning can help to ensure that projected energy efficiency performance will be achieved, if not exceeded. This planning will also support the "measurement and verification" provisions of many energy efficiency grant programs by planning in performance metrics and measurement provisions.

The aim of commissioning is to use a systematic, forensic approach to quality assurance. Commissioning and recommissioning have received a lot of attention as a means of increasing building energy efficiency via optimized HVAC and lighting systems. As an example, the Lawrence Berkeley National Laboratory compiled data on 643 building commissioning events, and estimated an average 16% median whole-building energy savings in existing buildings and 13% savings in new construction (Mills, 2009).

The commissioning process overview in Figure 4-11 illustrates the recommended planning and execution steps. While many of these steps are common in major wastewater construction projects, it is important to ensure that energy monitoring and verification are highlighted in the overall commissioning design and execution.

MWRD found success in mitigating technology risk in the Commissioning and Operations phases by training a select group of staff to support the new system. The trained staff benefited from this career development opportunity and gained a "swagger" associated with their status as go-to troubleshooters. Other staff gained confidence in the new system because they knew they would receive the support they needed from this specialized group.

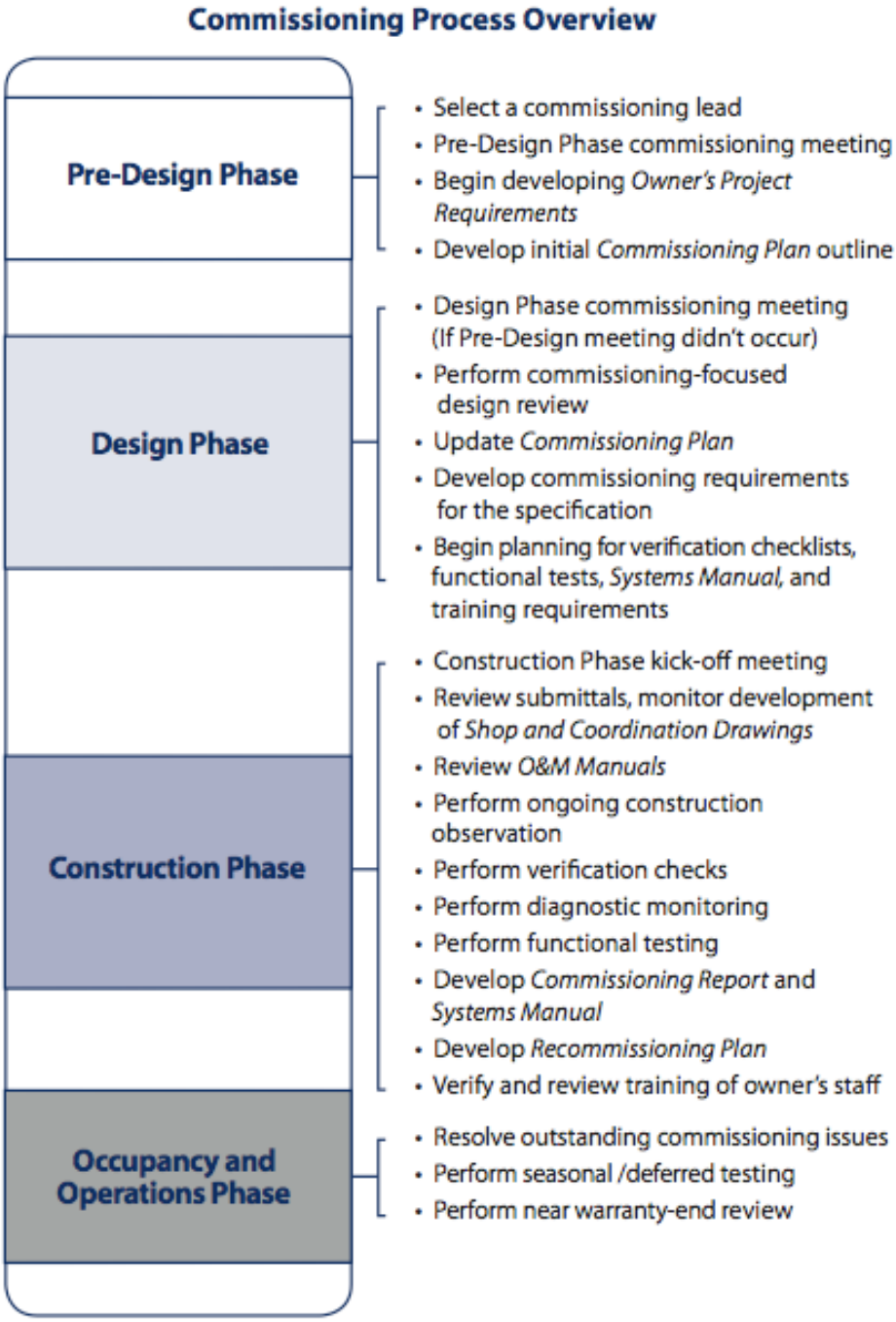


Figure 4-11. Commissioning Process Overview.
Source: Mills (2009) and Haasl (2006), California Commissioning Collaborative.

4.5 Other Capital Project Barriers and Strategies

The following two sections present barriers and strategies associated with capital projects that fell outside of the project progression framework presented above.

4.5.1 Quantifying the Hedge Value of Energy Efficiency and Renewable Energy Projects

Barrier. Natural gas commodity prices are not regulated, and have been subject to significant increases and decreases as the energy marketplace has evolved in recent years (Figure 4-12). Electrical costs are regulated so price changes tend to be less extreme, as shown in Figure 4-13. However, the electrical industry has been subject to significant changes because of renewables, distributed energy production, and increased reliance on natural gas for power generation, increasing the uncertainty in future electrical pricing.

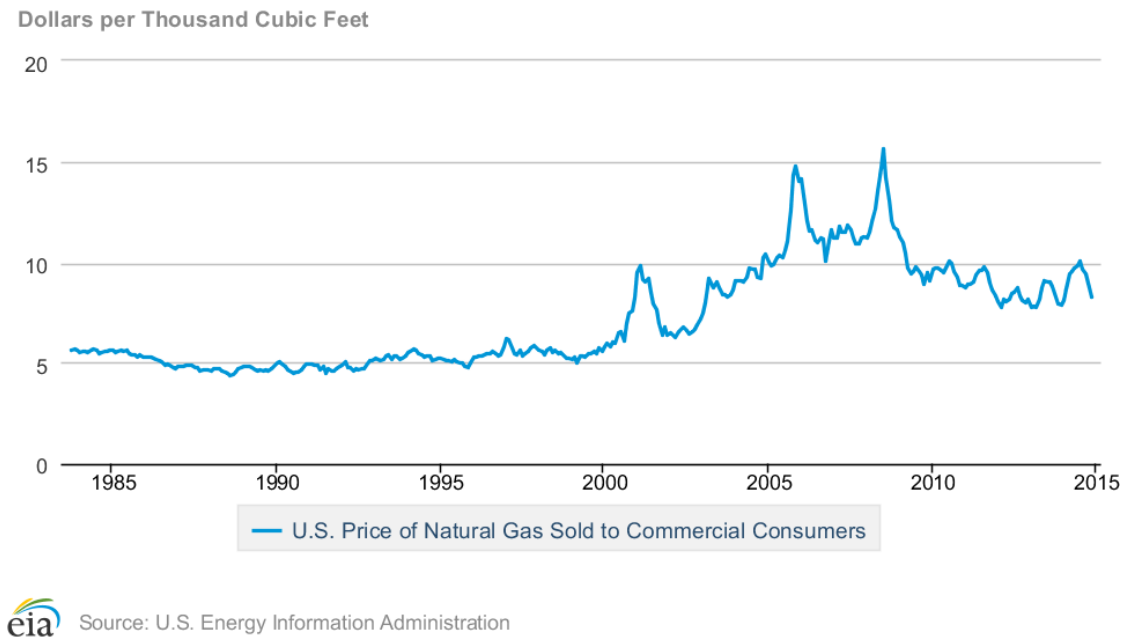


Figure 4-12. Historical Natural Gas Pricing Trends.

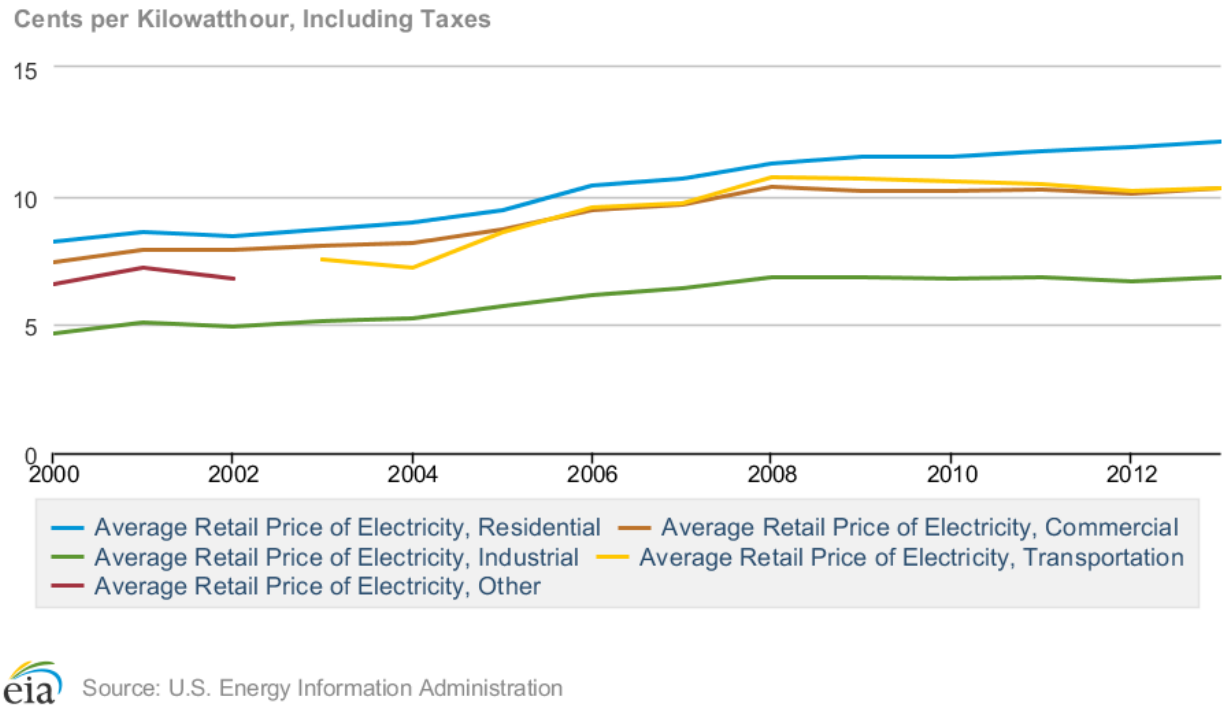


Figure 4-13. Historical Electrical Pricing Trends.

Strategy. The energy price variation issue can be either a barrier, because it creates uncertainty in project savings, or an opportunity, because energy generation and efficiency projects reduce utility exposure to price swings, effectively creating a hedge against increasing operating costs. Energy price volatility can be particularly problematic for wastewater utilities because they have very little budget flexibility and cost certainty can be as or more important than cost savings. The Hampton Roads Sanitation District (HRSD) (Virginia Beach, VA) relied heavily on the hedge concept to frame the initial life-cycle cost results of CHP at its Atlantic Treatment Plant. St. Petersburg, FL also found that locking in vehicle fuel prices justified a higher initial price for compressed upgraded biogas (BioCNG) sanitation fleet fuel.

4.5.2 Prioritizing Multiple Projects

Barriers. Multiple energy projects may compete for limited engineering staff attention. Some utilities reported that they had to reject some projects because there were more energy projects than they could realistically accomplish.

Solutions. As mentioned previously, some utilities, including Milwaukee Metropolitan Sewerage District (MMSD), have conducted an “Energy Master Plan” process to identify, prioritize, and schedule energy projects. This process benefits both the capital planning process and the prioritization of staff efforts.

4.5.3 Non-Monetary Benefits

Barriers. In many cases, additional non-monetary benefits must be presented to justify project approval because monetary savings may not be sufficient to meet organizational financial metrics. Many utilities struggle with how to capture the value of non-monetary benefits such as:

- Energy security and resilience: ability to run critical equipment using onsite power generation.
- GHG reductions and offsets.
- Environmental and public-health benefits.

Various researchers and planning efforts have attempted to monetize these factors as a means to improve decision-making (EPA, Epstein, Krugel), but a range of assumptions and subjectivity are inherent to this approach. As a result, some focus group participants had mixed feelings on monetizing benefits. Other multi-objective analysis methods such as Envision provide an alternate approach to monetizing.

Strategies. Clear and compelling arguments can be employed to bring non-monetary benefits into the project approval process. Focus group participants suggested the following approaches:

- Make benefits more understandable (e.g., "project emissions savings are equal to removing XX cars from road").
- Begin energy efficiency efforts with projects that achieve multiple **tangible** benefits. For example, one utility found new light-emitting diode (LED) lighting had very little maintenance relative to previous high-pressure sodium fixtures. Lighting projects can entice trying other energy projects; providing improved light quality, fast turn-on, and other side benefits.
- Bring the finance director into the loop to collaborate on/corroborate the combined financial/non-monetary justification messaging.

4.6 Summary

Table 4-2 summarizes the most significant barriers in each capital project phase based on survey and focus group findings.

Table 4-2. Significant Barriers.

Project Phase	Likelihood of Stopping Projects	Most Significant Barrier	Example Strategies to Address Barrier for Project Phase
Identifying Opportunities	**	Innovation and change create angst	Use pilot and demonstration projects
Feasibility Study	********	Financial viability	Build trust with credible financial evaluations
Project Approval and Capital Improvements Planning	******	Competition with clean water business objective Difficulty selling a project not required by capacity of condition	Develop a capital project scoring process that provides a defined level of credit for energy projects
Funding	**********	Refer to Chapter 5.0	Refer to Chapter 5.0
Design Initiation	*	Lack of energy guidelines and procedures	Include features to streamline O&M requirements to foster buy-in from plant staff
Procurement	*	Sole source issues	Best value contracting approach using weighted evaluation of price and other selection criteria
Construction Commissioning and Continued Operations		Lack of factory testing and onsite commissioning Equipment complexity, staff training	Advance planning for factory testing and onsite commissioning

[a] For projects that do not proceed.

CHAPTER 5.0

CAPITAL FUNDING OPTIONS

This chapter presents survey results related to energy project funding and presents utility experience with the following funding sources:

- Electric utility funding.
- Federal and state grant funding.
- State low-interest loan programs.
- Other financing alternatives.

5.1 Survey Findings: Funding Project Phase

Responses to barrier statements related to funding are shown in Figure 5-1. The barrier statements provide feedback regarding the following potential funding and project execution approaches:

- **Rehabilitation and replacement (R&R) funds.** Many utilities maintain R&R accounts to finance equipment renewal needs. As noted in Figure 5-1, many survey respondents indicated that they were able to tap these funds for projects that replaced existing equipment with more energy-efficient equipment.
- **Energy service companies.** ESCOs provide a range of services to wastewater utilities, depending on the specific utility's needs and preferences. Almost all respondents indicated that they were familiar with ESCOs and how they operate. Just under half of the respondents indicated that they had worked with an ESCO. Use of ESCOs appears to have increased recently, with 33% of respondents reporting that they had used an ESCO in the last 5 years.
- **ESCO project financing.** In some cases, ESCOs can be used to provide project financing, but many utilities find that they are able to access more cost-effective financing through municipal bonds and other approaches. While Figure 5-1 suggests respondents do not agree that better financing sources are available, the vast majority of survey respondents answered in the middle of the available responses or "not applicable," suggesting that they do not have a strong sense of the comparative benefits of ESCO financing vs. self-financing.
- **Grant funding.** For projects that were implemented, a majority of respondents believed that grant funding contributed to organizational buy-in for recent projects. In the survey results for projects that did not proceed, lack of grant funding was identified as the most significant factor.

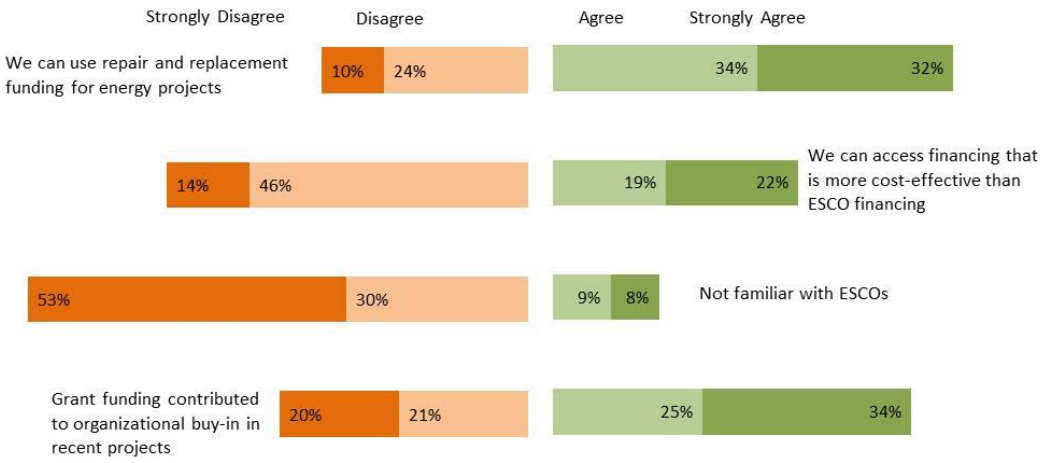


Figure 5-1. Barriers Associated With "Funding" Project Phase.

Focus group participants further articulated their most important funding challenges as follows:

- Capital funding for standalone energy projects.
- Identifying grants and rebate opportunities.
- Lack of variety of funding sources for flexibility.
- Securing adequate financing for proposed projects.
- Capturing "energy savings" to fund future energy projects.

5.2 Utility Experience With Grant Funding of Energy Projects

Almost 60% of survey respondents reported that they had received federal, state, or energy utility program grant funding for an energy project over the last five years, with an additional 7.5% indicating that they had received funding five to ten years ago.

One utility suggested that only 20% of its energy projects would have proceeded if no grant funds were available. It noted that its wastewater department is always in competition with other city departments (police, fire) and that grant funding has been an important advantage at the political/board level. Others noted that a lack of grant funding slows down adoption of projects, and that the amount of grant funding is not necessarily important; sometimes just having an outside grant provides momentum.

Focus group participants believed that CHP projects relied most heavily on grants. Energy efficiency projects also benefited significantly from grants, although projects with short paybacks are likely to be implemented regardless.

Aging infrastructure replacements that concurrently improve efficiency are more likely to proceed without grants because the drivers for replacement are strong enough that additional financial incentives are not required. Conversely, if a strategic priority is placed on energy, some utilities have gained approval for an equipment condition project by presenting it as an energy project.

Timing can be an issue for grant funding. For example, although NYC DEP sometimes uses grant funding to communicate the need and benefits of an energy project; it does not consider grant funding to be a main driver because its projects often have a long time cycle (7-10 years from concept to construction) that usually exceeds the timing requirements for grant funding.

The following sections discuss utility experience with grants from electrical utilities and state or federal programs.

5.2.1 Electrical Utility Grant Funding

Grant funding from electrical utilities is common because state electrical regulators often require that electrical utilities support these programs to meet state objectives for peak demand management and environmental goals. Electrical utility grant incentive programs take various forms, varying from state to state and from utility to utility. Some examples include:

- Minnesota legislation requires electrical utilities to invest 1.5-2.0% of their total gross revenue on energy conservation improvements.
- Puget Sound Energy (PSE), which serves King County, WA, has a rider that collects money from specific facilities (e.g., wastewater plants) and creates a "use it or lose it" pool dedicated to the facility. The LOTT engine-generator CHP and blower projects received $2 million in grants from PSE.
- Littleton/Englewood, MCES, and MWRD have participated in ongoing partnerships with their electrical utilities for efficiency upgrades, with efficiency projects and incentives developed in a collaborative environment. These partnerships can include financial support for non-conventional energy projects such as control programming changes that improve efficiency. Similarly, WLSSD meets quarterly with its electrical utility to monitor potential rebates.
- Many energy efficiency programs provide grant funding for feasibility studies as well as construction costs.

Additional discussion of state-mandated incentive programs is presented in Chapter 10.0.

5.2.2 Federal and State Grant Funding

Various government programs and agencies provide grant opportunities, often on an intermittent basis. A few utilities stated that they have designated staff members that track these programs to make sure they are aware of new offerings and application deadlines. The Database of State Incentives for Renewables and Efficiency (DSIRE) (http://dsireusa.org/) is an excellent source of information on current state and federal programs.

Federal funding sources include:

- **U.S. Department of Energy (DOE).** The Advanced Manufacturing program provides three funding streams to wastewater utilities: through state allocations, on a competitive basis, typically in the range of $200,000 to 400,000, and no-cost technical assistance.
- **U.S. Environmental Protection Agency (U.S. EPA).** The Green Project Reserve program may provide a principal forgiveness portion of an energy project in conjunction with the state revolving fund (SRF) program. Not all states allow energy projects to apply for this funding (e.g., New York funds only stormwater projects).

- **U.S. Department of Agriculture (USDA).** Rural Energy for America Program (REAP) is available for rural areas (less than 50,000 population).
- **Energy Efficiency Block Grants.** This funding mechanism was a significant source of energy project funding provided by the American Recovery and Reinvestment Act (AARA) stimulus program but is currently inactive.
- **Federal Emergency Management Agency (FEMA).** Flood recovery projects may provide opportunities for efficient replacement equipment, subject to FEMA approval.

For very large projects, specialized government funding can be pursued. For example, the City of St. Petersburg (FL) received a Congressionally Directed $2.5M Biosolids to Renewable Energy Assistance Agreement with DOE.

5.2.3 Grant Program Ancillary Benefits

Beyond the obvious financial benefits, grant programs (from either government entities or electrical utilities) sometimes offer ancillary benefits:

- Incentive programs often provide a third-party validator to help ensure that project designs are credible and achieved savings are verified.
- Wastewater organizations are accustomed to 100% compliance and are often risk-averse. Grant funding provides some cushion to mitigate risks that utilities are not used to taking (e.g., programmatic risks, technical risks, and risks associated with energy price variability).

5.2.4 Grant Program Limitations

Despite many grant program success stories, wastewater utilities note a few potential limitations and challenges with various grant sources.

- The Albert Lea (MN) microturbine CHP systems were funded by local electrical utilities in 2003, with grant funding from its electrical utility and the Minnesota Department of Commerce. However, the Albert Lea plant has found that while this grant funding was available when microturbines were a relatively new technology, it is more difficult to get grant funding for replacements as the equipment ages and more efficient second-generation units become available.
- Oneida County (NY) noted that it had considered variable-frequency drive (VFD) and motor incentives, but decided that is was not worth its time to apply for small dollar-value grants. Similarly, Gloversville-Johnstown (NY) believed that DOE funding packages of $200,000-400,000 might not be worth the effort, citing an approximate threshold of $1 million. For example, the extra “pain” associated with funding (buy American, Davis-Bacon wages, etc.) was worth it to receive ARRA funding awards since the funds awarded exceeded $1 million.
- Typical WRRF energy efficiency projects may not meet financial criteria established by electrical utilities. For example, an energy audit at the Albert Lea WRRF recommended new blowers, but the electrical utility will not contribute to replacement because the payback was too long (15 years), even though these blowers easily pay for themselves over their lifetime. On the other hand, an LED retrofit cost $46,000 and the project moved ahead because the payback was shorter, and the electrical utility paid $30,000.

5.3 Low-Interest Loans and Other Financing Alternatives

Primary financing sources, including SRFs, municipal bonding, and ESCO financing, are discussed in the following sections.

5.3.1 SRFs

SRF funding provides below-market financing for water and wastewater projects and is a very common funding mechanism for major efficiency projects.

Several utilities noted that the administrative burdens of SRF financing can be a disincentive. Administrative requirements vary from state to state, with most of these requirements coming from other federal or state government programs and policy goals (not the SRF agency). Pursuit of SRF loans depends on the magnitude of the project to justify administrative requirements. Examples of requirements from various states include:

- **Minority-/Women-Owned Business Enterprise (MWBE) utilization goals.** The New York State Environmental Facilities Corporation (NYS EFC) recently increased its MWBE utilization goal from 20 to 30% next year. New York utilities have had difficulty getting their MWBE plan approved and variances in MWBE plans must go to the governor. MWBE compliance can be a big constraint upstate because of lack of diversity, especially for specialty engineering and construction services required to complete wastewater energy projects.
- **Construction wage requirements.** Davis-Bacon Act wage requirements increase administrative efforts beyond state prevailing wage requirements.
- **Buy American.** The Water Resources Reform and Development Act (WRRDA) of 2014 includes American iron and steel requirements that are very similar to ARRA "buy American" provisions.
- **Environmental review.** Environmental review is generally a requirement for SRF funding. Washington State has recently tightened this review to require the State Environmental Review Process (SERP) and Cross Cutter reviews, where previously only a State Environmental Policy Act (SEPA) review was needed.

5.3.2 Municipal Bonding

The ability to leverage a municipal owner's "buying power" is critical for bond funding. For communities with stable financial circumstances, municipal bond interest rates can be very low compared to private financing and nearly competitive with SRF rates. However, communities that cannot get other funding are still seeking SRF funding, according to the NYS EFC.

5.3.3 Bank Loans

If public debt (municipal bonding) is not a viable option, commercial bank loans may be explored. Bank loans appear to be a relatively uncommon form of financing for energy projects. For example, Littleton/Englewood recently looked at financing a lighting efficiency project using a bank loan, but the scale and timeline of the project made this option unattractive (too small, too long, interest rate higher than bonding)

5.4 Power Purchase Agreements (PPAs)

PPAs and other third-party arrangements have been an option for implementing specialized power generation projects for several years. The Denver Metro plant was a pioneer in this area, implementing its 6 MW biogas turbine project via PPA in 2000. Interest in this approach has grown in recent years, especially for solar developments, but also for biogas utilization. The City of Thousand Oaks, CA implemented both solar and biogas PPAs (refer to case study in Appendix A).

The collaboration inherent in a PPA must be appropriately managed to reduce financial and process risks to the wastewater utility. Contracts must clearly establish all relevant boundary conditions for capital and/or operations. This collaboration is similar to partnerships for water reuse, where contractual boundary conditions govern the delivery of treated water.

Focus group participants believed that source-separated organics (SSO) programs are an example of a good fit for private-sector involvement (via contracts to provide pre-processed organic waste for digestion), especially if this function occurs outside the plant fenceline. On the other hand, the risks associated with private digester operators are more significant because of impact of recycle stream and potentially permit issues. PPA operation of biogas-fired CHP systems fell in the middle of the risk spectrum, with Nashville MWS actively considering a third-party own-operate arrangement for its biogas development.

Many of these arrangements get additional traction based solely on the premise that private industry should "do business" and can be "more efficient." While this sentiment is far from universal, there are locations where enabling private enterprise can create more support than having a public utility do it themselves.

5.5 Other Financing Approaches

Focus group participants have explored and implemented several other financing approaches:

- **Earmarking Incentive Payments within Utility Capital Budget**. In some cases, utility rebates can seem more like an untargeted "bonus" because the rebate money goes back to the general fund. Cedar Rapids, IA and other focus group participants believed that they could build more energy program momentum and implement more projects if they could earmark incentive payments for future energy projects.
- **Miscellaneous bonding.** NYC DEP's energy program has used private activity bonds, clean renewable energy bonds, and the hazardous mitigation grant program (HMGP, with energy projects justified as providing more resiliency). Qualified Energy Conservation Bond (QECB) money allocated with the ARRA is being looked at before it sunsets in 2017.
- **CHP system leasing.** Small projects, especially farm-based systems, have used this option to lower capital costs.
- **Manufacturer financing.** Major equipment suppliers, such as engine-generator manufacturers, have sometimes offered financing services, but focus group members believed that it might be difficult to address specifications and RFP requirements for bids.
- **Fleet retrofits.** Federal funding currently exists for vehicle fuel projects, including converting from diesel fleet vehicles to compressed or liquefied natural gas.

5.6 ESCOs, Leases

The ESCO approach to energy projects offers a continuum of contracting alternatives, with different projects including different possible components such as audits, performance guarantees, and financing options. Most of the utilities represented in the focus groups preferred not to use ESCO financing because they have access to low-interest bonding that is less expensive than the market-rate financing available to ESCOs. For example, Gloversville-Johnstown views the ESCO model as a delivery method instead of a financing method. This approach provides the advantage of combining design/build/energy savings guarantee benefits with low interest financing.

In cases where ESCO financing is used, the normal mechanism is lease financing. Lease financing is a means of financing large equipment purchases and projects in which ownership of the leased property is a key issue. WEF's Energy Conservation in Water and Wastewater Facilities (MOP-32) provides a good summary of various lease arrangements.

Some state energy agencies have developed programs to spur energy projects by standardizing and expediting the ESCO process in accordance with state policy and regulations. For example, Minnesota's Guaranteed Energy Savings Program (GESP) provides technical, contractual, and financial assistance to state agencies and local government units that choose to implement projects using ESCO services.

One focus group participant suggested that a potentially attractive arrangement might combine ESCO project execution with low-interest SRF financing. One model for this approach is the Delaware Sustainable Energy Utility (SEU), which uses tax-exempt state agency general obligation bonds supported by ESCO guarantees (Clean Energy Group and Council of Development Finance Agencies, 2013). SEU bond proceeds have funded a broad range of lighting and building upgrades in public buildings.

CHAPTER 6.0

OPTIMIZING OPERATIONS

Many plant processes can be optimized to reduce energy consumption, often at minimal cost to the utility. Although operational optimization may have lower funding barriers than capital projects, these initiatives may face other barriers such as limited staffing resources, aversion to operational changes, or perceived process risks.

6.1 Experience With Optimizing Operations

Overall, the level of implementation of operational optimization initiatives is fairly high, with 92% of respondents indicating that they had made improvements of some kind. However, 10% of these respondents also attempted to implement other operational improvement initiatives that did not get off the ground for various reasons.

The online survey asked respondents about their experience with the following five representative categories of operations-optimization initiatives:

- **DO optimization.** DO optimization initiatives could include lowering DO set points, improving aeration control by zone, or improving DO control between trains.
- **Energy monitoring.** Energy monitoring encompasses electrical or natural gas usage data for various plant areas or large pieces of process equipment. However, the survey did not assess whether respondents were actively leveraging energy monitoring as a tool to find opportunities to reduce energy use.
- **Digester optimization**. Digester initiatives may include changes to reduce mixing energy, or to increase digester gas production and/or utilization.
- **Other secondary treatment changes**. Other secondary treatment changes may include reduced solids retention time (SRT or mean cell residence time [MCRT]), internal mixed liquor recycle for nitrate recovery, or seasonal nitrification to reduce aeration requirements during cold weather.
- **Chemically enhanced primary treatment (CEPT)**. CEPT uses coagulating chemicals in conjunction with primary clarification to reduce secondary treatment aeration demand and increase biogas production in digestion.

As shown in Figure 6-1, DO optimization and energy monitoring were the most commonly implemented types of operational energy initiatives. Many respondents have also implemented digester optimization and other secondary treatment changes.

For those that did not implement these initiatives, the most common alternate response was “not considered,” suggesting a potential need for additional awareness or technical support to identify energy optimization alternatives. Very few respondents indicated that these types of operational initiatives were not implemented because of lack of financial viability.

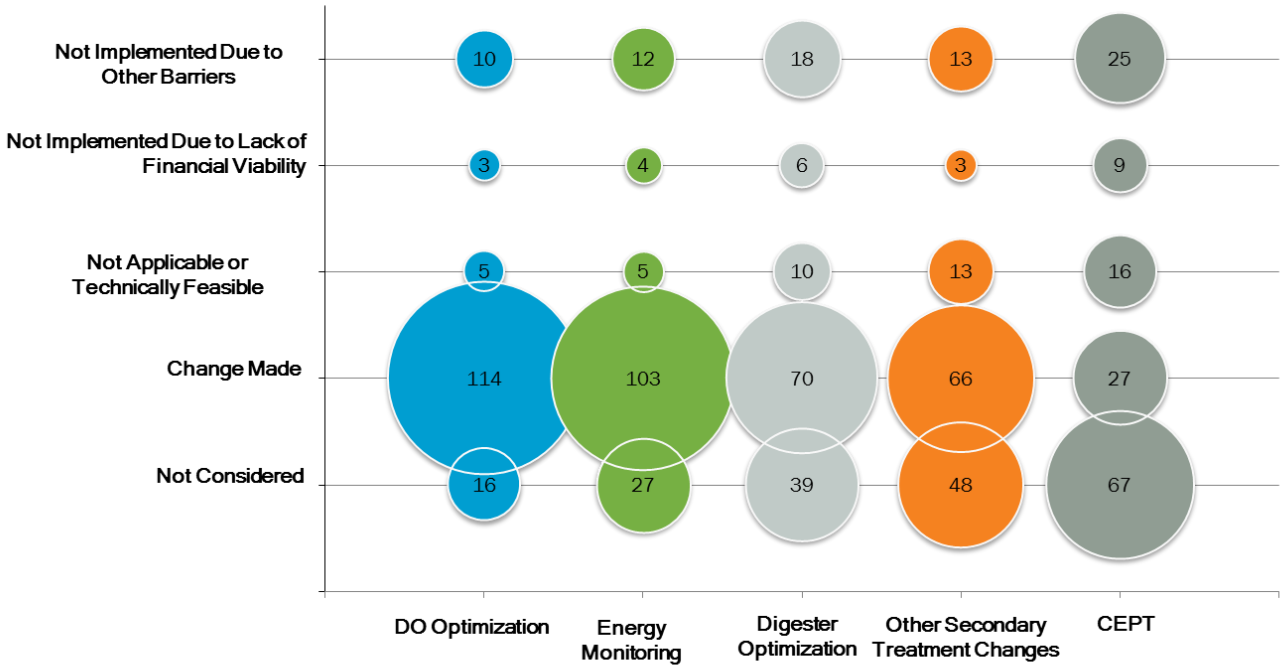


Figure 6-1. Experience With Optimizing Operations for Energy Efficiency.

In addition to the specific categories listed above, respondents were able to write in other operations optimization experience. Write-in responses included optimizing HVAC and odor control systems, combined sewer overflow (CSO) management, implementation of dissolved air flotation (DAF) performance improvements to improve float solids, options to improve dewatering to reduce incineration energy use/emissions, replacing DO probes, right-sizing pumps, and turning on certain UV banks as needed.

6.2 Barriers

Barriers to operational optimization for energy efficiency were considered in four main areas: 1) organizational culture and priorities, 2) leveraging energy data and technical support, 3) technology risk and change management, and 4) operations staff training and procedures.

6.2.1 Organizational Culture and Priorities

Utility staff at all levels and staff functional areas must juggle numerous priorities. Areas such as safety, water quality, and regulatory compliance have long been ingrained as being essential and can compete with energy optimization, in the same way that these business objectives competed for capital project resources (Discussed in Chapter 4.0).

Barriers. As indicated in Figure 6-2, survey results confirm that significant priority is placed on conservative operation to meet permit requirements, making operator conservatism a potentially strong barrier. Staff time and decision maker support appear to be lesser barriers.

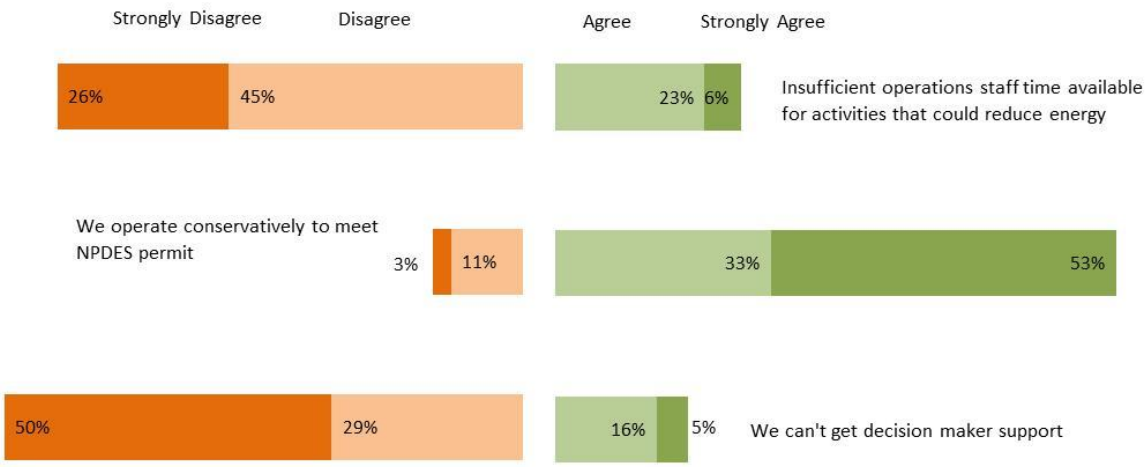


Figure 6-2. Barriers Associated With Organizational Culture and Priorities.

Focus group participants probed the operator conservatism survey finding to assess whether agreement with this barrier statement reflected an actual barrier to energy efficiency or a justifiable prioritization of water quality and regulatory compliance by utility staff. Utility participants generally agreed that permit compliance is foremost in operations priorities.

The Littleton/Englewood, CO, representative commented that their staff takes significant pride in not just meeting but exceeding permit requirements. As an example, the plant uses excess capacity to recirculate trickling filter flow at high levels, which improves effluent quality significantly beyond permit requirements – but at a cost in energy use.

Strategies. Focus group representatives from WLSSD (MN) observed that conservatism definitely drives WRRF performance, but it can be overcome by data and thorough analysis, feedback, consensus on operating targets, and the ability to dial in system parameters. WLSSD has seen this in optimizing its high-purity oxygen activated sludge system.

6.2.2 Leveraging Energy Data

Energy data collection, analysis, and proactive response strategies can be an important part of an energy efficiency program. In addition, energy data can be a key means of fostering buy-in, because operators tend to believe what they have seen more than what they are told. Likewise, the importance of energy data was mentioned repeatedly in the context of informing energy-conscious maintenance approaches (Discussed in Chapter 7.0).

Several energy-progressive utilities have invested in enhanced energy metering, including submetering and energy dashboards such as those being installed as part of the Nashville MWS energy program, and nine new power meters integrated with the Sheboygan (WI) SCADA system to monitor energy use for each unit process. Other utilities are interested in upgrading energy monitoring, but are struggling to determine where and how tightly to monitor to obtain useful data without information overload.

Barriers. For the most part, survey respondents did not consider energy data and technical support issues to be significant barriers (Figure 6-3).

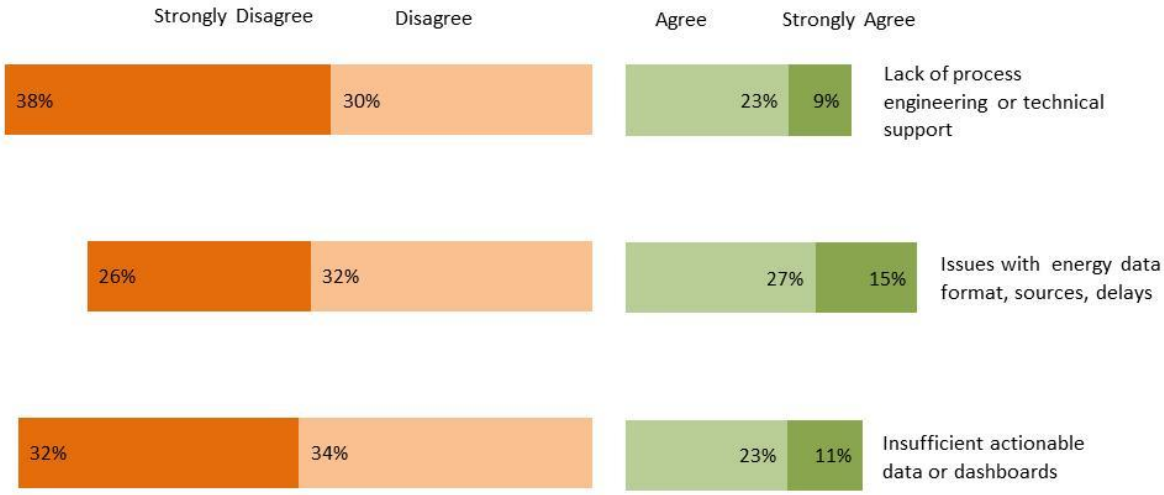


Figure 6-3. Barriers Associated With Energy Data and Technical Support.

Despite apparently low barrier strength, focus group participants still confirmed the importance of this area in supporting operating decisions. For example, one participant was interested in using energy data to optimize loading relative to capacity (i.e., the right number of units in service, and which units to favor).

Strategies. One utility representative described a structured method used to troubleshoot process equipment for efficiency optimization using energy data. In this approach, a key process/piece of equipment is tagged for analysis, and responsibility is assigned to a person (usually an engineer) who takes measurements and looks for ways to make incremental impacts on energy. Changes initiated by this approach are incremental, because “baby steps” are more likely to be well received by operators.

Another representative suggested using cost metrics instead of kW or kWh metrics to communicate energy performance if staff members do not understand energy concepts and terms well; as they do understand dollars.

6.2.3 Technology Risk and Change Management

In some cases, concerns with change or discomfort with emerging approaches can impede advancement in energy efficiency.

Barriers. Among the survey participants, resistance to change and concerns about new technology were not significant barriers, as seen in Figure 6-4. This finding parallels the findings in Chapter 4.0 regarding a fairly high reported acceptance of new technologies.

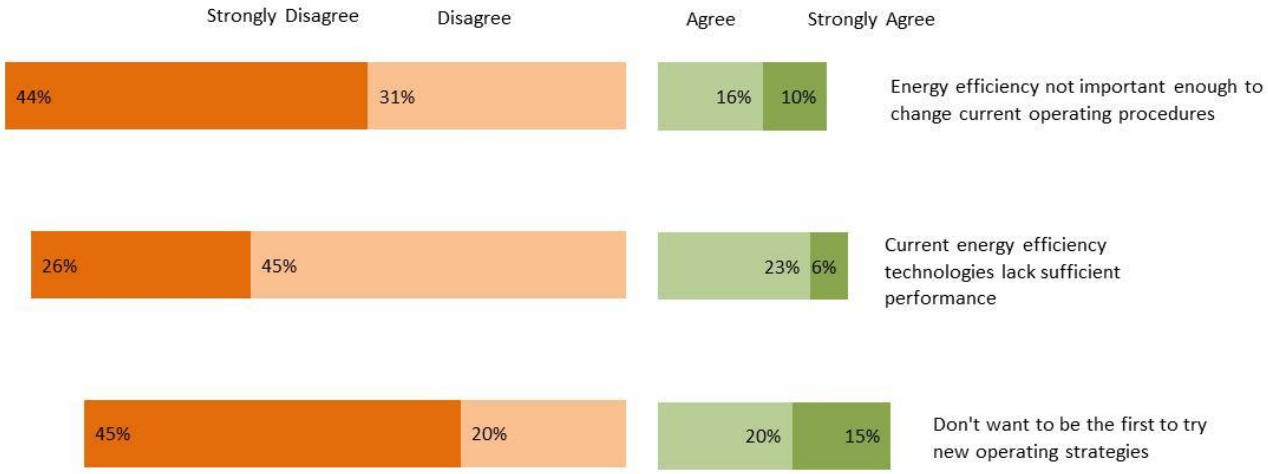


Figure 6-4. Barriers Associated With Technology Risk and Change Management.

Strategies. Despite a relatively low barrier perception for these issues based on the survey results, comments from focus group participants suggest that there are still common circumstances in which barriers of this nature must be addressed. A couple of interesting vignettes illustrate this point:

- **Site visits and peer information sharing.** Kitsap County (WA) staff found it helpful to have operators visit other plants to help "get their heads around" proposed changes. They also suggested that it would be useful to have a better way to share information between operators to build buy-in.
- **Delineating accountability.** Nashville MWS engineering staff tried to implement a new procedure to take channel blowers offline to reduce overall power when their 1,000-horsepower (hp) wet weather pump was operating and channel velocities were high. The impact on the treatment process appeared to be "overwhelming" because the channel blower change was blamed for all other problems. A breakthrough came when management was able to shift accountability for consequences via a meeting in which management took responsibility for any permit issues, relieving concerns from O&M staff.

6.2.4 Operating Staff Training and Procedures

Operational optimization is often strongly dependent on informed decision making by operations staff reacting to daily changes in plant conditions.

Barriers. Survey results for two barrier statements related to staff training and procedures are presented in Figure 6-5. Similar to the technology and change barriers, roughly two-thirds of survey respondents did not consider staff training or lack of response to high energy use to be significant barriers.

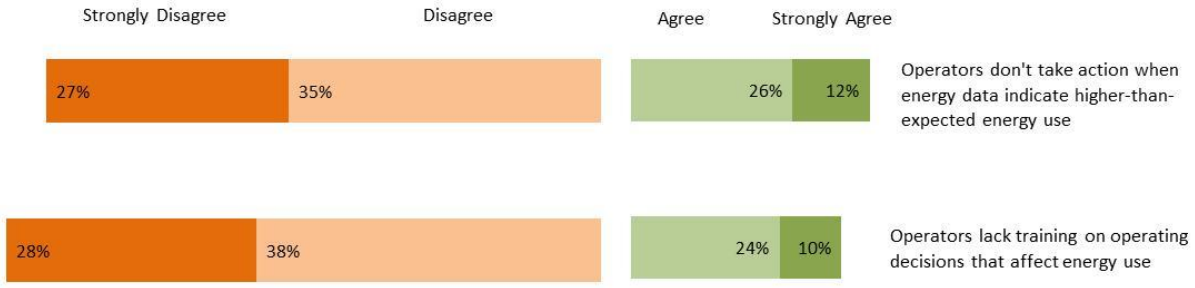


Figure 6-5. Barriers Associated With Operating Staff Training and Procedures.

6.3 Operator Engagement

Focus group participants emphasized the need for operator engagement in operational energy initiatives. Utility leadership may value and promote energy efficiency, but unless these leaders are directly engaged with operators, their organizational distance can erode buy-in at the operator level. Obtaining buy-in can also be challenging because of the competing interests and priorities of various staff groups. As one utility representative observed, "if the operators are not buying in, change doesn't happen."

Strategies. Utilities offered the following suggestions for improving operator engagement:

- **Energy savings supporting other plant needs.** NYC DEP is cultivating organizational buy-in by developing a reinvestment program that channels the first year's energy savings back to the plant where the energy project was implemented. The savings are used for plant-specific special projects that have great value to plant staff and could include projects (e.g., new locker rooms or kitchens), additional GHG/energy management projects, or simply state of good repair (SOGR) projects that may have a lower priority in the Capital Plan, but will make life easier for plant staff. The overall intent of this program is to increase buy-in by making the energy-savings benefits more tangible for plant staff.
- **Rewarding achievements.** Focus group members recommend structuring programs to devise methods so that plant staff sees a tangible benefit from achieving savings (e.g., funding for employee space renovations, awards). Fairfax County has found staff acknowledgement and county-wide awards to be positive means of maintaining staff buy-in. Similarly, the Des Moines WRF has found significant benefit in recognizing employees with energy-saving

ideas. For example, a recent project to slightly reduce blower power by changing to a high-performance lubricating oil was brought forward by operating staff.

- **Performance feedback.** Clean Water Services, OR, sends an energy report every month to all utility staff members so everyone is aware of current energy issues and performance trends (refer to case study in Appendix A for additional details).
- **Addressing midlevel and late shift resistance.** Mid-level staff, such as operations supervisors, are sometimes resistant to changing operations practices and may play a key role in bringing along other staff members. Nashville MWS also found that resistance to change can vary by shift, with old practices sometimes hard to change, especially on late shifts that do not routinely interact with daytime engineering and management staff.
- **Avoiding crisis mode.** The overall functional status of a facility plays a role in staff buy-in. A well-operated and maintained facility provides a good foundation on which to build energy improvements. Conversely, a WRRF with numerous issues may find itself in crisis management mode and unable to take on energy initiatives.

6.4 Role of Energy Cost Savings Reallocations

As discussed in Chapter 3.0, operating cost savings are a significant motivator for utilities pursuing energy efficiency. However, the methods utilities use to recognize and reallocate these savings can have positive and negative effects on staff engagement.

- **Operating budget reduction.** Energy cost savings measures may inadvertently create disincentives when reduced energy expenditures result in reduced plant operating budgets in subsequent years.
- **Reinvestment in energy projects.** City of Austin staff suggested that positive incentives are created when savings can be reinvested in other planned projects, as noted in Chapter 5.0.

6.5 Contract Operations

Several utilities that participated in the focus groups have contracts with private operations firms. Various contractual provisions and working relationships are used to incentivize operations practices in these third-party organizations.

MMSD's (Milwaukee) operations contractor receives performance incentives and bonus payments related to high effluent quality, so their incentives are structured to reward going beyond permit compliance. Energy is cost-shared to incentivize the operations contractor, but MMSD has observed more focus by the contract operator on large projects and capital upgrades (both energy-related and capacity/condition related) than on energy-efficient operations.

The Sewerage and Water Board of New Orleans provides incentives to its contract operator to save energy by splitting any energy savings between the municipality and operator.

6.6 Summary

Table 6-1 summarizes the strongest barriers to optimizing operations for energy efficiency and example strategies identified by utilities to overcome the barriers.

Table 6-1. Strongest Barriers to Optimizing Operations for Energy Efficiency.

Most Significant Barrier	Example Strategies to Address Barrier for Project Phase
Conservative operation	Use data and analysis, feedback, and consensus on operating targets
Resistance to change	During trial period shift accountability away from operating staff
Lack of operator buy-in	Provide utility-wide feedback on energy performance so that everyone is aware of current energy issues and performance trends

CHAPTER 7.0

OPTIMIZING MAINTENANCE

Many types of equipment require ongoing maintenance to retain their initial efficiency levels. Maintenance may not be given high priority because the equipment often continues to function adequately, albeit with an energy penalty.

7.1 Optimizing Maintenance for Energy Efficiency

Two key areas in which maintenance can be optimized for energy efficiency are pump maintenance and aeration diffuser cleaning. Relevant concepts related to pump and diffuser maintenance are briefly summarized below to illustrate the role of maintenance on energy use.

7.1.1 Routine Pump Maintenance

Over time, pump wear, ring, bearing, and seal wear contribute to a slow degradation in pump performance, including a drop in pump head, increase in power draw, and decrease in efficiency (Figure 7-1). This performance degradation is evidence of internal leakage because of improper impeller clearances, shown by the head-flow curve moving toward the zero flow axis by an amount equal to the internal leakage flow as shown in Figure 7-1 (Beebe, 2009). In a variable-speed pump system, the pump speeds up to compensate for the pump wear.

Unmaintained pumps tend to lose efficiency over the first few years, as shown in Figure 7-2. Over time, the pumps continue to operate, but at efficiencies that are 10 to 12.5% lower than the original efficiency. This loss of pump efficiency can be partially recovered by a routine pump maintenance program.

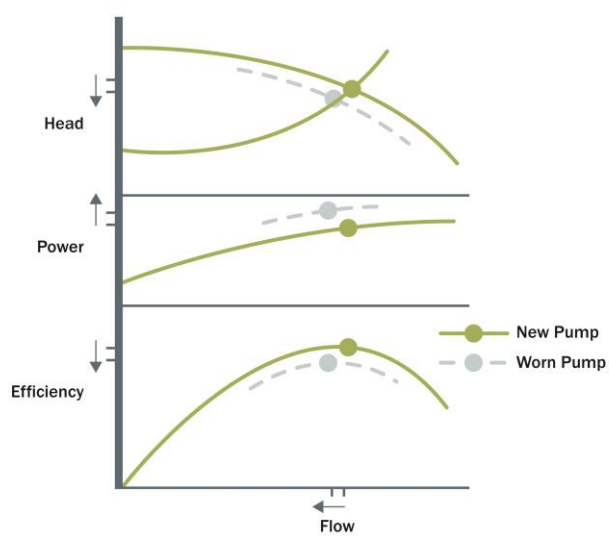


Figure 7-1. Effect of Pump Wear on Pump Performance.
European Commission, 2001.

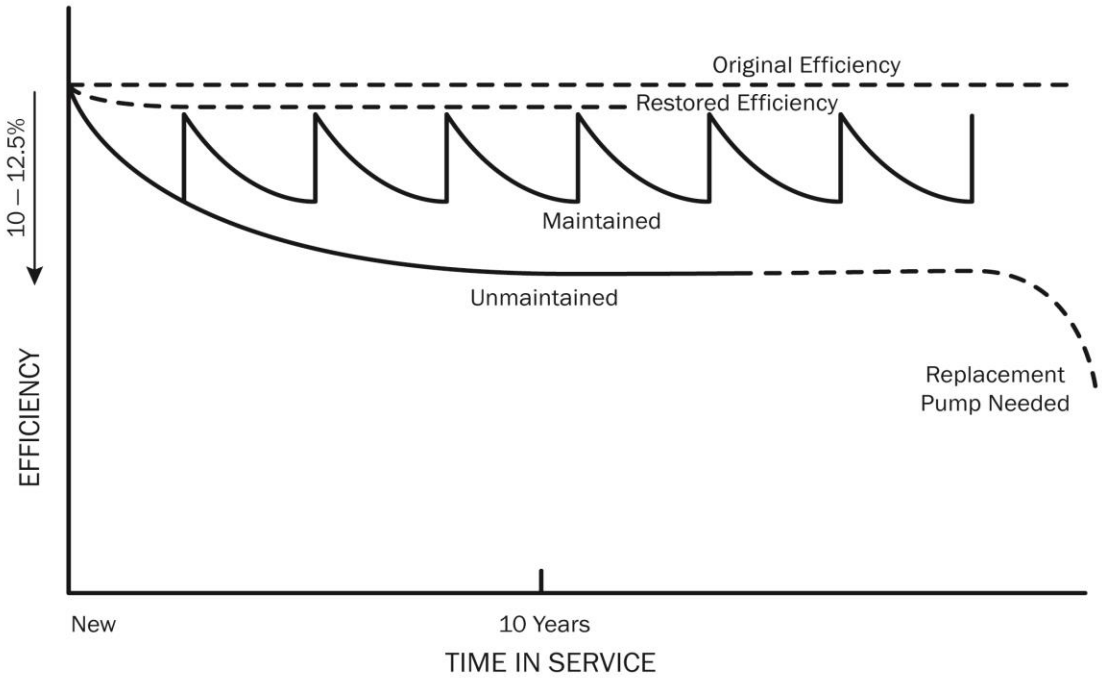


Figure 7-2. Effect of Routine Maintenance on Pump Efficiency Over Pump Service Life.
European Commission, 2001.

The frequency of pump overhauls can be established to minimize the combined cost of the pump overhaul program and the increased pump electrical consumption because of internal recirculation. As an example, the representative 400 hp pump depicted in Figure 7-3 would have an energy-optimized maintenance interval at the lowest point in the total cost curve; i.e., around 20 months. At more frequent overhaul intervals, the maintenance costs drive total costs higher. At less frequent intervals, the energy costs drive total costs higher. Each pump system will have its own rate of efficiency degradation based on operating conditions, and its own maintenance cost based on the cost of parts and the effort required to dismantle and tune the pump. Larger pumps generally warrant more frequent maintenance, while smaller pumps do not generate sufficient energy savings to justify the additional maintenance cost.

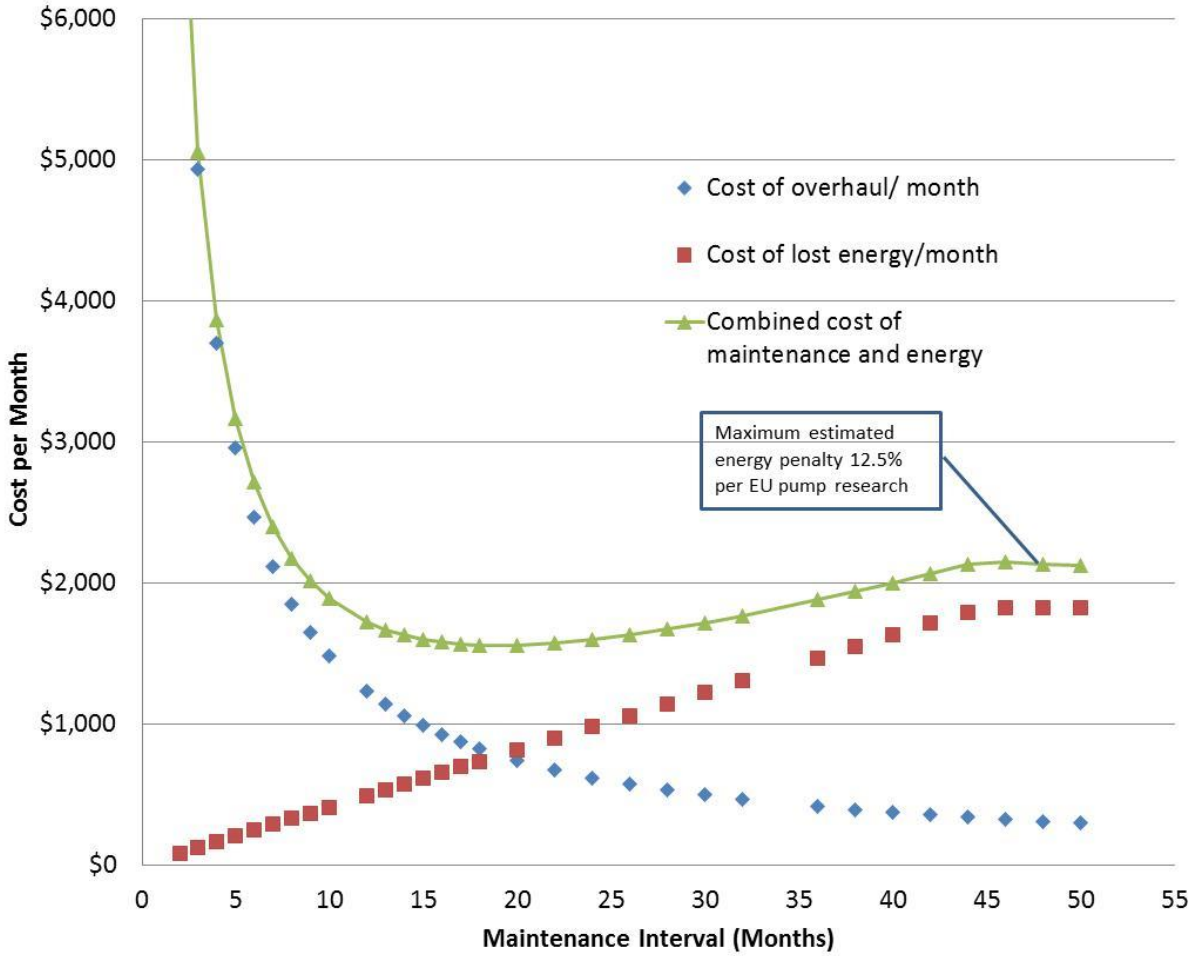


Figure 7-3. Optimizing Energy Savings and Maintenance Costs.

7.1.2 Monitoring Pump Performance for Impairments

In addition to the progressive pump wear described above, pumps can also be subject to periodic impairments. For example, wipes from the collection system that get stuck in pump impellers have been found to cause substantial energy increases as the pumps labor harder to overcome the plugged passages. Large pump systems that are subject to impairment may benefit from energy monitoring to detect higher-than-normal energy use.

King County (WA) has implemented a related initiative in which efficiency "checks" (seeing which pump is more efficient) identified problems that could be mitigated, whereas nothing would have been done without the initial efficiency comparison. As an example, when they see efficiency drop in one of a similar series of pumps, they often find that the large performance reduction is due to something more significant (like the presence of a foreign body in the pump bowl) than normal wear.

7.1.3 Aeration Diffuser Maintenance

The goal of aeration diffuser maintenance is to address diffuser fouling and aging in order to maximize air transfer efficiency while minimizing pressure drop. Various cleaning and replacement strategies can be used to accomplish these goals. Stenstrom, Russo, and others have described the types of diffuser fouling, operating conditions that affect fouling rates, and the observed benefits of diffuser cleaning at various frequencies (Russo, 2006).

While serious aeration system issues are evident in surface boils and bubble patterns, it can be more challenging to assess and quantify long-term diffuser condition trends in order to optimize maintenance frequency. Tools for assessment include in situ off-gas testing of air transfer efficiency, laboratory analysis of fouling types and quantities, vendor assessment of membrane parameters, monitoring progressive increases in air header pressure, and field monitoring of diffuser pressure drops.

7.2 Utility Experience With Optimizing Maintenance for Energy Efficiency

The online survey asked respondents about their experience with three representative categories of maintenance optimization:

- **DO probe and control components.** Although advances in DO measurement technology have reduced maintenance requirements, DO control systems still require ongoing maintenance to facilitate energy-efficient operations.
- **Pump maintenance.** As described above, increased pump maintenance frequency with a focus on maintaining pump clearances may be warranted to reduce energy costs for larger pumps.
- **Diffuser cleaning.** Diffuser cleaning encompasses various maintenance initiatives, such as periodic air bumping of membrane diffusers and chemical or physical cleaning of ceramic diffusers.

As shown in Figure 7-4, most utilities indicated that they were doing maintenance in these three areas on a periodic basis, with some utilities performing maintenance to maintain energy benchmarks. In some cases, these periodic maintenance practices may be sufficient, but in other cases it may be worthwhile to determine whether it is cost-effective to increase maintenance frequency to maintain higher levels of energy efficiency.

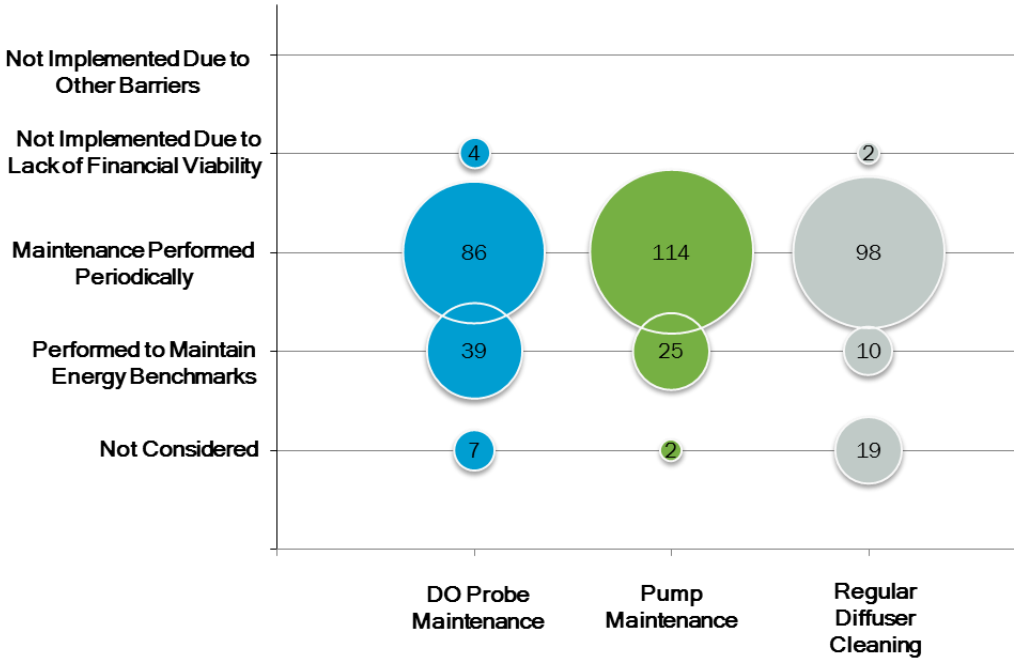


Figure 7-4. Utility Experience With Maintenance for Energy Efficiency.

A related WERF survey of New York State plants asked which of these maintenance practices were performed (Andrews, 2015). This survey may be more representative of the wastewater industry as a whole because it had a lesser degree of self-selection. Maintenance of key aeration components was found to be fairly low, with only 50% of respondents reporting that they maintained DO probes and controls, and only 40% reporting regular diffuser cleaning.

In general, utility representatives believed that current maintenance programs were focused on extending the life of equipment and that effort was needed to raise awareness and improve understanding of how maintenance procedures affect energy use.

Barriers. Figure 7-5 summarizes the findings of the online survey with regard to maintenance barriers. The most prominent barrier is competition with more pressing needs. Interestingly, the maintenance barrier with the least perceived strength was associated with cost-effectiveness.

Focus group participants concurred that maintenance was often an under-represented area of opportunity for energy efficiency. One utility described its current practice as operating until equipment goes “out of spec” based on process requirements, but not energy performance. Another utility contrasted its normal consideration of energy as a priority for procurement, but historically not for maintenance decisions.

Some utilities noted significant staffing constraints in the maintenance area. These maintenance groups cannot take more time for energy-related initiatives. Separation of

operations functions and maintenance departments and can also cause hurdles to implementing energy-related changes.

Focus group discussions noted that capital projects within energy programs tended to overshadow potential maintenance-related efficiency opportunities. One utility representative observed that utility staff may perceive these opportunities as "less sexy." Others echoed this sentiment, observing that capital projects are more prominent than maintenance because engineering staff have higher energy awareness. Another factor cited was that, as energy projects compete for resources, the "scale" of capital project drives attention.

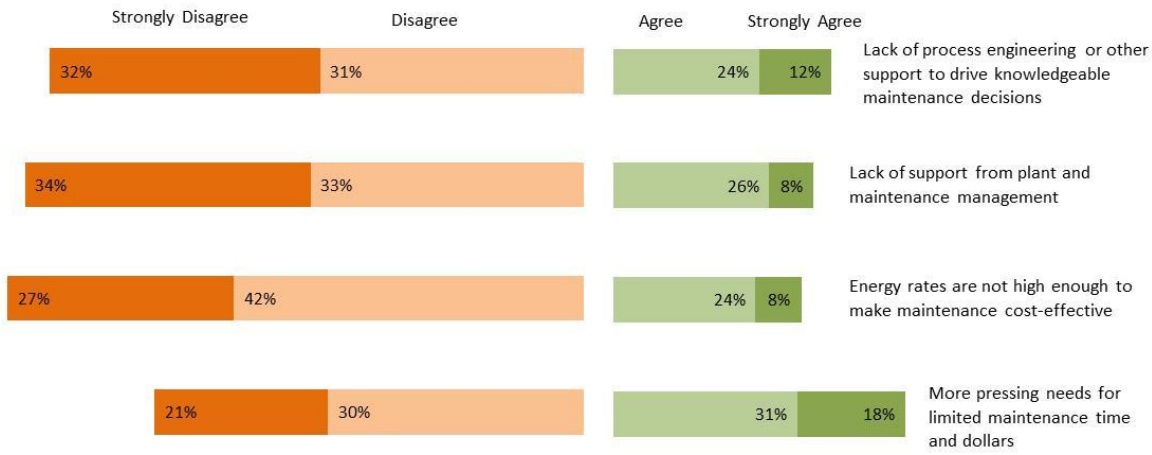


Figure 7-5. Utility Experience With Maintenance for Energy Efficiency.

Strategies. Several utilities have advanced methods of integrating energy efficiency into maintenance practices:

- Kitsap County, WA, has considered maintenance somewhat in its energy program, with maintenance staff implementing motor replacements and UV lamp retrofits. Kitsap County and Littleton/Englewood, CO are now looking at formalizing preventive maintenance procedures (PMs) and maintenance modules that proactively look at energy to keep equipment efficient.
- Vancouver, WA, has focused on discrete items like maintenance of DO probes for good aeration control.
- Nashville proposed that maintenance departments need to become more aware of energy savings in order to increase maintenance to reduce energy and generate quick wins.
- Several utilities are hopeful that submetering will help shine a light on energy benefits of maintenance improvements, including mining these data for evidence of plugging conditions or advanced indication of failing equipment.

7.3 Planned and Unplanned Equipment Replacement Strategies

Kitsap County; Albany, NY; and others mentioned that many equipment replacement projects have allowed inefficient equipment to be replaced with more efficient equipment. However, if the replacement is triggered by an unplanned failure, staff may scramble just to get an equivalent replacement.

WLSSD, MN, representatives suggested that the asset management process could be integrated with energy planning to identify more efficient replacements for major equipment so that the more efficient equipment can be procured in a timely manner to respond to unplanned equipment failures.

7.4 Funding Maintenance Improvements

Progress on optimizing maintenance may be hindered because O&M budgets do not generally have funds earmarked to support energy initiatives, including increased maintenance frequencies.

Outside financial incentives for maintenance activities are also relatively rare. One exception was noted by Vancouver, WA. It has a partnership with its electrical utility that financially rewards reductions in electrical use. Vancouver's energy performance program has an incentive ($0.025/kWh) for documented savings, including savings from operations or maintenance initiatives.

7.5 Contract Maintenance

Similar to contract operations services, contracted maintenance service agreements may not adequately require or incentivize maintenance activities that reduce energy use. For example, for MMSD in Milwaukee, the contractor is required to report completed preventative maintenance (PMs) monthly, but the contractor has not considered the potential for energy reduction in scheduling maintenance activities. In the future, the contractor and owner may collaborate on determining whether energy savings can justify increased maintenance intervals, and whether contract modifications are necessary to support this change.

7.6 Summary

Table 7-1 summarizes the strongest barriers to optimizing maintenance for energy efficiency and example strategies identified by utilities to overcome the barriers.

Table 7-1. Strongest Barriers to Optimizing Maintenance for Energy Efficiency.

Most Significant Barrier	Example Strategies to Address Barrier for Project Phase
More pressing needs	Place initial focus on high-priority, discrete items like maintenance of DO probes for good aeration control.
Poor coordination with equipment replacement planning	If near term replacement cannot be justified by energy savings alone, identify high-efficiency replacement in advance so that it can be procured under unplanned replacement conditions.
Insufficient maintenance budgets	Investigate electrical utility incentives for maintenance activities that improve efficiency (e.g., diffuser cleaning).

CHAPTER 8.0

ASSESSING ORGANIZATIONAL STRATEGIES

Several survey findings presented earlier in this report point toward the importance of creating organizational cultures within wastewater utilities that support and foster energy initiatives. This chapter presents the strategies that have been found to be most effective by utilities with successful energy programs and the impact of energy programs on reducing barriers to energy efficiency.

8.1 WEF Energy Roadmap Framework

As previously noted in Chapter 1.0, the WEF Energy Roadmap (WEF 2013, "Roadmap") established six interrelated energy management topic areas, and proposed a series of practical approaches and levels of progression to be used to prioritize actions to take toward energy sustainability (refer to the Roadmap framework summary in Figure 1-1). Tables 1-1 through 1-6 of the Roadmap itemize recommended approaches for each topic area in three successive levels of progress.

The online survey asked respondents about their experience with a representative selection of 25 of the Roadmap approaches. The survey asked whether each approach had been implemented at the respondent's utility and how effective each implemented activity was in *achieving significant, measurable energy reductions*.

The following sections present survey results as well as the focus group's experience with selected approaches.

8.1.1 Most Common and Most Effective Approaches

As might be expected, the approaches that were considered to be most effective by survey respondents were generally the approaches that were most frequently implemented, as shown in Figure 8-1. Most of the approaches were rated as "somewhat effective" or better.

Approaches from all five organizational topic areas were included in the survey: 1) Strategic Management, 2) Organizational Culture, 3) Communication and Outreach, 4) Energy Management/Demand Side Management, and 5) Innovations for the Future. The effectiveness ratings for all five areas were essentially equivalent, reinforcing the need for a balanced energy program covering all five areas.

Table 8-1 summarizes the approaches that were rated most and least effective. The less effective strategies in Table 8-1 also tended to be less tangible approaches, and may not have resonated in the survey question context of contributing to significant, measurable energy reductions. In other words, the less effective strategies could be considered ancillary long-term investments in cultural change that would not necessarily be visible as immediate energy achievements.

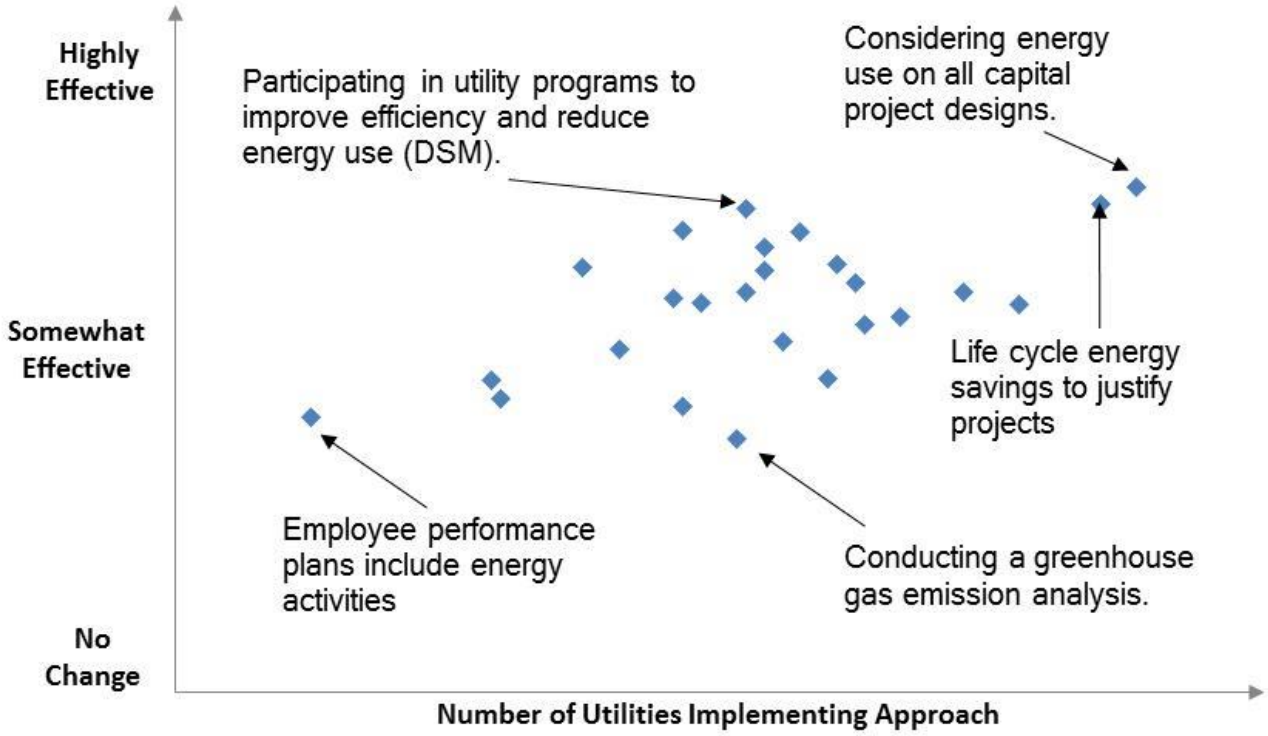


Figure 8-1. Organizational Approaches: Frequency of Implementation and Effectiveness.

Table 8-1. Approaches Considered Most and Least Effective by Survey Participants.

Most Effective Strategies	Rank	Effectiveness Rating (score 1–5)	Less Effective Strategies	Rank	Effectiveness Rating (score 1–5)
Considering energy use on all capital project designs	1	4.5	Supporting research and development (R&D) by having staff conduct research or collaborating with universities or other organizations to optimize or demonstrate processes or technologies	19	4.0
Using long-term energy savings over the equipment life cycle to justify project designs that save energy	2	4.4	Benchmarking data to compare to other wastewater utilities	20	3.9
Participating in utility programs to improve efficiency and reduce energy use (DSM)	3	4.4	Communicating energy program goals, vision, and achievement to your customers directly, or via media outlets	21	3.9
Establishing a staff group that meets regularly to identify and track energy projects	4	4.3	Collaborating with environmental advocacy groups and regulators	22	3.9
Establishing specific energy efficiency goals or targets	5	4.3	Creating a written, public policy regarding energy use and sustainability	23	3.8
Having an individual who could be described as an “Energy Director, Advocate, or Champion”	6	4.3	Creating employee performance plans that include energy program-related activities to support the wastewater utility’s energy vision	24	3.8
Implementing a specific management process to initiate and manage energy projects	7	4.2	Conducting a GHG emission analysis	25	3.7

8.2 Assessing Energy Program Level of Development Using Roadmap Implementation Benchmarks

In order to gauge the level of development of energy programs, a simple scoring system was developed based on how many of the identified approaches each respondent reported as being implemented at his or her utility. The scoring was weighted based on whether each approach fell into the initial "enabling" level of progression or the more advanced "integrating" level (refer to Figure 1-1). Implementing any of the nine "enabling" approaches was assigned one point each; implementing any of the 16 "integrating" approaches was assigned two points each. The number of utilities in each scoring category is summarized in Table 8-2.

As previously noted, the survey responses for this research include several utilities with well-developed energy programs. It must be reiterated that this assessment does not reflect actual reductions in energy consumption, but is focused strictly on organizational initiatives. Within each utility, different respondents showed various levels of organizational development scores, presumably reflecting various levels of energy program awareness among staff members.

Table 8-2. Number of Utilities at Various Development Levels.

Score	Number of Utilities
31–41 (developed programs)	65
21–30	50
11–20	33
0–10 (undeveloped programs)	21

8.3 Impact of Energy Development on Perceived Significance of O&M Barriers

A lower level of energy program development significantly increases the perceived strength of barriers related to O&M, as shown in Figures 8-2 and 8-3. Among operational barriers, lack of energy data and staff time, insufficient training, and insufficient operator response to high energy use were perceived to be much more significant in respondents with undeveloped energy programs. Among maintenance barriers, all barriers were greater for undeveloped energy programs, with the most dramatic shift appearing in the perceived lack of support from decision makers.

Overall, survey response and focus group input signal that the approaches presented in the WEF Energy Roadmap manual can enable the improved energy management attentiveness needed to reduce barriers to energy efficiency.

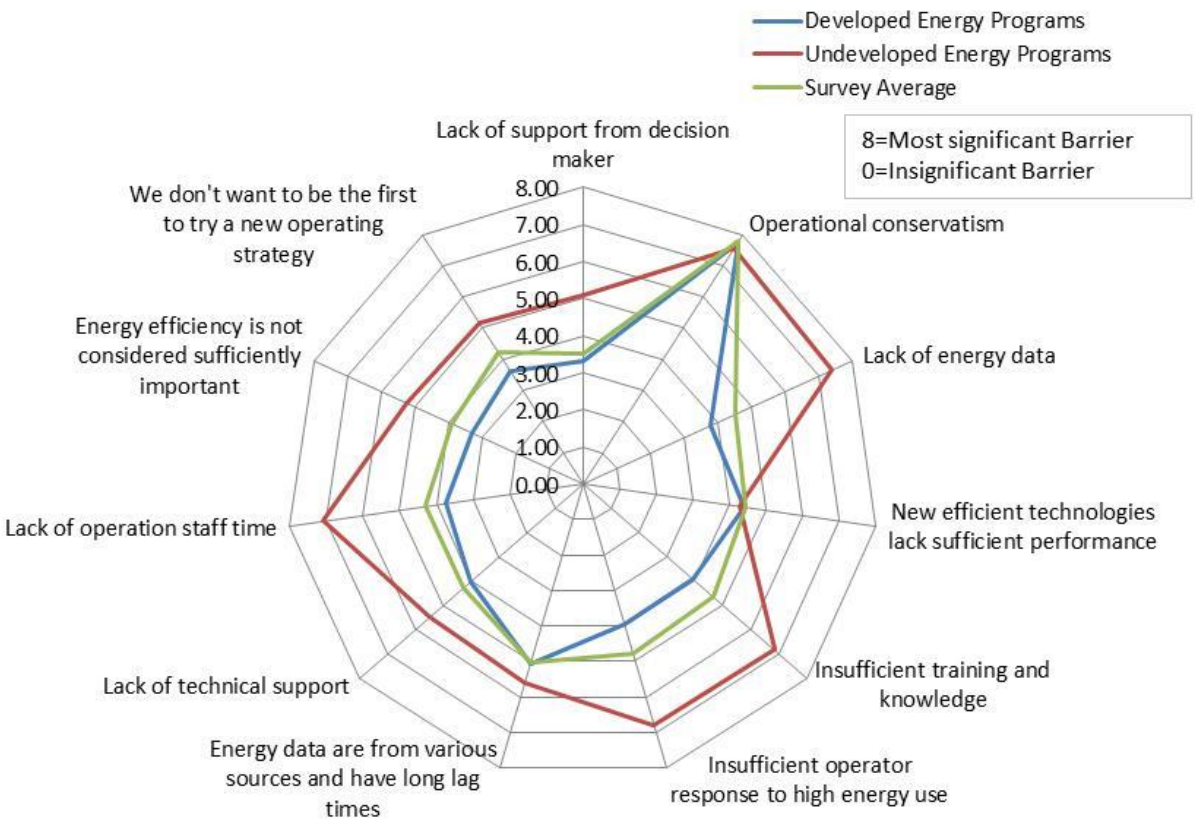


Figure 8-2. Effect of Energy Program Development Level on Barriers to Optimizing Operations for Energy Efficiency.

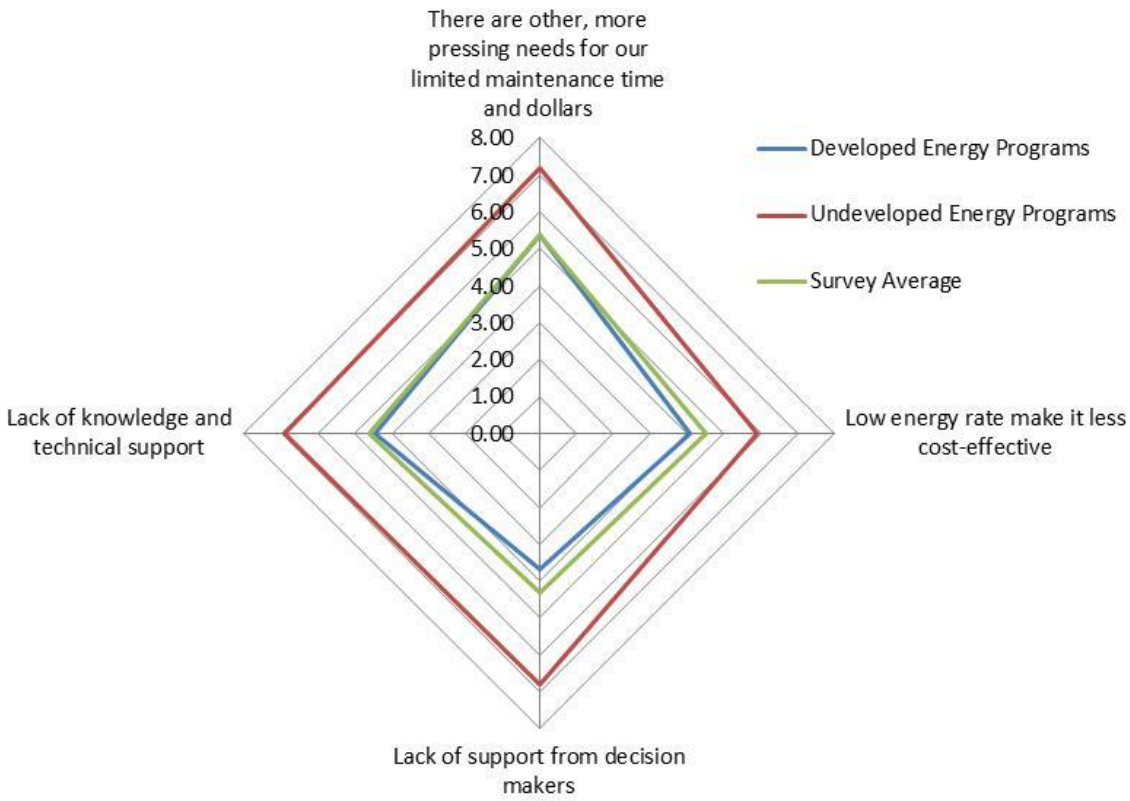


Figure 8-3. Effect of Energy Program Development Level on Barriers to Optimizing Maintenance Practices for Energy Efficiency.

8.4 Highlighted Roadmap Approaches

Two common Roadmap approaches – setting goals and creating energy teams – were discussed by focus group participants.

8.4.1 Setting Energy Goals

Many utilities establish specific energy goals and timelines (refer to examples in Table 1-1). There appears to be a divergence of opinion among utility representatives on whether these goals are important aspects of an energy program.

- **Progressive utility approach without highly defined goals.** Sheboygan, WI has no formally set energy goal, but expectations are to achieve energy neutrality. The plant currently generates 80% of its electrical demand and supplies most plant heating. Energy usage and generation rates are shown in real time on the utility website to increase public awareness. Likewise, Gwinnett County, GA has no specific energy goals, but all projects must go through a business case evaluation that includes potential cost savings through energy efficiency and generation. The Charlotte Water representative (Charlotte-Mecklenburg, NC) indicated a lack of interest in specific energy goals, preferring to work

with people to bring them along and increase understanding of energy use. He suggested that specific energy goals can be a "tail wagging the dog" approach for his utility.

- **Varying goal target parameters.** The most common type of goal is a percent reduction in purchased energy consumption from a baseline year. However, other targets include GHG emissions reductions and renewable energy targets (onsite renewable generation, purchased renewable energy generated offsite, or both). For example, Austin Water, TX achieved its goal of 100% renewable energy in 2012 through a combination of purchased and generated renewable power.
- **Flow down of goals from state and city mandates.** The Massachusetts Water Resources Authority (MWRA) Deer Island Treatment Plant (Boston, MA) is working to comply with an executive order from the governor's office that set the following 2020 goals: 1) reduce energy consumption by 35% by 2020, 2) increase renewable use by 30% (onsite energy production and purchased renewable energy), and 3) reduce GHG emissions by 40%.
- **Electric utility memorandum of understanding (MOU).** Other wastewater utility goals are set through an MOU in collaboration with an electrical utility. For example, MWRA is working with its electrical utility (NSTAR) toward a 5% per year (6 million kWh/year) reduction in electricity demand in parallel to the state goals presented above. These types of MOUs provide financial incentives to large electrical users for energy reductions as a means to help electrical utilities to meet their state energy efficiency goals.
- **Strategic goals.** WLSSD, with its Board of Directors and a multidisciplinary staff core team, developed three strategic goals to guide its energy program with the intention to become energy-neutral:
  1. Improve energy efficiency continuously by establishing and implementing an effective energy management and conservation program that supports modern technological capabilities and customer satisfaction and provides a safe and comfortable work environment, while complying with all permit requirements and maintaining effective operations.
  2. Collaborate with governmental agencies, utility companies, and other organizations on energy conservation opportunities. Actively seek out available funding sources and grants for projects that focus on energy reduction efforts or utilizing renewable energy source
  3. Establish funding sources dedicated to implementing energy reduction improvements.

8.4.2 Energy Teams

Several utilities highlighted the role of their energy teams in advancing energy initiatives:

- Vancouver, WA has a six-person energy team, including an energy advocate and an executive sponsor who helps to acquire funding.
- Clean Water Services, OR assembled a Process Control, Innovation and Energy (PIE) Team to concurrently address process optimization and energy reduction. Refer to Appendix A for the case study.
- Fairfax County, VA uses its existing management and operations team in lieu of a separate energy management team, discussing energy-use improvements as a standing agenda item.

CHAPTER 9.0

SMALL PLANTS AND SMALL UTILITIES

While previous chapters discuss barriers to energy efficiency for the wastewater industry as a whole, this chapter specifically considers barriers that affect small plants and small utilities. Previous studies and surveys have tried to delineate energy barriers based on plant size, as most wastewater treatment facilities in the United States are considered small (i.e., less than five million gallons per day [mgd]). For this project, approximately 25% of the survey responses were from small plants, as shown previously in Table 2-1. Small utilities also warrant specific focus because their energy intensity has been documented to be higher than larger facilities (see Figure 1-3).

While the survey sample set for small facilities is relatively small compared to the number of larger facilities, the survey results and focus group meetings feedback revealed several important similarities and distinctions between small and large facilities as described in the following sections.

9.1 O&M Barriers

Survey responses about barriers to operational optimization for energy efficiency greater than and less than 5 mgd are presented in Figure 9-1. The scope of the questions included operations staff availability and training, the importance or priority of energy conservation at the plant, and availability of technical support and energy data.

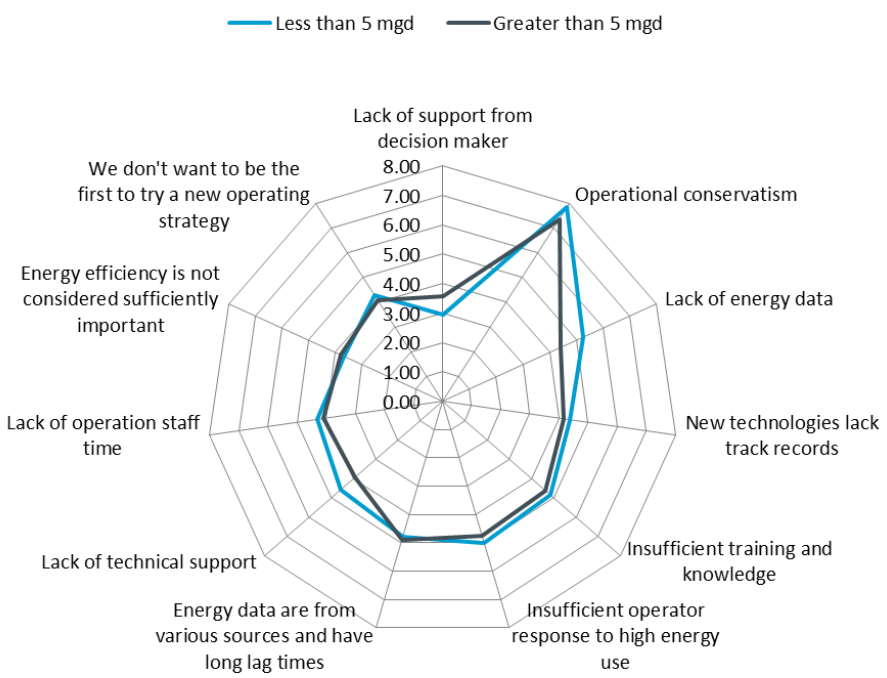


Figure 9-1. Comparison of Barriers for WRRF Sizes Greater Than and Less Than 5 mgd.

These responses reveal insight into a small plant's challenges to embrace and implement energy efficiency projects. Many of the responses are similar to the larger utilities' responses with variances in the following barriers:

- **Operational conservatism.** Compliance-driven operations are particularly evident in the small plant responses, with priority and resources focused on meeting regulatory requirements. Even if a project or change in O&M has a positive energy savings outcome, there can be opportunity costs if plant staff is diverted from other priorities or initiatives
- **Lack of technical support.** Survey results suggest that smaller facilities find lack of technical support to be a more significant barrier, perhaps in part because they seldom employ or retain process engineering staff. Further, operator training and certification tests are not focused on energy efficiency awareness or knowledge.
- **Lack of energy data.** Small plants rated lack of energy data as a more significant barrier, despite being more likely than large plants to report having energy dashboards (Figure 9-3)
- **Lack of support from decision makers.** Interestingly, decision maker support was less of a barrier for smaller utilities than for larger utilities. This result was expected as most of the small utility respondents for the survey are fairly progressive with respect to energy. Although not tested specifically during the focus group meeting discussions, the inference is that internal buy-in and support could be easier to achieve because of a smaller group of stakeholders and decision makers.

A similar comparison was conducted for barriers to maintenance initiatives for energy (e.g., diffuser cleaning). Survey results related to maintenance activities are shown in Figure 9-2. Similar to operational initiatives, lack of technical support for maintenance planning was a more significant barrier for small utilities. There was general support from decision makers, which correlated with the information presented in Figure 9-1. Despite this correlation, U.S. EPA officials commented that institutional barriers are typically more significant for smaller and medium-sized utilities than larger utilities.[1] Other maintenance barriers include the following:

- **More pressing needs for maintenance dollars.** Small utilities tend to operate with very lean staffing, increasing significance of limited maintenance resources.
- **Electrical billing awareness.** Although survey data suggest that both small and large utilities report low energy rates as an equal barrier, experience by Focus on Energy in Wisconsin suggests that the perception that energy is a low-cost commodity is often more pronounced for small utilities. Most small plant operators and plant supervisors never see their energy bill because it goes elsewhere to be paid.
- **Electrical rate factors.** Most small facilities do not have an on-peak electric or demand charge; they have only a flat rate. Therefore, they do not have an opportunity to reduce costs simply by adjusting the time when processes are operated. They can only reduce power use to reduce their costs.

[11] Jim Horne, U.S. EPA, WERF Barriers to Energy and Resource Recovery: Web Conference Focus Group, November 13, 2014.

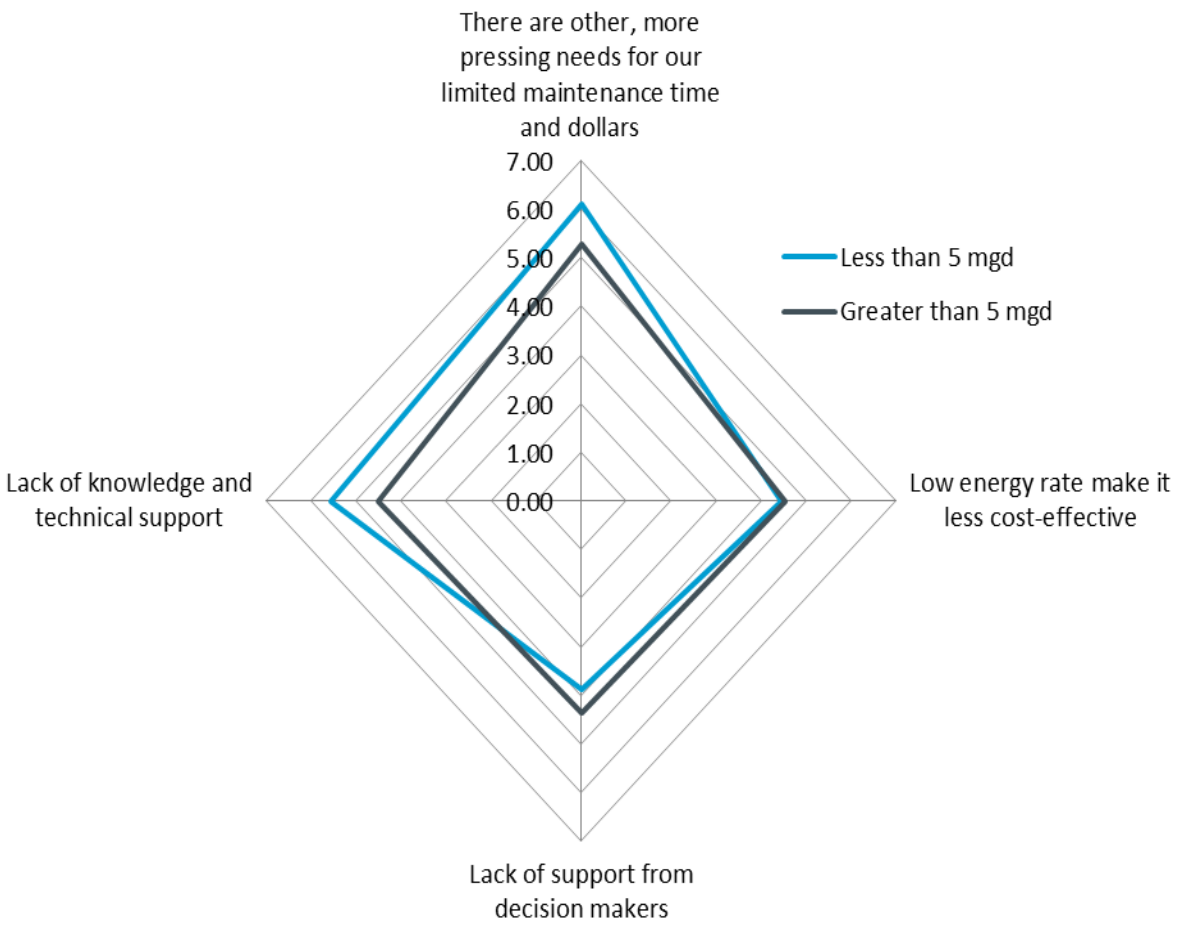


Figure 9-2. Barriers to Maintenance Practices to Reduce Energy.

9.2 Capital Projects Barriers

Several perspectives were tested and evaluated in the survey questions and focus group meetings, as described below.

9.2.1 Most Problematic Project Phase

As discussed previously in Chapter 4.0, survey participants were asked to think about projects that did not proceed to successful completion, and indicate which project phase was most likely to bog down or stop a project. Survey data in Table 9-1 indicate that these experiences are similar for small and large utilities, with minor differences considered not significant given small sample size.

Because of the facility size and limited number of personnel, there seems to be less organizational inertia associated with project approval and implementation in small utilities. Small utilities may also be more prone to difficulties with obtaining approval for energy projects because of lack of experience and resource availability in making the case for energy projects to local governing bodies.

Many smaller facilities must rely on regulatory drivers to justify a project and leverage consulting engineering support for capital projects. Improved energy management can be built into the selection/approval and scope of new capital projects if the energy goals and standards are clearly outlined.

Table 9-1. Survey Results: Project Phase Most Likely to Bog Down or Stop a Project.

	Identifying Opportunities	Feasibility Student	Project Approval	Capital Improvement Planning	Funding	Design Initiation	Procurement	Construction and Commissioning	Continued Operations
0–1 mgd	0.00%	33.33%	0.00%	0.00%	33.33%	0.00%	0.00%	0.00%	33.33%
	0	1	0	0	1	0	0	0	1
1–5 mgd	5.88%	23.53%	17.65%	0.00%	41.18%	5.88%	0.00%	5.88%	0.00%
	1	4	3	0	7	1	0	1	0
6–100 mgd	4.95%	22.77%	14.85%	2.97%	47.52%	2.97%	1.98%	0.00%	1.98%
	5	23	15	3	48	3	2	0	2
Greater than 100 mgd	7.69%	20.51%	20.51%	2.56%	35.90%	2.56%	5.13%	0.00%	5.13%
	3	8	8	1	14	1	2	0	2

9.2.2 External Technical Assistance and Grant Funding

The survey indicated the following with regard to technical assistance and funding participation for smaller facilities:

- Small and large utilities reported similar levels of ESCO participation.
- Small utilities were less likely to report having received federal, state, or energy utility program funding for an energy project (42% for small plants, 62% for larger).
- Small utilities were slightly less likely to report having received external technical assistance (35% of small plants reported receiving no assistance, 26% for larger).

These reported rates of participation may not reflect conditions in all areas of the country, since the types of technical support and incentive funding available to small wastewater plants vary by state and locality.

Most grants and funding opportunities are available for new facilities to be energy-efficient. In some cases, funding is also available through energy efficiency programs to assist in retrofitting a WRRF's present equipment through replacing existing less-efficient equipment with more energy-efficient equipment. In addition, there are opportunities to replace existing equipment with equipment that will operate through a wider range of loadings so the system becomes energy-efficient from startup through its design life (conditions). Small utilities would benefit from hands-on assistance with the application process for available grants.

Although capital projects are cost-intensive, smaller utilities with less funding can start with implementing energy-efficient measures. By pursuing cost-effective energy-efficient O&M practices, smaller utilities can increase energy awareness and momentum for additional energy projects. For the small plant category, the aggregate energy savings may seem low in comparison to larger plants (e.g., cost savings per facility basis); however, the value or impact of that savings is more pronounced. "Every watt of power that is saved is just as good – and less expensive – as compared to an equal amount that is recovered from the wastewater." [2]

9.3 Organizational Approaches

Another issue that was considered was how small utilities prioritize different Energy Roadmap activities, and if institutional support was a significant barrier.

Figure 9-3 compares participation rates for organizational approaches where a difference in rates was significant between utility size groupings. Based on survey responses, small utilities tend to lag behind larger utilities in implementing several of the organizational approaches outlined in the WEF Energy Roadmap and discussed previously in Chapter 8.0. However, small utilities (at least those responding to the survey) lead their larger peers in implementing energy dashboards to monitor short-term energy trends and benchmarking energy data.

Overall, energy efficiency specialists and small utility focus group participants suggest that there is a need for organizational approaches that further energy awareness education for small-utility operations staff through management and for their council and board members (decision makers).

[2] WE&T, January 2015, Roadmap to Resource Recovery, comment by Ed McCormick.

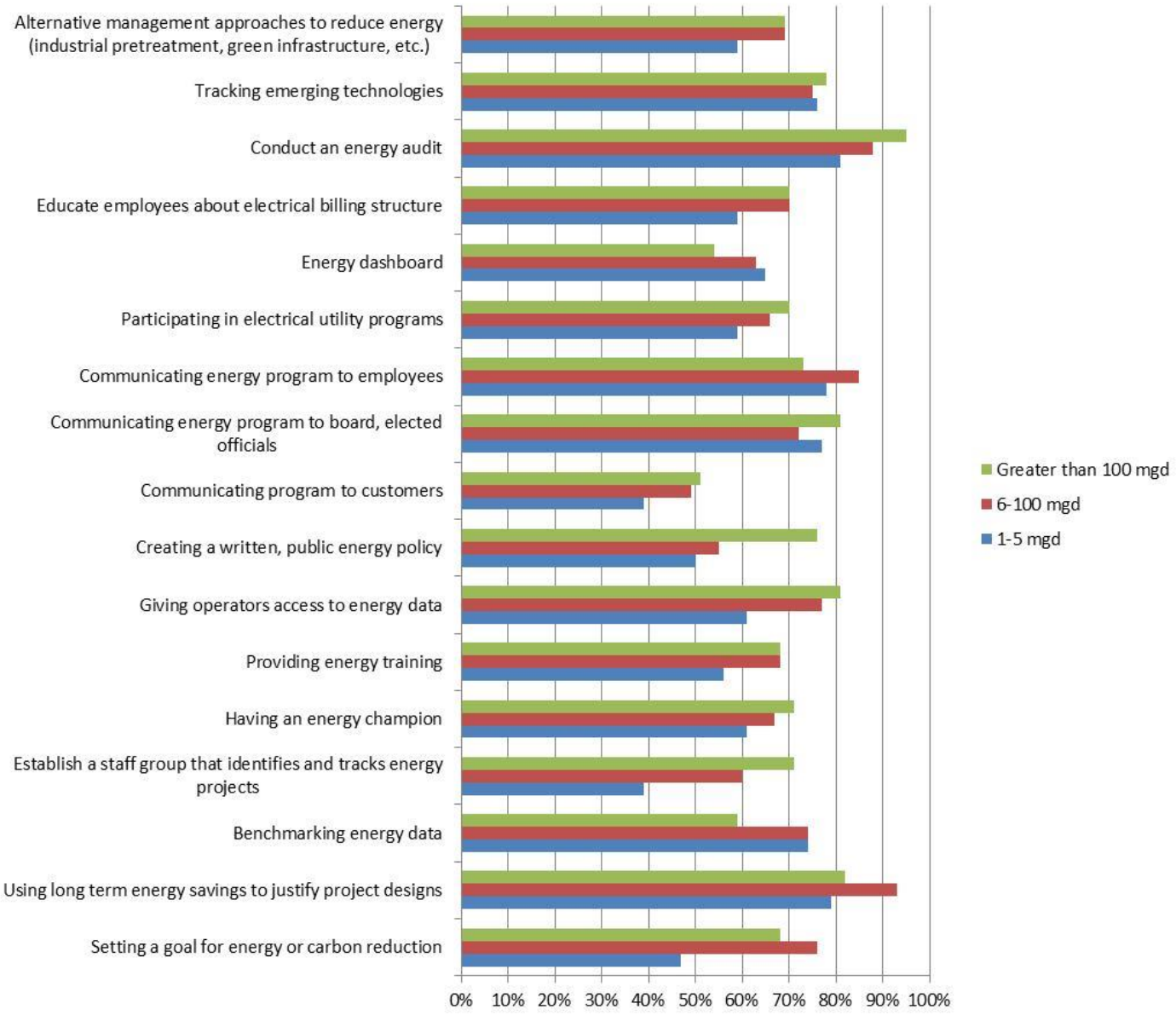


Figure 9-3. Degree of Implementation of Organizational Approaches: Comparison by Utility Size.

CHAPTER 10.0

BARRIERS AND INCENTIVES RELATED TO ELECTRIC UTILITY LEGISLATION

This role of state policy was prominent in focus group meetings, with the participant from AlexRenew, VA, stating that "regulatory and government support is needed in the form of national and state policy to support energy efficiency, not just 'utility leadership' in the wastewater industry."

This chapter summarizes barriers and incentives related to energy policy at the state level affecting the implementation or financial feasibility of energy efficiency and onsite energy generation projects. State level barriers and policy are compared for three example states, with three example projects, and for a number of specific project policy considerations. Local (city or county) level policies are not reviewed in this report.

It is also important to note that energy policies are constantly shifting, so the specific provisions cited in this chapter are offered as benchmarks for current conditions as a means of drawing distinctions between state approaches under current conditions. Policy revisions will undoubtedly shift specific provisions and major initiatives over time.

10.1 Introduction

Utility regulations vary from state to state in response to varying political climates and energy agendas. State energy legislation can affect many aspects of the practical and financial considerations for energy projects at wastewater utilities, including:

- Availability of financial incentives for various energy project types.
- Restrictions or promotion of energy performance contracting.
- Regulations that allow third-party contracting and PPAs for renewable power.
- Inclusion of CHP in RPS.
- Net metering provisions that provide attractive compensation for exported power, either from diurnal solar production peaks or for excess production from biogas CHP systems.
- "Organics bans" that prohibit landfilling of food waste and enlarge the supply of potential digestion feedstocks.

10.1.1 Three-State Comparison

In each state, legislative bills and executive mandates set the course for energy policy. In addition, all U.S. states have a type of utilities commission (also known as utility regulatory commission [URC], public utilities commission [PUC], or public service commission [PSC]) that regulates public utilities over the state's service areas. Generally, these groups are responsible for implementing policies that can enable or inhibit successful energy efficiency projects, though utility policies can also vary significantly even within a state.

Three states were selected to compare energy policies and to show a useful range of policy considerations: California, Georgia, and New York. These three states have varied average blended electrical rates as described in Table 10-1. Local rate conditions can vary considerably.

Table 10-1 also indicates the ranking of each state in the American Council for an Energy Efficient Economy's (ACEEE) 2014 State Energy Efficiency Scorecard. This scorecard is a broad measure of state support for energy efficiency via funding for energy efficiency, transportation support, building energy codes, promotion of CHP, state government initiatives, and appliance efficiency standards. In addition, Table 10-1 lists the 2013 incremental electrical savings resulting from energy efficiency programs offered in 2013, showing the relationship between high scorecard achievement and efficiency program savings.

Table 10-1. Three-State Energy Efficiency Comparison.

State	Typical Industrial Electrical Power Cost in December 2014 (S/kWh)[a]	ACEEE 2014 State Scorecard Ranking[b]	2013 Electrical Efficiency Program Savings (% of retail sales)[b]
California	$0.11	2	1.25%
Georgia	$0.06	35	0.22%
New York	$0.06	7	1.13%

[a] EIA, 2015.
[b] ACEEE, 2014.

The regulatory body and major electrical utility service areas for each state are described in the following three sections.

10.1.1.1 California

California investor-owned utilities (IOUs) are governed by the California Public Utilities Commission (CPUC). The three largest IOUs in California are:

- Pacific Gas and Electric (PG&E).
- Southern California Edison (SCE).
- San Diego Gas and Electric (SDG&E).

The various electric utility service areas are shown in Figure 10-1. Individual cities noted on the map may have relationships with the IOUs but also provide their own municipal power.

Figure 10-1. California Electric Utility Service Areas.

10.1.1.2 Georgia

Georgia's IOUs are governed by the Georgia Public Service Commission (GPSC). In general, electric power in Georgia is produced and sold by the Georgia Power/Southern Company but distributed through a number of smaller, independent transmission agencies known as Georgia's Electric Membership Corporations in addition to directly from Georgia Power. Georgia Power dominates the electrical market in Georgia, serving the major metropolitan areas of Atlanta, Columbus, Augusta, and Savannah directly. A map of the service area for the Electric Membership Corporations is shown in Figure 10-2.

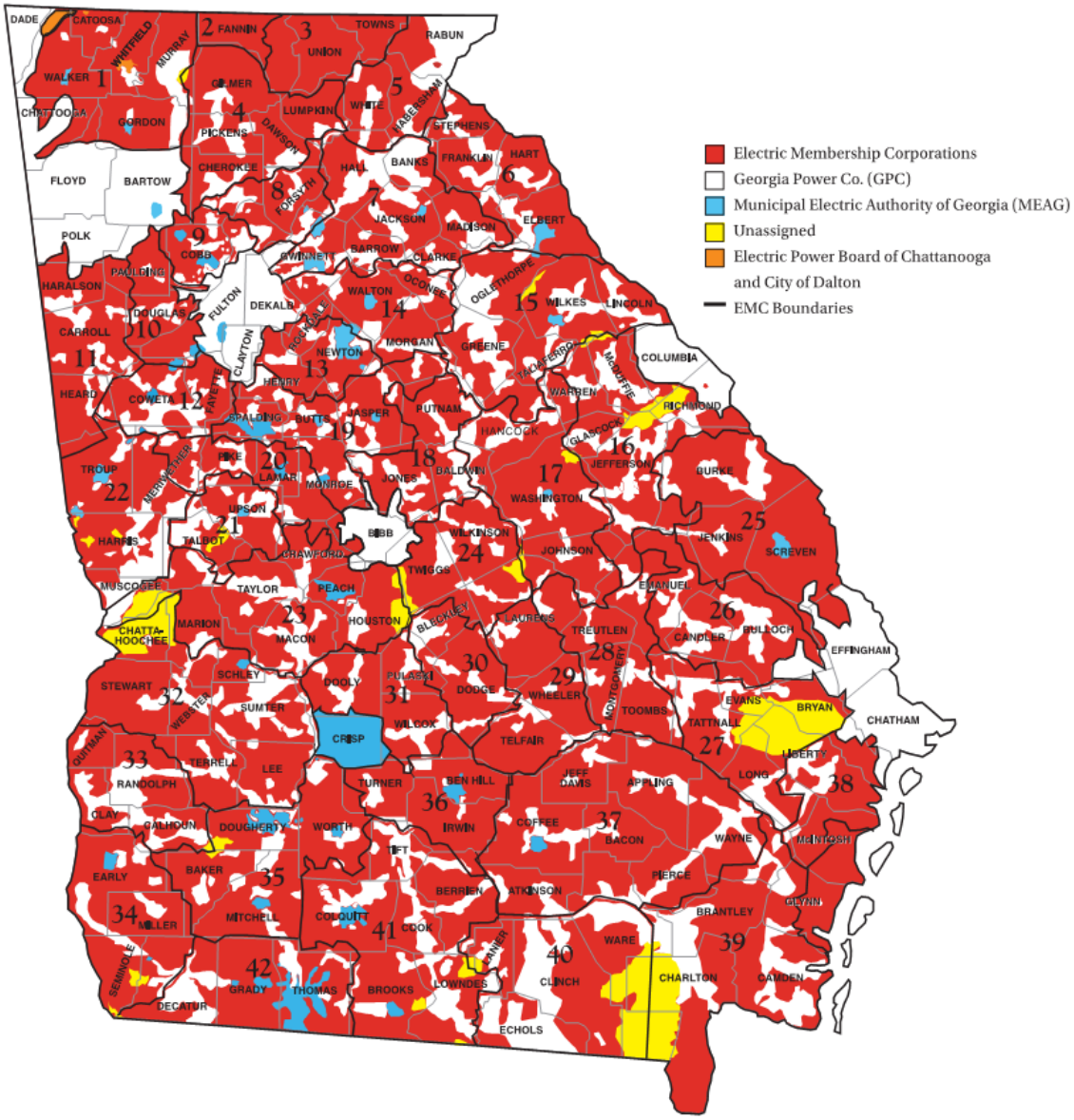


Figure 10-2. Georgia Electric Utility Service Areas.

10.1.1.3 New York

New York's IOUs are governed by the New York Public Service Commission. Some of the largest IOUs in New York are:

- National Grid.
- New York State Electric and Gas (NYSEG).
- Central Hudson Gas & Electric.
- Rochester Gas and Electric (RG&E).
- Con Edison.
- Orange and Rockland

The service area for these providers is shown in Figure 10-3.

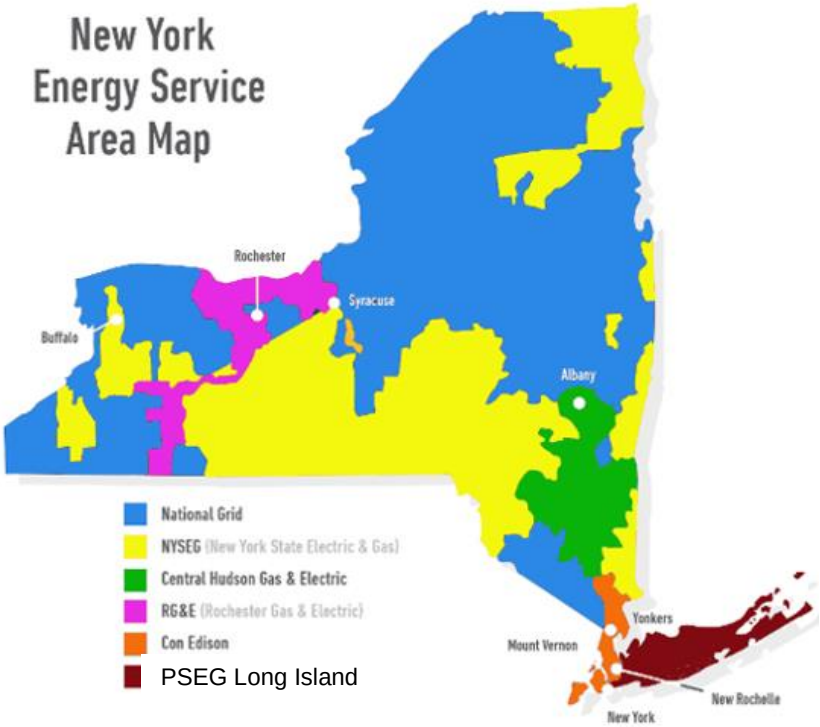


Figure 10-3. New York Electrical Utility Service Areas.

Another important New York state energy organization is New York State Energy Research and Development Authority (NYSERDA). NYSERDA helps New York entities, including wastewater utilities, increase energy efficiency and use renewable energy by offering objective information and analysis, programs, technical expertise, and funding for energy projects. Recently, New York developed the "Reforming the Energy Vision" (REV) plan, intended to accelerate positive changes in energy generation, distribution, and use. This plan reorganizes and focuses the New York agencies that promote energy efficiency, and encompasses statewide initiatives such as the NY Green Bank, NY-Sun (solar) Initiative, and NY Prize community microgrid competition.

10.1.2 Selected Project Types

Three types of projects were evaluated as representative examples of typical energy efficiency and onsite generation opportunities undertaken at a wastewater treatment plant. While onsite generation is not explicitly an energy efficiency improvement, these types of projects are popular and can be seen as an improvement to a plant's net operating energy efficiency. By considering each of these three project types, the major policy considerations listed in Section 10.1 can be assessed in context.

- Representative energy efficiency retrofit project: High-Efficiency Blower Upgrade.
- Representative biogas project: Biogas CHP Energy Generation.
- Representative renewable energy generation project: Onsite Solar Power.

10.2 High-Efficiency Blower Upgrade

Aeration air compression is usually the most energy-intensive process for a treatment plant. Older systems tended to stress reliability over operating efficiency and older blower equipment typically lost efficiency under turndown conditions. The High-Efficiency Blower Upgrade project highlighted here assumes the replacement of aeration air system blowers with new, high-efficiency models. This type of project also often includes improvements to the aeration air distribution and control systems. It usually falls under a custom project category, in contrast to standard rebates for high-efficiency lighting, chillers, VFDs, and other more common project types that are generally covered by prescriptive incentive programs.

The following sections discuss key policies that affect energy efficiency projects for major process equipment such as a high-efficiency blower upgrade. Findings are summarized in Section 10.2.6.

10.2.1 Energy Efficiency Goals and Resource Planning

Two commonly proposed policies facilitate energy efficiency as a utility system resource (comparable to increased power generation): integrated resource planning (IRP) and energy efficiency resource standards (EERS).

Many states have adopted plans or goals for energy efficiency in order to reduce grid demand and minimize emissions from electrical generation, with 26 states using an EERS policy for implementation.

Alternatively, 28 states have a requirement for utilities to prepare IRPs. By incorporating least-cost and IRP, a utility is required to report its load and resource forecast for a specified period, and use the least-cost resource mix, including both supply and demand-side options. Because energy efficiency is such a low-cost resource, proper use of IRP can encourage incorporation of energy efficiency as a utility system resource and reduce the need for additional supply resources.

ACEEE has examined the relationship between these two state energy efficiency policies and their outcomes on efficiency (Kushler, 2014). The two key indicators used to compare efficiency outcomes are spending on energy efficiency programs ($ as a percent of utility revenues) and annual electricity savings achieved (kWh reduced as a percent of annual sales). Comparing the EERS and IRP states, ACEEE concluded that having an EERS was the most effective state policy and found little evidence that IRP alone produces meaningful energy efficiency results in the absence of other strong policies.

Approaches to implementing energy efficiency goals and resource planning in the three example states are summarized below.

California. CPUC has adopted the California Long-Term Energy Efficiency Strategic Plan (an EERS) (Assembly Bill 2021), which includes goals for energy efficiency through 2020. The legislation directs the state IOUs to reduce both electrical energy and electrical demand by certain amounts per year, amounting to a 10% reduction relative to "business-as-usual" forecasted energy consumption by 2020. The primary mechanism for implementing these reductions is customer incentive and loan programs. Utilities must also file long-term plans.

Georgia: GPSC implemented utility goals and incentives for reducing energy use through an IRP framework in 2010 (Georgia statute OCGA § 46-3A-9). Every three years, regulated Georgia utilities must file IRPs with the commission. The plans must detail the utilities' forecast requirements, taking into account present and projected energy demands and any demand reductions that are the result of improved energy efficiency measures in any and all sectors, though reduction goals are not set by the GPSC. In Georgia Power's 2010 IRP (Docket 31081), the GPSC adopted a policy recognizing energy efficiency as a priority resource. Energy efficiency improvements are considered Demand Side Management projects.

New York: In 2008, the New York Public Service Commission established the Energy Efficiency Portfolio Standard to set energy efficiency goals through 2015 (an EERS). The plan includes annual reductions in electrical energy amounting to a 15% decrease in forecasted energy use by 2015. The State's IOUs were required to file energy efficiency programs, and NYSERDA was invited to submit energy efficiency program proposals for Commission approval. The primary mechanism for implementing this reduction in energy use is through end-user incentive programs.

10.2.2 Incentives to Electrical Utilities Affecting Utility Investment in Efficiency

Improvements in energy efficiency may reduce electric utility revenues, so utilities may not be incentivized to support energy efficiency. ACEEE identifies three key policy approaches to align electrical utility incentives toward energy efficiency and remove financial disincentives (Gilleo, 2014):

- Ensure that electrical utilities can recover direct costs associated with energy efficiency programs, which virtually every state allows in some form.
- Allow fixed-cost recovery through either decoupling electrical utility revenues from sales or lost revenue adjustment mechanisms (LRAMs).
- Provide performance incentives that reward utilities (or non-utility organizations) for reaching or exceeding specified program goals.

All three states have made some progress in these areas, as summarized in Table 10-2.

Table 10-2. Utility Efforts to Address Lost Revenues and Financial Incentives[a].

State	Electric Decoupling or LRAM	Electric Performance Incentives
California	Yes	Yes
Georgia	Yes[b]	Yes
New York	Yes	Yes

[a] Gilleo, 2014.
[b] No decoupling but some other mechanism for lost revenue.

10.2.3 Incentive or Loan Programs

Incentive programs, including grants, rebates, and low-interest loans, are affected by legislation and policies that establish funding levels, set program priorities, and mandate parameters such as eligibility and timelines.

California. Energy efficiency rebates, incentives, and loans are generally available, but details vary with each utility. The Blower Retrofit project type falls under the Statewide Customized Retrofit Offering and is standardized across the major electrical utilities. This project type and complexity would most likely qualify for a Targeted Non-Lighting incentive at a 2015 rate of $0.15/kWh over the first-year energy reduction.

Additionally, cities, counties, and special districts in California can apply for low-interest loans from the California Energy Commission (CEC) for energy efficiency projects. Loans are available up to $3 million and at a rate of 1%. Loan periods are determined on a case-by-case basis.

Georgia. Georgia Power has energy efficiency rebates available to commercial customers via the Custom Savings project type. This incentive provides $0.08/kWh (capped at $40,000) for the first year's electric savings.

The Georgia Green Loans Save & Sustain Program uses state funds to make loans up to $50,000 and rates and terms are determined on a case-by-case basis.

New York. NYSERDA's Industrial Process Efficiency Program currently provides $0.12 per kWh (upstate), $0.16 per kWh (downstate) for the first-year energy savings from an efficiency project, up to a maximum of $2 million.

The New York Power Authority's (NYPA) Energy Services Programs for Public Entities allows public agencies such as wastewater treatment plants to implement energy efficiency improvements at no up-front cost. The program lends the direct costs for an improvement. The loan is then repaid through sharing the energy cost savings after implementation, up to 10 years. Once the capital costs are recovered by the program, the public agency keeps all energy savings going forward.

10.2.4 Funding Sources

Funds to support incentives at the state level generally originate from special fees added by legislation to electric utilities' ratepayers' bills. These fees collect into public benefits funds, which form the basis for many state-level energy efficiency incentive programs. The funding for these programs nationwide has grown considerably over the past 10 years, as shown in Figure 10-4. Table 10-3 compares the funding levels for California, Georgia, and New York.

Table 10-3. Electric Efficiency Program Budget.

State	2013 Budget for Customer Funded Efficiency Programs ($ million)	Percent of Statewide Utility Revenues (%)	Energy Efficiency Budget (Annual Dollars Per Capita)
California	1189	3.2	31
Georgia	40.1	0.3	4
New York	593	2.6	30

(Gilleo, 2014)

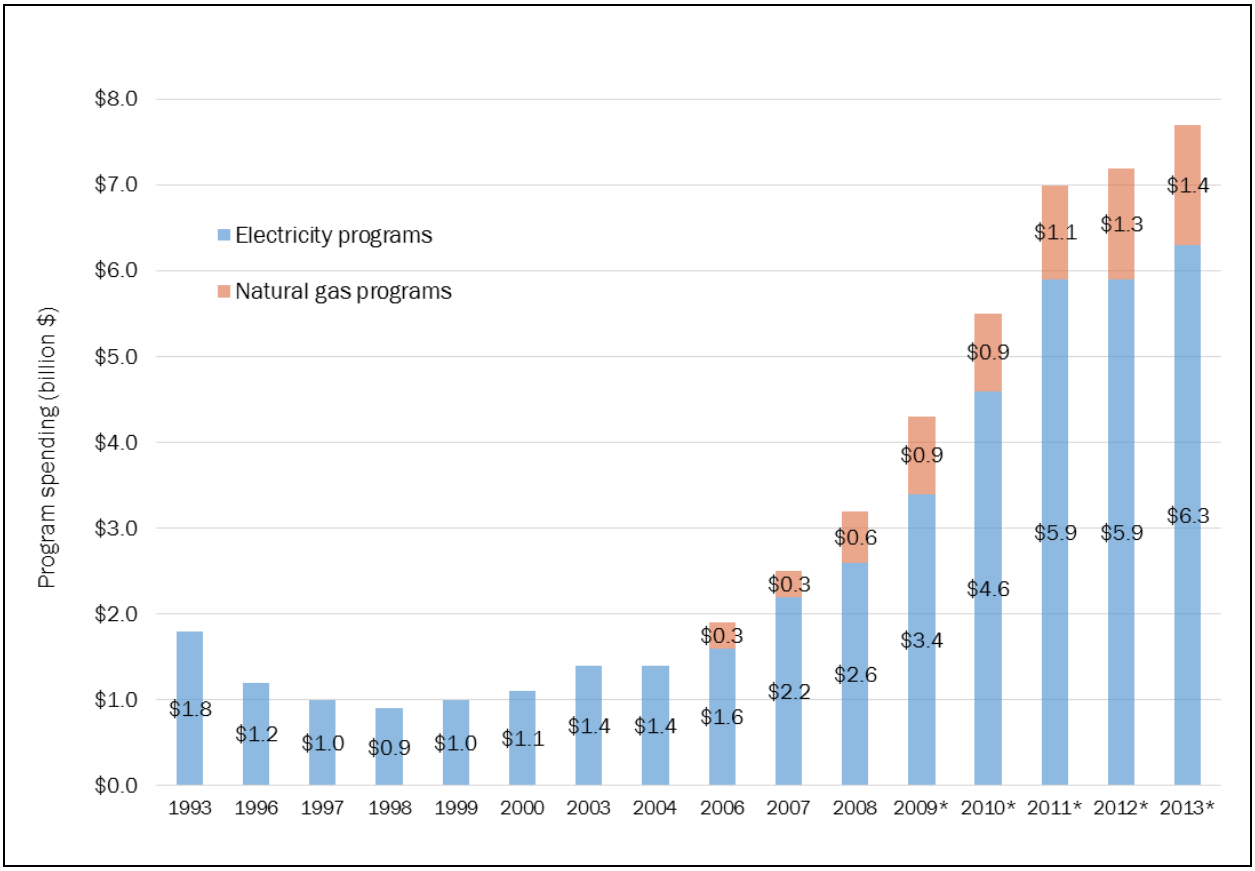


Figure 10-4. Nationwide Annual Electric and Natural Gas Energy Efficiency Program Spending or Budgets.
Note: *From 1993 to 2008, values represent actual program spending (including customer-funded programs); from 2009 on, they represent program budgets. Natural gas spending is not available for the years 1993-2004.

Sources: Gilleo, 2014, using Nadel, Kubo, and Geller 2000; York and Kushler 2002, 2005; Eldridge et al. 2008, 2009; Molina et al. 2010; Sciortino et al. 2011; Foster et al. 2012; Downs et al. 2013.

California. California established a public benefits fund in 1998 based on collection of a Public Goods Charge on ratepayers' bills. The fund handles approximately $1.2 billion directed toward energy efficiency programs annually.

Georgia. Georgia does not have a significant state Public Benefits Fund directed toward energy efficiency or renewable energy.

New York. New York's system benefits charge (SBC) was established in 1996 by the New York Public Service Commission based on a surcharge on customers' bills. The current SBC Technology and Market Development Program had a 2013 overall annual budget of $527 million and included incentive funding for energy efficiency projects.

In addition to funding for energy efficiency programs, low funding levels for wastewater utility operation can have an impact on energy efficiency initiatives. Plants with low funding levels tend to fall behind on critical maintenance and capital spending, leaving few staff and budget resources for energy programs. As such, statewide energy efficiency funding can be even more attractive to wastewater utilities.

10.2.5 Incentive Administration

Incentives for energy efficiency and onsite generation projects can be administered by agencies, depending on the individual state. The administration arrangement can impact the ease of procuring incentives because it determines the relationships that are involved in obtaining incentives. As an example, utilities that are incentivized to promote energy efficiency and also assigned the administration role may proactively contact wastewater utilities and facilitate incentive applications. Incentives that are administered at the state level or by a mix of state and utility administration may require more legwork from wastewater utilities.

Ease of access to incentives can have a strong impact on whether wastewater utilities take advantage of available programs. For example the City of Ithaca, NY representative stated that he typically does not bother trying to determine if incentives are available based on a perception that the advantages are not worth the effort.

California. While incentive programs are often crafted and mandated by CPUC, the administration of these programs is delegated to utilities. The incentive administrator for any given project will generally be the electric utility providing service to the project's host.

Georgia. Georgia's incentive program for energy efficiency is administered by Georgia Power, while the loan program is administered by Access to Capital for Entrepreneurs, Inc., a nonprofit financial organization.

New York. The New York SBC fund is administrated by NYSERDA, while the energy efficiency incentive program is administered by NYPA and each of the state IOUs.

10.2.6 High-Efficiency Blower Summary

Custom energy efficiency projects such as high-efficiency blowers are facilitated by funding for technical assistance to evaluate opportunities and grants or low-interest loans to implement feasible projects. This funding generally flows from public benefit funds. California and New York both have high levels of funding for energy efficiency, both on a percent of revenue and per capita basis, while funding in Georgia is very low. California and New York's efficiency programs also benefit from strong EERS frameworks, while Georgia has pursued utility-led resource planning (IRP). Evidence suggests that the IRP approach yields fewer results than the EERS approach, even though the IRP process includes consideration of efficiency measures.

Even where state funding levels are high, awareness of programs and ease of access are important to promoting increased implementation of custom energy efficiency projects. Limited anecdotal evidence suggests that California may have a slight edge over New York in this criterion. California electrical utilities participating in this project, such as Thousand Oaks, report aggressive marketing of efficiency incentives by their electrical utility and very little effort required to receive incentives. In contrast, while some New York wastewater utilities had received state funding for efficiency projects, others reported a lack of awareness about available incentive programs for process improvements.

Table 10-4 summarizes the key state policies related to process efficiency projects such as high-efficiency blowers.

Table 10-4. Project: High-Efficiency Blower Retrofits.

Key State Energy Policies	California	Georgia	New York
Incentives for Consumption Reduction	Utility rebate program as mandated by CPUC - $0.15/kWh.	Limited utility rebates - $0.08/kWh (capped at $40,000).	[a]Electric efficiency performance-based incentives for existing facilities program: -$0.12/kWh (upstate), $0.16/kWh (downstate). - 50% of project cost, up to $2 million per facility. - Must qualify for $30,000 minimum incentive. - Not less than 6-month payback.
Incentives Administration	Electrical utilities	Electrical utilities	NYPA and NYSERDA for process efficiency (state authorities).
Public Benefits Fund	CPUC oversees allocation of efficiency funds. Recent changes in funding mechanisms.	None for custom process equipment.	SBC program for energy efficiency financing.
Energy Performance Contracting (ESCOs)	State law encourages use. Department of General Services - Qualified pool	Constitutional amendment allows. State Pre-qualifies vendors.	NYPA implements for all public entities.
Energy efficiency goals	[b]Assembly Bill 2021: 10% reduction electricity by 2020.	No EERS goals, utilities required to perform IRP and self-select goals.	[c]Energy Efficiency Portfolio Standard (EEPS): - Reduce electricity usage by 15% relative to projected use by 2015.
State Sponsored Energy Research Organizations	California Energy Commission	None	NYSERDA

[a] http://www.nyserda.ny.gov/All-Programs/Programs/Existing-Facilities-Program

[b] http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/

[c] http://www3.dps.ny.gov/W/PSCWeb.nsf/All/2197DAD6F78ECCB085257BA9005E71A6?OpenDocument

10.3 Biogas Energy Generation

Biogas energy generation projects typically include a biogas treatment and conditioning system and new generation equipment such as internal-combustion (IC) engines, fuel cells, micro-turbines, or turbines. This equipment generates electric power from the biogas resource and typically helps to offset WRRF electric demand from the local electric utility, as well as recovering heat that can be used to reduce natural gas purchases.

Key policies that affect biogas energy generation projects are summarized in the following sections.

10.3.1 Biogas CHP and RPS

RPS (mandatory) or Goals (voluntary) are policies that encourage specific increases in renewable power generation in a state's electric power generation mix. As noted in the UOTF (NACWA, 2013) publication, nine states with an RPS (approximately 30 states currently have an RPS) do not include biogas-based generation as an eligible resource, reducing the incentives to invest in or buy power from these sources.

California. The California RPS includes "bundled" biogas, such as digester gas or landfill gas, as eligible renewable generation as long as the power is exported directly to the California electrical grid. The RPS goals are 25% by then end of 2016 and 33% by 2020.

A pending bill introduced by the California Association of Sanitation Agencies (CASA) in 2015 seeks to reclassify how wastewater plant produced electricity (used "behind the meter" or onsite at the facility) counts toward the state RPS. The bill would move the power from Tier 3 to Tier 1 and significantly improve the REC (see Section 10.3.6) value and marketability of this renewable generation.

Georgia. Georgia has no RPS or voluntary goals established.

New York. The New York RPS includes digester gas as eligible renewable generation. The current RPS goals are 30% by 2015.

Unlike the majority of state RPS programs that require utilities to supply a certain proportion of electric load through renewable energy, New York State currently uses a central procurement model to implement its RPS program. NYSERDA acts as a central procurement agency which manages various programs to promote renewable energy development in the State.

10.3.2 PPAs and Energy Performance Contracting

A PPA is a contract between the owner of an energy generation system and a client who purchases power from the owner's system. In the case of a biogas system, the client would provide biogas to the system owner for an agreed-upon fee (possibly zero), and the client would purchase some or all of the power generated by the system at a preset rate. Often the system itself is built on land owned by the client and leased to the system owner for an agreed-upon fee (again, sometimes zero). Where enabled by state law, these arrangements can significantly improve the financial and organizational feasibility of renewable-energy projects by reducing capital requirements and accessing federal tax incentives. Additionally, these approaches may allow a client to contract for gas treatment and cogeneration services that are often outside of their core business and that would require additional expertise.

ESCOs are usually commercial businesses that provide energy-related projects. Refer to Chapter 5.0 for additional background on ESCOs, including performance guarantees and financing options.

California and New York allow PPAs. All three states allow ESCOs, with various programs such as expedited contracting to facilitate their use.

10.3.3 Net Metering

For wastewater plants that are approaching or achieving net zero status, net metering gives an electric utility customer the ability to cache energy to the electric grid. This type of metering is useful when onsite generation capacity may, at times, exceed the local plant electric demand and the facility becomes a net exporter of power. Net metering lets a customer get "credit" for this exported power and "recover" the power at a later time, as long as their power produced does not exceed the power purchased (in billing kWh). Local net metering and wheeling provisions affect the ability of a wastewater utility to be compensated fairly for exported power produced by biogas, wind, or solar generation facilities. In general, without net metering available, facilities are not compensated for exported power, forced to sell it at a low wholesale rate, or not allowed to export at all. States and local utilities establish maximum net metering capacities, as summarized below for the three states evaluated in this study.

California. CPUC requires utilities to allow net metering for projects up to 1 MW in capacity. Multiple sites, all owned or operated by the same public agency, can pool their net metering benefits up to a maximum of 5 MW of capacity. Biogas and solar projects are eligible for this policy.

Georgia. The Georgia Cogeneration and Distributed Generation Act of 2001 allows net metering for solar and fuel cells (not any other type of biogas generation) up to 100 kW. For most biogas generation projects, net metering will not be available. Negotiations can allow power to be exported to the grid but generators recover only Georgia Power's "avoided cost" or a wholesale rate based on much larger scale than most biogas CHP projects.

New York. While farm-based biogas projects can be net metered up to 1 MW, municipal biogas-based generation projects cannot be net metered at this time, although power export is allowed. For example, the Gloversville-Johnson WRRF plans to export power at wholesale power rates under a PPA with the local electrical utility. Solar projects can be net metered up to 2 MW.

10.3.4 Organic Landfill Bans

In some states and communities, new regulations limit disposal of food and other organic wastes in landfills. The purpose of banning organics is to divert them to outlets that maximize their resource value, such as anaerobic digestion facilities rather than landfills. Diversion to digestion uses the energy in this waste stream via biogas generation equipment and reduces methane emissions from landfills. Massachusetts has pioneered this concept with organics waste disposal bans (for food waste generators over a prescribed size) that took effect in October 2014.

California. Assembly Bill 1826 Solid Waste: Organic Waste requires specified businesses to recycle their organic waste. This ban, which takes effect in April 2016, applies to businesses generating over a defined threshold of waste. In addition, Assembly Bill 341 set a goal of 75% diversion of waste from landfill by 2020. This diversion rate is aimed at municipalities, and includes diversion of organics as a key focus area.

Georgia. Georgia passed and repealed a ban on landfilling yard waste. Georgia has no bans on landfilling food or other organic wastes.

New York. The New York City Commercial Organics Law, which takes effect in July 2015, will ban landfilling of organic waste from commercial entities above a certain disposal size. In a related initiative, NYC DEP is taking steps to integrate food waste into its digestion process. The commercial organics regulation does not apply to the rest of the state.

10.3.5 Air Quality Regulations

Air quality can be regulated at the national, state, regional, and local levels, often by whichever of these is the most stringent. Biogas utilization projects that rely on combustion (every technology but fuel cells) have the potential for their exhaust emissions to be regulated. In some cases, special technologies or equipment are necessary to meet emissions goals.

Stringent criteria pollutant air quality regulations can significantly impact the technical and economic feasibility of biogas utilization projects. Additionally, the potential for carbon dioxide (CO_2)-based regulations and falling into a Federal Title V permitting process can leave many air quality-related pitfalls for municipal agencies. These factors are expanded on in the WERF Barriers to Biogas (Willis, 2012).

California. California's air quality is governed at the state level by the California Air Resources Board and by 35 regional air districts. The toughest emissions requirements are typically in the South Coast (Los Angeles area), San Joaquin Valley (Central Valley area) and Bay Area (San Francisco Bay area) Air Districts. Recent changes to NOx emissions standards for digester gas in these areas have forced the use of costly exhaust emissions control devices on equipment such as reciprocating combustion engines and gas turbines.

Georgia. The Air Protection Branch of the Georgia Department of Natural Resources, Environmental Protection Division regulates air emissions for the state. Regulations for digester gas-based power production conform to federal standards and generally do not require any special exhaust treatment devices.

New York. Air quality is regulated by the New York State Department of Environmental Conservation, Division of Air Resources. Some individual counties in New York fall back onto federal emissions standards in some areas, while others (such as Particulate Matter 2.5) often have stricter limits. In general, these limits do not require special exhaust treatment devices for digester gas based electrical production, but they may require an air Facility Permit with regular emissions testing.

10.3.6 Renewable-Energy Certificates (RECs)

A REC represents the "green" or environmental attributes of one megawatt-hour of renewable generation. In states with RPS there is a compliance market for RECs. In other states, only voluntary RECs may be traded. If a wastewater utility obtains compensation for RECs, they are selling all benefits, emissions reductions credits, environmental air quality credits, offsets, etc.

REC brokers connect renewable power producers with electrical utility customers that need to purchase RECs to comply with RPS goals. In general, the recent value of RECs has been very low. Compliance market RECs have some value, but the market for voluntary RECs is essentially nonexistent.

Some states and regions have developed tracking structures to support REC trading. For example, in 2012, New York Assembly Bill A6114-C required NYSERDA to establish a generation attribute tracking system (currently under development) that records electricity generation attribute information within the state. It also requires NYSERDA to process generation attribute information from energy imported and consumed within the state, in part to support the market for tradable RECs.

California. Compliance RECs are traded to facilitate electrical utility compliance with California's RPS. CPUC is currently updating the methods used to prioritize generation sources for RPS credit via its "RPS Calculator" program. Also, as discussed in Section 10.3.1, a new bill seeks to reclassify the unbundled RECs from wastewater treatment plant renewable generation as Tier 1 RECs, dramatically improving their value and marketability.

Georgia. There is no compliance market for RECs in Georgia because the state does not have an RPS.

New York. Biogas CHP systems qualify as a "Customer Sited Tier" or "main tier" under New York RPS standards, with NYSERDA administering the procurement process for renewable energy that is counted toward the RPS, as noted in Section 10.3.1 above.

10.3.7 Biogas Cleanup and Injection

Biogas generated from municipal anaerobic digestion, or digester gas, is typically about 60% methane by volume with the remainder mostly CO_2. In lieu of using biogas in onsite CHP systems, the gas can be purified by removing most of the CO_2 and injecting the resulting gas into a utility natural gas pipeline. Because the current price for natural gas is low and expected to remain low for the near future, the financial benefit of selling this gas is significantly enhanced by selling the associated RECs, renewable identification numbers (RINs), or other green attributes of the gas on top of the base commodity price.

California. To date, the utilities, not CPUC, have specified the fuel quality standards required to inject treated biogas to the pipeline. For the most part, injection of municipal digester-based biogas into California common natural gas pipelines has been banned. Recent changes from the state legislature (AB 1900) in 2012 and CPUC in early 2014 have now established a path forward for municipal biogas injection, though the fuel quality standards for biogas injection are quite high and can be difficult to meet.

Georgia. Natural gas regulations in Georgia are compatible with biogas injection.

New York. Natural gas regulations in New York are compatible with treated biogas pipeline injection, as evidenced by the current design of a large municipal biogas treatment and pipeline injection project at the Newtown Creek Wastewater Treatment Plant in New York City, expected to be online in fall 2016.

10.3.8 Grant Funding

Grant funding can help directly subsidize the costs for installing biogas-based energy generation. These programs often specify that new generation equipment must be installed and have a minimum service life, as well as specification of minimum efficiency and other parameters.

California. The Self Generation Incentive Program (SGIP), created by CPUC and administered by the three major utilities, provides direct incentives for installing onsite generation. The

incentive amounts decrease over time and currently are $2.08 per watt of expected output for renewable fuels and internal combustion (IC) engines and $3.45 per watt for fuel cells with renewable fuel. The full incentive amount applies up to 1 MW of capacity, and then decreases for larger systems (up to 3 MW). Half of the incentive is paid up front while the other half is paid as a performance incentive over a five-year period. The program, which is funded by utility ratepayer fees, has been approved for funding through 2019.

Georgia. Georgia does not offer any financial incentives for biogas generation projects for municipal agencies.

New York. The Anaerobic Digester Gas-to-Electricity Program is a directed effort to promote the beneficial use of digester gas in New York. This program offers a complex combination of a capacity-based incentive and performance-based incentive, as well as funding for new or substantially improved digester vessels, digester gas conditioning equipment, and large food waste acceptance facilities. While the capacity incentive varies, the performance incentive is generally $0.025/kWh over 10 years. The maximum incentive amount is $2 million per site, for projects up to 2 MW in capacity. The program, which is funded by utility ratepayer fees, has been approved for funding through 2015.

10.3.9 Biogas CHP Summary

Both California and New York offer financial incentives for CHP systems that are funded by public benefits systems and encouraged by RPS programs. As an example, a 1,000 kW IC engine CHP system would receive an incentive of approximately $2 million in either program. Both programs include funding caps (per installation) for projects above this size.

California has a REC market for RPS compliance. Pending California legislation could allow for future sale of RECs for power that is used behind-the-meter, which would be a significant benefit to biogas CHP systems at wastewater facilities.

CHP projects in California benefit from increased financial feasibility because of high electrical rates, although they are more often required to install costly air pollution control devices to meet air quality requirements.

California's and New York City's organics bans may provide increased levels of feedstocks for digestion, increasing the potential output of CHP systems. For wastewater utilities with co-digestion that are approaching net zero status, California has the most attractive net metering compensation structure for WRRF biogas CHP systems.

Table 10-5 summarizes the state policies relevant to biogas-based CHP systems.

Table 10-5. Biogas Based CHP.

State	California	Georgia	New York
Interconnection Limits	- Up to 10 MW: - Rule 21, follows Institute of Electrical and Electronics Engineers (IEEE) 1547	- Up to 2 MW: - Consistent with IEEE	- Up to 2 MW: - State standard - Modified Standard Interconnection Requirements (SIR)
Net Metering/ Feed-In Tariff	Net Metering allowed up to 1 MW in capacity CHP Feed-in Tariff Compensation rate based on 12-month average spot price for hours of 0700-1700	No net metering for conventional biogas IC engine or gas turbine projects	Utility providers not obligated to provide net metering for wastewater biogas projects
Incentives	[a] SGIP - 3 MW limit - Tiered payments based on production - $2.08 per W rebate for biogas engines	None	[b]Anaerobic Digester Gas-to-Electricity Program Rebate: Variable, max $2,000,000 or 50% of capital cost Performance Incentive: - $0.025/kWh for 10 years - max $2 million per site - max 2 MW capacity
Public Benefits Fund	Three major utilities collect a "Public Goods Charge" Renewables administered by: - CEC - Electric Program Investment Charge Fund	None	SBC program for energy efficiency financing CHP Acceleration Program
Third-party contracting (PPA)	Allowed	Not allowed	Allowed
Energy Performance Contracting (ESCOs)	State facilities	State projects	NYPA implements for all public entities
Air Quality Regulations	Senate Bill 1298 - Distributed generation units after 1/1/2003 - Require minimum efficiency	Federal RICE requirements	New York State Environmental Conservation Law 204-1 - Useful thermal output credited
Renewable Energy Credits	Used to meet RPS	No	Main Tier program administered by NYSERDA for NYS RPS compliance
RPS	[c] RPS - 20% by December 31, 2013 - 25% by December 31, 2016 - 33% by 2020	None	RPS - 30% by 2015 NYSERDA Main Tier and Customer-Sited Tier program targets for supporting the production of approximately 10.4 million megawatt-hours (MWh) of renewable energy annually by 2015 - RPS provides financial incentives
Local Organics Ban	Assembly Bill 1826 Solid Waste: Organic Waste Requires specified businesses to recycle organic waste - Commences April 1, 2016 and applies to businesses generating 8 cy or more - Assembly Bill 341 sets municipal landfill diversion goal at 75% by 2020	None	New York City - Large food waste generators - Starts July 2015

[a] CPUC, 2015.
[b] http://www.nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/PON-2828-Renewable-Portfolio-Stand-Customer-Sited-Tier-Anaerobic-Digester-Gas-to-Electricity.aspx
[c] http://www.cpuc.ca.gov/PUC/energy/Renewables/

10.4 Solar Power

Solar PV systems convert solar energy (sunlight) into electric power. This power can help offset electric demand from the local electric utility. Solar PV systems have been increasing in popularity dramatically since about 2009 and are by no means specific to wastewater treatment plants or the environmental sector.

Key policies affecting solar projects are summarized in the following sections.

10.4.1 PPAs and Solar Portfolio Arrangements

PPAs (previously discussed in Section 10.3.2) also apply to and are quite popular for solar power installations. The low- or no-capital cost financial structure can be very appealing for a costly solar PV system. Additionally, private entities can often take advantage of the 30% federal tax credit for the solar project (through January 1, 2017), something municipal wastewater utilities cannot do. California and New York allow both PPAs as vehicles for implementation of solar projects, while Georgia does not allow PPAs. Georgia is among only five states that prohibit PPAs (per the Georgia Territorial Electric Service Act: OCGA § 46-3-1). These differences are highlighted in Figure 10-5 from the DSIRE.

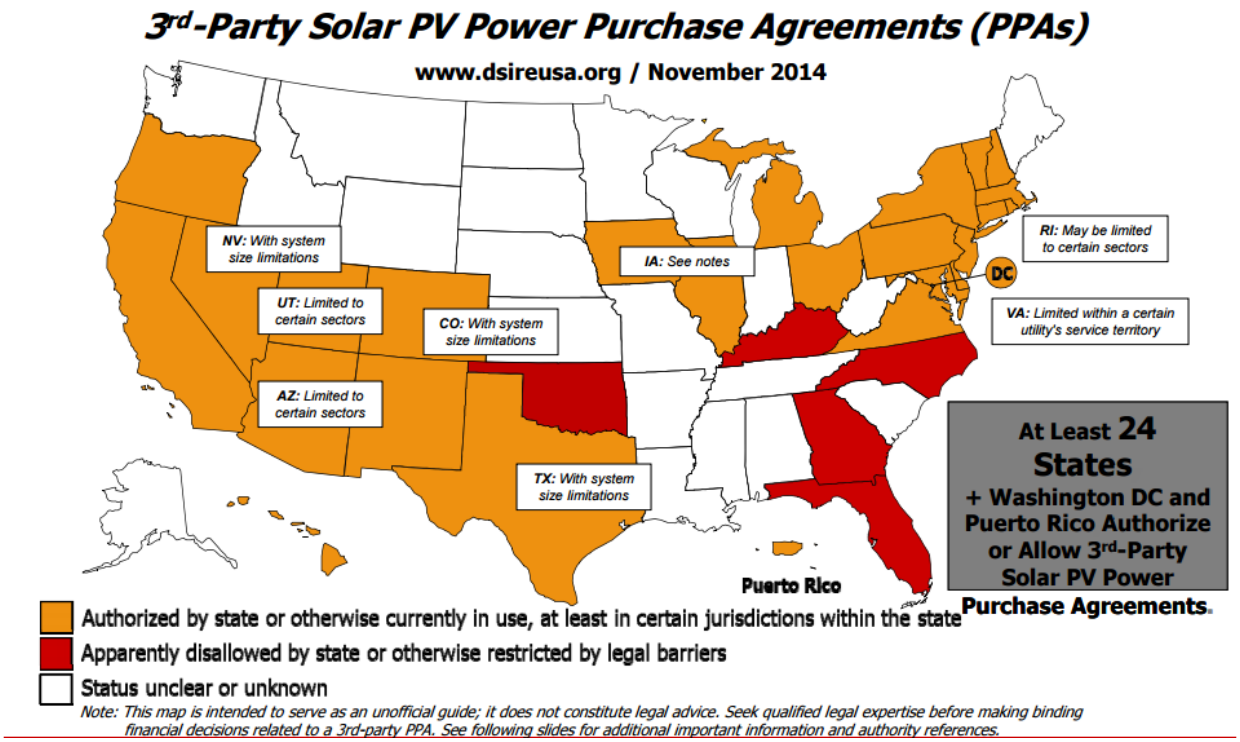


Figure 10-5. State Laws Regarding PPAs.
Source: DSIRE, 2014 Note: Minnesota also authorizes Solar PV PPAs.

10.4.2 Net Metering

Net metering (previously defined in Section 10.3.3) also applies to solar power systems, although the net metering provisions for solar can be different from the provisions for other renewable energy. Because of the surge in popularity in solar power, interconnection and net metering policies have been made friendlier to solar power and allow for most mid-sized systems to be net metered.

California. As with biogas net metering, CPUC requires that utilities allow solar net metering up to 1 MW for single systems and up to 5 MW for a pool of systems owned by the same agency.

Georgia. As noted in Section 10.3.3, a solar power system can be net metered up to 100 kW in capacity. Note that this size is fairly small (approximately 0.4 acre).

New York. Solar projects at up to 2 MW in capacity can be net metered for non-residential owners. New York regulations also allow remote net metering, allowing power generated at one site to be credited to an electric meter at another site if both properties are owned by the same customer.

10.4.3 Solar RECs

Solar Renewable Energy Certificates (SRECs) function in the same capacity as RECs (see Section 10.3.6) but are specific to generation from solar power. In states that have specific RPS "carve-out" goals for solar energy, SRECs may have a higher value than RECs.

California and Georgia. Neither of these states have solar RPS standards or specific solar REC programs.

New York. Until recently, onsite solar systems qualified as a "Customer Sited Solar Tier" under New York RPS standards, but now they are provided through NY-Sun.

10.4.4 Solar Grant Funding

Incentives for solar power were a very aggressive part of the boom in installed solar capacity since about 2009. Where available, the incentives often consist of lump-sum or performance-based grants that help to offset the costs of installing a system. These state level grants are in addition to the standing 30% federal tax credit for solar PV systems, but most municipalities cannot take advantage of this tax incentive, and the tax credit is currently authorized only through 2016.

California. The California Solar Initiative program provides performance-based incentives for mid-sized systems up to 1 MW in capacity. The funding for the program is split among the major utilities and has been exhausted for all but SDG&E. The incentive amount has been on a tiered structure design to reduce over time and is currently at $0.088 per kWh for nonprofit entities. The remaining funds in the programs are already reserved and the program is expected to close soon.

Georgia. The Georgia Power Solar Buyback Program, now fully exhausted, offered $0.17 per kWh for new installations up to 100 kW.

Currently, Georgia Power is implementing its Advanced Solar Initiative, which it claims is the largest voluntary solar portfolio in the country. This initiative is procuring solar generation to voluntarily increase the solar fraction of Georgia Power's portfolio. This initiative has a program for small-scale purchase (<100 kW) and medium-scale purchase (100-1,000 kW), with

a standard offer price of $0.13 per kWh. Participants in this program are selected by lottery, with less than 20% of the applicants chosen to participate.

New York. The NY-Sun program uses a Megawatt Block system to allocate incentives. Megawatt targets are set at certain incentive levels, referred to as blocks, in three sectors (residential, nonresidential up to 200 kW, nonresidential larger than 200 kW). As applications are submitted, incentives are assigned the kW associated with the applications and are added together. When the MW target for a block is reached, the block is closed and a new block is started with a lower incentive level. As an example, the first Upstate Residential block had an incentive of $1 per watt.

10.4.5 Community Solar

A few states have begun to enact community solar policies that allow solar developments in which a large solar installation is used to provide "shares" for purchase by groups of residential, business, or other electrical customers. This model leverages the economies of scale for larger solar systems and makes solar power accessible to customers who do not have access to favorable solar sites. Some wastewater facilities may have buffer land that would be suitable as a community solar garden site, perhaps generating a sense of community integration, as well as renewable power.

California. In January 2015, CPUC established approval for a community solar process and will allow utility customers to purchase some or all of their power from solar sources.

Georgia. Georgia HB 657 attempted in 2013 to introduce community solar policies in the state but was not passed into law.

New York. In December 2014, the NY-Sun initiative introduced the Community Solar NY program to facilitate community solar alternatives in the state.

10.4.6 Solar Markets

Other legislated solar policies can affect solar markets:

- **Support for state solar industries.** A few states have solar legislation provisions that promote local solar businesses, including rebates for equipment made in the state or other incentives. None of the three states in this comparison has adopted these provisions.
- **Value-of-solar (VOS) tariffs**. A VOS tariff is a rate design policy that gives customers with solar installations credit for the electricity generated by a PV system. The intent of the rate is to capture the net benefits of solar, including avoided utility variable costs (fuel and purchased power), avoided utility fixed costs (generation capacity, transmission, and distribution), distribution system and transmission line losses, ancillary services (to maintain grid reliability), and environmental impacts (carbon and criteria pollutant emissions). At this time, only Minnesota and Austin, TX have VOS tariff programs.

10.4.7 Onsite Solar Summary

All three states provide some level of financial support for solar development; however, solar incentives have been very popular and availability varies over time. The Georgia solar program differs from California and New York because it is a voluntary program, and not mandated by an RPS. Georgia regulations also prohibit PPA arrangements, which have been a cost-effective means of implementing solar power at WRRFs in other states.

One key solar policy consideration is the level of priority given to small and medium-sized systems that might be installed by wastewater utilities vs. support for large utility-scale systems. These policies are currently in flux in each state, with each trying to adapt to the newly competitive financial viability of large-scale solar systems.

Table 10-6 summarizes the state policies affecting solar PV installations at WRRF sites.

Table 10-6. Onsite Solar PV.

State	California	Georgia	New York
Interconnection Limits	- Up to 10 MW - Rule 21, follows IEEE 1547	State guideline applies only to net metered systems - Up to 100 kW - Consistent with Institute of Electrical and Electronics Engineers (IEEE) 1547	State standard - Modified SIR - Up to 2 MW
Net Metering/Feed-In Tariff	Net metering up to 1 MW single, 5 MW grouped	Net metering up to 100 kW	Net metering for solar up to 2 MW, remote metering allowed
Incentives	CSI program (no funding currently available)	Georgia Power Advanced Solar Initiative	NY-Sun Initiative
Public Benefits Fund	Three major utilities collect a "Public Goods Charge" Renewables administered by CEC Separate funds for CA Solar Initiative – Electric Program Investment Charge Fund	None	NY-Sun program for energy efficiency financing renewables. Annual collections targets for each utility established by the PSC
Third-party contracting (PPA)	Allowed	Not Allowed	Allowed
Energy Performance Contracting (ESCOs)	State facilities	State projects	NYPA implements for all public entities
Renewable Energy Credits RPS	Used to meet RPS - 20% by December 31, 2013 - 25% by December 31, 2016 - 33% by 2020	No regulatory market Voluntary RPS	No - 30% by 2015 - RPS provides financial incentives - Solar goal of 3 gigawatts installed by 2023

10.5 Summary

By comparing the energy policies of three states (California, Georgia, and New York) as they applied to three representative types of energy projects common to wastewater treatment plants, key policies were identified that either supported or hindered energy projects. Table 10-7 highlights selected policies for each project type.

Table 10-7. Barriers Related to Electrical Utility Legislation.

Project Type	Key State Incentives	Example Policy Impairments
Energy efficiency	CA and NY: Generous funding of energy efficiency programs public benefit fund to meet Energy Efficiency Resource Standard goals. CA and NY: Rebates for process efficiency projects (not just conventional lighting, motors, etc.).	GA: No Energy Efficiency Resource Standard and low levels of funding for energy efficiency programs.
Biogas CHP	CA and NY: Grant funding for biogas CHP to meet state RPS. RPS includes biogas projects.	NY: No net metering for wastewater biogas projects. GA: No RPS.
Onsite solar	NY and CA: Support for renewables to achieve aggressive state portfolio standards. GA: Large voluntary solar portfolio initiative.	GA: Solar development at WRRFs by private solar developers not allowed, reducing access federal tax advantages for solar that are not available to municipal entities.

CHAPTER 11.0

CONCLUSIONS AND RECOMMENDED NEXT STEPS

11.1 Motivation and Prioritization

Motivation is central to initiating energy efficiency initiatives and cost reduction is the strongest motivator. Utility management establishing energy as a priority is second only to cost reduction in importance as a motivating factor. Despite apparent widespread management support for energy efficiency, resource competition was evident in perceptions of barriers related to capital projects, operations, and maintenance.

11.2 Headwinds to Energy Efficiency

Because the project input regarding barriers to energy efficiency and strategies to overcome them was dominated by utilities that are progressive in their approach to energy, the research was able to compile a good picture of the characteristic experiences of these utilities. From this picture it is clear that these progressive approaches are accessible to a wide range of utility sizes and types.

Although progress is being made by many of these progressive utilities, it is clear that energy efficiency efforts are pushing against stiff headwinds:

- **Low cost of energy.** In most parts of the country energy rates are fairly low, and it can be tough to make the case for energy efficiency initiatives on a purely financial basis. Multiple benefits, such as replacing aging equipment, may be required to provide sufficient project justification.
- **Competing organizational priorities.** Wastewater utilities are fundamentally water quality-based organizations and water quality compliance is their core business objective. This organizational orientation affects the prioritization of all types of energy efficiency initiatives, from minor operating changes to major capital projects.
- **Appropriate financial bar.** It is important to set an appropriate financial "go" threshold that captures the long-term value of the project, as well as the value of non-monetary benefits. The financial feasibility evaluation must realistically consider all variables that could affect financial feasibility in order to maintain the credibility of the energy program, including the likelihood of increasing project costs during detailed design.
- **Less developed asset management.** Asset management practices provide a good platform for energy efficiency because they can highlight opportunities for efficient equipment replacements, detect abnormal operating conditions that increase energy use, and support intelligent maintenance practices to maintain efficiency levels. Conversely, plants that struggle to keep equipment operating reliably find it extremely difficult to make resources available for energy initiatives.

- **Unreliable process control and performance.** Optimization efforts and energy-efficient retrofits may have the effect of reducing the available margin of operating error in wastewater processes. For plants without predictable operations based on robust process controls, this reduction in margin is less likely to be accepted by plant staff.
- **Lack of state support for energy efficiency.** There is considerable variation between states in the degree of support for energy efficiency programs, in terms of goals, implementation methods, and funding levels. Wastewater utilities in states with higher funding levels, programs tailored to WRRFs, and more accessible incentives programs are more likely to implement energy initiatives.
- **Insufficient incentives for renewable power.** Financial incentives appear to be especially important to CHP projects because they reduce the initial capital outlay, helping to hedge against unforeseen performance and financial risks.

11.3 Organizational Approaches to Counter Headwinds

Because individual utilities experience these barriers in different ways, there is no single path to overcoming barriers. The WEF Energy Roadmap provides a good framework for organizational approaches that recognizes the variability in needs and priorities between utilities. This research illuminated the role of the Roadmap organizational approaches in lowering barriers, and identified approaches that utilities have found to have greater effectiveness.

Because funding and limited organizational resources were highlighted as critical issues, prioritization of various energy initiatives becomes a key consideration, especially when these initiatives face stiff competition from other water-quality related priorities. Energy master planning, either formal or informal, can be an important means of prioritizing among various capital, operations, and maintenance initiatives based on ranking of benefits, and allowing utilities to allocate funding and staff time for priority initiatives.

11.4 Recommended Next Steps

The following next steps are recommended as a result of this study:

- **Create peer support groups.** For example, 13 utilities participated in a group energy initiative sponsored by the Oregon Association of Clean Water Agencies, Energy Trust of Oregon, and Bonneville Power Administration. http://www.oracwa.org/pdf/acwa-energy-yields-savings_6-11.pdf. As an alternative to this type of in-person regional group, an electronic forum could provide crowd-sourcing of troubleshooting ideas, technology experiences, and discussion of energy saving ideas.
- **Continue programs that motivate utilities,** with a focus on the motivating factors identified as being most important: 1) cost savings, and 2) establishing the priority of energy reductions as on par with traditional utility priorities.
- **Develop a framework** for evaluating the sustainability tradeoffs between increased energy use and cost vs. “better-than-permit” effluent quality.
- **Support ongoing research and education** regarding methods for optimizing maintenance intervals for energy, especially for diffuser cleaning and maintenance of large pumping systems.

APPENDIX A

CASE STUDIES

Albany County Sewer District, New York

Energy Efficiency Barriers and Solutions

Utility Overview

The Albany County Sewer District (ACSD) owns and operates two plants:

- North Plant (35 mgd design, 24.0 mgd average flow in 2013)
- South Plant (29 mgd permitted, 21.5 mgd average flow in 2013)

Both plants are conventional activated sludge plants, requiring seasonal nitrification. The South Plant recently commissioned a new energy-efficient ultraviolet (UV) disinfection system. In both plants, waste activated solids are thickened with dissolved air flotation thickeners and combined with primary sludge, then dewatered using belt filter presses prior to incineration in multiple-hearth units.

In 2013, the North Plant successfully commissioned the first Organic Rankine Cycle (ORC) facility to recover energy from an incineration process at a WRRF. In recognition of this project and the South Plant gray water beneficial use program, the County was awarded the 2013 New York Water Environment Association (NYWEA) Sustainability Award.

Energy Program Genesis: Summary of Motivators

Beginning with aeration system upgrades in the 1990s, energy initiatives have been targeted to achieve both environmental and economic benefits. Capital improvements with a focus on energy conservation have generated annual savings that allowed further investment in needed infrastructure improvements while not burdening member communities with large rate increases. The County Executive and legislature have historically been strongly supportive of the energy elements of District budgets and capital plans.

While ratepayer stewardship has long been a motivator for energy projects, significant grant funding gave the primary impetus to move forward with the ORC project.

Energy Approach, Goals

In lieu of specific energy reduction goals, the District uses historical energy baseline data to quantify results of improvements. Energy tracking has documented a decrease in kilowatt-hours (kWh) consumed per million gallons (MG) treated over the past 20 years, as shown in Figure 1. ACSD also uses sub-metering to identify and improve equipment or processes with abnormally high energy consumption, such as aeration and UV systems.

To support the District's continuing focus on energy use reduction their ongoing capital improvement program gives significant emphasis on funding for projects that increase energy efficiency.

HIGHLIGHTS

Facilities

South Plant
Albany, New York

North Plant
Menands, New York

Contact

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Key Barriers

Innovation trepidation

ROI justification

Procurement of specialized equipment

O&M staff training

Success Strategies

Track and decrease kWh/MG

Invest energy savings in further capital investment

Monitor funding opportunities

Consider alternative project delivery strategies

Communicate cost savings to operating staff

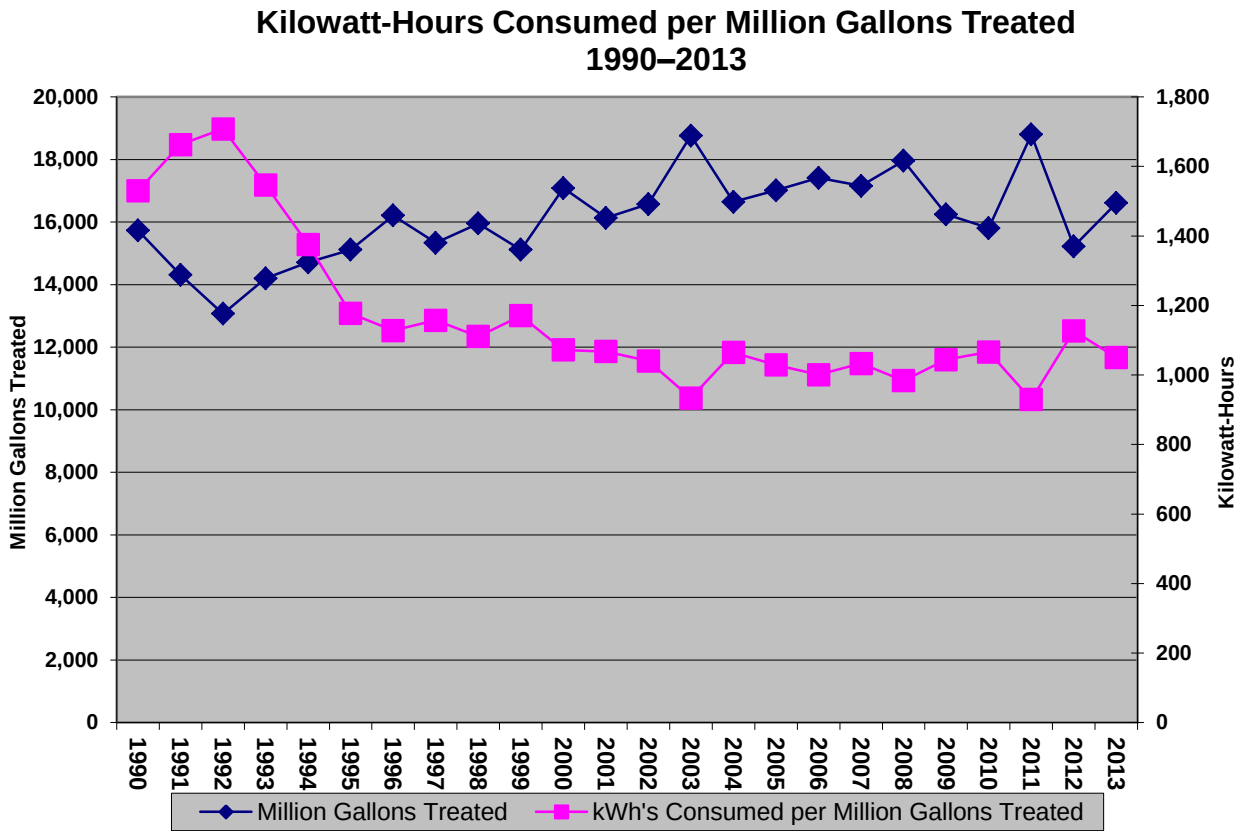

Figure 1. Historical plant flow rates and energy performance

Representative Recent Energy Projects

The ACSD has a long history of projects to reduce energy leading up to the most recent ORC project. Along the way the District has sought to combine ongoing efforts to retrofit aging equipment with upgrades that improve energy efficiency.

- **Aeration Improvements:** Both ACSD facilities achieved significant energy reduction by retrofits from mechanical aerators to fine-bubble diffusers and high-efficiency blowers. Additional savings have been realized in recent years by optimizing DO setpoints.
- **Raw wastewater pumping improvements:** Pump improvements at both facilities reduced electrical demand charges and consumption by correct sizing of pumps and incorporating energy-efficient motors, variable-frequency drives (VFDs), and improved supervisory control and data acquisition (SCADA) systems.
- **Sludge dewatering:** Both facilities have installed energy-efficient, high-pressure belt filter presses to produce dry cake, minimizing natural gas use for incineration.
- **Energy-efficient motors and VFDs:** Numerous installations have been completed of energy-efficient motors with VFDs on sludge pumps, plant water pumps, incinerator drives and fans.
- **925 kW ORC cogeneration:** This new facility uses a hot oil system to route recovered heat from the multiple-hearth incinerator at 1,250°F to a refrigerant-based thermal cycle to drive an electrical generator. Additional recovered heat is used to supply seasonal facility heating demands. The ORC facility produces 3.3 million kWh per year. Additional details can be found at http://www.heatispower.org/wp-content/uploads/2014/03/HiP-Albany-WWTP-WHP-Project-Profile.pdf

Figure 2. ORC system under construction

Energy Features: At a Glance

Size (utility total)	64 mgd permitted, 45.5 mgd average in 2013 Population served = 210,000
Energy provider and current costs	National Grid with Direct Energy 2013 average cost: $0.080/kWh North Plant and $0.092 South Plant
Energy focus area	Harvesting energy from incineration
Specific energy challenge	Now running a “power plant” as well as a WWTP
Operational issues	Skill levels, O&M procedures, fouling of heat exchangers
Implementation approach/methods	Design/bid/build execution
Energy efficiency outcomes	$475,000 in annual electrical and natural gas savings from the heat recovery and ORC system
Measuring and reporting energy progress	Annual tracking of kWh/MG, monthly therms of natural gas per dry ton incinerated, annual cost per 1,000 gallons and per pound of BOD_5

What Barriers Were Encountered in the ORC Capital Project?

The ORC project took shape over a nearly 10-year period:

- 2004 conceptual component of capital plan
- 2007 feasibility study completed
- 2008 $2M grant from NYSERDA
- 2009 design completed, RFB's issued
- 2009 – 2010 $5.9M grant from ARRA / GIGP
- Construction commenced April 2010, completed and commissioned March 2013,

Various challenges were overcome throughout the course of the ORC project cycle, as described in the following sections.

Funding: Barriers and Strategies

The District was originally unable to justify funding for the ORC project because the 2007 feasibility study indicated an insufficient return on investment. Fortunately, grant funding became available to overcome this barrier.

While the $5.9 million grant from the American Recovery and Reinvestment Act (ARRA) stimulus program in 2009 enabled the innovative ORC project to move forward, a few provisions of the grant presented significant challenges during implementation. The primary hurdle was the "Buy American" provision. Because no proven American-made equipment was available at that time, a U.S. Environmental Protection Agency (EPA) waiver was obtained. This waiver was time-consuming, increased engineering costs, and delayed project award by 3 months. Additional ARRA requirements, including Davis Bacon wage rates, proved to be challenging.

The ARRA grant funding was administered by the New York State Environmental Facilities Corporation, which required participation by Minority and Women Business Enterprise (MWBE) businesses. It was difficult to find suitable MWBE partners to support such a unique project with specialized requirements.

In addition to the ARRA funding, the District received a $2 million combined heat and power (CHP) grant from the New York State Energy Research and Development Authority (NYSERDA) to support the ORC project.

The District has also aggressively pursued funding from various sources for previous energy efficiency projects, including custom rebates and nonconventional energy projects. For example, a $1 million grant was received from the District's electrical utility for the aeration improvements from mechanical to fine-bubble diffused aeration. This project alone reduced electrical consumption per MG treated by more than 20 percent.

Grant opportunities are monitored by ACSD staff and the County Executive's office. Involvement with NYWEA, WEF, the National Association of Clean Water Agencies (NACWA), the New York State Department of Environmental Conservation (DEC), and New the York State Environmental Facilities Corporation (EFC) provides ACSD access to updates on funding sources.

PROJECT PHASES

- Identifying opportunities
- Feasibility study
- Project approval
- Capital improvement planning
- **Funding**
- Design initiation
- **Procurement**
- Construction and commissioning
- **Continued Operations**

Procurement: Barriers and Strategies

Normal design/bid/build procurement is difficult with innovative energy projects, especially when equipment is designed and manufactured overseas. Pre-selection of generating equipment was unsuccessful and the project contractor was inexperienced. Both issues resulted in increased costs and delays with resulting legal issues.

The District believes that this type of project would benefit from a design/build project approach, in lieu of the traditional design, bid, and build (or "design-tender") steps used for its project. A design/build approach relies on a single point of responsibility and is used to minimize risks for the project owner. The District suggests that using a design/build approach would have reduced the project completion schedule by overlapping the design and construction phases, and would have allowed the clearest contractual remedies for the owner.

Continued Operations: Barriers and Strategies

The District now has two maintenance staff who are dedicated to the incineration and power plant processes. The training of the operations staff has proved to be time-consuming due to the new technical skill set required. These skills include the ability to understand temperature profiles and to maximize electric production. Overall, staff has embraced operating a power plant and understands the role of the power plant in reducing the District's operating costs.

Focus on Energy for the Future

In the interest of increasing power generation beyond the ORC output and becoming a net zero or positive energy utility, the District is pursuing a food waste co-digestion and biogas CHP facility at the South Plant. A pilot study was completed in 2012 to investigate the energy benefits of mixed waste stream co-digestion. The pilot facility found that biogas yields were maximized when sewage sludge was co-digested with high-energy waste, such as residential food waste; bakery waste; and fats, oils, and grease (FOG).

This waste-to-energy program is anticipated to have environmental and economic benefit to Albany County residents by further offsetting purchased energy use at the South plant, saving valuable landfill space, and reducing landfill green-house gas emissions from organic waste decomposition.

Clean Water Services Hillsboro, Oregon

Energy Efficiency Barriers and Solutions

Utility Overview

Clean Water Services (CWS) is a water resources management utility serving communities in the Tualatin watershed west of Portland, OR. CWS operates four wastewater treatment facilities (WWTFs): Durham Advanced WWTF (26 mgd), Rock Creek WWTF (35 mgd), Hillsboro WWTF (1.2 mgd), and Forest Grove WWTF (3.6 mgd)

The four facilities treat wastewater by screening, primary clarification, activated sludge with biological nutrient removal, secondary clarification, and disinfection (hypochlorite at the two large plants and ultraviolet [UV] at the small plants). The Hillsboro and Forest Grove WWTFs are seasonally operated and are brought online during the wet weather season. The Durham and Rock Creek WWTFs operate year round. During the dry weather season, CWS must meet stringent phosphorus discharge limits; as a result, the Durham and Rock Creek WWTFs also include a tertiary clarification step with chemical addition for additional nutrient removal.

The Durham and Rock Creek WWTFs provide solids treatment and stabilization through anaerobic digestion. Solids from Hillsboro and Forest Grove are transferred to Rock Creek for processing. The digested biosolids are subsequently land-applied. In addition to beneficial land application of biosolids, CWS has pursued a resource-recovery initiative with respect to creating a beneficial product from struvite, building the first commercial struvite nutrient recovery facility in the nation at the Durham WWTF, and a subsequent facility at the Rock Creek WWTF.

HIGHLIGHTS

Facilities

Durham WWTF

Rock Creek WWTF

Hillsboro WWTF

Forest Grove WWTF

Contact

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Key Barriers

Staff availability

Success Strategies

Cross-cutting energy team

Employee motivation

Specialized staff to pursue energy project funding

Energy Program Genesis: Summary of Motivators

CWS's energy program is motivated primarily by a desire to reduce operating costs. The energy program has evolved organically as the result of new staff capabilities and ongoing process needs that created opportunities to make energy efficiency upgrades. In 2010, CWS created the Process Control, Innovation and Energy (PIE) Team, whose goal is to identify and pursue energy efficiency measures and process optimization projects at the four WWTFs.

Partnerships with the Energy Trust of Oregon (ETO) and the local electrical utility, Portland General Electric (PGE), provide significant momentum to the energy program through grant funding and other financial incentives. ETO is a ratepayer-funded organization that supports energy efficiency in Oregon. CWS employees identify potential energy-saving projects and ETO provides energy consultants to evaluate the viability of the ideas and to determine the potential incentive available for its completion.

Energy Approach, Goals

The CWS energy program is heavily promoted by CWS utility leadership. Instead of focusing on specific numeric energy reduction goals, CWS encourages energy reduction as a key part of process optimization projects. In FY2014, CWS completed nine ETO-recommended projects representing an estimated 2,200,000 kWh of energy savings and received $550,000 in ETO energy incentives.

Energy Projects, Type

Since 2010, CWS has completed numerous energy efficiency projects, with a focus on replacing older, inefficient equipment with more efficient technology. Specific project examples include:

- **Variable-frequency drives (VFDs)**: The Durham WWTF installed VFDs on one 1,000- and two 600-horsepower pumps in each of the facility's wet wells. Durham is also de-energizing VFDs that are not in service to eliminate "phantom loads" from VFD controls.
- **LEED-certified buildings**: CWS built the first public Leadership in Energy and Environmental Design (LEED) Gold-certified building in Washington County, OR. After improvements, the Durham Advanced WWTF pumping station received LEED Silver certification in 2008.
- **Turbo blowers**: The Rock Creek and Durham WWTFs have both recently commissioned high-efficiency blowers.
- **DO optimization**: The Durham WWTF has recently upgraded its DO control system. Plant staff are working to optimize the air distribution between zones and to implement a most-open valve approach, in order to ultimately enable the header pressure to be reduced.
- **DO probe maintenance**: The Durham and Rock Creek WWTFs implemented twice-per-week DO probe cleaning in order to maintain accurate and efficient aeration control.
- **FOG receiving station**: The Durham WWTF has just installed a fats, oils, and grease (FOG) receiving station to increase biogas production and upgraded its cogeneration system to accommodate this additional biogas production.
- **Lighting upgrades**: The Durham WWTF replaced old, inefficient lighting with more efficient technology, and added motion sensors and timers where possible.

Energy Features: At a Glance

Size (utility total)	Average flow = 64 mgd combined Population = 551,000
Energy provider and current costs	PGE, $0.059/kWh
Energy focus area	Overall WWTF process optimization
Specific energy challenges	Staff availability, tracking numerous projects
Operational issues	Increasing operations buy-in for revised practices that save energy
Implementation approach/methods	Standard operating procedure (SOP) changes and traditional procurement of capital projects
Measuring and reporting energy progress	Currently compiling data to illustrate total energy reduced and energy savings. Working on setting up a permanent energy tracking system.

Organizational Energy Initiatives: Barriers and Strategies

CWS has noted several barriers in its PIE Team initiative. Team members have worked with utility management to implement innovative strategies to address these barriers.

Managing Projects

One of the most significant barriers CWS noted was managing and working through the list of energy projects. PIE teams meet monthly. The following strategies have been used by the PIE Team to keep projects moving toward implementation:

- The PIE Team has found it easier to get work done on small initiatives, especially when money is available from operating funds.
- Larger projects are implemented via the Capital Improvement Program (CIP) process.
- New energy ideas are triaged briefly in the group setting. Ideas that don't seem feasible to the PIE Team may go back to the operations group for refinement.
- Individual team member accountability for implementation is encouraged by going through the active project list every month.

Motivating Staff and Promoting Organizational Values

CWS has found that the largest barriers are not technical issues, but rather staff limitations. These limitations include competing time commitments and getting people to understand why given energy activities are important. Strategies have been developed to promote engagement at both the PIE Team and overall organization levels.

The PIE Team approach relies on motivating staff to devote time to accomplish energy reduction initiatives:

- Monthly meeting attendance is expected – getting everyone in the room who need to be there.
- CWS relies on maintenance and operations staff to convey these issues to the PIE Team. Operations staff has a proactive attitude: "We can do this better."
- Individual members of the PIE Team are assigned responsibility for evaluating and completing energy projects within their area, especially ideas that they originate. This approach has been successful in keeping people excited because team members bring ideas to the team that they care about.
- CWS encourages participation from groups and individuals at all levels in the organization.
- Social issues regarding institutionalizing changes are recognized and addressed. As an example, staff collaboration was used to obtain buy-in for increasing the frequency of DO probe cleaning.

On a broader organizational level, CWS uses a program called "Goalshare" to reward employees for completing goals in various aspects of the utility operation. Every year, a series of objectives and measurable stretch goals are established that reflect the organization's values and priorities, such as reducing chemical use. The Goalshare program provides an employee benefit similar to profit sharing, with the annual amount determined by how many stretch goals have been met that year. All employees get the same amount in recognition of the joint efforts required. In the future, CWS intends to include energy-related goals in this program. Example goals being considered include achieving a specified annual energy kWh savings value or creating an energy dashboard.

Tracking Energy and Energy Savings

In an effort to increase organizational awareness of energy use and trends, everyone in the wastewater group gets a monthly e-mail that summarizes the energy budget and how that month's energy use compares to the budgeted amount. Explanations are provided if energy use is not on track to meet targets (e.g., if the cogeneration engine has experienced downtime). The monthly e-mails regularly remind everyone that energy is a concern.

CWS is also taking steps to improve documentation and quantification of total energy reductions, as well as improving staff communication with ETO so projects can be completed more efficiently.

Funding

Large improvement projects can be delayed while trying to obtain grant money and other funding. One strategy used by CWS to address this barrier was to hire a "business opportunities manager." This manager is an attorney with a business background and expertise in contracts and funding mechanisms. The business opportunities manager improves communication between ETO, PGE, and CWS, allowing grants and funding to be expedited and projects to be

started sooner. The business opportunities manager also supports the energy program by developing long-term contracts for FOG and sludge hauling.

Focus on Energy for the Future

In the near term, CWS is putting significant focus on improving project tracking and increasing staff energy awareness with energy dashboards. Looking further out, CWS will continue to evaluate pathways for future energy use reduction with projects such as the potential to generate renewable natural gas at the Rock Creek WWTF for local trucks and CWS vehicles.

Fairfax County Public Works and Environmental Services, Virginia

Energy Efficiency Barriers and Solutions

Utility Overview

Fairfax County provides sewer service to its customers through a system of approximately 3,350 miles of sewer lines, 65 pumping stations, 54 flow metering stations, and one wastewater treatment plant called the Noman M. Cole Jr. Pollution Control Plant (NMCPCP). Additional treatment capacity is available through contractual agreements with other regional wastewater agencies. The NMCPCP is a 67 mgd plant with moving-bed biofilm reactor (MBBR) secondary treatment for nutrient removal and incineration for solids management. The MBBR process went on-line in 2013; solids process improvements, including upgrades to incineration and ancillary process facilities, are currently in design. Energy recovery from the multiple-hearth incinerators is being evaluated.

HIGHLIGHTS

Facility

Noman M. Cole Jr. Pollution Control Plant (NMCPCP)

Fairfax, VA

Contact

Chuck Longerbeam

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Key Barriers

Financial/funding

Capital project approval

Procurement

Success Strategies

Energy audit/benchmarking

Leverage O&M team to make energy improvements

Energy Program Genesis, Summary of Motivators

In conjunction with a plant-wide facilities master planning effort beginning in 2008, plant and consulting staff identified project upgrades and needs with energy efficiency in mind. An energy benchmarking study against peer facilities was completed as part of that effort, and energy reduction/efficiency has been an operational goal ever since.

There is broad support for energy efficiency at NMCPCP:

- Utility management has established energy as a priority: short-, mid-, and long-term goals have been identified as part of a plant-wide energy plan
- Energy benchmarking conducted in 2009 helped establish energy goals and objectives
- NMCPCP participates in electric utility incentive programs (i.e., EnergyConnect)

Although Fairfax County supports energy efficiency, federal and local regulations and policies are significant drivers for all capital and operations and maintenance (O&M) projects. Competing regulatory drivers affect the priority and approval of energy-related projects and approval of energy capital projects is strongly driven by cost-benefit, financial considerations (e.g., grant funding availability).

Energy Approach, Goals

The Fairfax County Board adopted a countywide energy policy to promote energy efficiency and conservation and to reduce energy and greenhouse gas (GHG) emissions in 2009 (http://www.fairfaxcounty.gov/living/environment/county-energy-policy.htm). In addition, the Fairfax County Environmental Quality Advisory Council (EQAC) is an advisory group that has been appointed by the Fairfax County Board of Supervisors to advise the Board on environmental matters. The Council is composed of representative citizens, at-large members, and a student (high-school junior or senior) for a 3-year term. The EQAC provides advice to the Board of Supervisors through its Annual Report on the Environment and through resolutions and positions.

Energy efficiency goals, initiatives, and specific projects are identified and tracked by the NMCPCP's plant management and operations team. Progress toward those goals and projects is tracked quantifiably and as action items. NMCPCP's approach to energy efficiency includes:

- Training staff in electrical power billing and implementing process to receive, evaluate, and implement staff ideas for energy savings
- Implementing a wide variety of energy-saving projects and operational strategies including lighting changes, blower operations changes, pump testing and pump replacement, phased replacement of mixers, etc.

- Considering and implementing energy efficiency improvements/upgrades as part of capital improvements (i.e., disinfection and incineration process upgrades)

Energy Projects, Type

The Department of Public Works and Environmental Services has undertaken numerous innovating energy efficiency measures:

- **Use of landfill gas:** Multiple-hearth incinerators at the NMCPCP use landfill gas as auxiliary fuel, thereby reducing the purchase of natural gas and reusing a waste gas that could contribute to anthropogenic GHG emissions.
- **Use of solar mixers:** The use of these mixers saves about $40,000 in electrical costs per year.
- **Water reuse:** Reclaimed water is reused – approximately 560 million gallons (MG) for process purposes and 24 MG for irrigation annually. The reuse water project is used for the cooling towers at a Covanta waste-to-energy facility.
- **Phased replacement of equipment:** The County has replaced mixers with more efficient mixers in large activated sludge tanks and replaced tunnel lighting (motion detectors, induction lighting, timers)
- **Energy recovery from solids treatment:** NMCPCP is evaluating the viability and benefits of energy recovery from its multiple-hearth incinerators. Organic Rankine Cycle (ORC) technology is the preferred option.

More information is available at http://www.fairfaxcounty.gov/dpwes/wastewater/noman_cole.htm and http://www.fairfaxcounty.gov/dpwes/construction/water_reuse/.

Energy Features: At a Glance

Size (utility total)	Average flow = 67 mgd
Energy provider and current costs/incentives	Dominion Virginia Power (DVP) $0.66/kWh; participating in EnergyConnect program to reduce electricity demand when grid is unstable or opportunity of payment when grid prices are high
Energy focus area	Implement plant-wide energy goal – from liquid process operations to solids management
Specific energy challenge	Energy efficiency across the entire plant; energy recovery from incineration
Operational issues	O&M procedures supportive of energy efficiencies, but operations staff skill levels sometimes impede implementation
Implementation approach/methods	Mostly design/bid/build
Measuring and reporting energy progress	Good data tracking and confidence with data extracted from energy bills; auditable

What Barriers Were Encountered?

Although there is a conscious focus on energy efficiency plant-wide, constraints are encountered during the *project approval* and *funding* phases. These barriers are common to most wastewater resource recovery facilities (WRRFs). While staff is familiar with strategies to reduce energy, there is hesitation in embracing innovation and change, particularly during the *identifying opportunities* phase. When the initial hesitation is overcome, capital project approval seems to bog down due to financial feasibility and justification. Without strong financial incentives (e.g., payback and grant funding), it is difficult to get approval if the capital project is not required by capacity, condition, or regulatory drivers. Organizational buy-in and approval are significantly affected by financial metrics, primarily payback. Further, the *procurement* process can be lengthy and difficult if sole source purchasing is required as is often the case when implementing innovative technologies.

PROJECT PHASE(S) WHERE CONSTRAINTS ENCOUNTERED

Identifying opportunities
Feasibility study
Project Approval
Capital improvement planning
Funding
Design initiation
Procurement
Construction and commis-sioning
Continued operations

Barriers and Strategies

As part of the master planning and preliminary engineering phases, numerous solids treatment improvements, particularly incineration process upgrades to comply with the federal Sewage Sludge Incinerator Maximum Achievable Control Technology (SSI MACT) standards, were identified. The viability of energy recovery from the multiple-hearth incinerators is being evaluated: energy efficiency and production is a growing trend at WRRFs and energy recovery improves the triple bottom line with environmental, community, and economic benefits. Because energy recovery is not driven specifically by capacity needs or regulatory compliance, the project approval and justification process is complicated and requires stakeholder involvement from various levels.

There is a compelling case for the project based on the following, all of which require time and management to drive the decision-making process and to ensure project progression to subsequent phases:

- **Feasibility phase – technology barriers and strategies:** Energy recovery (ORC) is a viable technology that can produce over 1 MW of power at NMCPCP. Technology barriers are not a major concern due to design and operations lessons learned obtained from other facilities during site visits. The heat exchanger is a primary focus; ash deposition needs to be minimized and efficient ash removal/collection is a critical design element. The energy recovery system must be sized appropriately to operate efficiently with the plant solids loadings and the upstream solids handling operations.
- **Project approval and funding phases:** Continued evaluation and justification are being prepared for capital project approval of the energy recovery system. Implementation and operation considerations involve the use onsite or transmission offsite to the distribution system of the generated power. The County can likely obtain a net-metering agreement with DVP for electricity generated at NMCPCP, but additional negotiations must take place.

  The value of generated power at NMCPCP is estimated at $0.09 per kWh, including both generated electricity and renewable energy credits (RECs) (approximately $0.07 plus $0.02 per kWh, respectively), though the value of both are variable, subject to regulations, and are sold in complex markets. Continuing discussions with DVP and other stakeholders are required to obtain the best pricing agreement for the County.

  Funding is another complex issue, as potential sources for grant funding are scarce. One grant program, the State Energy Program, may be a source. The overall economic opportunities of energy recovery are compelling, nonetheless:
  - Beneficial use of available heat from the incinerators
  - Annual cost savings of $873,000 for power
  - Total savings of $17.5 million over a 20-year period
  - Production of renewable energy
  - Reduction of GHGs from conventional power plants

Focus on Energy for the Future

According to Mike McGrath, director of the Wastewater Treatment Division, “NMCPCP reduced its electricity consumption by 19 percent since its high in 2005. The plant uses less electricity now than in 1992, despite a population increase of 32 percent over the same period and the addition of nitrification, water reuse, and MBBR.” Implementation of mid-term and long-term goals is in progress. Energy efficiency improvements have been made across the entire plant, and staff is very supportive of considering and evaluating new operational strategies in the future.

City of Fort Worth, Texas

Energy Efficiency Barriers and Solutions

HIGHLIGHTS

Facility

Village Creek Water Reclamation Facility

Fort Worth, TX

Contact

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Key Barriers

Financial/funding

Lack of resources

Procurement

Success Strategies

Organizational approach

Energy audit

Use of contractor services

Utility Overview

The City of Fort Worth's Village Creek Water Reclamation Facility (VCWRF) is located on the eastern boundary of the city. Originally constructed in 1958 as a 5-million-gallon per day (mgd) facility, it has expanded to meet the needs of a growing city. It currently has a capacity of 166 mgd and serves more than 1 million people in 23 surrounding communities and a service area of more than 45 square miles. Treated effluent is discharged into the west fork of the Trinity River, a sensitive stream that during dry months may be composed of up to 95 percent treated effluent. VCWRF is a steward of the water environment and is committed to resource recovery by producing high-quality reuse water, energy from biogas, and Texas Class AB[1] biosolids that are land-applied on numerous sites around north Texas.

Energy Program Genesis: Summary of Motivators, Goals

Texas is a state that knows and understands energy, so it was intuitive in the early days of planning for initial construction and eventual expansions of the VCWRF to include energy efficiency as part of the designs. From the early 1960s through the 1970s, the facility expanded to 96 mgd, bringing with it more digesters, a methane gas sphere, and an engine-generator and heat exchanger to heat the digesters. Subsequent facility expansions to 147 mgd included the replacement of smaller generators and blowers with larger systems and additional digesters, bringing the total to 14. With each plant expansion, the concept of using biogas for the production of heat and electricity remained a design focus.

Figure 1. Aging engines (photo on the left) were replaced in the late 1990s by new turbine-generators (photo on the right).

The City decided in the late 1990s to replace aging reciprocating engines with two 5.2 MW turbine-generators fired by digester gas and landfill gas as air regulations became more stringent. In 2010, an exhaust heat recovery steam

[1] The Texas Commission on Environmental Quality (TCEQ) has rewritten its biosolids rules to create the new biosolids classification "AB," which is the equivalent to the federal 503 Regulations for Class A. Class A in Texas now requires additional processing after dewatering from either drying or composting.

generator (HRSG) was added to the gas turbine system. The steam is used to drive two blowers, displacing two 1,000-horsepower electric motor drives.

The City's comprehensive effort was ramped up with the passage of Texas Senate Bill (SB) 12 as political subdivisions in 41 designated counties had to implement cost-effective energy efficiency measures and report efforts and progress to the State Energy Conservation Office (SECO). This legislation led to a goal to reduce electricity consumption by 5 percent each year for the next 6 years, beginning in September 2007.

Energy Approach

The City's approach for the energy program included the development of an energy management team for VCWRF, and the alignment of vision/goals/objectives with the City's overarching energy mission. The VCWRF has embraced continual improvement across all of the organization's activities – from capital improvements planning and strategy, environmental management system (EMS) for biosolids, to energy road mapping and implementation. With the City under the provisions of SB 12 to reduce energy, Sam Steele, Administrator of Sustainability for the City of Fort Worth, saw a significant opportunity with the VCWRF to reduce energy and meet the legislative goals. To ensure alignment with City goals, an energy cross-functional team was established, consisting of Fort Worth staff members, outside consultants, and an energy services company (ESCO), to drive and track energy efficiency progress and implementation.

In 2002, the City competitively selected Johnson Controls, Inc. (JCI) as its ESCO. Subsequently, the City entered into an energy savings performance contract (ESPC) with JCI to reduce facility energy and water resource consumption and to provide guaranteed cost savings from these reductions to the City.

Representative Energy Projects

With the improvements made as part of the JCI contract, the VCWRF is well on its way to becoming energy net-zero through the several energy efficiency and production projects listed below:

- Process efficiency achievements:
  - Replacement of ceramic air diffusers with more efficient Teflon-coated membrane diffusers
  - Reduction of air demands in the anoxic zone of the aeration basins
  - Optimization of dissolved oxygen air supply through distributed controls
  - Modifications to heating, ventilation, and air conditioning (HVAC) and lighting
  - Replacement of supervisory control and data acquisition (SCADA) control
- Other energy recovery and controls:
  - Co-digestion: Facility designed to accept biodegradable high-strength waste (HSW) to increase gas production.
  - Anaerobic digestion linear mixing: Six of the fourteen 1.2-million-gallon (MG) anaerobic digesters were retrofitted with linear mixers to allow improved volatile solids destruction to produce more methane gas. Gas production in these six digesters has doubled.
  - Gas turbine generators: Two 5.2 MW low-BTU methane gas turbine generators were installed in 2000.
  - Heat recovery gas system: Waste heat from the existing turbine-engines is captured and high pressure steam is produced for use in steam-driven air blowers. Two old electrical blowers were retrofitted with a direct drive from steam turbines to provide up to 31,000 standard cubic feet per minute (scfm) of air to aeration basins.

Before the ESPC, methane gas generated from 14 anaerobic digesters and purchased from a municipal landfill approximately 3 miles to the north was used to power the turbine-generators. Electricity generated from these turbines provided as much as 50 percent of the power required to operate the facility; approximately 90 percent was used to power the massive air blowers that provided air to the aeration basins. Unfortunately, during this period, not enough methane gas was generated to put both gas turbines on line simultaneously. The recently completed co-digestion construction projects are expected to allow both turbines to be operated, with the goal to be off the power grid by the end of 2015.

Energy Features: At a Glance

Size (utility total)	Average flow = 108.5 mgd Population = over 1 million, which includes the city of Fort Worth and 23 surrounding communities
Energy provider and current costs/incentives	Cavallo Energy Texas LLC, Texas State Power Program $0.069/kWh
Energy focus area	Additional combined heat and power (CHP) for anaerobic digestion biogas use and energy generation
Specific energy challenge	To create and maintain energy sustainability To be energy net-zero upon completion of specified projects To comply with Texas SB 12
Operational issues	Skill levels O&M procedures Compliance and energy process protocols
Implementation approach/methods	Guaranteed ESPC Energy cross-functional team
Energy efficiency outcomes	Gains and cost savings attributed to energy efficiency and generation
Measuring and reporting energy progress	Good data and confidence with data extracted from energy bills and ESPC documentation; auditable measurement and verification (M&V) contract

What Barriers Were Encountered?

Since the early 1990s, the City and VCWRF have worked together to reduce energy and meet energy reduction goals. Over time, several barriers were encountered and strategies were developed, predominantly in the project phases of *approval, funding, and procurement*. The approval process included getting the right people in the room to provide insight and understanding into the ESPC type projects. This information had to be presented in a way that demonstrated the major beneficial impact from energy savings to the City. Several stages are required for City and Water Department approval: technical and financial review, VCWRF management review and support, Water Department management and approval, and approval by City upper management.

PROJECT PHASE(S) WHERE CONSTRAINTS ENCOUNTERED

- Identifying Opportunities
- Feasibility Study
- **Project Approval**
- Capital Improvement Planning
- **Funding**
- Design Initiation
- **Procurement**
- Construction and Commissioning
- Continued Operations

Within all operational divisions of the Water Department, numerous projects compete for limited capital dollars available from a decreasing operating budget. When SB 12 passed, the VCWRF represented almost 50 percent of the City's electrical expenditures for all departments. Thus, the City Energy Conservation Office viewed the VCWRF as a significant contribution (opportunity) to meet SB 12 energy reduction goals.

One of the major barriers to overcome was buy-in to the ESPC concept and the pessimism over how a third-party company could guarantee energy savings to pay for a project within a specified time frame, or be responsible for loan payments. It was considered "too good to be true"; there had to be a catch. Initial meetings with stakeholders would result in heated discussions related to paying an outside consultant for something that could be done in-house.

Using the lessons learned from successful past processes, in conjunction with new ideas and concepts, has been the key to being able to take on new projects while controlling risk. The VCWRF found that a champion was needed to promote and facilitate new concepts to saving energy. It was imperative that this individual be someone who was passionate about leading, moving forward, and achieving more as a group than any individual could. This person was not necessarily the project manager, but he/she needed to be in a position to solicit confidence in change.

Insight into the comprehensive needs of the VCWRF allowed some projects to be leveraged as part of the ESPC that would otherwise not have been constructed because of capital budgeting constraints. The innovative approach to ESPC

and the use of the municipal lease funding mechanism was able to address long-term capital needs that were already listed as part of the long-term Capital Improvement Plan (CIP), as well as releasing that CIP money to move up other projects that were needed.

Barriers and Strategies

Numerous projects compose the Resource Conservation Program for the City of Fort Worth. Below is a summary of project approvals and projections, including the Water Department and VCWRF projects listed previously.

Energy Conservation Program
Project Approvals & Projections

Resource Conservation Program	Project Approval		Project Projections		
	Mayor & Council Communication (M&C)		Construction Cost	First-Year Savings	Simple Payback
Project Name	Date	Ref. No.	$	$/Year	No. Years
ESPC Phase I	02-Sep-03	C-19739	$ 3,063,090	$ 397,247	7.7
ESPC Phase II	07-Feb-06	C-21289	$ 2,395,659	$ 342,854	7.0
ESPC Phase III	26-Sep-06	C-21737	$ 5,198,937	$ 711,324	7.3
LED Traffic Signals	17-Apr-07	C-22063	$ 1,959,678	$ 536,624	3.7
ESPC Phase IV	17-Jun-08	C-22868	$ 9,248,307	$ 944,814	9.8
ESPC Phase V, Sec.1	02-Feb-10	C-24070	$ 13,577,350	$ 949,275	14
ESPC Phase V, Sec.2	20-Jul-10	C-24360	$ 17,889,397	$ 1,643,221	11
ESPC Phase VI, Part A	17-Aug-10	C-24406	$ 1,815,526	$ 211,387	8.6
ESPC Phase VI, Part B	25-Jan-11	C-24718	$ 3,363,841	$ 173,793	19
Totals	FY01 - FY11	Various	$ 58,511,785	$ 5,910,539	9.9

Of the total projects approved, the project costs and benefits for VCWRF include:

- Total project cost: $35.0 million
- Total annual utility savings: $2.8 million
- Simple payback: 12.4 years

To achieve significant energy savings, Fort Worth required a new financing strategy. The introduction of ESPCs and funding projects with operational funds and cash reserves helped to make the affordability financial case for the implementation of projects. There were three funding mechanisms: cash fund, municipal lease, and grant funding. When asked about the change in energy strategy to overcome funding barriers, Andrew Cronberg, Assistant Director, said “the introduction of ESPC and funding the cost of the project(s) via operational funds and cash reserves made the project(s) affordable.”

Focus on Energy for the Future

The Fort Worth Water Department VCWRF has reduced energy purchased by an average of 75 percent since the implementation of the JCI ESPC facility improvements. Commissioning, operation, and maintenance of equipment not typically found in water reclamation facilities have elevated the expectations required for operators and mechanics. According to Ana Pena-Tijerina, Technical Services Manager, “we will continue to communicate future opportunities and current achievements, including periodic updates of energy reports so our employees will see and participate in continual improvement toward our goals.” Self-sustainability for the future is now the vision and the goal, to be energy independent as resources are safely returned to the environment. The JCI ESPC project has allowed the City of Fort Worth and the VCWRF to go above and beyond to meet the needs of the community now and well into the future.

Metro Wastewater Reclamation District, Colorado

Energy Efficiency Barriers and Solutions

Utility Overview

The Metro Wastewater Reclamation District (MWRD) provides wastewater services to approximately 1.7 million people in the Denver metropolitan area. The Robert W. Hite Treatment Facility (RWHTF) has an average daily flow of 140 million gallons per day (mgd) and consists of two distinct secondary plants: the South Secondary pure oxygen plant, and the North Secondary activated sludge plant. Solids are stabilized using acid-phase anaerobic digestion, utilizing biogas for on-site power generation.

Energy Program Genesis: Summary of Motivators

Over the last 20 years, energy management has been, and continues to be, a priority for sustainable practices at the RWHTF. MWRD has transitioned from MWRD-owned and -operated generators in the 1980s to contract-operated biogas-fired turbines today. As a wastewater utility-only business, staff are actively involved in daily activities affecting cogeneration and demand-reduction of power, and committed to continuous improvement across the organization.

Energy Approach, Goals

Energy efficiency is a critical factor inherent in technology selection and decision making (triple bottom line, financial evaluation), and optimization of existing treatment operations. MWRD's approach is "portfolio-based," meaning that decisions and operating procedures are based on proven energy-efficient measures supported by data rather than where a technology or process falls on the proven-emerging continuum. This approach helps to define and communicate energy savings and risks and how to balance or mitigate them.

Energy goals are focused on optimization of plant processes, and are prioritized according to available opportunities and the efficacy of those opportunities (i.e., portfolio-based). These goals are aligned with the organization's internally driven annual operations goals and in participation with the local electrical utility. Cogeneration projects and agreements are based on numerous sustainability plant goals and factors including financial benefits and risks, energy markets, and electrical tariffs. Process optimization and operations goals are established using pilot testing results, hands-on technology operations, and improved process control.

Energy Projects, Type

The following process efficiency projects are highlights of the MWRD energy program:

- **Advanced process control technology:** Process control to adjust the dissolved oxygen (DO) set points based on real-time influent loadings was evaluated and tested at the RWHTF (described below).
- **Contract-operated turbines and power consumed on site:** Power and heat are generated on site using two biogas-fired, 3.1 MW gas turbines to produce about 45 percent of the plant's electrical load. Contractor performance, electrical tariff issues, and contractor-utility responsibilities are clearly outlined in energy services agreements.

HIGHLIGHTS

Facility

Robert W. Hite Treatment Facility

Denver, CO

Contact

Steve Rogowski, Director of Operations and Maintenance
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Key Barriers

Financial/funding

Opportunistic approach

Success Strategies

Operations optimization

Energy services agreement

Power generation contract experience

Other

Technical Services Group acts as SWAT team to test and operate new technology

Energy Features: At a Glance

Size (utility total)	Average flow = 140 mgd Population = 1.7 million
Energy provider and current costs/incentives	Xcel Energy $0.75/kWh (2010 value)
Energy focus area	Advanced process control to enhance energy efficiency Additional combined heat and power (CHP) for anaerobic digestion biogas use and energy generation
Specific energy challenge	Identifying opportunities to provide cost-effective energy management
Operational issues	No major issues; leverage Technical Services Group to test new technology and optimize operations
Implementation approach/methods	In-house optimization and testing, Energy services agreements
Energy efficiency outcomes	Gains and cost savings attributed to energy efficiency and generation
Measuring and reporting energy progress	Conducts rigorous monthly reviews Strong understanding of utility billing

Energy Program Overview: Barriers and Strategies

In recent years, emphasis has been placed on tracking and reducing power consumption for wastewater treatment processes. This emphasis ranges from plant staff just being mindful of removing unnecessary treatment trains in service to the implementation of dynamic DO set point adjustments based on ammonia-based aeration control. To illustrate this intuitive, progressive approach, the North Secondary (NSEC) Energy Optimization Initiative was formed in 2010 to support operations staff in the identification and implementation of operational changes and technologies to reduce energy consumption.

Dynamic DO set point control has started to become popular as online instrumentation improves and energy costs increase. With more than 50 percent of the connected motor load associated with aeration, RWHTF operations staff make process decisions with aeration energy in mind. As part of the NSEC Energy Optimization Initiative, operators were actively involved in technology (BioChem) pilot testing to determine process performance and found that an average of 12 percent less air was used with advanced process control. The controller used a feed-forward control algorithm to provide the required DO set points to meet the variation in diurnal loadings. By lowering the DO within the aeration tanks, aeration energy savings can be realized. As DO levels drop, the oxygen transfer efficiency increases, requiring less airflow to meet the same oxygen demand.

PROJECT PHASE

- **Identifying Opportunities**
- Feasibility Study
- Project Approval
- Capital Improvement Planning
- **Funding**
- Design Initiation
- Procurement
- **Construction and Commissioning**
- Continued Operations

MWRD's Model User Group (MUG) also worked with consultants to conduct model simulations to determine potential aeration savings based on different DO set points. The simulations showed that feed-forward control was able to save 12 to 23 percent in aeration compared to current operating parameters with no negative effect on effluent quality. [2]

After 6 months, the pilot test results verified that dynamic DO control of the aeration systems based on feed-forward control would reduce the aeration demand while meeting treatment process requirements. "The estimated aeration savings during the pilot, as a direct result of reduced airflow requirements, is approximately $18,635. With a full

[2] 2013. Kestel, Gray et al., Energy Savings from Advanced Process Control: Two Case Studies, BioChem Technology.

installation of the control system, the estimated yearly savings is $134,026."[1] Based on these cost data and operations input, MWRD proceeded with full-scale installation of the control system.

This optimized mode of operation reduces the margin for error in the secondary system, so building operator confidence and buy-in was essential to the control upgrade. One innovative strategy employed by MWRD to build operator confidence was to train a specialized "SWAT Team" to respond to issues as they arose, especially during startup and initial operations. This specialized training provided career-building opportunities for the SWAT team and a "swagger" in their step because of their status as recognized specialists in this new technology. The overall operating community benefited from the assurance that these specialized staff were available to provide on-call troubleshooting support.

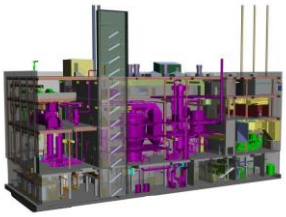
Because the advanced control system technology was new, there was uncertainty about the potential electrical savings. MWRD benefited from its ongoing process efficiency partnership with the local electrical utility, Xcel, in pursuing this project despite initial uncertainty and technology risk. Xcel provided financial support for the studies and capital costs associated with this project.

Focus on Energy for the Future

MWRD continues to focus on energy efficiency for existing operations as well as evaluating energy use for selecting and implementing new technologies and processes. This approach has been ingrained in the culture of MWRD for many years as evidenced by its energy savings and leveraging of energy services agreements. By making a strong case for energy efficiency – setting and communicating realistic goals and risks – plant professionals are able to show progress and success in achieving those goals with desired outcomes. "Have a strong storyline … don't overestimate promised savings and then have to eat those words, and ultimately lose trust with your stakeholders" is the advice that Steve Rogowski gives to others when evaluating and implementing energy efficiency projects.

NEW Water
Green Bay, Wisconsin

Energy Efficiency Barriers and Solutions



Utility Overview

NEW Water (formerly the Green Bay Metropolitan Sewerage District (GBMSD)) has a long history of innovation since its initial treatment facility was placed into operation in 1935. In response to more stringent federal clean water regulations promulgated in the 1970s, GBMSD identified the need to change from a trickling filter system to activated sludge for secondary treatment, becoming the first facility in the nation to simultaneously treat municipal and pulp mill wastewater. In the 1990s, additional aeration tanks and clarifiers and improved solids handling modifications were constructed, along with improved nutrient removal. NEW Water currently treats 30 mgd at the Green Bay Wastewater Resource Recovery Facility (WRRF).

In the 2000s, GMMSD acquired the 8 mgd De Pere WRRF, resulting in GBMSD becoming a regional collection and treatment system.

Recently, GBMSD branded itself NEW Water, reflecting the vision of wastewater utilities serving as resource managers, rather than disposers of waste – a philosophy presented in the NACWA Utility of the Future (UOTF) report. In pursuing this vision, NEW Water is addressing many environmental and aging infrastructure issues, with a focus on new solids handling systems and energy production.

HIGHLIGHTS

Facilities

Green Bay WRRF

De Pere WRRF

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Key Barriers

Budgetary constraints

Competing priorities

Long project payback

Success Strategies

Whole-plant efficiency

Life-cycle cost analysis to justify projects

Incremental operating changes

Energy Program Genesis: Summary of Motivators

In the early 2000s, responding to a confluence of rising crude oil prices and associated increases in natural gas (NG) costs and polymer costs, NEW Water began to look for opportunities to manage these rising costs, including reduction of its NG and electrical demand. In the interest of cost control, the utility also looked for NG purchasing agreement options and entered into electrical contracts that reduced its rate, provided a monthly credit, and helped it to manage cost and supply risks.

At this time, NEW Water also partnered with Wisconsin Focus on Energy, the state's energy efficiency and renewable energy program. Focus on Energy helped NEW Water identify and implement energy initiatives, and in turn NEW Water assisted Focus on Energy in the development of an energy best practice manual.

NEW Water also teamed up with a consultant to develop a strategic plan for sustainability. NEW Water strives to include sustainability in all decisions to protect the environment for future generations. In its effort to balance financial responsibility and environmental stewardship, NEW Water is constantly searching for ways to work smarter, more efficiently, and more cost-effectively.

Energy Approach, Goals

Electrical power and natural gas costs account for 10 percent of NEW Water's overall budget. NEW Water began its movement toward energy efficiency by identifying the organizational backing it would need to pursue energy efficiency, including the NEW Water Board of Commissioner's support, upper management support, development of an Energy Sustainability Committee, a partnership with the local energy utility, and encouragement to employees to provide ideas on energy efficiency.

NEW Water's Energy and Sustainability Team meets monthly to discuss current projects, future projects, energy grant opportunities, and incentives. This cross-functional team includes members of management, maintenance, operations, and engineering; a representative from the electrical power supplier; and a representative from Focus on Energy. The

committee also reviews ideas and opportunities for energy reduction. A key part of this discussion is a monthly review of the utility's energy bills. This is an opportunity for all members of the committee to review usage and trends, and see how changes in facility operation affect utility costs.

NEW Water has seen that these ongoing small contributions, when aggregated, result in notable improvements. As one example of the collaborative Energy and Sustainability Team process, the team demonstrated that plant effluent could be used for polymer make-down water instead of potable water with little adverse effect. This change resulted in a 25 percent reduction in city water usage.

The committee used WEF's "*Energy Roadmap*" manual as a "tool" to remind them that they were making the right decisions related to energy planning. Examples of "Roadmap" initiatives include:

- Communicating costs and efforts to reduce costs to upper management
- Encouraging employees to have energy reduction/cost savings performance goals

Energy Projects, Type

NEW Water management and staff have taken the initiative to identify and implement a number of process and energy efficiency modifications:

- **Interior and exterior lighting:** NEW Water has upgraded interior and exterior lights with more energy-efficient technology, including motion-sensing lighting in the maintenance garages and light-emitting diode (LED) lighting in other locations.
- **Upgraded HVAC in administration building:** NEW Water upgraded the administration building's HVAC system including new controls with setback capability and variable air volume control in most areas.
- **Installation of VFDs:** NEW Water continually reviews all of its process equipment to assess if constant-speed equipment can and should be modified to variable-speed drives (VFDs). Further, it reviews and assesses existing variable-speed drives to identify if current-technology VFDs would be more energy-efficient and potentially provide improved control. NEW Water has installed VFDs on all of its return activated sludge (RAS) pumps, resulting in reduced energy use and improving process control.
- **Anoxic mixers:** NEW Water replaced its conventional submersible anoxic contact tank mechanical mixers with hyperbolic mixer technology at both the Green Bay and De Pere WRRFs. This modification resulted in a notable energy use reduction with no impacts to the treatment process.
- **Solar panels:** NEW Water has installed solar panels at a remote flow monitoring and sampling station.
- **Direct load control of backup generators by local electrical utility:** NEW Water communicated with the local power company to identify a beneficial use of its standby generators during peak electric demands periods. This energy cost management action is providing $13,900 in cost savings per month.

NEW Water has also initiated a number of low- or no-cost operational modifications to improve energy efficiency, touching a variety of treatment processes. A few of these modifications are summarized below:

- **Backwash tertiary filters at night:** The backwashing process is electrically intensive. NEW Water staff programmed the backwashing of the tertiary filters at the De Pere WRRF to clean during electric off-peak demand times. The ability to manually override this programming or to backwash during high flows was also built into the programming.
- **Transfer wastewater between facilities:** The NEW Water collection system is able to transfer raw wastewater from the De Pere WRRF to the Green Bay WRRF. A cost/benefit analysis revealed that it is less expensive to treat the wastewater at Green Bay during the winter months than it was to treat it at De Pere. Conversely, during the summer months it is most cost-effective to treat locally at the De Pere WRRF.
- **Installed a new UV system with automatic cleaning system and controls:** NEW Water recently completed an ultraviolet (UV) system upgrade that resulted in a 50 percent reduction in electrical usage while improving disinfection.

Energy Features: At a Glance

Size	Average flow = 38 mgd (Green Bay and De Pere WRRFs) Population = 219,000
Energy provider and current costs/incentives	Wisconsin Public Service $0.0605/kWh
Current energy focus area	Maximizing energy production from solids processing (see R2E2 description, p. 4)
Specific energy challenges	Projects over $50,000 receive scrutiny from ratepayers Long return on investment (ROI) of some renewable energy projects makes project approval difficult
Operational issues	Difficulty implementing improvements like lighting retrofits with in-house staff due to lack of time and resources, resulting in higher implementation costs for contracted labor
Implementation approach/ methods	Traditional design and contracting procurement

What Barriers Were Encountered in Process Efficiency Initiatives?

NEW Water staff has encountered various challenges in implementing both O&M optimization changes and capital projects to reduce energy. The five most important challenges identified by NEW Water include:

1. Providing funding for initiatives and projects
2. Getting "buy-in" from all employees
3. Time for staff to follow up on and implement energy-saving initiatives
4. Having to effectively run processes to meet compliance while reducing energy use
5. Implementing "small" energy reduction projects that add up to "big" reductions; i.e., overcoming a reluctance to do the projects if they do not represent a lot of savings

Operations and Maintenance: Barriers and Strategies

The Barriers to Energy Efficiency survey data from eight NEW Water staff members provides some insight on attitudes toward barriers affecting optimizing O&M practices for energy efficiency:

- **Operations:** Similar to most national survey respondents, there is strong agreement among most NEW Water staff that the plant is operated conservatively to ensure compliance with National Pollutant Discharge Elimination System (NPDES) permits, although many indicated a willingness to try new and unproven operating strategies.
- **Maintenance:** Most NEW Water staff indicated that maintenance is done "periodically" instead of being scheduled to meet energy benchmarks. Operations and management appear to have divergent views of the role of maintenance practices on plant energy use. Most staff tended to agree with the statement that "there are other, more pressing needs for our limited maintenance time and dollars," while the director and process engineer strongly disagreed. Likewise, there is a division of opinion regarding whether management supports prioritizing maintenance activities that reduce energy.

NEW Water has made it a priority to educate all staff in the value derived from becoming energy-efficient. Operating staff have become the continuous eyes in the field to identify and try modifications to reduce energy use. NEW Water encourages this mindset by incorporating energy reduction ideas as a component of personnel performance reviews.

A key aspect of training and awareness is tracking energy use. Energy monitoring devices are provided on all motor control centers (MCCs) and are integrated into the supervisory control and data acquisition (SCADA) system. As an example of this approach, SCADA screenshots include a display of plant peak demand value and associated billing cost (Figure 1). The operators compare this peak demand value against actual plant demand. When plant electrical use approaches a new peak demand, the operators implement peak shaving by starting the onsite diesel generators to provide 3.2 MW of plant electricity. Operators also use this procedure when rotating the 2,500-horsepower (hp) aeration blowers into service to avoid setting a new peak.

The analysis and trending of the gathered energy data is a routine operations task. This tracking has been beneficial in providing operations personnel with insight on the real-time energy use per process and even energy use for individual pieces of process equipment, such as blowers. Monthly energy billing information is also available to all operating personnel so they understand the cost components of energy use.

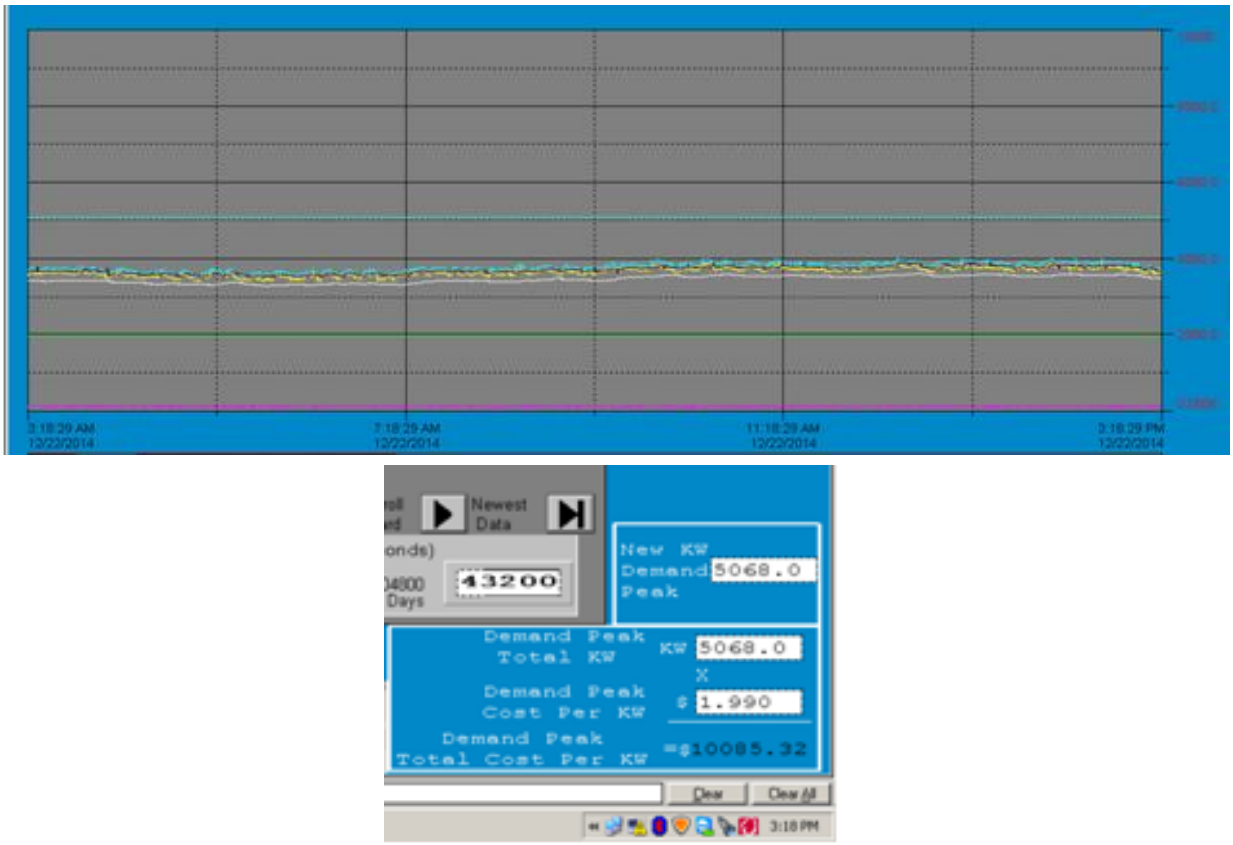

Figure 1. SCADA screens used to monitor plant energy use relative to peak demand

Focus on Energy for the Future

In summing up NEW Water's energy program, the operations manager notes, "Energy reduction goals and strategies can be complicated or easy to understand. We start out easy. Inform those that run the processes of the cost associated with the operating the equipment. Give them the information and challenge them to reduce energy costs where they see opportunities. It begins to grow from that point as the employees begin to see opportunities, come up with ideas, and observe the results."

Looking forward, NEW Water is currently designing a new solids handling complex to address the utility's pressing concerns with aging multiple-hearth incineration infrastructure, stricter air emissions standards, and insufficient processing capacity. The project is a Resource Recovery and Electrical Energy generation system known as the R2E2 project. This system handles all Green Bay WRRF solids, with a first stage of anaerobic digestion and a second stage of fluid bed incineration in order to maximize overall energy production. The main components of the project are:

- Anaerobic digesters for primary and secondary solids
- Supplemental high-strength waste feed for increased biogas production
- Biogas-fired engine-generators for electrical energy generation and facility heating
- Centrifuge dewatering
- Dryers to further increase the concentration of the digested solids as needed for autogenous combustion.
- Fluid-bed incineration with hot oil heat recovery for drying and other site heating requirements
- Nutrient recovery via struvite precipitation

The project, which is expected to start during the last quarter of 2017, will ultimately reduce overall energy costs for the utility by approximately 50 percent, while reducing natural gas use for incineration by 90 percent.

Department of Environmental Protection, New York City

Energy Efficiency Barriers and Solutions

Utility Overview

The New York City Department of Environmental Protection (DEP) manages New York City's water supply, providing more than one billion gallons of water each day to more than nine million residents, including eight million in New York City. The water is delivered from a watershed that extends more than 125 miles from the city, comprising 19 reservoirs and three controlled lakes. Approximately 7,000 miles of water mains, tunnels and aqueducts bring water to homes and businesses throughout the five boroughs, and 7,500 miles of sewer lines and 96 pump stations take wastewater to one of the largest wastewater utility systems in the country, with 14 facilities treating approximately 1.2 billion gallons per day. These facilities range in size from 40 mgd to 310 mgd. Six of the facilities have been upgraded over the past 10 years to provide nitrogen removal and more are expected to be upgraded within the next ten years.

All NYCDEP solids are stabilized via anaerobic digestion. Solids dewatering is consolidated at 6 of the 14 treatment facilities.

Energy Program Genesis: Summary of Motivators

DEP's current energy focus is part of a citywide initiative known as PlaNYC, which was initiated in 2006 and greatly expanded upon in 2014to create a blueprint for sustainability. The PlaNYC framework promotes, among other things, reductions in the carbon footprint of City operations and cost-effective clean energy projects. DEP is a significant contributor to the achieving PlaNYC goal; it is third largest municipal user of energy in the City.

Energy Approach, Goals

PlaNYC set a goal of reducing citywide greenhouse gas (GHG) emissions from 2005 levels by 30 percent by 2030. To further this goal, the plan envisioned that City agencies would lead by example, accelerating their own progress to meet the 30% GHG reduction goal by 2017. In 2014, these goals were expanded in *One City Built to Last,* to reduce emissions from 2005 levels by 80 percent by 2050 citywide, and by 35 percent by 2025 for City agencies.

DEP GHG reductions are attributable to a myriad of initiatives including: a lower carbon intensity of purchased power (due to the changing mix of grid power generation sources); improvements in fleet operations; reductions in methane emissions from landfills; elimination of residual fuel oils and increased reliance on natural gas and renewable energy; improvements to the state of good repair; reductions in nitrous oxide; and efficiency improvements. Improved energy efficiency, renewable power generation, and reduction in fugitive emissions will be central to meeting DEP's GHG emissions goals.

PlaNYC also established a goal of beneficially using 60 percent of digester biogas output by 2017. DEP is nearing this goal and expects to beneficially use 58 percent by 2017.

In order to make tangible progress toward the PlaNYC goals and maintain focus on reducing annual energy costs, DEP created a centralized Energy Office that is responsible for:

HIGHLIGHTS

Facilities

Bowery Bay, Queens
Hunts Point, Bronx
Tallman Island, Queens
Wards Island, Bronx
Newtown Creek, Brooklyn
North River, Manhattan
Oakwood Beach, Staten Island
Port Richmond, Staten Island
Red Hook, Brooklyn
26th Ward, Brooklyn
Coney Island, Brooklyn
Jamaica, Queens
Owls Head, Brooklyn
Rockaway, Queens

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Key Barriers

Competing priorities
Large organization
Unanticipated project costs
New technology risks
Energy data
Lack of staff resources

Success Strategies

Integrating energy efficiency into capital projects process
Rewarding plants for energy savings

- Elevating the importance of and increasing focus on energy and GHG management
- Enabling centralized coordination of energy programs, ideas, and projects
- Centralized tracking and reporting of energy use
- Application of uniform energy policies across the complex organizational structure of DEP
- Energy billing review and identification of opportunities to reduce billed costs

Energy Projects, Type

DEP uses several approaches and funding sources to implement energy projects and has received more than $98 M in grant funding. As an example, the energy efficiency projects listed below were funded by the City's "Accelerated Conservation and Efficiency" (ACE) program. The ACE-funded projects are expected to reduce total electricity use at the four affected plants by about 6 percent.

- **High-speed turbo blowers:** A multi-stage centrifugal blower at the Bowery Bay plant will be replaced with a high-speed, low-horsepower blower.
- **Lighting Upgrade**: A plant-wide lighting upgrade with LEDs at Oakwood Beach WWTP is underway.
- **Improve Digester Mixing**: Installation of digester mixing pumps at Owls Head WWTP to maximize volatile solids destruction and increase digester gas production. The increased digester gas will be beneficially used on-site to offset the purchase of natural gas and/or used in the plant's electric generators.
- **Improve Performance of Primary Sedimentation Tanks**: Installation of new low power mixers in the influent channel at the Wards Island WWTP will keep solids in suspension and improve the hydraulic distribution throughout the influent channel. This new system will replace the existing diffused air mixing system.

As noted previously, NYCDEP has also made increased biogas utilization part of its energy goal. Examples of recent biogas projects include:

- **Cogeneration:** 12 MW of new dual-fuel (natural gas and digester gas) engine-generator equipment at the North River plant will replace 10 outdated direct-drive engines. The improved efficiency of the new equipment is expected to almost double the plant's beneficial use of biogas. Combined with the natural gas supplement, the system will provide enough capacity to meet 90 percent of the plant's base load electrical demand and peak heat demand.
- **Renewable gas:** The Newtown Creek plant is partnering with National Grid to upgrade its biogas to pipeline quality. A pilot-scale food waste processing project in partnership with Waste Management is also being implemented to maximize biogas production in the Newtown Creek digesters and reduce GHG emissions associated with long-haul trucking, landfill emissions, and fossil-fuel generated natural gas.

In addition to the capital projects noted above, revisions are being made to 16 standard operating procedures (SOPs) intended to reduce energy use in aeration systems, digesters, boilers, HVAC and main sewage pump systems were implemented in 2014 as part of the "OpX" program.

Energy Features: At a Glance

Size (utility total)	14 facilities, 1,200 mgd total Population = 8 million
Energy provider and current costs	Long Island Power Authority (LIPA) operated by PSEG, New York Power Authority (NYPA) and Consolidated Edison of New York (ConEd) $0.11/kWh (blended rate)
Focus areas	Improvement to the solids handling train to increase gas capture, production and beneficial use as a combined heat and power source to lower emissions and increase resiliency. Integration of energy efficiency into all expense and capital project planning and design projects.
Specific challenges	Managing numerous energy initiatives at several plants. Limited funding/competing funding needs with state of good repair projects.
Operational issues	Complex organizational structure, competing staff priorities, obtaining staff buy-in, staff skill sets

Expected Outcomes	Elimination of methane leaks 100% beneficial use of digester gas by 2025 30% reduction of GHG emissions from a FY 2006 baseline by 2017 35% reduction of GHG emissions from a FY 2006 baseline by 2025 80% reduction of GHG emissions from a FY 2006 baseline by 2050
Measuring and reporting energy progress	Recent implementation of monthly Commissioner-level reporting of individual plant energy usage is increasing the upper management visibility of the energy program

Energy-efficient Capital Project Planning and Design: Barriers and Strategies

The DEP has encountered several challenges since the inception of its Energy Office, including barriers and challenges related to cultural and organizational priorities and constraints, funding, regulatory risk management, data collection/analysis, and procurement. A few examples of these barriers include:

- Organizational concern that energy projects divert resources from State of Good Repair (SOGR) projects
- Unanticipated upstream and downstream modifications for energy efficiency projects and methane capture projects, which often mushroom upfront costs and dilute payback and $/MT CO_2 avoided metrics
- Uncertainty in project savings
- Energy data coming from disparate sources, in different formats, and with long lag times, hindering data analysis and reporting for day-to-day energy management; ability to ask the right questions and develop appropriate policies; and capacity to build robust business cases to justify investments
- Management fear that failure of new/different technology/processes will result in plant upsets and subject DEP to regulatory risk and/or community complaints, as was the case with odor releases from a past acid-gas phased digestion project

In order to address these and other challenges, DEP has taken steps to improve accountability, cultivate organizational allies, and improve communications. One specific focus has been modifying the capital projects process to include energy considerations.

Collaboration, Planning and Accountability

In order to support goal setting in a formal process, the DEP published a strategic plan that includes carbon and energy management goals (StratPlan 11-14). Staff have found that this written plan helps implementation and minimizes backsliding. Because the strategic plan was developed with significant input from throughout the organization, the plan has fostered a sense of accountability.

The DEP StratPlan: http://www.nyc.gov/html/dep/pdf/strategic_plan/dep_strategy_2011_sustainability.pdf

As a further means of increasing awareness of GHG emissions, energy use and costs (while potentially reducing energy billings), Energy Office liaisons have been imbedded within the major business units to investigate significant usage deviations and utility metering and billing errors.

Operating units are held accountable for progress toward energy performance goals by regular, site-specific energy reporting to the Commissioner (Figure 1).

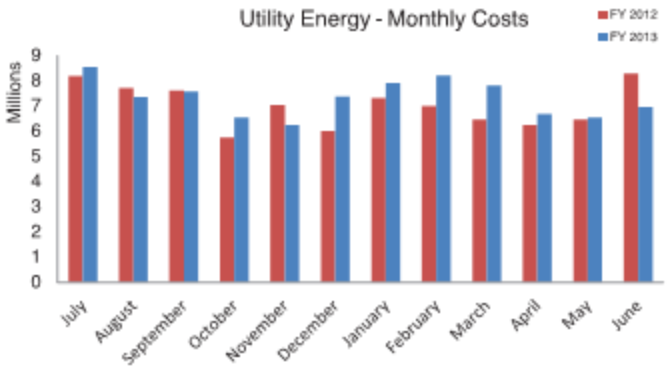

Figure 1. Sample energy dashboard for communicating energy performance

Cultivating Organizational Allies

Significant energy reduction progress requires innovation and changes to "business as usual" practices. Because change can create "angst" among various organizational factions, it has been important to cultivate organizational allies among upper management and all levels of plant staff.

Management support. Strong support for the Energy Office came from the former Chief Operating Officer and was critical for developing early momentum. Over time, buy-in has also grown from wastewater treatment directors. In an ideal world, energy conservation and/or recovery would be financially attractive and risk-free. In reality, financial and performance risks associated with energy initiatives require continued team management and communications to preserve and strengthen management support.

Competing Priorities. In order to address competing priorities between energy projects and SOGR projects, an Energy Grant Fund is being considered. Various business units could apply to this fund for GHG and energy management projects without needing to make tradeoffs from an SOGR perspective.

Plant-level support. At the plant level, a new "Energy Reinvestment Fund" program is being developed to recycle energy savings back into the plants. The first year savings would be returned to the plants for projects that have great value to plant staff and could include "quality of life" projects (e.g., new locker rooms or kitchens), additional GHG/energy management projects, or simply SOGR projects that may have a lower priority in the Capital Plan, but will make life easier for plant staff. This incentive is intended to increase buy-in for the energy program at the plant and operating staff level.

Going forward, DEP recognizes the need for continuing progress in employee empowerment; future priorities include providing more energy reports, advanced technologies to measure and manage energy use, and training so employees can make educated operating decisions that minimize GHG emissions and energy use.

Embedding Energy Efficiency in Capital Projects

Energy efficiency in all design projects. When people think of energy efficiency in capital projects, the emphasis is usually on projects whose specific focus is to reduce energy. However, almost any capital project can have an impact on energy use, either positive or negative. With this in mind, DEP recently established an Energy Design Policy stating that the Engineer of Record for **all** reconstruction, replacement, and new construction projects shall evaluate equipment, systems, design options, and operations with the goal to reduce energy consumption and GHG emissions.

Attention throughout the project process. The Energy Design Policy encourages projects to weave energy efficiency into the entire capital project process. This policy encourages design alternatives that contribute to DEP's energy and GHG reduction goals, in addition to meeting other traditional criteria such as reliability, ease of operations, maintainability, and life-cycle costs. The following example policy components illustrate the comprehensive nature of the approach:

- Requiring that design engineer selection includes energy and GHG management experience and qualifications
- Incorporating energy and GHG benchmarking and energy efficiency commissioning activities into engineering scopes

- Mandating energy reporting in conjunction with 30, 60, 90, and 100 percent design submittals, including anticipated energy consumption and GHG reduction estimates, both for the project as a whole and for alternatives evaluations
- Standardized formats for energy calculations and reporting
- Controlling changes during construction that could negatively affect energy benchmarks as established in the "Final Selected Design"
- Incorporation of energy management into O&M manuals and training programs

Sustainable design practices. As part of the capital project design process, holistic, sustainable design practices that include and transcend mechanical efficiency are encouraged. Examples include:

- Optimizing the layout of facilities to reduce heating, cooling, and lighting demands
- Maximizing digester gas production and usage while eliminating fugitive emissions
- Incorporating control and operational strategies that save energy
- Identifying opportunities for energy source conversion (e.g., heat recovery)

All project alternative comparisons are required to include a comparison of energy use and GHG emissions. An "Energy Profile Report" is used to quantify and track the energy and GHG impact of each project, with updates submitted as the design progresses to completion.

Energy considerations incorporated into design guidelines. Energy efficiency design guidelines have also been added to existing design guidelines for major equipment such as motor starters, digester gas handling systems, and main sewage pump systems.

Considering procurement alternatives. One method used to implement energy and GHG reduction projects that are subject to procurement issues is to use an innovative bid process. The "best value" approach looks at all bidders within a predetermined percentage of the lowest bid (10 percent by default) and then uses project-specific best-value criteria to select the successful bidder. This process was used for the first time with the selection of engine-generators for the North River WWTP Electrification and Cogeneration Project.

Focus on Energy for the Future

Aeration accounts for approximately 50 percent of the energy use consumed in treating wastewater, and DEP foresees tremendous opportunities for future improvement in this area. DEP has been piloting the use of anaerobic bacteria for short circuit nitrogen removal in sidestream treatment, which has the potential to cut energy use associated with secondary treatment by 10 percent or more. DEP is now ready to move to full scale implementation. Looking beyond sidestream treatment, DEP intends to build on the early work that WERF and HRSD have begun in adapting this process change to mainstream nitrogen treatment.

The future of DEP's GHG and energy conservation efforts will be significantly challenged by increased environmental regulations such as reducing runoff from combined sewer overflows (CSOs) and continued efforts to increase nitrogen removal – all energy-intensive processes. For example, the DEP has built four water detention facilities with underground tanks and pipes that have a total capacity to store over 118 million gallons to prevent CSOs. This water is detained during storms and then must be pumped to the wastewater treatment plants rather than relying on gravity. DEP continues to seek ways to mitigate these energy-intensive processes such as a green infrastructure program to divert about 900 million gallons per year from the sewer system, decreasing the energy needed to store, pump, and treat wet weather flow.

City of St. Petersburg, Florida

Energy Efficiency Barriers and Solutions

Utility Overview

The City of St. Petersburg owns and operates three water reclamation facilities (WRFs) in the metropolitan St. Petersburg area. The City provides wastewater collection and treatment to approximately 317,000 people in the region with a total average flow treated of 35 mgd. The City owns and operates the Northeast, Northwest, and Southwest WRFs, which treat an average of 8.4 mgd, 10 mgd, and 10 mgd of wastewater, respectively. The WRFs use complete-mix activated sludge, filtration, and disinfection with sodium hypochlorite to treat influent wastewater. The City also operates the Albert Whitted WRF, but plans to transfer this 6 mgd flow to the Southwest WRF for treatment.

Effluent is reused in the community and any excess flows are discharged to deep injection wells; the facilities do not discharge effluent to any surface waters.

Biosolids handling at the WRFs currently consists of gravity belt thickening of waste-activated sludge (WAS), mesophilic anaerobic digestion, and dewatering using screw presses to meet Class B biosolids standards. Biogas is currently flared. Aging solids handling systems have created an opportunity for the City to pursue the Biosolids to Energy project, an innovative system-wide approach that maximizes the energy and economic value of the biosolids and other available energy sources.

Energy Program Genesis: Summary of Motivators

St. Petersburg is Florida's first "Green City," and its city council and mayor are committed to sustainable operation and ongoing improvement. Furthermore, they have found that "being green" can often also "save green" and that the operational savings creates a resiliency of its own.

Energy Approach, Goals

In early 2014, the City appointed a director of sustainability and green initiatives. The director has been the main driver behind the Biosolids to Energy project and the new renewable compressed natural gas (rCNG) program.

While the City has not established specific numerical energy reduction goals, the current biosolids project builds on previous energy initiatives to reduce energy use in the City's activated sludge systems.

Energy Projects

A number of approaches have been used that have resulted in (or are in progress by the City for) improved energy efficiency. Some of the most significant are described below.

HIGHLIGHTS

Facilities

Northeast WRF

Northwest WRF

Southwest WRF

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Key Barriers

Financial/funding

Lack of staff resources

Success Strategies

Multiple revenue sources

Grant funding for new technology

Technology review

Other

Low Energy Demand Aeration Process. The City has adopted a very-low-dissolved-oxygen aeration-basin operational strategy at all of its plants, consisting of the following components:

- **High-efficiency aeration retrofits:** All of St. Petersburg's WRFs originally had mechanical aerators. These have been systematically replaced with high-speed "turbo" blowers, fine-bubble diffuser aeration, and dissolved-oxygen- or oxidation-reduction-potential (ORP)-based control systems.
- **SRT optimization:** Because plant effluent is either reused or deep-well injected, none of the plants are required to nitrify. Plant staff have found that they can run their carbonaceous activated sludge systems at 4–5-day solids retention times (SRTs) and maintain less than 1.0 dissolved oxygen levels to use considerably less power.

Integrated Class A Solids Handling Upgrades and rCNG Upgrades. The second-largest capital project in City history involves consolidating utility-wide solids handling at the Southwest WRF and adding the following energy-saving or energy-leveraging features:

- **Primary clarifiers:** Addition of primary clarification will not only capture highly digestible Northeast and Northwest WRF primary solids upstream of the Southwest WRF, but it will also reduce the energy required to treat the raw sewage via the secondary process. The clarifiers will be equipped with flocculating features and the ability to add iron salts and polymer to improve solids and organics capture and further reduce power demand.
- **TPAD digestion:** Temperature-phased anaerobic digestion (TPAD) will produce biosolids for beneficial reuse by increasing pathogen destruction through operation at higher digester temperatures. This process also improves volatile solids destruction over the existing mesophilic system – producing more biogas and less biosolids.by improving volatile solids destruction.
- **FOG receiving:** Addition of fats, oils, and grease (FOG) receiving will allow imported feedstocks to further increase biogas production.
- **Renewable CNG:** All of the produced biogas will be upgraded to rCNG quality for use in the City's CNG-fueled sanitation-collection trucks; the equivalent of 1,700 gallons of diesel will be produced each day. The fuel will be certified as a renewable vehicle fuel and the Renewable Identification Numbers (RINs) will be sold to enhance the return on investment. A new, dedicated CNG pipeline will convey the produced rCNG to the sanitation fleet fueling grounds.
- **CHP:** New natural-gas-fired combined heat and power (CHP) engines will be installed and sized for 100 percent of plant capacity. The City plans to base load the engines at 90 percent of plant load and then trim the plant demand with Duke Energy. The engine heat will be recovered and used to heat the TPAD process. If desired, the engines can be supplied with biogas as a renewable fuel if fuel market conditions or plant energy objectives change.

Energy Features: At a Glance

Size (utility total)	Average flow = 35 mgd Population = 317,000
Energy provider and current costs	Duke Power $0.17/kWh, 9 hours per day on work days and $0.07/kWh for the balance of power consumed
Specific energy challenge	Need to upgrade to a Class A biosolids program, desire to reduce carbon emission reductions
Energy focus area	Highest-value use of biogas is vehicle fuel; CHP with natural gas fuel was an attractive way to power the plant and heat the thermophilic digesters
Implementation approach	Pre-negotiation of system costs for the sole-source gas upgrading system and use of a Construction Manager at Risk for the construction contract
Energy efficiency outcomes	The biosolids project will stabilize City fleet fuel costs and reduce the City's 20-year present worth of operation by over $40 million

Project Phase Barriers

- Identifying opportunities
- Feasibility study
- Project Approval
- Capital improvement planning
- Funding
- Design initiation
- Procurement
- Construction and commissioning

Biosolids to Energy Project: Barriers and Strategies

Feasibility Study

Because the technology used to support the vehicle fueling operation is somewhat new to the marketplace, limited industry precedent is available to estimate project costs. In addition, as the project proceeded from the initial alternatives evaluation to final concept, the level of project definition increased. During this process the projected construction costs escalated, creating challenges for project financial feasibility, project approval, and funding. In order to address escalating project costs the project was temporarily paused at 60 percent design completion while a Construction Manager at Risk was procured so that cost could be "locked in" at an earlier than normal stage.

Technical Maturity

Several aspects of the rCNG process are relatively new to the market, especially the wastewater industry, including the devices used to upgrade the biogas to separate the carbon dioxide fraction, compressors to raise the biogas pressure to 3,500 to 4,000 pounds per square inch (psi), storage vessels, and rCNG dispensing equipment.

The design team evaluated numerous gas cleaning technologies and shortlisted two that seemed most appropriate for our project. The team addressed concerns about technical maturity by visiting operating installations, including a water scrubbing system at Fair Oaks Farms in Fair Oaks, Indiana, and a molecular gate gas cleaning system at the San Antonio Water Systems wastewater treatment plant.

On the usage side, the CNG engines represent a significant change in technology relative to traditional diesel engines used for garbage collection vehicles, but the City had already decided to convert the fleet to CNG—now the gas supplied will be produced at the WRF and be renewable.

Funding and Financial Viability

The project was identified and enhanced through an iterative review of the present worth of more than 25 varied options. Savings were identified from:

- Reduced operational costs realized through consolidation of solids handling at one plant.
- Mutually beneficial fuel purchase agreements developed to govern the terms of the sanitation department's use of rCNG; the sanitation department will enjoy a stable fuel cost over the 20-year contract period, while the wastewater department obtains sufficient revenue to justify the investment.
- Federal funds to convert the City's sanitation trucks to operate on CNG.
- RIN sales are expected to defray a portion of the rCNG's operating costs because they have a current value of approximately $1 per diesel gallon equivalent. The RIN system is used to commoditize the "premium" associated with renewable fuels, for use by petroleum companies that are required to meet U.S. Environmental Protection Agency (EPA) renewable portfolio standards for transportation fuels.
- A congressionally directed $2.5 million Biosolids to Renewable Energy Assistance Agreement with the U.S. Department of Energy.

Focus on Energy for the Future

The City of St. Petersburg's current biosolids project will have a profoundly positive impact on the City's energy independence. In addition, the digestion complex will have the capability to process imported FOG waste, so the City looks forward to developing its imported waste program and reducing the environmental impact of this waste, which is currently landfilled.

Plans are under way to ensure that the new digestion and rCNG processes live up to their promise in terms of energy benefits. For example, the City plans to use a commissioning agent to ensure that all of the equipment is installed correctly and that it properly operates as a system to produce the specified biogas quality. Traditional operations and maintenance manuals will be used to train staff on the operation of the equipment and the various systems as a whole. For the gas cleaning and handling systems the City will contract directly with the manufacturers and/or others to provide additional training and instruction beyond the basic training provided by the Contractor.

City of Stevens Point, Wisconsin

Energy Efficiency Barriers and Solutions

Utility Overview

The City of Stevens Point (SP) operates a single wastewater resource recovery facility (WRRF), which provides wastewater services to approximately 27,500 residents and 10,000 college students in the City of Stevens Point and also serves the Village of Park Ridge.

The original SP-WRRF began operation in 1940, and some structures from the initial system are still in use today. The WRRF generally consists of raw sewage screw pumps, a mechanically cleaned bar screen, grit removal, primary clarification, activated sludge with enhanced biological phosphorus removal, secondary clarification, and ultraviolet (UV) disinfection. Solids are anaerobically digested and the biogas produced is beneficially used to generate electricity and heat. Co-digestion of high-strength waste has boosted the facility's biogas production. As a result, the facility was one of the first nationwide to produce sufficient electric power and heat to be nearly self-sustaining.

HIGHLIGHTS

Facility

Wastewater Treatment Facility

Stevens Point, Wisconsin

Contact

Chris Lefebvre,

Superintendent

CLeFebvre@stevenspoint.com

Key Barriers

Operator conservatism

Competing priorities

Successful Strategies

Whole-plant efficiency

Life-cycle cost analysis to justify projects

Incremental operating changes

Energy Program Genesis: Summary of Motivators

The SP-WRRF began its journey into energy efficiency in the early 2000s. The City was an early participant in "Wisconsin Focus on Energy" (Focus), the state's energy efficiency and renewable energy program. Focus developed an energy efficiency report for the facility, with the goal of reducing energy while still maintaining effluent quality compliance. SP-WRRF began quickly implementing some of the smaller low- or no-cost modifications and continued to move forward with additional energy efficiency projects because the SP-WRRF leadership was realizing the value in energy efficiency.

The SP-WRRF superintendent and chief wastewater operator were both responsible for identifying the value that energy efficiency could bring to their WRRF and motivating the staff to become aware of energy use. Both of these key staff members lobbied the City Council to approve funding for a variety of expenditures for energy efficiency and renewable-energy projects.

Energy Approach, Goals

Specific (numeric) energy reduction goals were not set by the SP-WRRF. Rather, the SP-WRRF moved to minimize the energy used by each unit process. This approach has proved to be successful because they continue to identify additional adjustments in set points or small modifications that result in energy use reduction.

The SP-WRRF aggressively pursued both energy efficiency and energy generation. Over time, the plant realized that by achieving sufficient energy use reduction it could become energy self-sustaining via an upgraded anaerobic digestion system, co-digestion, and a new 180 kW combined heat and power (CHP) system.

Energy Projects

SP-WRRF staff have taken the initiative to identify and implement a number of low- or no-cost energy efficiency modifications:

- **Optimized operation of WAS thickening:** SP-WRRF staff identified ways to optimize thickening, removing additional water from the digester feed. This initiative reduced digester heating needs and increased solids retention time, leading to further solids digestion, with concomitant benefits of increased biogas production and reduced quantities of digested solids.

- **On-peak demand control:** SP-WRRF staff reviewed and prioritized the various treatment processes to identify ones that could be interrupted without impacting their effluent limits. The control system was modified to allow the operator to either turn off or delay the start of a process to manage on-peak electric demand. For example, starting a second aeration blower or influent pump is now manual instead of automatic.
- **Operate mixed liquor channel aeration blower only during low flows:** This operational adjustment has been found to keep mixed liquor solids adequately in suspension.
- **Yard lighting placed on switches rather than photo-sensors:** This modification reduced the operating hours of the outside lighting system and eliminated the need for photo-sensors.
- **Process equipment and tanks idled when not needed for treatment purposes:** The superintendent and staff identified tanks and equipment, such as poorly-functioning Perth-type digester mixers, that could be idled to reduce energy consumption when not needed. Redundant equipment primary clarifier, secondary clarifier, and DAFT equipment are shut down when not needed.
- **Integrated biogas-fired boilers with building boiler heating loop:** Connecting the boiler hot water circulation system, including the with the building heating boiler hot water circulation system allowed heat generated from the CHP system to be used in additional facility buildings.

The SP-WRRF also installed a number of capital projects to improve energy efficiency, touching virtually every part of the treatment process. A few of these projects are summarized below:

- **Installed a new technology energy-efficient aeration blower:** The SP-WRRF had a scheduled project to replace an aging aeration blower. A screw blower was selected for the replacement because it was more efficient than other technologies at the same price. The screw blower was only the second one installed in the state of Wisconsin.
- **Retrofitted existing ceramic fine-bubble diffusers with flexible membrane diffusers:** The plant's existing diffusers, although fine-bubble, had aged and their transfer efficiency had reduced. The decision was made to retrofit the diffusers with flexible-membrane fine-bubble diffusers and to integrate dissolved oxygen (DO) control provisions because the flexible-membrane diffusers would allow reduction of their DO set points from 2 mg/L to 1 mg/L.
- **Installed a new UV system, automatic cleaning system and controls:** The SP-WRRF reviewed the projected energy reduction that could be achieved with newer UV technology. Even with the system being operated only seasonally, the plant decided that the energy savings were sufficient to justify a retrofit to the UV system.
- **Installed linear-motion mixers in the anaerobic digester:** The original Perth gas mixing system had deteriorated and was basically non-functional. A linear-motion mixer has been installed on one of the three digesters to provide energy-efficient mixing.
- **Installed new reduced-horsepower anoxic submersible mixers.** Using a technical suggestion from Focus, new low-horsepower submersible mixers were installed.

Energy Features: At a Glance

Size	Average flow = 2.7 mgd Population = 27,000 plus 10,000 college students
Energy provider and current costs	Wisconsin Public Service $0.075/kWh
Energy focus area	Energy efficiency through process improvements to reduce energy consumption while achieving and maintaining discharge permit compliance After achieving energy efficiency, CHP installation and co-digestion
Specific energy challenge	Initial operator and maintenance staff resistance to change
Operational issues	Maintaining co-digestion feedstock supplies
Implementation approach/ methods	Traditional procurement
Energy efficiency outcomes	Electrically energy neutral most months
Confidence grade	Good data and confidence with data extracted from energy bills

Whole-plant Energy Program: Barriers and Strategies

The SP-WRRF encountered barriers that are common in the wastewater industry: becoming energy efficient is not a code requirement, nor is it required to obtain funding or to meet effluent water quality permit requirements. The most significant resistance came from operations and maintenance personnel who resisted the change in operations because the plant had historically met its discharge requirements without any problems or challenges.

Operations and Maintenance

A particularly difficult operational modification to save energy was the decision to reduce the operating DO from 2 mg/L to 1.5 mg/L, or to 1 mg/L or even to 0.75 mg/L. To address this risk concern the SP-WRRF management proceeded to slowly reduce the DO level and continually monitor the other treatment processes for any adverse reaction. They worked through each energy efficiency modification in this trial-and-monitor mode so the risk factors were assessed as they moved forward. As the monitoring proved the success of the modifications, management was also building team "buy-in" because the operations staff and their concerns were incorporated into the program. The operations staff began to forward ideas on energy efficiency opportunities, which management assessed and addressed.

Capital Projects

The SP-WRRF implemented several capital projects to reduce energy. In general, the project approval and funding phases were the most difficult project phases.

- **Project Approval phase:** For capital projects, the most significant hurdle to implementing projects was encountered during the Project Approval phase. SP-WRRF staff focused on developing and presenting the financial benefit of each energy efficiency project pursued in order to obtain acceptance from the City Council. Each energy efficiency project that was proposed included a cost analysis that presented the total purchase, installation, and operating costs. These costs were then analyzed through a thorough life-cycle cost analysis that demonstrated that the lowest capital cost did not always correspond to the lowest operating cost. If the financial assessment did not result in an acceptable and plausible payback period, the funds were not approved.
- **Funding phase:** The management of the SP-WRRF strategized that full or partial funding was available through strategic use of repair and/or replacement fund accounts. Most WRRFs have operation, maintenance, repair, and replacement (OMR&R) accounts, which are intended to set aside funds available for the noted purposes. These funds could be strategically used by the SP-WRRF for projects that have been identified as needing repair/replacement, both due to being energy inefficient and reaching the end of their useful life.

PROJECT PHASE(S) WHERE CONSTRAINTS ENCOUNTERED

- Identifying opportunities
- Feasibility study
- **Project Approval**
- Capital improvement planning
- **Funding**
- Design initiation
- Procurement
- Construction and commissioning
- Continued operations

Focus on Energy for the Future

SP-WRRF is very confident in what it has accomplished and is positioned to maintain its energy-efficient operations and renewable energy beneficial use. However, SP-WRRF is also aware that energy efficiency and energy management is not a onetime initiative or single modification, and plant staff are continuously searching for additional opportunities to reduce energy use. The following additional modifications are currently in construction:

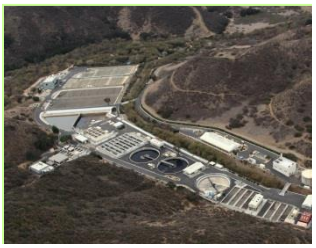
- An auxiliary feedstock receiving station
- A high strength waste force main to the anaerobic digesters to reduce transporting via trucking or through the sewer system

In addition, the following approaches are being considered for future implementation:

- Installation of additional biogas storage to improve biogas management with the goal to eliminate the flaring of biogas
- Review of developing cell lyses technology with the goal of improving sludge digestibility and/or increasing biogas production
- Possible redundant biogas conditioning system and second CHP unit
- Locating additional auxiliary feedstock suppliers

City of Thousand Oaks, California

Energy Efficiency Barriers and Solutions



Utility Overview

The City of Thousand Oaks owns and operates the Hill Canyon Wastewater Treatment Plant (HCTP), which provides treatment for about 90 percent of the city's 128,000 residents, treating an average 9 mgd of wastewater.

HCTP is an advanced tertiary wastewater treatment plant that includes screening, grit removal, primary clarification, activated sludge with nutrient removal, multimedia filtration, disinfection, and dechlorination. Plant solids are anaerobically digested with industrial high-strength wastes (HSW) and dewatered by a belt filter press.

Biogas produced from co-digestion is exported to a privately owned and operated combined heat and power (CHP) system owned by CHP Clean Energy. Electricity and heat are returned to the plant via a power purchase agreement (PPA). The plant controls its HSW feed with software developed by a local integrator to control gas production when dealing with a high degree of energy variability in the feedstock.

Thousand Oaks supplements its biogas electricity with a 500 kW onsite solar photovoltaic (PV) system, producing power during the peak hours of the day when electrical rates are highest. The plant manages its total monthly power generation output, with the goal of having the combined solar and biogas electrical production result in zero net electrical consumption.

HIGHLIGHTS

Facility

Hill Canyon Wastewater Treatment Plant (HCTP)

Contact

Chuck Rogers, Superintendent
cerogers@toaks.org

Key Barriers

Power purchase agreement (PPA) learning curve

Success Strategies

Use of specialty contractors (through PPAs) to provide energy generation services

Staff shared vision

Energy reduction goal-setting and communication

Energy Program Genesis: Summary of Motivators

For more than a decade, HCTP has focused on continuously making improvements that benefit not only the plant, but also the community. The biggest step to benefit the community was taken in 2010, when HCTP Superintendent Chuck Rogers met with the City Council and proposed a plan to achieve net-zero energy use.

HCTP leadership sees their net-zero initiative as the **right thing to do.** In other words, for the HCTP, energy is not always just about return on investment (ROI), in the same way that a new clarifier would not necessarily be required to show a positive ROI. HCTP has found its net-zero status to be a source of pride and community engagement, with numerous tour groups visiting from local schools, universities, environmental groups, and other wastewater utilities. In addition, electricity generated by the cogeneration plant is significantly cheaper than grid-supplied power.

Energy Approach

HCTP used a three-step approach (conservation, optimization, and energy generation) to achieving net-zero energy. HCTP staff found that opportunities to reduce energy use were numerous. Some required process optimization, some required simply turning off unnecessary equipment and processes, and some evolved along with new technology applications.

As the HCTP moved from optimization to generation, it chose to use PPA arrangements with solar and biogas cogeneration companies to implement the projects. This approach allows the HCTP to focus on its core competency areas in wastewater treatment, while retaining outside entities to provide the specialty construction and operations and maintenance support for the energy generation services. Both cogeneration and solar projects were commissioned in 2007. The land for the solar power equipment is leased to a third party that constructs and operates the system, obtains federal solar tax credits, and sells the solar power back to the HCTP at $0.168 per kWh.

Simultaneously, the biogas PPA was initiated using an RFP and evaluated bid process. The private biogas PPA contractor accepts metered biogas from the anaerobic digesters and sells power back to the plant for $0.072/kWh, a savings of $300,000 per year over purchasing power from the grid. Excess heat from the engines warms the digesters and a nearby administration building.

Energy Projects

A number of energy initiatives have contributed to the plant's net-zero plan. Some of the plant's larger energy projects include:

- **Cogeneration project:** The biogas-fired CHP system produces 550–600 kW of electricity. The system comprises two units, a 600 kW unit that runs continuously and a small engine that runs as needed based on feedstock availability.
- **Solar panels:** The 500 kW-rated solar PV system generates an average output of 130 kW (daytime solar production divided by 24-hours).
- **Co-digestion:** HCTP routinely achieves a 100–200 percent increase in biogas production with the addition of 15,000–30,000 gallons per day of fats, oils, and grease (FOG) and industrial HSW, which includes waste from coffee, biodiesel, yogurt, and beer production.
- **Seasonal air-drying biosolids:** HCTP reduces transportation and disposal costs by air-drying the biosolids when conditions allow and is currently evaluating alternative biosolids technologies to reduce costs and carbon footprint.
- **Anaerobic digester mixing:** Pumped digester mixing energy use was reduced with no deleterious effect by slowing the recirculating pump speed to reduce the tank turnover rate to 1.5 per hour.

Energy Features: At a Glance

Size (utility total)	Average flow = 9.5 mgd Population = 128,000
Energy provider and current costs	Southern California Edison: grid power $0.13 to $0.15/kWh PPA rates: solar $0.168/kWh and biogas CHP $0.072/kWh
Energy focus area	Conservation, optimization, and then renewable energy
Specific energy challenge	Identifying a business arrangement that moved renewable energy initiative forward effectively
Operational issues	Maintaining target biogas production with the supply of industrial high-strength wastes
Implementation approach	Power purchase agreements (PPA) Self-Generation Incentive Program (SGIP) through electrical utility (no longer available)
Energy efficiency outcome	Achieves net-zero energy status on a monthly average basis
Measuring and reporting energy progress	Energy production and consumption is constantly being monitored by all levels of staff to meet monthly net-zero targets

Path to Net Zero: Barriers and Strategies

The HCTP's path to net-zero energy status has involved overcoming barriers using strategic pursuit of process equipment optimization improvements, onsite power generation opportunities, and staff engagement.

Equipment Optimization

HCTP often uses a trial-and-error approach to achieve optimal operation, while keeping an eye on "ripple effects" in other parts of the operation. For example, HCTP incrementally lowered its digesters at turnover rates over a trial period of 6 months. HCTP found that it could operate at much lower than typical recommended rates and still get adequate mixing and biogas production. Optimizing digester mixing allowed HCTP to reduce electricity consumption without spending money on improvements.

Renewable Energy Generation via Power Purchase Agreement Contracting

The decision to explore and pursue a public-private partnership via the PPA allows the treatment plant staff to focus on the current plant's operation and assign the operation and maintenance of the two renewable energy sources to outside contractors.

The development of the initial PPA involved a learning curve because this type of contracting arrangement was new for the City. For example, the City used standard RFP language to assign benefits and responsibilities associated with solar incentive payments from the state. For the CHP project it was able to better refine expectations and issues. As the City learned, it was able to add relevant performance requirements to the PPA contractual language. Ultimately, the City's goal is to make sure that the partnership succeeds financially for both parties.

The HCTP also uses net metering to get full value for its energy generation. It generally operates off the grid during the day and exports some solar production, using net metering to bank the energy that it needs as it operates partially on the grid overnight. Staff has found that at this point, it is easy to either slightly over-produce or slightly under-produce electricity during any given utility billing period. Net metering also allows a zeroing of the bill through over-production during times of peak energy costs even if less than 100 percent of the actual electrical load is created for a given billing period.

Staff Engagement

HCTP staff engagement has been key to their success. The plant has adopted several of the "Organizational Culture" strategies documented in the WEF Energy Roadmap:

- **Having an individual that could be described as an "Energy Director, Advocate, or Champion."** Chuck Rogers' decision to challenge the organization with an audacious goal of becoming energy neutral has provided the spark to initiate and maintain HCTP's energy program.
- **Providing energy-related training to plant staff.** Plant staff discuss various aspects of plant energy use and generation on a daily basis. They take significant pride in their energy achievements. Staff members accept that energy is a priority, and ideas for improvement come from across the organization.
- **Creating employee performance plans that include energy program-related activities to support the wastewater utility's energy vision.** Specific job functions are critical to HCTP's energy program and these people have specific energy-related performance expectations. These job functions include control and instrument technicians, operations leaders, supervisors, and laboratory staff.
- **Creating a written, public policy regarding energy use and sustainability.** The net-zero goal approved by the City Council provided momentum and a shared vision for the net-zero energy program.

Focus on Energy for the Future

While the HCTP has met its goal of becoming net-zero, the City of Thousand Oaks and HCTP continue to work together to meet a citywide energy consumption reduction goal of 2 percent each year. HCTP is constantly making improvements to its process to increase the plant's efficiency. HCTP is working toward being able to supply excess electricity to the local community, using electric vehicles and other approaches to cost-effectively leverage its energy resources. According to Chuck Rogers, "There is always opportunity if we invest wisely. Utilities need to spend their money like it was their kid's money."

The plant's success with renewable energy PPAs is also being considered as a template to make progress toward a new initiative: "Transformational Biosolids." HCTP envisions using a public-private partnership to produce a biosolids product."

In the near future, the plant will transition to new leadership, but will continue their energy focus. With less than a year left before retirement, Rogers is optimistic, and bristling with ideas on how to save money and provide better service. "I have a great team here, and it will only get better when I'm gone. We have energy plans for the next 2 years that should reduce our electrical use by at least another 5 percent. I am very thankful for City leaders who make audacious goals for us and expect us to achieve them."

APPENDIX B

BARRIERS TO ENERGY EFFICIENCY SURVEY, ENERGY CAPITAL PROJECTS, AND "OTHER" ANSWERS FROM SURVEY

Section I: Demographic Information

Welcome! This survey has been developed for the Water Environment Research Foundation (WERF) project on "Identification of Barriers to Energy Efficiency and Resource Recovery and Solutions to Promote these Practices".

INSTRUCTIONS:

This survey will take approximately 20-25 minutes to complete. Questions marked with an asterisk (*) require a response. Your name, utility name, and specific location will remain confidential within the project team.

You may return to any question to modify your answer during the survey. Note that if you take a break, you can pick up where you left off. **If your survey is partially complete, your answers will be retained until you shut down your computer.** However, if you share a computer you will need to complete the survey in one sitting to avoid losing your work.

Please fill out this survey by Wednesday, August 13 (close of business). If you have any questions or problems, please contact Yinan Qi (yqi@brwncald.com, 206-749-2305) or Nancy Andrews (nandrews@brwncald.com, 651-468-2043).

Thank you very much for taking the time to help with this critical WERF research!

*1. Your Title:

Other (Please Specify)

*2. Contact Information

Name

Email Address

Phone Number

Section 1: Wastewater Plant Information

*3. Utility Name, State

Name

State/Province

*4. How many Wastewater Treatment Plants does your utility own/operate?

5. If you are affiliated with one specific plant, what is the Name of the Wastewater Treatment Plant?

***6. What is the total average annual flow of all Wastewater Plants your utility operates? If you are affiliated with one specific plant, select the flow that applies to your plant alone.**

- ◯ 0-1 mgd
- ◯ 1-5 mgd
- ◯ 6-100 mgd
- ◯ Greater than 100 mgd

Section I: Motivators

7. Please rate the importance of the following motivators at your utility to implement an energy project. (1 being highest importance and 3 being lowest important)

	1 (High Importance)	2	3 (Low Importance)
Utility management has established energy as a priority.	◯	◯	◯
Community interest in lowering carbon footprint.	◯	◯	◯
Federal or local regulations, policies.	◯	◯	◯
Providing leadership within our community with regards to sustainability.	◯	◯	◯
Operating cost reduction.	◯	◯	◯
Capacity or regulatory-driven capital projects provide opportunity to make energy efficiency upgrades	◯	◯	◯
Electric utility incentive programs.	◯	◯	◯
Grant funding availability.	◯	◯	◯
Neighboring or peer utilities have energy efficiency programs so we should	◯	◯	◯

Other (please specify)

Section III: Energy Efficiency Experience Profile - Capital Projects

This section will explore your experiences with implementing capital projects to reduce energy use.

8. Has your utility or plant made or considered any Capital Projects to reduce energy use? Examples may include liquid/solids process improvements such as high efficiency diffuser retrofits, building related improvements such as HVAC changes, or energy generation such as heat recovery from incineration or CHP.

- ◯ Yes
- ◯ No
- ◯ Considered but did not implement
- ◯ Implemented some capital projects, but others did not get off the ground

Section III: Energy Efficiency Experience Profile - Capital Projects

Have any of the following plant upgrades been implemented in the last 10 years or being implemented that would contribute to energy savings?

9. Liquid/Solids Process Capital Projects to Improve Energy Efficiency?

	Not Considered	In Progress	Completed	Considered but not pursued due to insufficient life cycle cost savings	Considered but not pursued due to other factors
Pumping optimization	◯	◯	◯	◯	◯
High efficiency blowers	◯	◯	◯	◯	◯
Diffusers retrofit to improve air transfer efficiency	◯	◯	◯	◯	◯
Low energy thickening/dewatering	◯	◯	◯	◯	◯
Energy efficient UV disinfection system	◯	◯	◯	◯	◯
Low energy mixing	◯	◯	◯	◯	◯
Other – Rate here and describe below	◯	◯	◯	◯	◯

Other

[ ]

10. Energy Generation Capital Projects to Improve Energy Efficiency and/or recovery.

	Not Considered	In Progress	Completed	Considered but not pursued due to insufficient life cycle cost savings	Considered but not pursued due to other factors
Biogas utilization (beyond boiler use)	◯	◯	◯	◯	◯
Codigestion	◯	◯	◯	◯	◯
Heat recovery from incineration	◯	◯	◯	◯	◯
Effluent heat recovery (heat pump)	◯	◯	◯	◯	◯
Wind/Solar	◯	◯	◯	◯	◯
Hydropower	◯	◯	◯	◯	◯
Other – Rate here and describe below	◯	◯	◯	◯	◯

Other

11. Building Related Capital Projects to Improve Energy Efficiency

	Not Considered	In Progress	Completed	Considered but not pursued due to insufficient life cycle cost savings	Considered but not pursued due to other factors
High efficiency lighting	◯	◯	◯	◯	◯
HVAC Improvements	◯	◯	◯	◯	◯
Reduced winter ventilation rates	◯	◯	◯	◯	◯
Other – Rate here and describe below	◯	◯	◯	◯	◯

Other

12. Outside the Fenceline Capital Projects to Improve Energy Efficiency

	Not Considered	In Progress	Completed	Considered but not pursued due to insufficient life cycle cost savings	Considered but not pursued due to other factors
Water conservation (or I/I reduction) to reduce pumping energy	◯	◯	◯	◯	◯
Adaptive management/nutrient trading - meeting nutrient or other regulatory goals with less energy	◯	◯	◯	◯	◯
Purchase of 3rd-party renewable energy	◯	◯	◯	◯	◯
Other – Rate here and describe below	◯	◯	◯	◯	◯

Other

Barriers and Strategies along the Project Path: Capital Projects

13. Capital projects for energy efficiency go through several project stages. Thinking of your projects that didn't get off the ground, which project phase is most likely to bog down or stop a project?

- ◯ Identifying Opportunities
- ◯ Feasibility Study
- ◯ Project Approval
- ◯ Capital Improvement Planning
- ◯ Funding
- ◯ Design Initiation
- ◯ Procurement
- ◯ Construction and Comissioning
- ◯ Continued Operations

Barriers and Strategies along the Project Path: Capital Projects

Thinking of projects that didn't get off the ground, please rate your degree of agreement with the following barriers and motivators to the implementation.

14. Identifying Opportunities Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Resources for energy audits and studies are limited.	○	○	○	○	○	○	○	○	○	○	○
Staff is familiar with strategies to reduce energy.	○	○	○	○	○	○	○	○	○	○	○
Staff is unfamiliar with recent technology advances that have made equipment more energy efficient.	○	○	○	○	○	○	○	○	○	○	○
Innovation and change create “angst”.	○	○	○	○	○	○	○	○	○	○	○
We have management support for identifying energy efficiency opportunities.	○	○	○	○	○	○	○	○	○	○	○

Barriers and Strategies along the Project Path: Capital Projects

Thinking of projects that didn't get off the ground, please rate your degree of agreement with the following barriers and motivators to the implementation.

15. Feasibility Study Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
There is too much uncertainty with projected savings.	○	○	○	○	○	○	○	○	○	○	○
We've done studies on energy project(s) but the financial viability is not adequate.	○	○	○	○	○	○	○	○	○	○	○
We trust third party independent reviews for energy efficiency feasibility studies.	○	○	○	○	○	○	○	○	○	○	○

Barriers and Strategies along the Project Path: Capital Projects

Thinking of energy projects that didn't get off the ground, please rate your degree of agreement with the following barriers and motivators to the implementation.

16. Project Approval Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Energy goals are clear regarding financial criteria for approval of energy efficiency projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We can get the decision makers support needed for this kind of project.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Our core business objective is to produce clean water and comply with our NPDES permit.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Our existing equipment works fine. We don't want to make any changes.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We are not able to sell a project that is not required by capacity, condition, or regulatory drivers.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Our wastewater utility was concerned that failure of new energy-efficient technology would result in plant upsets and subject our agency to notice of violations (NOVs) and/or community complaints (e.g. odor releasesfrom acid-gas phased digestion).	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Barriers and Strategies along the Project Path: Capital Projects

Thinking of energy projects that didn't get off the ground, please rate your degree of agreement with the following barriers and motivators to the implementation.

17. Capital Improvement Planning Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Our equipment has not reached its depreciation time so replacement cannot occur.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Our wastewater utility does not have an energy goal, so energy projects are not given priority in the CIP process.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Energy efficiency is considered sufficiently important relative to other capital improvements.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Barriers and Strategies along the Project Path: Capital Projects

Thinking of energy projects that didn't get off the ground, please rate your degree of agreement with the following barriers and motivators to the implementation.

18. Funding Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Grant funding contributed significantly to organizational buy-in for recent projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We don’t know what an energy servicescompany (ESCO) is and how they operate.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We can access financing that is more cost-effective than ESCO-financing.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We have repair and replacement (O, M, R&R) funding that can be used to support energy retrofit projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Barriers and Strategies along the Project Path: Capital Projects

Thinking of energy projects that didn't get off the ground, please rate your degree of agreement with the following barriers and motivators to the implementation.

19. Design Initiation Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Site-specific issues such as space limitations, noise, emissions affected the viability of our project.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We have guidelines and procedures in place to integrate energy efficiency features into capital projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Barriers and Strategies along the Project Path: Capital Projects

Thinking of energy projects that didn't get off the ground, please rate your degree of agreement with the following barriers and motivators to the implementation.

20. Procurement Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Normal design/bid/build is troublesome for innovative energy projects.	○	○	○	○	○	○	○	○	○	○	○
The procurement process is lengthy	○	○	○	○	○	○	○	○	○	○	○
Sole source criteria have a high bar	○	○	○	○	○	○	○	○	○	○	○

Barriers and Strategies along the Project Path: Capital Projects

Thinking of energy projects that didn't get off the ground, please rate your degree of agreement with the following barriers to the implementation.

21. Construction and Commissioning Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Our wastewater utility uses factory testing or on-site commissioning to confirm energy performance.	○	○	○	○	○	○	○	○	○	○	○

Barriers and Strategies along the Project Path: Capital Projects

Thinking of energy projects that didn't get off the ground, please rate your degree of agreement with the following barriers and motivators to the implementation.

22. Continued Operations Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Advanced control system and new equipment are too complicated to operate.	○	○	○	○	○	○	○	○	○	○	○
We use well trained staff to support operations to mitigate technical risk.	○	○	○	○	○	○	○	○	○	○	○

Barriers and Strategies along the Project Path: Capital Projects

For Capital Projects that were considered, **and were implemented**, where did you encounter barriers or success in the Project Lifecycle?

Indicate degree of agreement or disagreement with statements below (1-10 or not applicable).

23. Identifying Opportunities Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Resources for energy audits and studies are limited.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Staff is familiar with strategies to reduce energy.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Staff is unfamiliar with recent technology advances that have made equipment more energy efficient.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Innovation and change create “angst”.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

24. Feasibility Study Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
There is too much uncertainty with projected savings.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We've done studies on energy project(s) but the financial viability is not adequate.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We trust third party independent reviews for energy efficiency feasibility studies.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

25. Project Approval Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Energy goals are clear regarding financial criteria for approval of energy efficiency projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We can get the decision makers support needed for this kind of project.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Our core business objective is to produce clean water and comply with our NPDES permit.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Our existing equipment works fine. We don't want to make any changes.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We are not able to sell a project that is not required by capacity, condition, or regulatory drivers.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Our wastewater utility was concerned that failure of new/different technology/process will result in plant upsets and subject our agency to notice of violations (NOVs) and/or community complaints (e.g., odor releases from Acid-Gas phased digestion).	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

26. Capital Improvement Planning Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Our equipment has not reached its depreciation time so replacement cannot occur.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Our wastewater utility does not have an energy goal, so energy projects are not given priority in the CIP process.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Energy efficiency is considered sufficiently important relative to other capital improvements.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

27. Funding Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Grant funding contributed significantly to organizational buy-in for recent projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We don't know what an energy services company (ESCO) is and how they operate.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We can access financing that is more cost-effective than ESCO-financing.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We have repair and replacement (O, M, R&R) funding that can be used to support energy retrofit projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

28. Design Initiation Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Site-specific issues such as space limitations, noise, emissions affected the viability of our project.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We have guidelines and procedures in place to integrate energy efficiency features into capital projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

29. Procurement Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Normal design/bid/build is troublesome for innovative energy projects.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
The procurement process is lengthy.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Sole source criteria have a high bar.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

30. Contruction and Comissioning Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Our utility uses factory testing or on-site commissioning to confirm energy performance.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

31. Continued Operations Phase

	Strongly Disagree 1	2	3	4	5	6	7	8	9	Strongly Agree 10	Not Applicable
Advanced control system and new equipment are too complicated to operate.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We use well trained staff to support operations to mitigate technical risk.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Section III: Energy Efficiency Experience Profile - Maintenance Projects

This section considers your experiences with adopting maintenance practices that reduce energy.

32. Has your plant made maintenance improvements to increase energy efficiency such as increased pump maintenance or diffuser cleaning?

- ◯ Yes
- ◯ No
- ◯ Considered but did not implement
- ◯ Implemented some maintenance improvements, but other ideas did not get off the ground

Section III: Energy Efficiency Experience Profile - Maintenance Projects

Have any of the following plant upgrades been implemented in the last 10 years that would contribute to energy savings?

33. Maintenance to Improve Energy Efficiency?

	Not Considered	Maintenance Performed to Maintain Energy Benchmarks	Maintenance Performed Periodically	Considered but not implemented due to lack of financial viability	Considered but not implemented due to other factors
Regular diffuser cleaning	◯	◯	◯	◯	◯
Dissolved Oxygen probes and control components maintained for accurate Dissolved Oxygen control and blower savings	◯	◯	◯	◯	◯
Pump maintenance	◯	◯	◯	◯	◯
Other – Rate here and describe below	◯	◯	◯	◯	◯

Other

Section III: Energy Efficiency Experience Profile - Maintenance

34. Rate your degree of agreement with the following barriers and motivators to the implementation of maintenance practices to improve energy efficiency (e.g.diffuser cleaning).

	Strongly Agree 10	9	8	7	6	5	4	3	2	Strongly Disagree 1	Not Applicable
There are other, more pressing needs for our limited maintenance time and dollars.	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Energy rates are high enough to make this maintenance initiative cost-effective	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
We have pursued and obtained support from plant and maintenance management for prioritizing maintenance activities that reduce energy .	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
There is a lack of process engineering or other support to drive knowledgeable maintenance decisions (e.g. determining the diffuser cleaning frequency that is cost-effective based on energy savings).	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Section III: Energy Efficiency Experience Profile - Operations Projects

Has your utility made or considered any improvements in the following category to save energy?

35. Operational Improvements to Increase Energy Efficiency? (e.g. DO Optimization, Energy Monitoring)

- ◯ Yes
- ◯ No
- ◯ Considered but did not implement
- ◯ Implemented some operational improvements, but others did not get off the ground

Section III: Energy Efficiency Experience Profile - Operations Projects

Have any of the following plant upgrades been implemented in the last 10 years that would contribute to energy savings?

36. Operational Improvements to Improve Energy Efficiency?

	Not Considered	Operational change made to reduce energy consumption	Operational change not applicable or not technically feasible	Considered but not implemented due to lack of financial viability	Considered but not implemented due to other barriers
Dissolved Oxygen Optimization	◯	◯	◯	◯	◯
Chemically Enhanced Primary Treatment to reduce secondary treatment aeration demand	◯	◯	◯	◯	◯
Other secondary treatment changes (SRT, IMLR, seasonal nitrification)	◯	◯	◯	◯	◯
Energy monitoring to identify and improve equipment or processes with poor energy performance	◯	◯	◯	◯	◯
Digester operational optimization to maximize biogas or reduce energy use	◯	◯	◯	◯	◯
Other - Specify Below	◯	◯	◯	◯	◯

Other

Section III: Energy Efficiency Experience Profile - Operational Improvement...

37. Please rate your degree of agreement to the following barriers and motivators to the implementation operational energy projects (e.g. dissolved oxygen control optimization).

	Strongly Agree 10	9	8	7	6	5	4	3	2	Strongly Disagree 1	Not Applicable
We can get the decision makers support needed for this kind of project.	○	○	○	○	○	○	○	○	○	○	○
We operate conservatively to ensure that our NPDES permit limits are met.	○	○	○	○	○	○	○	○	○	○	○
We have sufficient "actionable" energy data collection and analysis dashboards to make timely decisions to reduce energy use.	○	○	○	○	○	○	○	○	○	○	○
Current energy-efficient technologies lack sufficient performance to ensure we can anticipate meeting regulatory requirements.	○	○	○	○	○	○	○	○	○	○	○
Our operators are trained and knowledgeable about operating decisions that affect energy use.	○	○	○	○	○	○	○	○	○	○	○
Operations staff take action when energy data indicate higher-than desirable energy use.	○	○	○	○	○	○	○	○	○	○	○
Relevant energy data are from disparate sources in different formats and have long lag times.	○	○	○	○	○	○	○	○	○	○	○
There is a lack of process engineering or other technical support to drive knowledgeable operating decisions for energy reduction.	○	○	○	○	○	○	○	○	○	○	○
Operations staff do not have enough time for activities that would contribute to reducing energy.	○	○	○	○	○	○	○	○	○	○	○
Energy efficiency is not considered sufficiently important to change current operating practices.	○	○	○	○	○	○	○	○	○	○	○
We don't want to be the first to try a new operating strategy.	○	○	○	○	○	○	○	○	○	○	○

Section II: Organizational Efforts to Improve Energy Efficiency

38. Rate the degree of effectiveness of all Strategic Management elements your wastewater utility has used to achieve significant, measurable energy reductions. If your wastewater utility has not implemented any of these strategies select "Not Implemented".

	Not Implemented	Highly Effective	Somewhat Effective	No Change	Somewhat Ineffective	Highly Ineffective
Setting a goal for energy or carbon reduction.	◯	◯	◯	◯	◯	◯
Using long term energy savings over the equipment life cycle to justify project designs that save energy .	◯	◯	◯	◯	◯	◯
Considering energy use on all capital project designs.	◯	◯	◯	◯	◯	◯
Conducting a greenhouse gas emission analysis.	◯	◯	◯	◯	◯	◯
Benchmarking data to compare to other wastewater utilities	◯	◯	◯	◯	◯	◯

Other (please specify)

39. Has your wastewater utility worked with an energy service company (ESCO) or engaged Energy Savings Performance Contracts (ESPC)?

- ◯ Yes, in the last 1-5 years.
- ◯ Yes, in the last 6-10 years.
- ◯ Yes, more than 10 years ago.
- ◯ No
- ◯ I don't know

40. Have you received any federal, state, or energy utility program funding for your energy project(s)?

- ◯ Yes, in the last 1-5 years.
- ◯ Yes, in the last 6-10 years.
- ◯ Yes, more than 10 years ago.
- ◯ No
- ◯ I don't know

41. Have you received technical assistance?

- ◯ Yes, from local electrical utility.
- ◯ Yes, from NYSERDA.
- ◯ Yes, from other state energy organizations or agencies.
- ◯ Yes, from other local or state energy efficiency organizations.
- ◯ Yes, from Department of Energy (DOE) Industrial Technical Assistant Program
- ◯ Yes, from Energy Efficiency and Renewable Energy (EERE) CHP Assistance Partnership
- ◯ No
- ◯ I don't know

Other (please specify)

42. Have you sold or investigated Renewable Energy Certificates (RECs)?

- ◯ Yes, in the last 1-5 years.
- ◯ Yes, in the last 6-10 years.
- ◯ Yes, more than 10 years ago.
- ◯ No
- ◯ I don't know

43. Has your wastewater utility improved its energy performance over the last 10 years?

- ◯ Yes, reduced energy purchased by 50% or more
- ◯ Yes, reduced energy purchased by 25-50%
- ◯ Yes, reduced energy purchased by 1-25%
- ◯ No
- ◯ Don't Know

44. In your opinion, how does your utility compare to your peers in term of energy performance?

- ◯ We are doing better than our peers.
- ◯ We are on par with our peers.
- ◯ We are behind our peers.
- ◯ I don't know.

Section II: Organizational Efforts to Improve Energy Efficiency

45. Rate the effectiveness of all Organizational Culture elements your utility has implemented to achieve significant, measurable energy reductions. If your utility has not implemented any of these strategies select "Not Implemented".

	Not Implemented	Highly Effective	Somewhat Effective	No Change	Somewhat Ineffective	Highly Ineffective
Establishing a staff group that meets regularly to identify and track energy projects.	○	○	○	○	○	○
Having an individual that could be described as an “Energy Director, Advocate, or Champion”.	○	○	○	○	○	○
Providing energy related training to plant staff.	○	○	○	○	○	○
Giving operators access to energy data.	○	○	○	○	○	○
Creating employee performance plans that include energy program-related activities to support the wastewater utility’s energy vision.	○	○	○	○	○	○
Implementing a specific management process to initiate and manage energy projects.	○	○	○	○	○	○
Creating a written, public policy regarding energy use and sustainability.	○	○	○	○	○	○
Establishing specific energy efficiency goals or targets	○	○	○	○	○	○

Other (please specify)

46. Rate the effectiveness of all Communications and Outreach elements your wastewater utility has implemented to achieve significant, measurable energy reductions. If your wastewater utility has not implemented any of these strategies select "Not Implemented".

	Not Implemented	Highly Effective	Somewhat Effective	No Change	Somewhat Ineffective	Highly Ineffective
Communicating energy program goals, vision, and achievement to your customers directly, or via media outlets.	○	○	○	○	○	○
Communicating energy program goals, vision, and achievement to board members, local elected officials, and other civic leaders.	○	○	○	○	○	○
Communicati energy program goals, vision, and achievement to employees.	○	○	○	○	○	○
Collaborating with environmental advocacy groups and regulators	○	○	○	○	○	○

Other (please specify)

47. Rate the effectiveness of all Energy Management/Demand-Side Management (DSM) elements your wastewater utility has implemented to achieve significant, measurable energy reductions. If your wastewater utility has not implemented any of these strategies select "Not Implemented".

	Not Implemented	Highly Effective	Somewhat Effective	No Change	Somewhat Ineffective	Highly Ineffective
Participating in utility programs to improve efficiency and reduce energy use (DSM).	◯	◯	◯	◯	◯	◯
Tracking short-term (e.g. daily) trends in energy use using an energy "dashboard".	◯	◯	◯	◯	◯	◯
Educating employees about the electrical rate structure and billing details affecting your plant's electrical costs.	◯	◯	◯	◯	◯	◯
Conducting an energy audit or similar study to identify energy savings opportunities.	◯	◯	◯	◯	◯	◯

Other (please specify)

48. When was the last time your wastewater utility conducted an energy audit or similar study to identify energy savings opportunities?

- ◯ In the last 1-5 years.
- ◯ In the last 6-10 years
- ◯ More than 10 years ago.
- ◯ Never

49. Rate the effectiveness of all Innovating for the Future elements your wastewater utility has implemented to achieve significant, measurable energy reductions. If your wastewater utility has not implemented any of these strategies select "Not Implemented".

	Not Implemented	Highly Effective	Somewhat Effective	No Change	Somewhat Ineffective	Highly Ineffective
Staff tracking of emerging technologies.	○	○	○	○	○	○
Identifying and prioritizing innovation risks and benefits	○	○	○	○	○	○
Alternative management approaches to reduce energy, such as industrial pretreatment, resource recovery, decentralized treatment, green infrastructure, watershed-based planning and regionalization (as appropriate)	○	○	○	○	○	○
Supporting research and development (R & D) by having staff conduct research or collaborating with universities or other organizations to optimize or demonstrate new processes or technologies	○	○	○	○	○	○

Other (please specify)

Section III: Energy Efficiency Experience Profile

50. How can senior leadership (e.g. Director of Public Works, Mayor or Commissioners Office leaders) be best informed of the benefits of energy conservation and/or recovery at your facility and support further energy conservation efforts?

End of Survey

On behalf of the Water Environment Research Foundation, New York State Energy Research and Development Authority, and Brown and Caldwell; we thank you for your participation in this survey!

The results of this survey will be published by WERFin early to mid - 2015.

Process Related Projects

Low power centrifuges

Anoxic zones, aeration control, pump and motor upgrades

Repair of ducking weirs and other return flow leakage

Process control upgrades

Energy usage review and optimization at the local MCC levels

Additional piping to allow the flow of return activated sludge via gravity.

New centrifuges, scrubbers and conveyors

Recuperative thickening in digesters

Battery backup system to address peak loads

Change out Belt Filter presses for Screw Press

Installation of variable frequency drive units;

Elimination of I/I contributing to lift stations

Move from aerobic digestion to anaerobic digestion for gas utilization

New energy efficient compressor for O2 plant

Centrate Pretreatment, Mainstream Anammox

Added anaerobic selector to aeration process

Automated dissolved oxygen control

Change aeration blower control strategies, converting to most open valve technology

Piloting algae and Anammox treatment for nutrient removal

Electrical Generation and Heat Recovery Projects

Gas Blender for Cogen

Solar heat recovery, geothermal and effluent heat recovery

Turbine waste heat recovery

Organic Rankine Cycle (ORC) process to recover heat from incinerator

Repair of methane leaks for beneficial use in boilers and fuel cells

Cleaning of digester gas for injection into the natural gas distribution system

Selling excess biogas to industrial customer instead of flaring. Exploring additional synergies for the use of excess biogas.

Building Related Projects

Power factor corrections

Building envelope improvements

Green Roofs

Installation of Building Energy Management Systems

Replacing older motors & VFDs with new more efficient models

Switches installed on non-essential exterior lighting

Solar water heaters, low energy lighting.

Outside the Fenceline

Solar and Cogen Power Purchase Agreements (PPAs) at facility

Considering solar PPAs in progress.

Use of Solar PV on own site

Zero surface water discharge No nutrient removal

Finding alternative uses for excess biogas, looking for partners to use effluent

Solar power installation at a remote meter station

REFERENCES

Andrews, N., Willis, J., Nascimento, D., *Energy Position of New York Wastewater Utilities,* Water Environment Research Foundation, ENER7C13a, 2015.

Beebe, R. *Predictive Maintenance of Pumps Using Condition Monitoring*. Oxford: Elsevier Science, 2009.

Burton, F. *Water and Wastewater Industries Characteristics and Energy Management Opportunities,* Electric Power Research Institute, Report CR-106941, 1996.

CPUC, *Self-Generation Incentive Program Handbook,* California Public Utilities Commission, January 2015.

EIA. *Electric Power Monthly with Data for December 2014,* Table 5.6.A. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, Energy Information Administration, 2015.

EPRI. *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010-2030)* Electric Power Research Institute, Product No. 1016987, January 2009.

EPRI. *Electricity Use and Management in the Municipal Water Supply and Wastewater Industries*, Section 6 "Opportunities and Constraints for Energy Management", Page 6-2, Electric Power Research Institute and Water Research Foundation, 2013.

Epstein, P. *Full Cost Accounting for the Life Cycle of Coal,* Center for Health and the Global Environment, Harvard Medical School, http://solar.gwu.edu/index_files/Resources_files/epstein_full%20cost%20of%20coal.pdf, 2011.

European Commission. *Study on Improving the Energy Efficiency of Pumps, 2001*.

Gilleo, A., Chittum, A., Farley, K., Neubauer, M., Nowak, S., Ribeiro, D., and Vaidyanathan, S. *The 2014 State Energy Efficiency Scorecard,* American Council for an Energy-Efficient Economy (ACEEE), October 2014.

Haasl, T. and Heinemeier, K. *California Commissioning Guide: New Buildings"*. California Commissioning Collaborative, 2006.

Krugel, S., Warburton, J., McKelvey, I, Fiorante, R., and Brcic, T., *Monetizing Triple Bottom Line: Beyond Black Art,* WEFTEC 2010.

Kushler, M. *IRP vs. EERS: There's One Clear Winner Among State Energy Policies,* http://aceee.org/blog/2014/12/irp-vs-eers-there%E2%80%99s-one-clear-winner-, December, 2014

Mills, E. *A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions,* http://cx.lbl.gov/documents/2009-assessment/lbnl-cx-cost-benefit.pdf, Lawrence Berkeley National Laboratory.

National Academy of Sciences, *Hidden Costs of Energy.* http://www.nap.edu/catalog.php?record_id=12794, 2010.

NACWA. *The Water Resources Utility of the Future: A Blueprint for Action.* National Association of Clean Water Agencies (NACWA), Water Environment Research Foundation, Water Environment Federation, 2013.

National Laboratory, California Energy Commission. Public Interest Energy Research (PIER), 2009.

Russo, D. and Stenstrom, M. *Economic Implications of Fine Pore Diffuser Aging,* Water Environment Research, Volume 78, Number 8, page 810-815, August 2006.

U.S. EPA. *Fact Sheet: Social Cost of Carbon*, Environmental Protection Agency, November 2013.

Willis, J., Stone, L., Durden, K., Beecher, N., Hemenway, C., and Greenwood, R. *Barriers to Biogas use for Renewable Energy,* Water Environment Research Foundation, OWSO11C10, 2012.

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