Opportunities for Strategic Energy Management in the Municipal Water Sector

March 2018

Table of Contents

Acknowledgements

This report reflects the invaluable contributions of multiple individuals.

We recognize the report's lead authors John Balfe, Buildings and Communities Solutions Senior Associate and Dave Lis, Director of Technology and Market Solutions.

Other NEEP staff members served key roles in the development of the report including Lisa Cascio, Public Relations Senior Manager and Chris Tanner, Digital Marketing Senior Associate.

NEEP acknowledges and thanks the following stakeholders for contributing to the development and review of this report. We very much appreciate their valuable input.

- Layne McWilliams, Cascade Energy
- Tricia Cioni, Cascade Energy
- Andre Defontaine, US Department of Energy
- Robert Bruce Lung, US Department of Energy
- Alice Dasek, US Department of Energy
- Sharon Rivard, NH Department of Environmental Services
- Kathleen O'Connor, NY State Energy Research and Development Authority
- Greg Baker, Vermont Energy Investment Corporation
- Jason Lenihan, Vermont Energy Investment Corporation
- Paul Markowitz, Vermont Energy Investment Corporation
- Jeffrey Hullstrung, Vermont Energy Investment Corporation
- Tom Coughlin, National Grid

About NEEP

NEEP was founded more than 20 years ago as a non-profit to accelerate energy efficiency in the Northeast and Mid-Atlantic states. Today, it is one of six Regional Energy Efficiency Organizations (REEOs) funded, in part by the U.S. Department of Energy to support state efficiency policies and programs. Our long-term shared goal is to assist the region to reduce carbon emissions 80% by 2050. For more about our 2018 strategies and projects, see this 2-page overview or these project briefs. You can also watch this brief video regarding our history.

Disclaimer: NEEP verified the data used for this white paper to the best of our ability. This paper reflects the opinion and judgments of the NEEP staff and does not necessarily reflect those of NEEP Board members, NEEP Sponsors, or project participants and funders.

Executive Summary

An increasing number of municipalities across the Northeast & Mid-Atlantic region are establishing energy and carbon reduction goals as the benefits of such goals – which include costs savings, and increased environmental stewardship – become more widely recognized. With approximately 35 percent of a typical municipal-wide energy budget attributable to public water utilities, this represents an attractive area to explore opportunities for significant energy and carbon savings.

A core strategy for cities and towns to meet their climate objectives is focusing on energy efficiency. Strategic Energy Management (SEM) is an emerging opportunity for municipalities to capture comprehensive savings, especially in water-wastewater infrastructure.

SEM is an increasingly popular, comprehensive approach for medium-to-large facilities to reduce their energy use and related expenditures. SEM is the holistic approach to managing energy use in order to continuously improve energy performance and achieve energy, cost, and carbon savings over the long term. For years, SEM has been focused on industrial companies and operations, but there are many factors that indicate its applicability to the municipal water sector. Similarly to industrial facilities, municipal drinking water and wastewater facilities utilize energy-intensive equipment, operate day-to-day processes with decision makers that are often located offsite, and don't place important priority on energy consumption. There has already been some success applying SEM to the municipal water sector but significant potential still exists in this market segment to help communities reduce their energy budgets and meet their greenhouse gas reduction goals.

Exciting examples of successful utilization of SEM in the municipal water sector are becoming more common. We highlight several programs across the United States including Vermont, New Hampshire, New York, the Northwest, as well as federal programs through the United States Department of Energy (U.S. DOE) and Environmental Protection Agency (EPA).

Transforming the municipal water sector to use energy more efficiently will require support from local-level organizations all the way up through national-level organizations. NEEP identified several recommended actions for key stakeholder groups. For SEM to become a reality, stakeholders should implement these recommendations for the broad adoption of SEM by municipal water sector:

- **Municipalities/communities should adopt SEM practices in their public water utilities;**
- **Energy efficiency programs should offer SEM trainings and resources to public water utilities;**
- **US Department of Energy should continue to provide programs and resources that support public water utilities in their adoption of SEM;**
- **U.S. Environmental Protection Agency should continue to collect data and support efforts to reduce energy usage in public water utilities;**
- **Stakeholders should work both locally and regionally to support the adoption of these key recommendations.**

NEEP facilitates regional stakeholder working groups to coordinate implementation of regional strategies. These coordinated discussions will be part of the agenda in both the Northeast SEM Collaborative as well as the High Performance Buildings and Communities Working Group. Stakeholders should engage these regional groups to not only move these recommendations forward, but also to bring new ideas and strategies to a broader network of stakeholders.

Introduction

Scope and Purpose

An increasing number of municipalities across the Northeast & Mid-Atlantic region are establishing energy and carbon reduction goals as the benefits of such goals – which include costs savings, and increased environmental stewardship – become more widely recognized. A core strategy for cities and towns to meet their climate objectives is focusing on energy efficiency. Strategic Energy Management (SEM) is an emerging opportunity for municipalities to capture comprehensive savings, especially in water-wastewater infrastructure. SEM is the holistic approach to managing energy use in order to continuously improve energy performance and achieve energy, cost, and carbon savings over the long term. Most of the recent program developments have focused on utilizing SEM practices in medium-to-large industrial and commercial facilities. The potential to integrate SEM into the municipal sector has remained largely untapped in the Northeast and Mid-Atlantic region.

Photo Credit: Town of Exeter, NH

This report will focus on the opportunity to integrate SEM into the municipal water-wastewater sector by providing recommendations and resources for key stakeholders, namely municipalities and those working within the facilities and utility program administrators who are in a strong position to support adoption. The report will present findings related to energy use in water-wastewater treatment facilities, barriers preventing SEM implementation in the municipal sector, and opportunities to address those barriers and expand SEM adoption in water-wastewater treatment facilities in the Northeast & Mid-Atlantic region. Current and past initiatives targeting these facility types have yielded significant results, but these programs are not yet pervasive, leading to an overwhelming feeling that ample opportunity still exists.

The SEM Approach – Definition and History

Often viewed as the cost of doing business, energy utility bills are regularly overlooked by business owners or building operators as a source of potential savings, even though energy is a controllable expense. Furthermore, in the industrial sector – which is the largest energy-consuming sector in the United States and the prime target for SEM – the cost of energy often accounts for a significant portion of the operating budget for any given facility. SEM presents an emerging opportunity for both the industrial and commercial sectors (wastewater treatment plants are characterized as commercial facilities by the Energy Information Administration) to reduce energy costs and carbon emissions by focusing on the adoption of energy efficient equipment, staff behavioral changes, and optimized operations and maintenance (O&M) procedures. Unlike traditional energy efficiency programs, SEM is a continuous progression incorporated into the core business operations of a facility, ultimately changing the culture of how a business thinks about energy.

SEM is often delivered to end-users through a cohort approach. This method focuses on bringing groups of organizations, typically with similar processes or lines of business, together to undergo collective training. Representatives from these facilities meet several times over the course of the engagement to undergo training workshops and share best practices and lessons learned from their experiences. Implementers have found that the peer-to-peer exchange helps to leverage the group's collective wisdom and experience to uncover process improvements that can be beneficial for everyone.

The Northeast and Mid-Atlantic region has experienced uptake in SEM program activity focused on the industrial sector, but much less has occurred in the public water utility sector. In the Northwestern portion of the United States, however, SEM pilot programs began as early as 2008. These programs continue to be refined and improved, revealing a number of models and best practices that are transferrable across the country. Based on the ISO 50001 Energy Management System Standard, the three key components of SEM include: (1) organizational commitment; (2) planning and implementation; and (3) measuring and reporting energy performance. Table 1 below provides a summary of the core elements of SEM programs.

Table 1: Minimum Elements of SEM Programs

Phase I: Customer Commitment	1. Set and communicate continuous improvement objectives and long-range energy performance goals
	2. Ensure SEM initiatives are sufficiently resourced and a responsible individual is designated
Phase II: Planning & Implementation	3. Assess current energy management practices using a performance scorecard
	4. Develop a map of energy use and cost
	5. Establish clear, measurable metrics, and goals
	6. Register or record actions to be undertaken to achieve the energy performance goals
	7. Engage employees
	8. Implement planned actions
Phase III: Measuring & Reporting	9. Periodically reassess energy performance
	10. Collect and store performacne data, making it available over time
	11. Analyze energy use data determining relevant variables affecting use compared to a baseline
	12. Reporting

Efficiency Vermont (EVT), with its Continuous Energy Improvement (CEI) Program, is leading efforts in the Northeast. This program is available for large commercial and industrial customers and focuses on four main components: (1) process improvements; (2) maintenance; (3) employee engagement; and (4) capital upgrades. Launched in 2014, the first cohort included eight organizations with a diverse set of business focuses, including six industrial, one hospitality, and one healthcare facility. Experiences with the first cohort were crucial to identifying barriers to CEI implementation that will be discussed later in this report. Overall the first cohort achieved an average of three percent electricity savings in 2015 by participating[1]. In late 2015, EVT introduced a second cohort to the pilot, this time with a technology-specific concentration allowing for targeted technical assistance and enhanced peer-to-peer interactions between the participating organizations. EVT has continued to expand its CEI program in 2017 by introducing the CEI-Lite program which focuses on small and medium size commercial customers and employing an online education and training approach. EVT also managed a wastewater initiative which is described later in this report.

The New York State Energy Research and Development Authority (NYSERDA) is engaged in an ongoing Industrial SEM Pilot program that began in 2017. The first pilot group consisted of eight facilities with an energy expenditure of $500,000 or more. Program participants had access to training, coaching, and peer-to-peer knowledge exchange to enhance energy efficiency at their facilities on an ongoing basis. NYSERDA is offering a second pilot program in 2018 for eleven industrial companies consisting of twelve training sessions.

Other public water utility related initiatives will be described later in this report.

NEEP's Municipal Initiative

One of NEEP's core strategy areas has always involved improving energy efficiency within the municipal sector. Historically, NEEP's efforts have largely been directed towards schools, public buildings, energy codes, and leading-by-example initiatives. More recently, this has evolved into a more comprehensive approach that includes LED street lighting, zero energy buildings, electric vehicle charging, and now, water-wastewater treatment facilities. The expansion of NEEP's work at the community level comes at a time where more and more municipalities across the region are progressively setting aggressive energy and carbon reduction goals.

NEEP's long-term goal is to assist the Northeast and Mid-Atlantic region in reducing carbon emissions 80 percent by 2050 (relative to 2011 levels). In the NEEP region, cities such as Boston (Mass.) and Ithaca (N.Y.), and states like Rhode Island and Maryland are establishing similar goals.

Market Assessment

Access to clean water is one of the most fundamental and critical services provided by communities across the United States. Collectively referred to as public water utilities, two distinct facility types will be referenced throughout this report. Traditionally referred to as a wastewater treatment plant, the industry now prefers the term water resource recovery facility *(WRRF).* The core meaning of the term remains the same, however, as WRRFs protect human health and the natural environment by removing pollutants from used water. The new term's scope is expanded to include the sector's increased focus on resource recovery. The other type of facility that will be discussed is a drinking water treatment plant *(DWTP)*, which is a facility that supplies residents with

[1] http://publicservice.vermont.gov/sites/dps/files/VT%202015%20CEI%20Behavior%20Pilot%20Evaluation%20Report.pdf

clean, safe water suitable for human use and consumption. Public water utilities are highly regulated to protect both the health of those drinking the water as well as the natural bodies of water found throughout the country. The Environmental Protection Agency (EPA) is the regulatory body tasked with establishing acceptable standards for water quality in the United States.

Wastewater Treatment

The main functions of WRRFs are to collect and treat water used in homes, industrial facilities, and other businesses to reduce the amount of pollutants and contaminants in the water, prior to reintroducing the water back into earth's natural ecosystems. The functions of WRRFs have evolved over time and now include the recovery of energy, nutrients, and clean water for beneficial uses. WRRFs that discharge to surface water sources must adhere to the regulations set forth in the Clean Water Act (CWA). These plants require a National Pollutant Discharge Elimination System (NPDES) permit, in addition to any state requirements, to operate legally. Plants that discharge directly to groundwater sources do not require NPDES permits, only State Discharger permits.

Drinking Water Treatment

Community drinking water facilities are tasked with the important role of supplying residents with clean water usable for drinking, cooking, showering, and more. Public drinking water supply is regulated through the Safe Drinking Water Act (SDWA) to ensure contaminants such as lead and arsenic are maintained at acceptable levels. Drinking water and wastewater flow through a seemingly endless series of pipes and endure a number of different processes to ensure that EPA's standards are met. Transport of water can be very energy intensive and present significant potential for municipalities to save money.

Organizational Structure

Proper management and oversight is a key component for public water utilities to meet the regulatory requirements set by the EPA. The staffing structure of public water utilities varies depending on a few different factors. The size of the service territory plays a key role in determining the structure of the water utility. For instance, a county-level WRRF may differ from a town-operated plant. The Albany County Sewer District in New York is overseen by a superintendent of operations and an executive director who ultimately reports to the district's board of commissioners. Municipally-operated plants commonly fall under the department of public works and are managed by a director or commissioner. The differing structures of these organizations plays a role in some of the key barriers discussed later in this report. However, these organizations are typically well-organized, staffed by professionals, and have a clear chain of command making them strong SEM candidates.

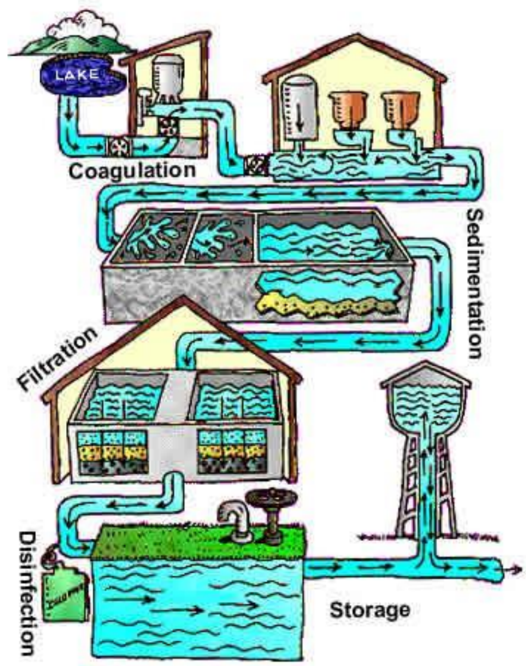
Public Water Utilities Overview: Energy Consumption and Typical Processes

Water and energy are very interrelated resources, especially in public water utilities. Energy is needed during every step of the process to collect and treat water for both potable water and wastewater purposes. The amount of energy required for these processes varies greatly depending on factors such as geographical distance spanned, water losses and inefficiencies in the process, topography of the area, and required level of treatment.

Drinking Water Treatment Plants

In total, there are approximately 51,000 community water systems in the U.S. supplying water for drinking, cooking, bathing, and more.[2] As described in Figure 1 below, the water treatment process begins with the collection of water from underground or surface level sources which then gets conveyed to the local treatment facility. Next, chemicals are added to neutralize sediments and other contaminants in the water, forming larger particles (called floc) that later settle to the bottom in sedimentation tanks. The settled particles, or sludge, remain on the bottom of the tanks while the clear water flows through various filters to remove the remaining dissolved particles. Lastly, a disinfectant, typically chlorine or UV light, is added to the water to eliminate any pathogens and retain a residual level in the system to prevent regrowth. The final step of the process (and often the most energy intensive) is to deliver the potable water through a series of pipes to the end user.

Figure 1: Drinking Water Treatment Process

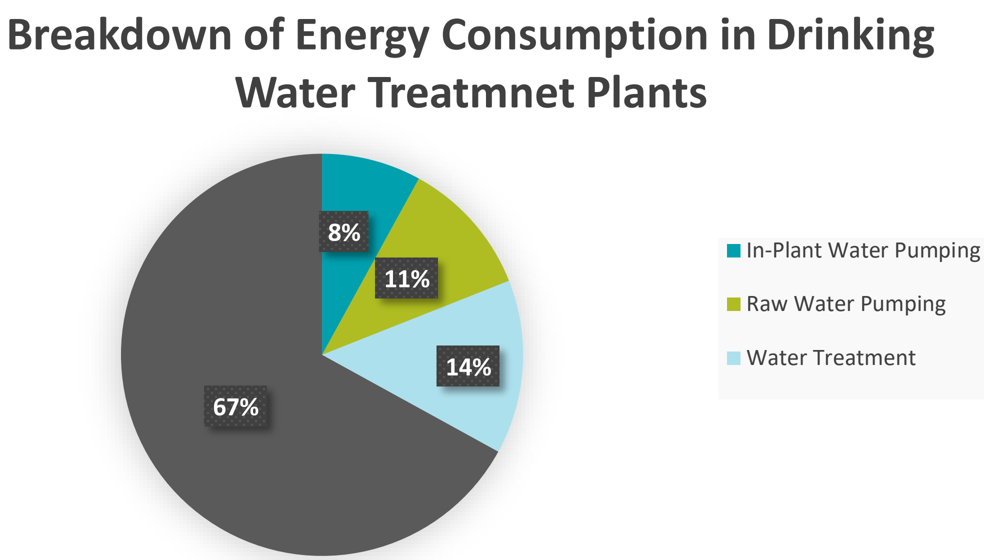


Source: https://www.cdc.gov/healthywater/drinking/public/water_treatment.html

The major energy uses to produce clean drinking water are pumping, processing, and then treating it to meet the water quality standards established by the SDWA. On a global scale, approximately 80-85 percent of electric use in the water treatment process is due to pumping.[3] Energy consumption varies depending on the system and source of the water. For instance, groundwater systems require significantly less energy for the treatment process due to its relative purity to begin with. *Figure 2* below provides context for typical energy end uses in DWTPs and is not meant to be applicable to all drinking water systems.

[2] https://www.epa.gov/sites/production/files/2016-03/documents/20160322-16-p-0108.pdf
[3] https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExcerptWaterEnergyNexus.pdf

Figure 2: Energy Use in Drinking Water Treatment Plants



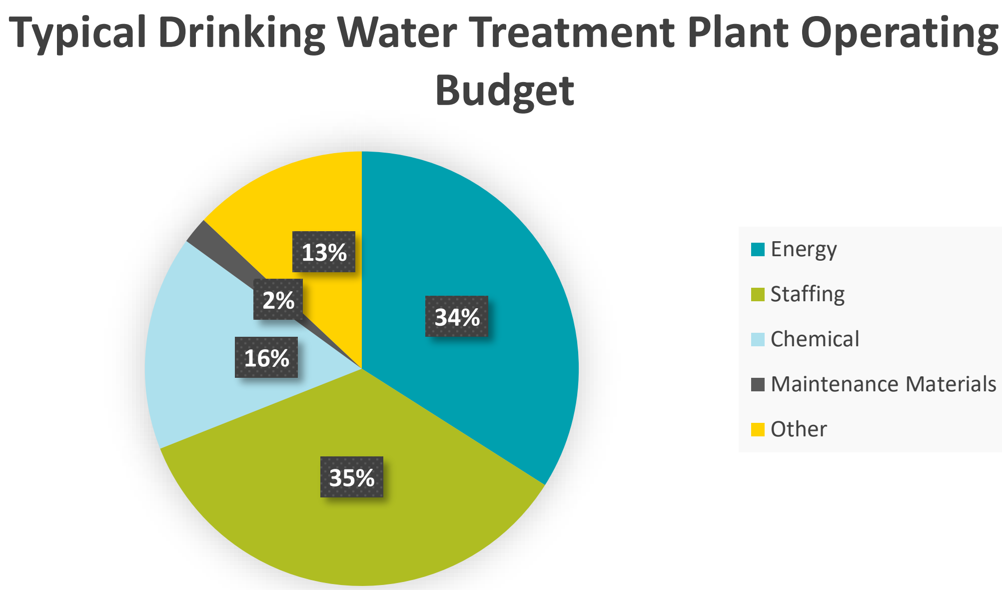
Source: Water Research Foundation - Electricity Use and Management in the Municipal Water Supply and Wastewater Industries[4]

Energy is the second-highest operating cost for a typical DWTP, accounting for over one-third of the operating costs for the facility.[5] *Figure 3* below provides more information about the typical costs at DWTPs. At the facility level, electricity accounts for about 80 percent of DWTP processing and distribution costs.[6] The collective energy used across the system presents a significant opportunity for savings in DWTPs.

Energy is the second-highest operating cost for a typical DWTP, accounting for over one-third of the operating costs for the facility.

[4] http://www.waterrf.org/PublicReportLibrary/4454.pdf
[5]http://www.energy.ca.gov/2004publications/CEC-500-2004-901/CEC-500-2004-901.PDF
[6] https://www.epa.gov/sites/production/files/2015-08/documents/wastewater-guide.pdf

Figure 3: Drinking Water Treatment Plant Operating Budget Breakdown



Source: Awwa Research Foundation and the California Energy Commission: Water and Wastewater Industry Energy Efficiency: A Research Roadmap [7]

Wastewater Treatment Plants

Compared to the number of DWTPs in the United States, there are far fewer WRRFs, totaling approximately 14,691 altogether.[8] Within the NEEP region, there are approximately 2,328 WRRFs. Refer to *Table 2* below for a breakdown of facilities by state. In the United States, the greatest portion of water-related electricity is consumed by WRRFs. These numbers are based on EPA's Clean Watershed Needs survey which is not a comprehensive database of WRRFs. These figures should be taken as approximations, and it should be understood that there may be more or fewer WRRFs per state than what is listed below.

The primary purpose of WRRFs is to clean wastewater collected from homes, businesses, and industrial facilities before reintroducing that water back into U.S. waterways (i.e. streams, oceans, lakes, etc.). Prior to the construction of WRRFs, the earth was able to dilute and break down harmful contaminants found in wastewater through natural processes without the assistance of any man-made infrastructure. However, global population growth has resulted in significantly higher levels of wastewater production necessitating the development of WRRFs. The population trend is expected to continue, putting an even greater strain on WRRFs. According to EPA's *Clean Watershed Needs Survey 2012: Report to Congress*, approximately 75 percent of the United States population, or 234.1 million people, are served by wastewater treatment facilities that provide at least secondary levels of treatment. By 2032, this number will grow to 79 percent of the population, or 294.9 million people,[9] and is a result of fewer populations relying on private septic tank services. Coupled with the issue of

[7] http://www.energy.ca.gov/2004publications/CEC-500-2004-901/CEC-500-2004-901.PDF
[8] EPA's Clean Watershed Needs Survey; https://www.epa.gov/cwns
[9] https://www.epa.gov/sites/production/files/2015-12/documents/cwns_2012_report_to_congress-508-opt.pdf

aging infrastructure, the upward trend in population and subsequent increased dependence on public wastewater treatment services substantiates the theory that WRRFs will be strained in the near future. Two other issues facing this sector include more stringent water quality requirements, leading to increased energy use, and aging infrastructure. These issues present an opportunity for upgrades to be made at WRRFs with a focus on energy efficiency.

Table 2: Number of Wastewater Treatment Facilities in the NEEP Region by State

State	Number of Facilities
CT	89
DC	1
DE	17
MA	126
MD	174
ME	135
NH	90*
NJ	157
NY	588
PA	846
RI	20
VT	87
Total: 2,328	

Source: EPA's CWNS, 2012

**Number of Facilities was provided by the State Department of Environmental Services*

The wastewater treatment process varies depending upon the technologies utilized at the plant and the level of treatment needed, as regulated by the CWA. To begin, wastewater containing human and other organic wastes, food scraps, fats/oil/grease, industrial waste, and more, flows to the local WRRF via the forces of gravity or with the assistance of lift and pump stations. The wastewater then undergoes a series of different treatment stages including primary, secondary, and sometimes tertiary or advanced treatment. The chart below, *Figure #*, describes a typical wastewater treatment process. Some variation may exist from one treatment plant to another.

Figure 4: Typical Components of the Wastewater Treatment Process

Preliminary Treatment

Wastewater enters the plant and flows through screens, removing large objects such as wood, rocks, dead animals, and other items that should not be in the public water system.

Primary Treatment

Removal of fats, oils, greases, sand, and gravel using grit and/or sedimentation tanks. Heavier materials sink to the bottom (primary sludge) and lightweight materials such as grease or small pieces of debris, rise to the top. Floating materials are skimmed off the top and the settled primary sludge is then pumped to the plant's sludge handling facilities.

Secondary Treatment

Biological processes are used to further breakdown organic matter in the wastewater. Oxygen is pumped into the wastewater promoting the growth of microorganisms that consume most of the remaining organic matter contaminating the water. Wastewater then flows to the final settling tanks where heavie particles (secondary sludge) settle and get removed. This is the traditional activated sludge process. Secondary sludge is then transported to the sludge handling facilities for additional treatment. Biological Nutrient Removal may also occur during this stage.

Tertiary or Advanced Treatment

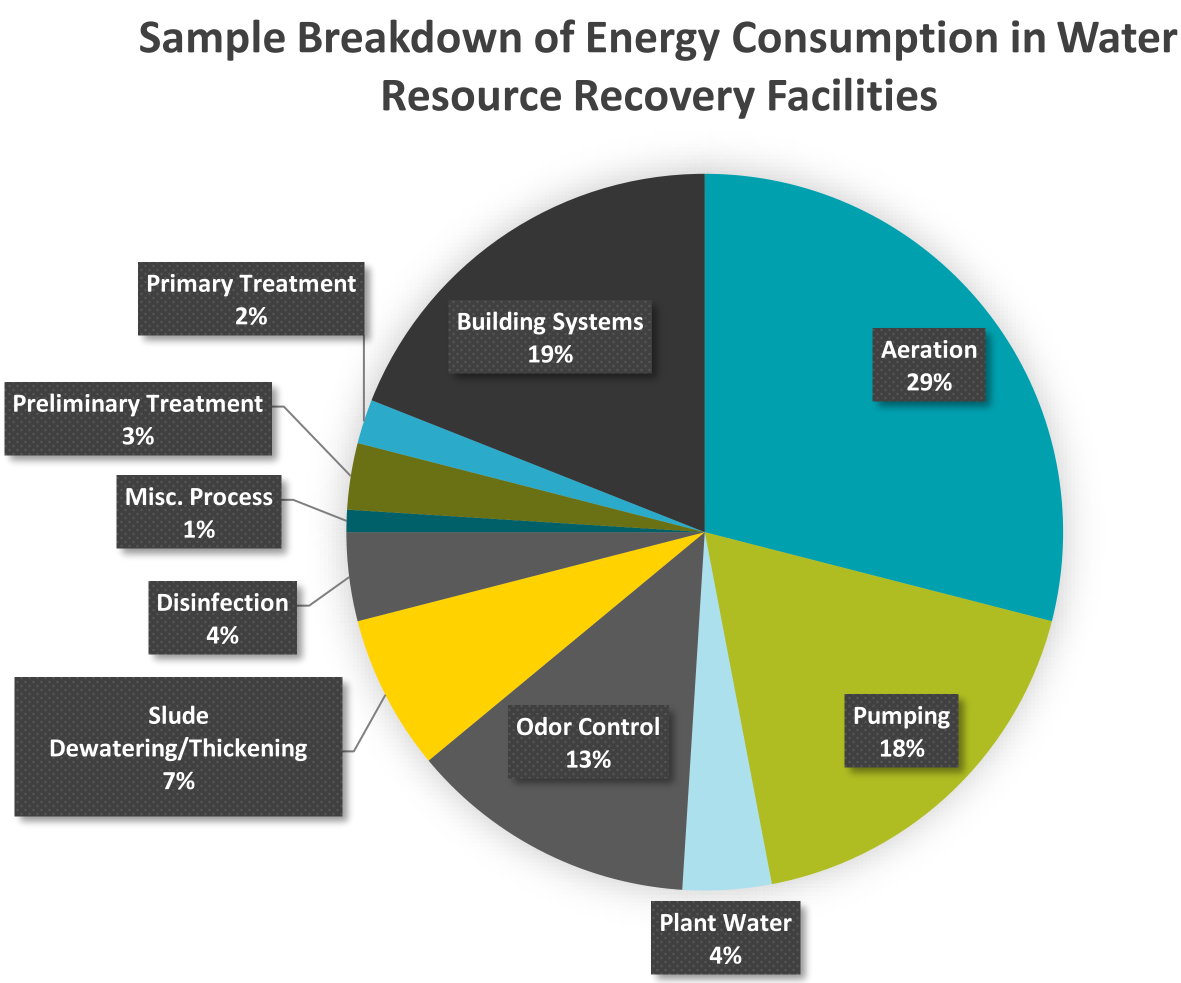
In some WRRFs, this additional stage helps make water clean enough for reuse and/or removes unwanted nutrients such as nitrogen and phosphorous.

Disinfection

Before water is discharged from the treatment plant, it undergoes a chemical or UV disinfection process to eliminate any remaining microorganisms.

Of the four stages mentioned above, secondary and advanced treatment consume the most amount of energy. More specifically, aeration, or the introduction of air to the wastewater, is the single most energy intensive process accounting for approximately 30-60 percent of the energy used in a typical WRRF. Refer to *Figure #* for a further breakdown of the energy end uses in WRRFs.

Figure 5: Energy Consumption in Water Resource Recovery Facilities



Source: NH DES, NH OSI, NH Utilities, and Process Energy Services, LLC

The economic impacts of energy usage in public water utilities is widely documented, substantiating the theory that significant savings are achievable in these facilities. Approximately 35 percent of a typical municipal-wide energy budget is a direct result of the functions of the public water utility.[10] At the facility level, electricity accounts for about 25-40 percent of the operating budget of a normal WRRF.[11] An increased focus on SEM in these facilities can yield significant savings through capital upgrades as well as low-to-no cost operational changes.

SEM Experience in the Public Water Sector

Barriers to Implementation

Similarities between the industrial sector and public water sector become even more apparent when focusing on barriers to SEM adoption. In addition to the traditional barriers that impact the industrial sector, there are a few unique barriers that inhibit the application of SEM to the water-wastewater sector. This section offers an overview of both the traditional and unique barriers impacting these facility types.

Regulatory Compliance is the Top Priority: Industrial facilities and public water utilities share this commonality. Water and wastewater plants are primarily concerned with meeting their permit requirements and are hesitant to try anything new that may negatively impact water quality. Little time (if any) is given to anything beyond the processes that impact the water quality in that facility. This, in turn, leads to a lack of understanding of energy usage by facility operators and decision makers, further reducing the likelihood of implementation of energy efficiency practices and projects. Lack of prioritization or knowledge of energy saving practices by upper management filters down through the plant and energy-saving measures are often overlooked as a viable cost-cutting opportunity.

Oversizing of Equipment: Public water utilities are often designed and constructed to handle much larger water flows compared to what is actually needed today. This is because planning agencies forecast for continued population growth in the future and public water utilities are built, and often required through policy enactments, to accommodate larger-than-anticipated capacities. Oversized equipment operating below the designed capacity level leads to less-than-optimal energy performance. Additionally, equipment is often operational 24 hours a day for 365 days per year, even when not needed.

If It's Not Broken, Don't Fix It: The public water sector is very risk averse and conscious of staying out of the public spotlight. This barrier speaks to the unwillingness of decision makers to make changes that could negatively impact their water quality permits. Energy projects that have any chance of hindering operations are perceived negatively. Similarly, the aging workforce typically found in this sector may contribute to an overall inability or unwillingness to change old habits.

Lack of Capital Availability and Prioritization: Municipal budget constraints are widely understood. The most recent EPA estimates indicate that $197.8 billion in capital investments are needed for wastewater pipes and

[10] https://www.epa.gov/sites/production/files/2015-08/documents/wastewater-guide.pdf
[11] https://www.epa.gov/sites/production/files/2015-08/documents/wastewater-guide.pdf

treatment facilities alone.[12] The American Water Works Association estimates that $1 trillion is needed to maintain and expand drinking water systems to meet the projected increased demand.[13] The need for improvements is clearly well-documented but energy efficiency projects will fall low on the priority list for a sector that is almost entirely focused on making process-related investments. Public water utilities may receive state and/or federal funding but municipalities are under pressure to minimize upfront costs, maintain low rates, and adhere to increasingly stringent regulatory requirements.

Little Incentive for Employees to Improve Energy Performance: Public water utilities have few internal mechanisms in place that incentivize employees to generate energy savings, whether through capital projects or changes in operations and maintenance. They typically do not even see their plant's energy bills, further reducing the motivation to make changes to energy performance.

Understanding these barriers is a critical component of designing an SEM program that leads to success. The core elements of any SEM program help facilities address and overcome the obstacles highlighted above.

Applying SEM to WRRFs and DWTPs

Many of the same principles that make industrial facilities a good fit for SEM apply to water and wastewater facilities as well. Both WRRFs and DWTPs utilize energy-intensive equipment such as pumps and blowers that help generate an end product (effluent discharge or clean drinking water). Similarly, industrial facilities operate high energy-consuming equipment (most notably motors) that help produce end products such as paper or electrical components. Another similarity between the two facility types is that operations are very end-product oriented and energy usage tends to be viewed as relatively unimportant. SEM provides a great opportunity for decision makers to engage more closely with those working within the plant to unlock the potential energy and costs savings upgrades.

Additionally, differences exist between the industrial sector and public water sector that make SEM even more applicable for WRRFs and DWTPs. Public water utilities are not competing against one another to generate higher profit margins. This enables increased collaboration and sharing amongst cohort participants who can speak freely without fear of giving away any "company secrets". Another factor involves the payback duration that public water facilities are able to withstand. Typically, industrial facilities are seeking 1-3 year payback periods, while public water utilities are more likely to be okay with 7-10 year (or more) payback periods. The longer payback horizon allows WRRFs and DWTPs to realize even greater savings over the lifecycle of the facility.

SEM is an increasingly popular approach for achieving energy savings in, primarily, industrial settings. To date, the majority of SEM activity has taken place in the Northwest portion of the country and has been led by Northwest Energy Efficiency Alliance (NEEA), Bonneville Power Administration, and the Energy Trust of Oregon. As of 2016, 707 industrial sites have been served by energy efficiency programs that offer some form of SEM. Building off the success of programs in the Northwest, Efficiency Vermont and NYSERDA are leading the uptake of SEM programs in the Northeast & Mid-Atlantic region. Most of the documented success with SEM has been in the industrial/manufacturing sector, but there are a small number of exemplary programs targeting the municipal water sector that can be used as models.

---

[12] https://www.epa.gov/sites/production/files/2016-01/documents/cwns_2012_fact_sheet_final_01_14_16_0.pdf
[13] https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Drinking-Water-Final.pdf

DOE's Superior Energy Performance Water and Wastewater Pilot Project

DOE's Superior Energy Performance (SEP) program is designed to significantly reduce energy use and carbon emissions in the manufacturing and commercial buildings sectors by focusing on systematic energy performance improvements. DOE is partnering with seven WRRFs and DWTPs to pilot test the applicability of SEP to the public water sector. Two of the program partners, including Kent County, Delaware and Ithaca, New York, are within the NEEP region. The fundamental concept of SEM, to integrate energy management into business operations and culture, is also the core strategy in the SEP program. Partner water utilities agree to implement SEP at one of their facilities while DOE offers tools and training sessions over twelve months to assist the water utilities.

Cascade Energy

Cascade Energy is a national leader in the application of SEM to the municipal water sector. Cascade works with water and wastewater professionals to develop a pipeline of capital improvement projects and operations and maintenance projects. In total, Cascade Energy's program has reached 94 water and wastewater sites across the country, including Kent County, Delaware and in 2018, ten WRRFs in New York. Some key elements of Cascade's comprehensive SEM approach includes integrating energy coaches, optimizing processes, and engaging stakeholders. This cohort-based program has involved water facilities ranging from small towns to regional facilities serving over one million people generating an average energy savings of nine percent, with many of the facilities achieving greater savings.[14]

In 2013, Cascade Energy contracted with Idaho Power Company to offer an SEM cohort within its Custom Efficiency Program. This two-year program involved 11 participating facilities that ranged in load size from 1,600,000 kWh per year to 16,000,000 kWh per year. As of the second year, the group of facilities was on pace to achieve 7.8 percent savings by exclusively targeting operations and maintenance (O&M projects).[15] Year one of this two-year program focuses heavily on engaging stakeholders during five mandatory workshops. These workshops included talks from regulators, plant managers, utility program administrators, and engineering firms to help frame the conversation about the advantages of participating in the SEM program. Technical workshops were also held geared towards site specific processes and provided opportunities to review individual site data. This cohort not only resulted in significant savings for the participating facilities, but also produced a number of lessons learned that can be applied to other municipal water systems. Lessons learned are summarized in the table below (*Table 3*).

New York

The New York State Energy Research and Development Authority (NYSERDA) will begin offering an SEM program focused on WRRFs in 2018. This, however, is not NYSERDA's first SEM initiative. In 2017, industrial facilities exceeding $500,000 in energy costs were able to apply to the state's SEM Program. The first Industrial SEM pilot consists of eight industrial facilities located across the state and are participating in a series of 10 energy coach-facilitated workshops over the course of 12 months. The first cohort commenced training in September 2017

[14] Cascade Energy: Water and Wastewater Program Overview
[15] https://aceee.org/files/proceedings/2015/data/papers/1-180.pdf

and a second cohort, seeking approximately 12 industrial facilities, is scheduled to begin around the summer of 2018.

The new wastewater SEM program will be the first of its kind offered in the Northeast region. It is anticipated that each cohort will include 8-10 plants located within a geographically-similar region of the state; and that there will be a WRRF minimum kWh annual consumption threshold. Year one, of the two-year engagement, will involve active participation from cohort members including educational workshops, peer-to-peer engagement, and onsite visitations to the various WRRFs. The second year of the program will entail bimonthly check-ins with energy coaches and ongoing monitoring. Similar to the industrial SEM program offered by NYSERDA, the wastewater offering will aim to drive continuous energy improvements by changing the business culture of WRRFs.

NYSERDA has compiled a variety of technical resources for WRRFs which can be accessed online here.

New Hampshire

In 2015, the Office of Energy and Planning (renamed in 2017 to the "Office of Strategic Initiatives") and the Department of Environmental Services partnered with the state's four largest electric utilities to secure funds from the U.S. Department of Energy State Energy Grant Program. This three-year project aims to reduce municipal energy costs by identifying and investing in energy efficiency measures at WRRFs. Although New Hampshire's initiative is not referred to as an official SEM offering, many features of the project align with the core elements of SEM.

The first task for the New Hampshire project was to benchmark and establish a baseline of energy use for each of the 72 municipally-owned WRRFs in the state. N.H. developed a specific benchmarking tool for this effort that uses both loading and flow data and allows comparison of WRRFs across many different treatment attributes. Following the benchmarking effort, the project team led five workshops around the state to educate WRRF operators and decision makers on the importance of energy efficiency through a combination of energy and wastewater experts as well as through peer-to-peer learning. Currently, the state is working with an outside vendor to perform comprehensive energy audits at up to 32 WRRFs and nine DWTPs throughout the state. A number of engagements with stakeholders including plant operators and local decision makers will follow the collection of energy data. In total, four initial workshops will be held to educate the wastewater community about the opportunity for improved energy efficiency and specific topics including, lagoons and activated sludge treatment, will be explored. Each comprehensive energy audit is followed by a technical assistance meeting with WRRF staff, local decision makers, energy and wastewater experts and funding partners to discuss implementation and funding strategies for the audit findings. The last portion of the scope of work is to share results and lessons learned with the totality of the wastewater community in New Hampshire.

The goal of this project is to identify opportunities to reduce energy use in participating New Hampshire's WRRFs by an average of 33 percent. N.H. is on-target with this goal with individual WRRF findings ranging from 20-47 percent savings with an average 2.6-year payback. The technical assistance meetings have been very successful in moving the identified projects toward implementation for real savings. This program will help the state with its commitment to reduce greenhouse gas emissions by 20 percent compared to 1990 levels by 2025.

In 2018, N.H. submitted an application to the U.S. Department of Energy State Energy Grant Program for a project that will continue and build on the current program. The proposed program will include SEM program development at up to 15 WRRFs, additional outreach and education and energy audits as well as expanded benchmarking.

Vermont

Efficiency Vermont (EVT) has engaged with municipalities on energy efficiency in WRRFs for years. In 2016, the landscape of WRRFs in Vermont was on the verge of change and major facility upgrades were going to occur over the next ten years. EVT hired a consultant at that time, who had previously completed over 30 energy audits throughout the state's WRRFs, to develop energy efficiency guidelines for WRRFs. The guidelines were developed through a collaborative process with the Department of Environmental Conservation and the Environmental Committee of the American Council of Engineering Companies (ACEC). The efficiency guidelines provide guidance on proven cost-effective energy saving options. WRRFs seeking funding through Vermont's Clean Water State Revolving Fund are required to address energy and water efficiency in their upgrades.

Lessons Learned from WRRF SEM Cohorts

Previous SEM engagements have led to a number of best practices and lessons learned that can applied to future programs. NEEP has compiled a short list of five strategies that will assist with the development of electric utility program offerings going forward.

Table 3: Lessons Learned and Best Practices from Previous SEM Engagements at Municipal Water and Wastewater Treatment Facilities

Best Practice/Lesson Learned:	**Importance:**
Peer-to-peer exchange	Working in the municipal water sector doesn't allow for much collaboration with others outside of the facility or even the upper-management or decision makers within the facility. An SEM cohort allows for greater exchange amongst external plant operators, decision makers, engineering firms, regulators, and others. Water and wastewater utilities are not competitors. Water professionals are able to speak openly with each other and dialogue can be free-flowing without fear of giving away any business secrets.
Development of trust	Making changes to municipal water system processes is challenging. Developing trust by demonstrating a deep understanding of these systems is crucial to persuade operators that energy efficiency improvements would work. Incorporating regulators into the discussion is also important as it helps breakdown preconceived opinions that both sides may have and shows that regulators are there to help. Another best practice is to include a plant operator from a previous cohort (or one that has implemented energy efficiency projects) to speak to the viability of the program and/or effectiveness of focusing on energy efficiency projects in general.
Comprehensive cohort design	Cohorts should be designed to include the broad range of stakeholders involved in the management, operation, regulation, design, (and more) of municipal water utilities. Decision makers must be included so that changes and improvements can be made. Often times, however, it is the plant operators brainstorming the best strategies for energy-efficient process improvements.

Inclusion of water/wastewater expert	Traditional SEM cohorts typically include some form of energy coach that meets regularly with the participating facilities. Due to the specific vernacular of Public Water Utilities, it is necessary to ensure the energy coach and others working closely with the cohort members are well-versed in the terminology that resonates with plant operators. For example, plant operators speak in terms of loadings and flow rates rather than kilowatt-hours (kWh) or energy use intensity (EUI). Including a water/wastewater expert as part of the cohort management team enables effective dialogue between both sides and eliminates the possibility of vocabulary becoming an obstacle. This can also help build the trust that is important to breaking down barriers.
Slow start	Often times, plant operators and others working in the facility never see their energy bills. A useful opening exercise is to provide an overview and explanation of a facility's energy bill. Benchmarking is another initial step that helps familiarize cohort members with energy consumption of their own site. It then enables comparisons to be made in the future when actual energy saving measures are implemented. When the time comes to implement energy saving actions, generating quick-wins, such as lighting retrofits, are a great way to raise personal investment in the SEM program.
Inclusion of local engineering community	Most WRRFs and DWTPs work closely with a group of engineers on capital improvement projects. Crucial to the long-term success of new infrastructure is designing systems that reflect the city's commitment to energy efficiency. Including the engineering community in the cohort enables more experimentation that leads to more sensible design and operating strategies.

Tools, Programs, and Resources to Expand SEM Practices in Public Water Utilities

There are a number of national programs available to assist public water utilities with the reduction of energy usage. Initiatives described in this section range from comprehensive approaches to single components of SEM programs

DOE Programs

50001 Ready

Building a culture that is committed to improving energy performance on a continual basis is the underlying principle of SEM. The 50001 Ready program was developed by U.S. DOE to help facilities establish an energy management system that enables project identification, prioritization, planning and implementation. Users of this free online tool will be directed through a series of 25 tasks. Facilities that complete the program are encouraged to pursues ISO 50001 certification, although it is not required.

More information about the 50001 Ready program can be found here.

Better Plants Program

Participants of U.S. DOE's Better Plants Program commit to an energy savings goal, typically a 25 percent reduction over a ten year period. Program partners receive support to establish energy baselines, develop energy management plans, identify projects, and track performance over time. The program also offers multi-day events led by experts in the field that can help identify cost-effective projects to meet their goals. Participation also opens up facilities to other benefits including resources and national recognition for their successes.

U.S. DOE has been increasingly targeting the public water sector leading to 24 public water utilities participating in the Better Plants Program today. Five partners have already received in-plant trainings. Eight of the partners are from within the NEEP region. Learn more about the Better Plants Program here.

Sustainable Wastewater Infrastructure of the Future Accelerator (SWIFt)

SWIFt is one of U.S. DOE's Better Buildings Accelerators created to demonstrate specific innovative approaches that help accelerate investment in energy efficiency. Launched in 2017, this three year accelerator seeks to improve energy efficiency in participating plants by 30 percent or more. This accelerator will generate model plans and proven methods that other wastewater treatment plants can replicate to work towards a more sustainable future for wastewater systems.

Accelerator news and updates can be found here.

Industrial Assessment Centers

Information collection is an important element of SEM programs that spurs significant interest in facility energy management by shedding light on capital projects that cut costs and save energy. U.S. DOE's Industrial Assessment Centers (IACs) provide assessments to uncover these opportunities. Twenty eight universities and six satellite locations around the country perform facility audits to generate energy savings and productivity improvements specifically in small to medium size industrial facilities. As a result of these assessments, more than $47,000 is saved on an average annual basis at each facility. As of December 2017, over 18,000 assessments have been conducted by IACs across the U.S., the vast majority of which have targeted industrial facilities rather than public water utilities.

Over the past several years, U.S. DOE has put an emphasis on increasing the number of DWTPs and WRRFs targeted by IACs, a trend that is expected to continue as savings opportunities in these facilities become more desirable. U.S. DOE has tasked each IAC to perform assessments at 1-2 water-wastewater facilities per year. In Maryland, IACs have conducted seven assessments resulting in 51 suggestions to water and wastewater facilities yielding recommended savings exceeding $2 million. Typical recommendations made to public water utilities include the installation of equipment to convert waste to fuel, high-efficiency lighting, optimization of motors and pumps, and powering off equipment when not in use. Information, insights, and recommendations gained from these assessments can be used as buildings blocks for an SEM program at the facility level.

U.S. DOE provides a list of criteria that each industrial facility must meet to be eligible for an IAC assessment. To learn more this no-cost opportunity, click here. Additionally, U.S. DOE provides a list of tools that assist plants with energy management.

EPA's Portfolio Manager and Energy Assessment Guidebook

EPA's ENERGY STAR Score for WRRFs

EPA's ENERGY STAR Portfolio Manager is an online tool that enables simple measuring and tracking of facility energy and water usage and greenhouse gas emissions. Over 80 property types are available in Portfolio Manager, one of which is WRRFs. Primary, secondary, and advanced treatment facilities are all able to use the free benchmarking tool. As of 2016, 1,377 WRRFs have used Portfolio Manager resulting in an average ENERGY STAR score of 48, indicating there is much room for improvement in this sector.

To complete the benchmarking process, users of the software must compile some basic facility information such as square footage and location, as well as more detailed data including average influent flow, and presence of fixed film trickle filtration process. Analysis of input data is based on data collected by the American Waterworks Association Research Foundation.

EPA provides a number of detailed resources, fact sheets, webinars, and direct technical assistance to communities looking to complete benchmarking for their facilities. More information on the WRRF program can be found here. As of 2017, DWTPs are not eligible to receive an ENERGY STAR score through Portfolio Manager. Portfolio Manager is a useful tool for benchmarking building energy use but not necessarily process energy use.

EPA's Energy Management Guidebook

In 2008, EPA developed the Energy Management Guidebook for Wastewater and Water Utilities. This report provides specific activities that public water utilities can follow to reduce energy consumption and greenhouse gas emissions by categorizing them into a four-pronged approach; Plan, Do, and Check & Act. Although the guide does not refer to SEM explicitly, most (if not all) of the integral components of an SEM program are mirrored in this EPA resource, including securing buy-in from employees and leadership. The guidebook also provides a number of case studies highlighting real-world examples of energy management programs being implemented at DWTPs and WRRFs.

In addition to the guidebook mentioned above, EPA provides a number of resources for sustainable water infrastructure that can be found here. The Energy Management Guidebook for Wastewater and Water Utilities is located here.

Electric Utilities SEM Offerings by State in the NEEP Region

There are a limited number of electric utilities in the NEEP region already offering some level of SEM program targeting industrial, commercial, and municipal customers. While not all of these programs are unequivocally SEM program offerings, they do, on some level, contain the core concepts of what makes up a SEM program. Furthermore, not all programs listed below may be available to public water utility customers. These programs tend to develop and evolve over time and the highest likelihood for SEM water-wastewater offerings will be in states with previous industrial SEM program experience. Details of these programs within the NEEP region are provided below:

State	Program Details
Connecticut	Energize Connecticut's Business Sustainability Challenge (BSC) is available to municipal, industrial, and commercial customers of United Illuminating and Eversource. The program is focused on "continued efficiency and sustainability" to ensure long-term economic, environmental, and social benefits are reached. Training and education, continuous operational improvement, strategy development, and systematic behavioral change are all components of this program. Industrial facilities take the following steps throughout the BSC:

	• Make a commitment • Assess performance and set goals • Create a plan • Implement the plan • Evaluate the plan's progress • Recognize achievements • Reassess the process
Massachusetts	Currently there are not SEM offerings in Massachusetts. However, The 2016-2018 Massachusetts joint Statewide Three-Year Electric and Gas Energy Efficiency Plan (p. 120) states that utility program administrators will be "…examining methods to expand SEM to a broader market as the concept becomes a more familiar model in the business community."
New Hampshire	New Hampshire's electric utilities offered a series of Energy Master Planning seminars to commercial, industrial, and municipal customers in 2016. Building on the success of these events, the electric utilities committed in their 2018-2020 statewide energy efficiency plan to continue to explore and support customers' efforts to develop Energy Master Plans. This support would include the planning and evaluation effort, as well as prescriptive and custom incentives to help customers implement resulting projects.
New York	In 2017, industrial facilities exceeding $500,000 in energy costs were able to apply to the state's SEM Program. The first SEM pilot consists of eight industrial facilities located across the state and are participating in a series of 10 energy coach-facilitated workshops over the course of 12 months. The first cohort commenced training in September 2017 and a second cohort, seeking approximately 12 industrial facilities, is scheduled to begin around the summer of 2018. In 2018, a new SEM cohort will target the wastewater sector and will be the first offering of its kind in the NEEP region.
Pennsylvania	PPL electric utility offers the Custom Program to industrial customers, which includes financial incentives for continuous energy improvement measures (e.g. behavioral and strategic energy initiatives). The other program administrators in Pennsylvania do not have SEM initiatives. More information on PPL's program can be found here (p. 34).
Rhode Island	There are currently no industrial SEM offerings in Rhode Island. National Grid will explore an industrial SEM program with program administrators in neighboring Massachusetts. This is discussed in [National Grid's] "Annual Energy Efficiency Plan for 2018 – Settlement of the Parties" More information is available here (p. 172).
Vermont	Efficiency Vermont's Continuous Energy Improvement (CEI) program is a tool for industrial and institutional facilities in the state of Vermont to improve their energy efficiency on an ongoing basis. The program incorporates many important elements of SEM such as; employee engagement, ongoing maintenance, equipment upgrades, energy tracking, and more. The CEI program helps larger commercial and industrial customers cut consumption by 10-15 percent in the first three years.

Call to Action

Strategic Energy Management (SEM) is a proven methodology for reducing energy consumption in large, energy intensive facilities. The applicability of this program type to the municipal water sector is clear for many reasons; (1) very high energy users, (2) detached upper management, (3) aging equipment, (4) increased number of municipalities establishing energy and greenhouse gas reduction goals, and (5) potential success of peer-to-peer exchange amongst public water utility staff members. A growing number of past experiences in this sector have proven the viability of this program type. Lessons learned and best practices from previous engagements should continue to be refined and adopted by future program administrators. SEM not only has the ability to deliver significant energy and cost savings to municipalities, but these programs can also be a crucial step forward to the realization of greenhouse gas reduction goals.

Communities to adopt SEM practices in their public water utilities: The production of clean drinking water and treatment of wastewater are costly undertakings for any municipality. Incorporating SEM into these facilities should be viewed by municipal decision makers as an opportunity for significant costs savings. Additionally, communities that are establishing greenhouse gas reduction goals can achieve major reductions by targeting this underserved sector. To incorporate SEM at the facility-level, municipal stakeholders can leverage their local utility providers to learn more about what programs and incentives are available, as well as utilize resources that U.S. DOE has made available.

Energy efficiency programs to offer SEM trainings and resources to public water utilities: A growing number of SEM offerings targeting industrial facilities are becoming available in the Northeast and Mid-Atlantic region but significant opportunity remains in the municipal water sector. Electric utilities and energy efficiency utilities should seek to expand their interactions with local municipal water and wastewater facilities to help municipalities adopt SEM practices, and in the process reducing energy budgets and improving resiliency. Key lessons learned referenced above should be incorporated into all SEM program offerings. Perhaps most important is the inclusion of a water/wastewater system expert in the process which allows for unimpeded discussion between program participants and electric utility staff members.

NEEP has developed two other resources to inform efforts for SEM program offerings:

EM&V (Evaluation Measurement and Verification) Best Practices & Recommendations for Industrial SEM Programs: The purpose of this report is to provide energy efficiency program planners, evaluators, and regulators with information on the issues related to evaluation of savings and cost-effectiveness based on some of the current experience associated with evaluation, implementation and verification of SEM, including consideration of associated non-energy benefits.

Northeast and Mid-Atlantic Industrial Sector Report: Market Assessment & Recommended Strategies to Accelerate Energy Efficiency: This report seeks to assess the characteristics of the region's industrial base, understand the current best practices related to energy efficiency in this sector, quantify energy and peak savings opportunities, and then provide recommended actions to realize the region's energy efficiency opportunities.

U.S. Department of Energy should continue to provide programs and resources that support public water utilities in their adoption of SEM: Currently, U.S. DOE is already participating in many activities to support the implementation of SEM in public water utilities. U.S. DOE's accelerators, including the Sustainable Wastewater

Infrastructure of the Future Accelerator, will help provide best practices and create success stories that are critical to others adopting similar approaches in public water utilities.

DOE's Industrial Assessment Centers (IACs) recent increased focus on public water utilities is another indicator that progress is being made in this sector. Promotion of this program to public water utility operators is important to ensure that the program benefits are as far-reaching as possible. Equipping IAC staffers with resources and knowledge of SEM is another logical step to implementing SEM measures in these facilities.

Strategic partnerships between U.S. DOE and associations such as the American Water Works Association and Water Environment Federation (WEF) can lead to enhanced understanding of the importance of energy in public water utilities. Training workshops and other resources could be shared amongst members of the association. ISO 50001 Ready, for example, could be a useful conference workshop or training session for water professionals.

U.S. Environmental Protection Agency should continue to collect data and support efforts to reduce energy usage in public water utilities: Process energy benchmarking is a great way for facilities to gain a better understanding of their energy usage but it's also useful for industry experts to gain insights into trends that are occurring at specific facility types. Increasing the amount of data reported and collected in the municipal water industry should be a focus of EPA moving forward. Furthermore, implementing energy or right-sizing requirements into permit regulations could be a consideration for EPA.

Stakeholder should work both locally and regionally to support the adoption of these key recommendations:

NEEP facilitates regional stakeholder working groups to coordinate implementation of regional strategies. These coordinated discussions will be part of the agenda in both the Northeast SEM Collaborative as well as the Communities Working Group. Stakeholders should engage these regional groups to move not only move these recommendations forward but to bring new ideas and strategies to a broader network of stakeholders.

Conclusion

The number of state and local governments establishing energy and carbon emissions reduction targets continues to grow throughout the Northeast and Mid-Atlantic. In order for these goals to be met, efforts must be directed towards high energy consuming facilities – such as municipal water facilities – where proven methodologies, such as SEM, have been effective. Success in this sector is highly dependent upon the engagement of a broad spectrum of stakeholders due to its unique position as a locally operated facility with federal and state regulation. Implementing SEM programs presents an emerging opportunity for municipalities to capture comprehensive savings, allowing for the achievement of energy and carbon emissions reduction goals.