Water Energy Future Workshop

Executive Summary

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1 Introduction

On Nov. 27, 2012, the Water Environment Federation (WEF), Alliance to Save Energy (ASE), and Danfoss hosted a workshop with a broad representation of energy and water experts from federal agencies, local government, non-governmental organizations, finance, and industry.

The meeting focused on the need for coordination among stakeholders in the water and energy sector to increase energy generation and efficiency at wastewater treatment facilities. During discussions, participants identified barriers and solutions in the key areas of policy, finance, and technology. One of the goals of the meeting was also to define a set of actionable steps to advance energy efficiency and generation in the water sector.

Meeting participants included senior staff from the U.S. Environmental Protection Agency (EPA), Department of Energy (DOE), U.S. Department of Agriculture (USDA), Bureau of Reclamation, and the House Water Resources Subcommittee. There were also representatives from a variety of engineering and consulting firms that specialize in energy resource recovery from wastewater.

1.1 Background

Water and wastewater facilities represent about 3-4% of U.S. electricity consumption. According to the DOE, these facilities are the third largest energy consumers, using more than 55 billion kilowatt hours per year. On the reverse side, it takes between 3,000 and 6,000 gallons of water to power one 60-W incandescent bulb for 12 hours per day over the course of a year, according to EPA.

However, there are many opportunities to improve energy efficiency at treatment facilities, from technology improvements to more efficient system design. Energy generation at wastewater facilities is already a reality. In fact, some plants are generating enough energy for onsite use and selling electricity back to the grid. The most common generation method is anaerobic digestion, which is used to create biogas. Anaerobic digestion is used at about 1,238 water resource recovery facilities (WRRFs) in the U.S. It is a process by which bacteria break down organic material without oxygen. As a result, the bacteria produce carbon dioxide and methane, also known as biogas, which can be used to generate energy. Only about 292 facilities generate energy, while many others flare the biogas without a way to harness its potential. In the U.S., WRRFs that do generate large quantities of energy generally do not use municipal waste alone. Cooperation with food or agricultural entities is often an important source of organic material. However, there are utilities in Europe and Canada that are energy neutral and use only municipal waste.
2 Presentations

Prior to the plenary discussions and the breakout sessions, presentations were provided to set the stage for the workshop. Summaries of the presentations follow.

2.1 WEF’s Role in the Water-Energy Nexus

Presenter: Dr. Barry Liner, PE, Director of WEF’s Water Science & Engineering Center

WEF is a nonprofit technical and educational organization for the advancement of the water sector. One of WEF’s key focus areas is on resource recovery from wastewater, one of those key resources being energy. WEF’s goal is to drive WRRFs to become sustainable energy consumers and producers.

In 2011, WEF hosted its first energy-specific conference. WEF’s second biennial energy conference, Energy and Water 2013, will be held in Nashville May 6 – 9.

Innovation was a major theme at WEFTEC 2012—in technical programming and roundtable discussions. During meetings with EPA—an interested partner on WEF’s energy initiatives—WEF members identified many barriers to energy generation at water resource recovery facilities.

- Plants using anaerobic digestion but not producing energy are flaring gas and wasting that potential energy.
- Some power utilities help with conservation, but hinder WRRFs that try to generate energy.
- Payback times are a barrier, often utilities are only doing projects with short payback periods (even as short as 2 years).
- There is money in the private sector that is not being used for water infrastructure.

WEF’s Energy Roadmap is a series of steps arranged in six categories to help water and wastewater utilities plan and implement an energy program. The road map is applicable whether plants choose simply to increase energy efficiency or to build a full-scale cogeneration system. Topics range from technical needs to managerial aspects, and steps are applicable to small, medium, and large facilities.
2.2 DOE’s Role in the Energy Policy and Regulation Landscape

Presenter: Dr. Holmes Hummel, U.S. DOE, Senior Advisor, Office of Undersecretary of Energy

Efforts by DOE and the federal government to overcome barriers to energy efficiency and generation in the water sector:

- Water and wastewater facilities can be part of DOE’s Better Buildings, Better Plants Program by committing to reduce energy intensity by 25% over 10 years. Partners also have access to technical assistance and research and development from DOE.

- ISO 50001 is the international energy management standard that provides a standard methodology for a wide range of stakeholders—industrial, commercial and institutional—to establish systems and processes to manage energy and improve energy performance transparently. DOE provides support for implementing the standard.

- In August of 2012, President Barack Obama issued an Executive Order on Accelerating Investment in Industrial Energy Efficiency. It calls for 40,000 MW of additional combined heat and power added to grid—led by DOE through the agency’s Advanced Manufacturing Office.

- Public utilities have unique challenges with access to funding. However, about $2 billion in low cost capital is available to states in the form of qualified energy conservation bonds.

- DOE, the Department of Transportation and others have joined in support of an infrastructure bank.

- Resilience and local energy assurance planning — DOE has committed $50,000 to states and local communities to develop plans for emergency response. Every utility ought to have energy assurance plan. However, water resource recovery facilities aren’t taken into account as critical loads. Do local authorities know what assets utilities have and their needs are?

- Water reuse and harvesting — why contaminate or treat more water than is necessary?

- Building codes can advance water and energy efficiency if users both adopt and comply with them. Codes have helped improve the energy efficiency of new buildings by 30%.

- Public engagement and outreach — DOE continues to work on compliance standards and public engagement (energysavers.gov). Many electric companies now offer customers easy access to their energy-use data (green button standard). Consumers deserve to have data about the resources they use in order to better manage them. Applications are also available on energy.data.gov that allow consumers to manage their energy use. This is needed in the water sector.
2.3 EPA's Role in the Water Policy and Regulation Landscape

**Presenter: Dr. Ellen Gilinsky, U.S. EPA, Office of Water**

As interconnected resources, reducing the demand of either water or energy can help conserve both resources. EPA is working to minimize the impacts of water and wastewater treatment processes on energy production and vice versa. Here are a few ways to reduce demand.

- Using programs like Energy Star and Water Sense,
- Reusing water (treatment for the appropriate use) and implementing a full cost rate structure,
- Using new technologies with improved energy and water efficiency,
- Eliminating leaks in collection and distribution systems,
- Conducting energy audits of water and wastewater facilities.

In addition to reducing demand, EPA is also focused on the potential for generating energy at WRRFs.

EPA is encouraging the water and energy sectors to move toward integrated resource management. In doing so, EPA is reviewing their policies to determine whether they have unintended consequences, such as preventing innovation.

EPA is also working to improve public outreach on the connection between water and energy and the value of both resources and the agency’s efforts.

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**EPA's Six Principles for an Energy Water Future**

1. Efficiency in the use of energy and water should form the foundation of how we develop, distribute, recover, and use energy and water.

2. The exploration, production, transmission and use of energy should have the smallest impact on water resources as possible, in terms of water quality and water quantity.

3. The pumping, treating, distribution, use, collection, reuse and ultimate disposal of water should have the smallest impact on energy resources as possible.

4. Wastewater treatment facilities, which treat human and animal waste, should be viewed as renewable resource recovery facilities that produce clean water, recover energy and generate nutrients.

5. The water and energy sectors – governments, utilities, manufacturers, and consumers – should move toward integrated energy and water management from source, production and generation to end user.

6. Maximize comprehensive, societal benefits.
2.4 Meet Strict BNR Limits at Net “0” Energy
Presenter: Elena Bailey, PE, Ovivo Water, Director Business Development North America

WRRFs are constantly improving to meet more stringent treatment standards, such as biological nutrient removal limits. **In general, treating wastewater to a higher standard requires more energy.** The challenge is meeting new strict water quality regulations and using less energy doing so. Everything in a WRRF uses energy, yet anaerobic digestion is generally the only process that generates energy. Most plants are not using anaerobic digestion because it is not incentivized.

While there are no plants in the U.S. that are entirely energy neutral using only municipal waste, there are some in Europe and Canada. This means the technology and the processes exist to accomplish energy neutrality. However, it requires WRRFs to change their processes by thinking outside of the box, for example, abandoning the conventional norm that uses biological processes to remove carbon.

Furthermore, becoming energy neutral using municipal waste does not cost much more. Yet, operators are typically evaluated by one key criterion — achieving permit requirements. So, there are no incentives to innovate. Another issue is that the value of water in the U.S. is artificially low.

![Graph showing energy usage in WRRFs](image)

**2.5 Energy Systems Technologies and Strategies**
Presenter: John Masters, Danfoss, Vice President

Technology improvements offer huge potential for energy savings in water, wastewater, and irrigation, particularly through motor efficiency upgrades, improved control schemes, and variable speed control. For example, water leakage accounts for 30% net revenue water loss in some cities. Variable speed technology can help reduce water loss through better process control. In addition, process optimization and improved system design can also improve energy efficiency. Intelligent process controls can use the amount of energy necessary based on demand.
However, new technologies require EPA and state regulatory approval. Therefore, **regulatory acceptance of new technologies is a barrier to innovation**, and this situation makes it difficult for venture capitalists to invest in water technologies because the technologies are not easy to implement.

In addition to new technologies, there is also a group of proven technologies and retrofits that are easily implemented and offer major areas for savings. For example, aeration is one of the most energy intensive processes at a water resource recovery facility, so properly sizing, improving blowers, and using intelligent controls can significantly reduce energy demand.

Municipalities typically invest their money into large infrastructure upgrades, so municipality budget constraints are a major barrier to innovation. In addition, there is a lack of financing models and incentive programs. **Technologies exist today, but remain under-deployed in the U.S., where energy and water are comparatively cheap.**

2.6 Private Financing Strategies

**Presenter: Thad Wilson, M3 Capital Partners**

Most large infrastructure investments come from private funds. However, much of that capital is not well suited to the U.S. water sector. Investing in municipalities can be difficult due to the local decision making process for improvements. Most investment companies are looking for $200–$500 million projects with a horizon of 5–7 years. This cost is generally too high to match with a municipality’s needs. **Costs and avoiding risk can be barriers to implementing new processes or technology for energy efficiency and generation.**

The M3 approach offers a better match up for the municipal water sector. M3 offers public-private partnerships with long-term investments (25-30 years) for smaller projects. M3 focuses on water infrastructure and the specific needs of municipalities and service providers. Therefore, energy efficiency is a driver for the types of investments M3 is looking to make.

M3’s interest rates are higher than municipal bonds, but they offer life cycle cost benefits and other community benefits not offered by the bonds. The company is not looking to privatize the utility but simply to deliver a project (new pipeline, upgrade, etc.), which M3 manages over the investment...
period. However the treatment plant retains long-term ownership and maintains control over rate setting.

The M3 option offers an accelerated launch and streamlined approach that is more quickly implemented than other financing options. It can also drive down operating costs over the life of the project. M3 puts its equity in and is at risk for the project. Therefore, they have incentive to deliver projects on time and on budget and are required to meet set performance requirements.

2.7 ESCOs and Performance Contracting

Presenter: Greg Miller, Johnson Controls

There is a large funding gap in the amount of money available for water infrastructure and the amount it will cost to upgrade that infrastructure. Most water resource recovery facilities have aging facilities and equipment, so they are spending reactively rather than proactively.

Energy performance contracting is another financing option available to utilities. Energy performance contracting is a partnership between a municipality and an energy service company (ESCO), such as Johnson Controls. Through this partnership utilities will determine ways to save energy and implement those projects. The projected energy savings are leveraged to pay for energy efficiency improvements. In addition, the ESCO assumes the risk, and utilities have the option to select equipment with the best efficiency and value rather than the lowest bid. The municipality sets up an agreement with a financial institution to establish an Escrow through which authorization and funds are funneled.

Currently, 48 states, excluding Alaska and Wyoming, have some form of performance contracting legislation. However, in many states water and wastewater facilities are not identified for service provider opportunities. So, there is some need for standardization.
3 Plenary Discussion- Issue Identification

After the presentations, a plenary discussion was held where barriers were identified and clarified. In general, these issues were categorized into four areas: Economics & Payback; Policy & Permitting; Technology Performance; and Partnerships, Public Outreach & Communication.

The following four exhibits discuss the barriers and potential actions the water sector could consider, based on the suggestions from the workshop participants.
3.1 Economics & Payback

Key Potential Actions

1. Incentivize energy efficiency and energy generation at water and wastewater facilities.
2. Provide cost data on improving energy efficiency and implementing an energy generation program.
3. Provide easily accessible information on funding options.
4. Quantify nonfinancial benefits and document energy-related costs and payback for use in education campaigns.

Barriers

- There is a lack of incentive for utilities to be energy efficient or to generate energy.
- Utilities are typically risk averse.
- Infrastructure projects are costly, and often focused on upgrading outdated equipment and facilities (competing priorities).
- Most municipal projects do not attract private investors due to project size and cost. Private investment is further hampered by the local decision making process and slow regulatory acceptance of new technologies.
- There is not very much data on project costs for energy generation or energy efficiency improvements. Data needs to show that this makes economic sense. Net benefit payback, market-based benefits, and life-cycle benefits would be helpful.
- Anaerobic digesters are only cost effective if you can sell electricity back to the grid.
- Utility managers have limited time to devote to energy issues with many other competing issues. Consultants and technology purveyors could facilitate energy efficiency implementation.
- Funding sources may not be available or are not well known, particularly local sources. Funding could help minimize risks to the investor and provide for capital investment.
  - Sources of funding could include: the private sector; water and wastewater rates and bonds; federal state revolving fund; Green Project Reserve; and grants.
  - In some states, electric customers pay a public benefits charge to fund energy efficiency improvements called for in a state’s energy efficiency portfolio standard. Adding such a charge on water/wastewater treatment bills could fund efficiency improvements in the water sector.
  - Electric utility incentives could ease the burden on wastewater utilities.
3.2 Policy & Permitting

Key Potential Actions

1. Provide guidance for improving energy efficiency and implementing energy generation at water treatment facilities.
2. Encourage policy and integrated planning that supports a permit process incentivizing energy efficiency and energy generation in the water sector.
3. Offer grants, tax credits, state revolving funds, public private partnerships, or other options to help with financing the energy transition.
4. Work to harmonize ESCO legislation in all 50 States

Barriers

- There is little guidance from the federal level down to the state. A framework that is useful for local officials, operators, and others is needed. This framework should be interwoven with the permit process, and actions like an energy efficiency analysis could be a state-driven requirement. Looking at the state permitting process could help identify opportunities to innovate.

- Regulations are not streamlined and often mandate other priorities over energy efficiency and power generation from anaerobic digestion in combined heat and power systems. Sometimes regulations even present barriers to innovation (RICE rule, emissions permits, FERC regulations). Integrated planning (water quality, energy savings, air quality, etc.) is needed.

- At federal level, energy generated from biosolids and biogas is not included in renewable energy portfolio standards. If it were, calls for 80% renewable energy by 2035, coupled with market forces, could boost energy generation in the water sector. Standardization of eligible sources is needed.

- Utilities need the flexibility to innovate while meeting permit requirements.

- Some members of congress are already knowledgeable about energy-water issues. However, there is a need to further educate congress and provide them with concrete action items. A common voice across congress with recommendations would be helpful.

- Selling excess electricity back to the grid is sometimes hindered by tariffs and interconnection policies.

- Standardization is needed for the state definition of energy service companies – WRRFs and their energy streams (biogas/biosolids) should be included.
3.3 Partnerships, Public Outreach and Communication

**Key Potential Actions**

1. Cultivate partnerships to bring feedstock from agriculture, stores, universities, and others to WWRFs.
2. Provide education and training for water professionals on energy efficiency and generation, and facilitate peer-to-peer training.
3. Create a messaging and information campaign for the public and decision makers including case studies of successes and provide a platform for feedback.
4. Develop a recognition program for sustainable energy use at water and wastewater utilities.

**Barriers**

- Training, certification, and recognition programs are necessary in the water-energy nexus. Utilities that have already implemented programs should help communicate best practices.

- The public and decision makers are unaware of energy opportunities in the water sector.

- Sometimes energy generation requires complex relationships with food processing companies. There is a lack of incentive for anaerobic digestion partners, such as dairy farmers, because it is cheaper to take their waste to a landfill. Policy could incentivize or require feedstock to go to WRRFs.

- Operators must go beyond the mindset of meeting regulatory requirements. It is important to communicate the importance of energy programs and an understanding of technology deployment at all levels of utility personnel (utility managers to operators).

- Utilities need a path forward, peer networking on energy issues, and guidance—for example, on benchmarking for energy efficiency.

- There is a lack of awareness of funding and financing opportunities along with other helpful energy-related programs.

- Sometimes there is direct hindrance by electric companies to selling electricity back to the grid. Engaging electric utilities as potential partners would be helpful.

- Giving customers easy access to their water use data, along with an awareness of the amount of energy used to generate that water (green button option).
3.4 Technology Performance

Key Potential Actions

1. Increase the practice of energy benchmarking and the adoption of energy efficient technologies.
2. Use processes that maximize the effective use of carbon for energy generation and water quality benefits.
3. Streamline the approval process for new technology.
4. Develop a framework for identifying reference installations for new technologies to speed adoption.
5. Create an integrated data set for the water sector to facilitate prioritization of efforts as well as benchmarking.

Barriers

- Carbon is a necessary source of energy for bacteria in aerobic nutrient removal and anaerobic processes. Getting enough carbon for both aerobic and anaerobic processes can be problematic. More carbon can go to the anaerobic treatment process if a lower retention time is used during the aerobic processes.

- Water quality improvements require more energy. As nutrient regulations have become more stringent, plants must use more energy for aeration in nutrient treatment.

- Operators do not know how much energy is being used by specific treatment processes. Reporting requirements and benchmarking could help. This would give facility owners a starting point in terms of energy efficiency and would allow them to track their improvement over time.

- Technologies exist for energy efficiency and generation but are underdeveloped or not deployed because of the other barriers mentioned.

- Regulatory acceptance and permitting of new technologies takes time and hinders innovation.

- New technology can be expensive, but can be implemented during routine upgrades.

- Water resource recovery facilities in Canada and Europe are generating energy using 100% municipal waste. Their process and technology is not being adopted in the U.S. due to other barriers identified here.
### 4 The Path Forward

One of the goals of the workshop was to define a set of actionable steps to advance energy efficiency and generation in the water sector. As such, the participants will develop Action Teams for Education and Outreach; Policy and Permitting; and Technology Adoption. These teams will include a number of stakeholder groups to address some of the more complex initiatives. However, participants are implementing some actions immediately as shown below:

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<th>Issue</th>
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| **Identifying reference installations for new technologies to speed adoption** | Leaders Innovation Forum for Technology (LIFT) ([http://www.werf.org/lift](http://www.werf.org/lift)) is a joint WEF/WERF innovation initiative The LIFT Technology Evaluation Program (TEP) is a new program that provides:  
- A credible, well-documented vetting system to screen new technologies and processes by facilitating collaboration among facilities for the evaluation and testing of new technologies.  
- Ability to more rapidly deploy new technologies and remove existing impediments such as the mitigation of risk and cost of innovative technology deployment through collaborative partnerships. |
| **Framework to help utilities move towards sustainable energy management** | WEF’s Energy Roadmap is a series of steps arranged in six categories to help water and wastewater utilities plan and implement an energy program. The roadmap is applicable whether plants choose simply to increase energy efficiency or to build a full-scale cogeneration system. Topics range from technical needs to managerial aspects, and steps are applicable to small, medium, and large facilities.  
Watery™ ([http://www.watergy.org](http://www.watergy.org)) is a program by the Alliance to Save Energy to help cities realize significant energy, water and monetary savings through technical and managerial changes in water supply systems, providing consumers with quality water while using a minimum amount of water and energy. |
| **Education regarding Performance Contracting & ESCO** | At the Energy & Water 2013 Conference in May ([www.wef.org/energy](http://www.wef.org/energy)), WEF will be presenting a workshop on Performance Contracting 101 in addition to technical sessions on Alternative Service Provision. The Alliance to Save Energy is a co-sponsor of the conference and Danfoss is an exhibiting sponsor. |
| **Recognition Program** | WEF has begun developing the framework for a utility recognition program to promote innovation and sustainability in the water sector. The details will be announced at WEFTEC 2013 ([www.weftec.org](http://www.weftec.org)). |
| **Education on Resource Recovery** | This virtual tour of a WRRF discusses how these facilities recycle water, recover nutrients, and generate energy. [http://www.youtube.com/watch?v=A2FmNrEmowE](http://www.youtube.com/watch?v=A2FmNrEmowE) |
| **Identification of Potential Stakeholders and participants** | In order to better promote energy issues in the water sector, communication and outreach to an extended group of stakeholders is needed. The Action team for Education and Outreach will work with a number of organizations, potentially including U.S. EPA, U.S. DOE, US Conference of Mayors, National Government Association, National Association of State Energy Officials, Association of Clean Water Administrators, U.S. Green Building Council, USDA, Water Utility Climate Alliance, Consortium for Energy Efficiency, Association of State Drinking Water Administrators, International Association of Plumbing and Mechanical Officials, and others |
This report was developed from the Water Energy Future Workshop, a meeting hosted by the Water Environment Federation, Danfoss and the Alliance to Save Energy on November 27, 2012.