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Document Title:	Notes from California Energy Commission Workshop – Water & Energy Innovation to Achieve a Low-Carbon Future
Description:	This memo summarizes key opportunities and practical considerations from the California Energy Commission (CEC) Workshop titled: Water & Energy Innovation to Achieve a Low-Carbon Future held November 19, 2019, as part of CEC Docket: 19-ERDD-01. The workshop agenda is attached to this memo.
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MEMORANDUM

Pacific Northwest NATIONAL LABORATORY

Date:	**12/5/2019**	Project No.:	**71385**
To:	**DOE – Water Power Technologies Office**	Internal Distribution:	**PNNL-29495**
From:	**Juliet Homer**		
Subject:	**Notes from California Energy Commission Workshop – Water & Energy Innovation to Achieve a Low-Carbon Future (Docket 19-ERDD-01)**		

Introduction

This memo summarizes key opportunities and practical considerations from the California Energy Commission (CEC) Workshop titled: Water & Energy Innovation to Achieve a Low-Carbon Future held November 19, 2019, as part of CEC Docket: 19-ERDD-01. The workshop agenda is attached to this memo.

All slides will be made available on the Docket 19-ERDD-01 (as of December 5th, they are not posted). Kevin Mori from the CEC Water Program led the workshop.

The purpose of the workshop was to gather information to inform the next round of Electric Program Investment Charge (EPIC) research projects and awards. EPIC projects must benefit electric investor-owned utility (IOU) customers because money for the EPIC program comes from electric IOU customers.

Key opportunities by category

Wastewater - Aeration is the single biggest energy user in wastewater treatment (WWT). Carbon diversion, the act of diverting solids from aeration, and the use of anaerobic treatment methods instead of aerobic treatment methods can reduce energy use in wastewater treatment. Two EPIC projects were presented that demonstrated how this can be done, which are listed as items 1 and 2 below. Additional ideas for reducing energy use that emerged during the workshop follow.

1. Use a primary filter instead of a primary clarifier. Primary filtration reduces energy needed for aeration, increases biogas production, reduces the primary treatment footprint, and increases treatment efficiency. By filtering out a large amount of the organics prior to the aeration basins, it reduces the amount of energy that must got to aeration. Organically rich solids are removed prior to aeration and go directly to digestors where they are converted to biogas.

2. Anaerobic secondary WWT using a Staged Anaerobic Fluidized Bed-Membrane Bioreactor (SAF-MBR). SAF-MBR leverages the power of anaerobic microbes and reduces energy needed for aeration, cuts solids in half, increases biogas and

reduces necessary footprint. Some initial evidence suggests that contaminants of emerging concern (CEC) are better removed through anaerobic treatment than aerobic treatment.

3. Lowering dissolved oxygen (DO) levels - Another energy saving option is to lower the DO levels needed to achieve nitrification. Nitrification can occur at DO levels of 0.5 milligrams per liter (mg/L) rather than 2.0 mg/L. Some experienced operators are aware of this and don't immediately start up large blowers when DO levels start to drop, resulting in lower energy use.

4. Synergizing wastewater treatment plants (WWTP) and Fertilizer Production - A large amount of greenhouse gases (GHG) are emitted from making fertilizer through the Haber Bosch process, which converts nitrogen to ammonia. In wastewater, nitrogen is a key component that is essentially converted to nitrogen gas and sent into the sky. What if resource recovery through WWT could support fertilizer production? Policy innovation is needed to credit WWTPs with things not on their balance sheets, such as if they were able to reduce GHG from fertilizer production. Need to find a way to get the right people to pay for the right things and not have all these costs on the backs of the water customers.

Direct Potable Reuse – There is a big push in California to directly use treated wastewater for potable purposes. Direct potable reuse may drive new technologies and there are significant plans for direct potable reuse in California. There are two categories of direct potable reuse: 1) treated water augmentation and 2) raw water augmentation. New membrane technology, such as EPIC grantee Porifera, can be used for direct potable reuse. Porifera is a promising technology that uses a combination of forward osmosis plus reverse osmosis technology that is particularly suited for direct potable reuse because it includes real-time high-resolution integrity monitoring.

Premise Scale Water Reuse - A participant asked, "What about premise scale water reuse?" San Francisco is looking at this. Premise scale water reuse is tough economically because there are no economies of scale, but it may be valuable from a climate change perspective. A lot of low-lying plants are at risk due to sea level rise. If the buildings were higher, it would bring the treatment point higher above sea level.

- There is an industry push to create the right water for the right use.

- It is hard to retrofit existing buildings to add decentralized wastewater treatment

- The model of decentralized wastewater treatment is hard for regional boards who are charged with protecting public health. Instead of one or a few potential points of failure (or unexpected wastewater discharges), there would be thousands of control points.

- Premise scale water reuse would require extensive monitoring, control, and sensors to ensure the systems are working properly. One could leverage the tools of the 21st century to conduct monitoring of remote systems and ensure "permits" were being met.

- Premise scale water reuse would put the treatment closer to the point of reuse, reducing energy use. Currently, wastewater treatment plants (WWTPs) are located at the lowest point in the system. If treated wastewater is to be reused, it must be pumped from the WWTPs back to the point of reuse, which takes energy.

Leak Reduction - In many cases it is not cost-effective to proactively check for leaks. Often utilities just wait until water comes up to the surface before addressing water leaks. Participants discussed leak reduction strategies. An existing EPIC project that was presented studied two different leak reduction technologies: Echologics and Utilis. Echologics uses sensors on fire hydrants that can detect leaks in the system. Utilis uses satellite-based leak detection that looks at an imprint of chlorine coming in contact with soil. Advanced metering infrastructure can reveal leaks in a house and make people aware of how much water they are using.

Senate Bill 555 approved in October 2015 requires, for the first time, that water suppliers audit and report water loss performance on or before Oct. 1, 2017, and on or before Oct. 1 of each year thereafter.

Responsive water demand to mitigate the "duck curve" - California water and wastewater utilities can help mitigate the duck curve. With increased renewables on the system, energy efficiency isn't as important as the timing of when energy is used. Real time energy use data are critical but not always available. An aggregate monthly bill that includes four large pumps is not helpful in designing an energy management strategy. In California there is a move to dynamic energy rates, but some operators need support in figuring out demand charges versus other charges.

UC Davis (Frank Loge) is developing an open source tool that supports operating water and wastewater systems in a way to maximize benefits to the grid.

A lot of the ability to dynamically manage energy at water and wastewater plants comes down to information technology. The industry needs more technology vendors working in this space. A lot of this hinges on data security and privacy to enable technology vendors to come in and work in this space. Amazon Web Services and Microsoft type organizations need to be explicitly involved in dealing with privacy and customer data. This may be an area for DOE to support.

A pilot test at Laguna WWTP added a flow equalization basin, combined heat and power (CHP) system with biogas, and batteries. The most valuable asset was the CHP system, followed by the flow equalization basin and then the batteries. Insufficient sizing limited the impact of the batteries.

Practical Considerations

- Incrementalism and modular designs - Incremental retrofits or repairs are more practical than building new facilities. Most of the WWT infrastructure needed in California is already built out. It is not likely that these systems will be rebuilt from scratch. Ways to incrementally introduce new technologies (like primary filters and anaerobic secondary wastewater treatment) are necessary. Building new plants is expensive and not common. Energy savings alone may not warrant changes to what is built and used. One

option is to switch to more modular systems, swapping out membranes module by module or replacing one primary clarifier at a time.

- Capital cost savings – Where new plants are constructed and new technologies are used that require smaller footprints, smaller footprints result in reduced capital costs for new construction, which is big.

- Regulations are drivers for change - New regulations can force new technologies, but short of that, the same old tried and true technologies will likely be used, particularly at existing plants.

- Operators are critical - For some new technologies, maintenance requirements are huge. Operators likely cannot support maintenance requirements that double or triple in size. Operators are in short supply and need to be considered. Research efforts need to account for the human factor. It was suggested that energy targets be incorporated into performance goals of operators. There are water operator trainings offered by the Department of Water Resources every year that could potentially include energy trainings and create a groundswell in the operator community. One water professional expressed their priorities as the following as key ideas:
    - 1a. Get the water there.
    - 1b. Have the right water quality
    - 3. Energy

- Need to look at the whole system, holistically and intelligently - If a water utility installs solar panels that provide a lot of their energy needs, it may not then be cost effective for them to install high efficiency blowers. It's necessary to holistically evaluate the system to determine an appropriate combination and sequence of energy management practices. This is true even for the small utilities.

- Resilient systems are very attractive for water utilities. It is recommended that the CEC fund research into systems that can handle unexpected events at relatively low cost. It was suggested that making a system resilient should include making it simple. In California, with the Public Safety Power Shut-offs, some water plants self-supply power. Storage units won't help for more than an hour. Self-generation and microgrids are good options. Diesel generators are currently the go-to option. There are many small systems with no backup power. There is admittedly shaky chlorination upon system restart in some locations. Power shutoffs and back-up power needs are real issues with many rural systems.

- Sharing costs between different entities who benefit – Certain activities water utilities could do would benefit upstream entities and electric utilities. Water utilities and electric utilities could coordinate with electric utilities providing some funds to support mutually beneficial actions that water utility can take. This could happen if the water utility is optimizing for and realizing carbon reductions. A cost sharing mechanism is needed so those who benefit would share in the costs. Without a whole system approach, beneficial activities will likely not be undertaken. For example, from a retail water utility perspective, it isn't cost effective to proactively detect and then replace leaks. Perhaps an

energy/water cost share to locate and repair leaks would enable proactive water utility behavior to enable benefits beyond the retail water utility.

- Life cycle analysis is an important lens to look at potential water solutions through. Ben Stanford from Hazen and Sawyer, working for the water reuse foundation, developed a triple bottom line life cycle analysis tool that is available for free for people to download.[1]

- Who benefits from energy savings dollars? At municipal water utilities, money generated through savings it often transferred from the water utility to the general fund rather than to benefit the water utility. This is an issue and may reduce enthusiasm about saving energy. Decoupling for water is needed to incentive energy savings/management at water utilities.

- Water utilities need to be partners - Water operators say: "Make us partners in this. Don't just give us mandates. Make us partners and when the benefits extend beyond water, help us pay for the co-benefits that are produced." More collaboration with water utilities would go a long way. Involve water utilities more.

XXX/XXX/xxx (*Signer/originator/typist initials*)

Enclosures/Attachments – Workshop agenda

[1] https://cdn.ymaws.com/www.ncsafewater.org/resource/collection/8A06F077-41D7-46E8-A6F8-87C45AC49201/PM_Mon_AM_11.00_Ishii.pdf

WORKSHOP AGENDA

Energy Research Innovations in Water Treatment, Delivery and Energy Recovery

November 19, 2019
9:30 AM – 4:00 PM

CALIFORNIA ENERGY COMMISSION
1516 Ninth Street
1st Floor, Art Rosenfeld Hearing Room
Sacramento, California

Web Conference: https://energy.webex.com/ec
Audio Conference: **1-866-469-3239**
Access Code: **929 106 078**

Workshop Background and Objective: The energy used to extract, treat, convey water and dispose of wastewater currently accounts for nearly 20% of the California's electricity consumption. Since 1996, there has been a 74% increase in energy use in municipal wastewater treatment and a 39% increase in energy usage for public drinking water systems. This workshop will highlight some of the Energy Commission's innovative research on water treatment, delivery and energy recovery, seek public input on future research needs and identify potential pathways to commercialization for emerging technologies.

Event	Time
1. Introduction	9:30 AM
2. Program Overview for the Water Energy R&D	9:35 AM
3. Advancements in Reducing Energy Use in Wastewater Treatment Moderator: Christian Fredericks This panel will discuss promising advancements in wastewater treatment aimed at reducing energy consumption, opportunities to deploy advanced technologies into treatment plants, and future research needs of the industry. a. *Raw Wastewater Filtration to Increase Organic Removal Efficiency and Achieve Significant Electrical Savings*, Kennedy/Jenks Consultants, Inc.; Dr. Onder Caliskaner b. *Maximizing Energy Efficiency and Reducing Bio-solids Waste from New Anaerobic Wastewater Treatment Technology*, Silicon Valley Clean Water; Sebastian Tilmans c. Silicon Valley Clean Water – Eric Hansen d. Linda County Water District – Brian Davis e. Los Angeles County Sanitation District – Phil Ackman f. City of Manteca – Mark Houghton	9:45 AM
4. Progress Toward Maximizing Water Resources and Energy Grid Opportunities Moderator: Kevin Mori This panel will discuss California's water infrastructure and energy efficiency and water efficiency advancements, research advancements needed and metrics for determining success. a. *Demonstrating Innovative Leakage Reduction Strategies*, Hazen and Sawyer; Tori Yokoyama	10:45 AM

Event	Time
b. *Water-Energy Impacts of Disaggregated Water System Decision-Making*, University Of California, Los Angeles; Nicholas Chow c. *Advancing DR in the Water Sector*, UC Davis; Frank Loge d. *DPR Shield*; Porifera, Erik Desormeaux	
5. Lunch Break	12:00 PM
6. Innovations in Energy Generation for the Water Sector Moderator: Katharina Gerber This panel will discuss several innovative projects for energy recovery and identification of potential research needs. a. *In-conduit Demonstration Project*, San Gabriel Valley Water Company; Bob DiPrimio b. *Lowering Food-Waste Co-Digestion Costs*, Kennedy Jenks; Ganesh Rajagopalan c. *Waste Water Treatment Plant: Biogas to Beneficial Use*, Tetra Tech; Paul Stout d. UC Irvine - Dr. Diego Rosso e. Pacific Northwest National Laboratory - Juliet Homer f. Department of Energy - Madden Sciubba (invited)	1:00 PM
7. Pathways to Create Markets for Innovative Technologies Moderator: Virginia Lew This panel will discuss different programs and opportunities available for water agencies to implement innovative technologies, challenges and potential for collaborative efforts. a. California State Water Resources Control Board - Jelena Hartman b. California State Water Resources Control Board - Joe Karkoski (invited) c. CEC: Efficiency Division - ECAA Loan Program - Shahid Chaudhry d. Lawrence Berkeley National Laboratory - Peter Fiske e. West Yost Associates - Jon Wells f. Department of Energy - Diana Bauer g. Los Angeles Metropolitan Water District - William McDonnell h. Los Angeles County Sanitation District - Phil Ackman	2:00 PM
8. Q&A Session	3:30 PM
9. Closing Remarks	3:55 PM
10. Adjourn	4:00 PM