Energy and Water

Efficiency, Generation, Management, and Climate Impacts

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This conference is held by the Water Environment Federation in cooperation with the American Council for an Energy-Efficient Economy, the Consortium for Energy Efficiency, the Alliance to Save Energy, Imagine H20, the Alliance for Water Efficiency, the Illinois Water Environment Association, the Central States Water Environment Association, and the Water Environment Research Foundation.

Abstract Guide

TECHNICAL SESSION 1

Session 1: Heat Pumps

Monday, August 1, 2011 **Hyatt Conference Center Room 10AB**
10:45am – 12:00pm **1.25 PDHs**

1A 10:45am Using Green to Get to Blue: How Alternative Energy Technologies Reduce the Carbon Footprint of Wastewater Treatment
J. Osgood, M. Walsh, *CDM*; D. Bernier, *North Conway Water Precinct*

Water and wastewater treatment facilities typically represent one of the primary consumers of energy in a community. A progressive wastewater utility, the North Conway Water Precinct, reduced its energy costs in an environmentally responsible way by improving the energy efficiency of existing systems and incorporating new alternative energy technologies into its power supply portfolio. The precinct's Alternative Energy Systems project included the installation of 744 solar panels; 16 geothermal wells; heat pumps; and heating, ventilation and air conditioning (HVAC) improvements to reduce reliance on carbon-based energy sources and associated greenhouse gas emissions. This project serves as a model for wastewater facilities seeking to improve the sustainability of plant operations and reduce facility energy costs through the application of green technologies.

1B 11:05am Wastewater Heat Extraction for Commercial HVAC Applications: A U.S. Pilot Project
J. Chen, M. Boufadel, *Temple University*; E. Haider, J. Wang, *NovaThermal Energy*; A. Wang, *Tianjin Jin Da Di Energy Engineering and Technology Co.*

NovaThermal Energy's wastewater heat pump technology combines a geothermal heat pump with a patented filtration device to transfer heat energy directly from wastewater for commercial HVAC applications. By tapping directly into the pre-existing pipe system provided by the sewer infrastructure, the technology delivers geothermal savings to large urban buildings (> 100,000 sq ft) where traditional geothermal is often infeasible. Heat pumps move heat from one location to another, drawing heat from environmental sources (air, groundwater, and wastewater) and transferring that heat into buildings. Wastewater follows a highly predictable temperature curve relative to outside air, and is warm in the winter and cool in the summer. In the heating cycle, warm wastewater is transported to the wastewater heat pump which absorbs this heat. The heat pump then transfers heat to the building's clean water circulation loop, which provides heating to the building. The wastewater is then returned to the sewer main, whereupon the 6~20oF degree temperature differential is dissipated. NovaThermal Energy's filtration device makes direct use of wastewater feasible without creating blockage in the heat pump system. The high efficiency heat pump has a coefficient of performance (COP) of up to 6.26 in the cooling mode. The system is being installed and tested at the 20,000 sq ft (1,858 m2) Philadelphia Water Department (PWD) Compressor Building in the Southeast Wastewater Treatment plant in the City of Philadelphia.

1C 11:25am Towards Net Zero - Reducing Community Energy and Water Consumption by 50%

E. Lindquist, A. McCartie, *DEC Design Mechanical Consultants Ltd.*

DEC has pioneered and developed a patent pending district heating, cooling and water reclamation technology collectively referred to as a District Energy Sharing System (DESS) with the ability to reduce community energy and water consumption by up to 50%, construction costs by 30% to 50%, and greenhouse gas emissions by 50%. Many of the district energy innovations developed were driven from a financial model that demanded the adherence to four key principles for energy and water management, including demand side management, recovery and reuse, fitness for purpose, and optimizing the total lifecycle costs of infrastructure and community amenities.

DEC's district energy patent pending innovations are based on modern building system principles, making a DESS a logical extension of the building systems. The goal of modern building construction is to reduce the energy consumption of the building to net zero; this is typically cost prohibitive. By connecting a building to a DESS the remaining imbalance in energy consumption, heating or cooling, can be recovered and shared within the community. In addition, the DESS provides a means for clean effluent from water reclamation systems to be distributed within the community for reuse in non-potable applications. This allows developers and architects to reduce the individual costs of both new buildings and retrofits to existing buildings, while allowing the entire community to move towards net zero energy and water consumption.

TB1 11:45am Wastewater Effluent is Hot – Capturing Effluent Heat for Swimming Pools and Snowmelt Systems

S. Vandenburg, *CDM*; J. Schneider, *Town of Avon*; T. Rynders, *CDM*; J. Strehler, J. Hildreth, *Town of Avon*; D. Parry, *CDM*

The Town of Avon, Colorado, and the Eagle River Water & Sanitation District in Eagle County, partnered to construct a district heating system based on the recovery of low grade heat in wastewater effluent. The system uses a heat pump to capture heat from the Avon Wastewater Treatment Plant (WWTP) effluent and push it through a district heat loop running between the WWTP and the center of town. Heat is extracted from the loop to provide space heat for town - and district-owned buildings and swimming pools in the community recreation center. In the future a snowmelt system will be connected to the district heat loop to melt snow on roads and sidewalks in the downtown corridor.

The district heating system consists of two main buildings and an 200 mm (8-in) pipe that circulates between the buildings. The heat pump building is on the WWTP grounds and houses the heat pump and the heat recovery loop pumps. Adjacent to the WWTP is an effluent wet well, which pumps wastewater through the evaporator side of the heat pump. The heat distribution building is located in the downtown corridor of Avon. This building houses the recreation center pool heat exchangers (for the Jacuzzi, lap, slide, and leisure pools) and a supplemental boiler. The building is large enough to allow the installation of a future snowmelt system, which will be installed in an upcoming project and will be capable of melting snow on as much as 6,040 m2 (65,000 ft2) of roads and sidewalks. The heat distribution system and the WWTP are located about 0.8 km (0.5 mile) apart.

The heat recovery system was started up in February, 2011. Data recorded to date show that the system has produced over 1,500 GJ (1.4 million BTU) of heat. The electrical demand for the

system has been just under 200,000 kw*hr. Over a similar seasonal period in past years the Town of Avon has used about 3,600 GJ (3.4 billion BTU) of natural gas for heating the pools, domestic hot water, and space heating. Since the startup of the heating district system the Town has reduced its recreation center natural gas demand by approximately 1,800 GJ (1.7 billion BTU) of natural gas relative to previous years. Converting to common units, the heating district has currently supplied 158 kW of power as heat at an electrical power draw of approximately 92 kW. The net carbon impact of the operation of the heating district system is an estimated reduction in carbon dioxide emissions of over 23 tonne (25 ton) per month.

TB2 11:50am Heat Extraction from Plant Effluent: "Pumped-Up Heat Pumps"
E. Jacobson, B. Vestergaard-Hansen, *Brown and Caldwell*

High-temperature effluent-source heat pumps are able to meet the heating requirements of a wastewater treatment plant. The use of heat pumps can make anaerobic digester gas that might otherwise be used for heating available for other purposes. More than four times the heat required by a wastewater treatment plant is available with just a 1°C drop in effluent temperature. At least four U.S. heat pump manufacturers can provide heat pumps to meet digestion process temperature needs utilizing effluent at typical temperatures. The anaerobic digester gas that would otherwise be used for heating can be upgraded to natural gas quality using mature technologies.

The alternative to install effluent-source heat pumps and upgrade digester gas to pipeline-quality biomethane can be economically attractive under certain scenarios. A number of states have favorable conditions for considering this alternative, namely low electricity prices and high natural gas prices. An analysis of a hypothetical 76 mld plant provides an approach to assess when this alternative may have a better net benefit than cogeneration. King County's South Plant in Renton, Washington, is an example of the use of effluent-source heat pumps with digester gas upgrading for sale. The plant has been operating for 25 years and could produce enough revenues from the sale of biomethane to provide a simple payback for the digester gas upgrading system and heat pumps in less than 10 years.

TECHNICAL SESSION 2

Session 2: Water Supply Issues

Monday, August 1, 2011 **Hyatt Conference Center Room 10CD**
10:45am – 12:00pm **1.25 PDHs**

2A 10:45am The Potential of Adaptive Water Management Techniques in Wisconsin
A. Hable, *AECOM*

Management. Based on 14 global climate models using three emissions scenarios of the Intergovernmental Panel on Climate Change, projections for the State of Wisconsin indicate changes by the end of the century that could significantly affect groundwater-based water utilities. The vast variability of climate change and other uncertainties including population growth and demand fluctuations challenge the ability of water managers to predict future conditions. Specific adaptive water supply alternatives are proposed in this study that aim to enhance the ability of a groundwater-based supply system to operate under a wider range of

future variability. Two fundamental means are used to reach this end: residential water usage reduction as a means to minimize vulnerability to potential water stresses and groundwater recharge as a means to mitigate exacerbation of water stresses. A city in Wisconsin currently considering expansion of its supply system is used to provide context to the study. The city's existing supply alternatives are used as baselines for comparisons to the proposed alternatives of this study.

A residential water usage reduction program (based on technology updates alone, i.e., without any behavioral change) and groundwater recharge options are developed and assessed in the case-specific context. The city's existing alternatives are modified using the reduction program and groundwater recharge options to compose new, proposed alternatives. Data sources include existing research of residential water end-use, existing groundwater recharge practices in Wisconsin, the local water utility, the Census Bureau, and the Environmental Protection Agency. The existing and proposed alternatives are assessed within a multi-criteria decision analysis based on pairwise comparisons using a holistic selection of metrics and various weighting scenarios to represent the range of stakeholder value systems.

The results demonstrate that a comprehensive program to reduce residential water usage can reduce monetary costs of a water supply system as follows: a 3% reduction in capital costs, 15% reduction to the present value of total costs over 10 years, and 23% reduction to the present value of total costs over 50 years. The largest cost savings are in ongoing operations and maintenance, including a reduction in the high energy costs associated with deep-aquifer wells. The reduction program provides significant benefits beyond the monetary, including environmental and social benefits. The water usage reduction provides a reduction of over 16% in energy usage for residential water heating, generating direct savings for the customers totaling over $1.3 million annually. Carbon emissions fall by 39 to 63%. Aquifer drawdowns are mitigated and surface water baseflows improve. When groundwater recharge is also added, capital costs increase while the present value of total costs over 50 years still decreases slightly, compared to the existing alternatives. The groundwater recharge greatly amplifies the benefits to aquifers and surface water baseflows.

The study demonstrates that fundamental adaptive measures can improve water supply alternatives in terms of monetary cost, environmental impacts, and social benefits, including a reduction in energy consumption at both the utility and household levels. However, various barriers currently obstruct transitions toward the adaptive measures discussed. A series of context-specific recommendations are provided that are intended to remove existing barriers to change.

2B 11:05am Carbon and Energy Footprint Analysis of an Advanced Oxidation Process for Removing NDMA in Indirect Potable Water Reuse Operations

R. Sobhani, D. Rosso, *University of California*

The indirect potable reuse system operating in Orange County, CA is currently one of the largest water reuse systems in the world, with average flow treated of 62 MGD, planned for future expansion. The water reuse process is operated by the Orange County Water District (OCWD), using the treated wastewater from the adjacent Orange County Sanitation District (OCSD) Plant 1. The wastewater train includes primary and full secondary treatment with nutrient removal; the water reuse train includes microfiltration (MF), reverse osmosis (RO), a UV/H2O2 advanced oxidation process (AOP), and lime conditioning. N-Nitrosodimethylamine (NDMA), classified as probable human carcinogen by the US EPA, is a contaminant of concern

for this system and its effluent concentration is regulated at 10 ng/L. The goal of this research is to show the weight of the AOP on the energy footprint of the water reuse process at OCWD, and on the combined process at OCSD-OCWD. We also show the effects of varying NDMA removal on AOP's carbon and energy footprint for increasingly stringent effluent limits. The AOP's carbon footprint is dominated by the carbon equivalent of the energy footprint. This is amplified during peak periods in comparison to the nighttime, due to the reduced efficiency for power generation that power utilities experience during peak power demand periods. Therefore, even though the consumed energy could be the same during different diurnal periods, carbon footprint could vary significantly. This suggests that flow equalization, when possible, would be a solution to mitigate carbon-equivalent emission, while leaving the energy-footprint and process throughput unaltered.

2C 11:25am Energy Management of the Water Sector in Municipal Climate Action Plans

A. Nuding, *Western Resource Advocates*

The purpose of this study was to determine the ways in which energy and greenhouse gas (GHG) reductions in the water sector have been included in western cities' climate action plans, and to identify the suite of strategies that can most effectively achieve water-energy conservation under this policy program. The water-energy nexus is increasingly relevant in the western US, where water supplies closely match demand. Moreover, water utilities operations can account for 20-40% of government GHG emissions. Three western cities, Albuquerque, Denver and Phoenix, were selected for this study for their size and robust development of climate action plans. By reviewing city documents and holding conversations with city and utility staff, we found that water-energy programs are rather limited under climate action plans, but more frequently incorporated in sustainability programs, which have a broader focus. Nonetheless, climate action plans offer a unique focus on greenhouse gas mitigation strategies that sustainability plans do not, and thus they can be a useful policy tool to leverage water-energy conservation while ensuring greenhouse gas reductions. Among the most effective strategies for managing energy use in the water sector that should be utilized more is energy performance contracting, which addresses the energy used in the infrastructure and operations of the water-sector, and increased partnerships between water utilities and energy utilities to co-fund rebates and incentive programs for end users.

TB1 11:45am Energy Efficiency in the Water Industry

R. Lung, *Alliance to Save Energy*; J. Gledhill, R. Graf, *Policy Navigation Group*; A. Filippov, *Alliance to Save Energy*

While there have been energy efficiency programs targeting the water & wastewater utility industry, implementation of energy efficiency has been uneven within the industry. The water & wastewater utility industry faces a number of challenges when implementing energy efficiency measures due, in part, to its capital intensive nature and the interaction of public interests on water treatment. Because of these capital limitations many water & wastewater utilities have not invested in their infrastructure and water delivery assets in as many as thirty years, with the result that many water & wastewater utilities are currently served by aging and sometimes inefficient equipment.

As water becomes scarcer due to drought conditions in some parts of the United States and water treatment regulations become more stringent and energy-intensive, improving efficiency in water and energy use will become indispensible for water and wastewater utility managers and end use customers across a variety of economic sectors.

This paper will provide valuable insights into the Watergy approach to tackle the issues and opportunities faced by water and wastewater utilities. Based on a successful Watergy project at a utility in Pennsylvania that improved energy efficiency at several pumping stations and waste water treatment plants, other water & wastewater utilities and municipalities will learn how they can implement similar projects and achieve significant water and energy efficiency gains, thereby addressing both water scarcity and energy costs simultaneously. This paper will also help funding entities design programs that take into account the unique characteristics of the water utility industry. The authors conclude with policy and technical recommendations for future energy efficiency efforts in the water and waste water industry.

TECHNICAL SESSION 3

Session 3: Water Startups Saving Energy: Meet the Winners from Imagine H2O's Water-Energy Nexus Prize

Monday, August 1, 2011 **Hyatt Conference Center Room 11**
10:45am – 12:00pm **1.25 PDHs**

Innovation in Wastewater

N. Turner, *BlackGold Biofuels*

There are currently over 15,000 wastewater systems including approximately 6,000 Publicly Owned Treatment Works (POTWs) in the U.S.(EPA, 2008) Global Water Intelligence values current US wastewater utility capital expenditures at $14.4B and forecasts that this will double in the next 6 years(Global Water Intelligence, 2010). Despite this multi-billion dollar marketplace, the water industry has historically not been a target for innovative, cutting edge technologies and entrepreneurial investment dollars. In fact, over the past 30 years, there has been relatively little change in the technologies utilized in the wastewater industry despite massive technological advances in the rest of modern industry. This is due in part to industry protocols - most utilities plan for growth and capital investment 10-20 years in advance, which is not conducive to capitalizing on current technological advances. Additionally, this slow adoption rate is also the product of a risk-averse culture: water utilities safeguard public health and the environment and are justifiably unwilling to risk their efficacy in this function with new technologies.

Hydrokinetic Turbines for Distributed Power Generation in Artificial Water Channels

B. Hamner, *Hydrovolts*

Moving fluids such as water and air have kinetic energy that can be harvested to make renewable electric power. Wind turbines are a common example of kinetic power technology. Water cur-rents have 784 times as much energy density as air. Hydrokinetic turbines can harvest this pow-er, and are now being developed and tested in ocean and river currents. However, the developers are seeking megawatt-scale power generation; these are difficult and expensive installation envi-ronments with limited scope for development. In contrast, there are millions of miles of artificial water channels, such as irrigation canals, water treatment systems, aqueducts etc., that can be developed for distributed renewable power generation. Hydrovolts Inc. has invented and is de-veloping a hydrokinetic turbine that can harvest power from a variety of artificial water channels. Lab and field tests have demonstrated its performance and that it will

produce steady renewable power at less cost than comparable wind, solar or micro-hydro systems.

TECHNICAL SESSION 4

Session 4: Pumping and Aeration: Wastewater Treatment Plant's Biggest Energy Uses

Monday, August 1, 2011 **Hyatt Conference Center Room 10AB**
1:45 - 5:15pm **2.75 PDHs**

4A 1:45pm **Energy Efficiency in Wastewater Treatment In North America: A Compendium of Best Practices and Case Studies of Novel Approaches**
J. Sandino, G. Crawford, *CH2M Hill*; L. Fillmore, *WERF*; D. Kinnear, *HDR, Inc.*

After manpower, energy is the highest operating cost item for most water and wastewater companies. Over the last decade, energy consumption by the sector has considerably increased as a result of implementation of new technologies to meet new effluent and potable water quality standards. High energy consumption will affect the water industry worldwide and is inextricably linked to the issue of Climate Change. Through its Optimization Challenge program, the Water Environment Research Foundation (WERF) participated in the Global Water Research Coalition's (GWRC) project titled Energy Efficiency in the Water Industry: A Compendium of Best Practices and Case Studies. For this project, WERF served the role of North America practice coordinator, developing a Compendium of best practices in the energy efficient design and operation of water industry assets for this region of the world.

4B 2:05pm **Turning Pump Monitoring Data into an Energy Optimization Tool**
N. Andrews, S. Paske, *Brown and Caldwell*; D. Mathews, *Western Lake Superior Sanitary District*; B. Gehring, *Metropolitan Council Environmental Services*

Large pump systems can provide significant ongoing opportunities for energy optimization. Tailored energy monitoring approaches are needed to alarm inefficient pump conditions and provide real-time diagnostic tools. An ideal energy monitoring approach directs operations and maintenance efforts toward strategies that provide the maximum energy reduction, while minimizing unnecessary maintenance on pump system components that are operating efficiently.

Many pumping facilities measure flow, pressure, and power consumption, but few take full advantage of the energy management value of this data. An initial energy audit can identify pumps that are experiencing long-term wear problems or are operating at an inefficient condition on the pump curve due to a change in operating conditions relative to design conditions. Following the initial audit and optimization work, pump operating data can be used to monitor long-term pump wear and efficiency degradation, and to provide detection of increases in pump energy use due to plugging or other abnormal conditions.

Pump operating data can be configured into a simple energy dashboard to alert plant engineering and management when pumping equipment is operating inefficiently. An energy trending system has been developed to allow plant engineering staff to set a pump performance target that adapts to varying flow conditions, and to monitor energy performance relative to the target.

A diagnostic system using discharge pressure and pump speed data was also developed to assist in determining whether pumps are using extra energy because they are fouled or because the piping is obstructed. This system compares day-to-day operating data with actual pump data from known optimized performance conditions. This approach to using operational and energy management data to provide clear energy performance and diagnostic trending is a powerful tool for improving energy awareness and optimizing energy performance in large pumping systems.

4C 2:25pm Case Study: Retrofits Yield Dramatic Energy Savings at California Reclaimed Water Pump Stations

E. Myers, *Lescure Engineers, Inc*.; J. Rosenblum, *Rosenblum Enviromental Engineering;* J. Bidwell, *Quantum Energy Services and Technology, Inc.*

Two large reclaimed water pump stations owned and operated by the City of Santa Rosa, California, were retrofit for improved energy efficiency. A detailed energy audit developed mathematical pumping energy models to provide a scenario evaluation platform for the retrofit design, and predict the performance of the retrofits. Three new pumps were purchased through a competitive bid process that took into account life cycle energy costs, and incentivized the pump vendors to balance pump performance and up-front cost. Both retrofits were measured for energy performance, and yielded an 875 MWHr annual reduction in electricity demand, saving an estimated $96,000 per year. The post retrofit energy performance was measured and compared to the estimates from the mathematical models. Minor variances in energy performance between model predictions and measured performance were attributed to real-world features that were not incorporated into the pumping energy models. California public programs targeting energy efficiency were vital, providing financial support for up-front engineering, a substantial cash incentive, and a loan for the capital cost.

TB 1 2:45pm Evaluating "Wire to Air" Energy Use of Competing Blower Technologies

A. Balberg, J. Oleyar, B. Quinton, *HSI, Inc.*

Uniform evaluations of energy efficiency between different blower technologies is not readily available, nor encompassed by any available third party referenced specifications to require blower manufacturer's to follow. Owners and consultants cannot evaluate performance in a fair and consistent manner, leading to misinformation and unfair comparisons between technologies. Further, the performance verification process is difficult to prove.

TB 2 2:50pm Base Line for Energy Conservation, Water Transmission Main - Florida Keys Aqueduct Authority (FKAA)

P.Keskar, *CH2M Hill*; R. Coley, *FKAA*; A. Smyth, *CH2M Hill*

The Florida Keys Aqueduct Authority is the sole provider of potable water for all of the residents of the Florida Keys. Potable water is transported from the FKAA Water

Treatment Plant (WTP) in Florida City to the Keys through a 130-mile transmission pipeline, installed all the way to Key West.

The water distribution system is an energy intensive process which includes large horsepower pumps at the WTP high service pump stations and at several booster pump stations along the route of the water transmission main. The FKAA's energy bill for water production and distribution can be estimated at $2.5 million per year. Even a 10 percent reduction in the energy usage has a potential of saving up to $250,000 per year in energy cost. Recognizing this potential for savings in the energy cost, FKAA tasked CH2M HILL to evaluate the water distribution pumping systems to establish a "Baseline for Energy Conservation." As part of this task, a preliminary investigation was carried out at the main WTP and the booster pump stations to identify energy cost saving opportunities. For each pump station typical energy rate structures, energy consumption data, wire to water efficiency of pumps and power distribution/monitoring schemes were analyzed to arrive at a set of recommendations that would optimize overall energy costs for the FKAA Water Distribution System. This paper presents the methodology used and the recommendations made to FKAA as a result of this energy conservation study.

4D 4:00pm Energy Reduction and Nutrient Removal in WWTPs Using Feed-Forward Process Control

T. Stahl, G. Lee, M. Gray, S. Kestel, *BioChem Technology, Inc.*

Aeration is by far the largest electrical consumer in a wastewater treatment plant (WWTP), accounting for greater than 50% of total energy consumption. Typically, DO set-points are based on peak loading and are therefore much higher than what is needed for the majority of the day. Lowering DO set-points can have a significant impact on total energy consumption of a plant. A real-time, model-based process control system that calculates optimal DO set-points to treat the incoming loading without compromising effluent quality can reduce aeration and hence energy requirements. The process control system can also control mixed liquor recycle in a BNR plant, to maximize denitrification in the anoxic zone, thereby maximizing Total Inorganic Nitrogen (TIN) removal.

Pilot projects in Phoenix, Arizona and Enfield, Connecticut demonstrated aeration energy savings of 15% to 17% and improved TIN removal by over 35%.

4E 4:20pm Fine-Pore Diffuser Studies in BNR Wastewater: Performance Variation and Effects on Energy Footprint

D. Rosso, L. Jiang, J. Zhong, D. Coller, A. Kim, M. Firouzian, M. Jeung, M. Anaya-Santiago, K. Gellerman, *University of California, Irvine*; D. Hayden, *Irvine Ranch Water District*; P. Pitt, C. Hocking, *Hazen and Sawyer*

Fine-pore diffusers are the most common aeration system in municipal wastewater treatment plants. Fouling is inevitable and inexorable for all types of fine-pore diffusers, and is dependent on process layout, water quality, diffuser type, and time in operation, but independent of diffuser make and model. The decline in diffuser performance, resulting in increased aeration energy footprint is reflected onto the standard oxygen transfer efficiency (SOTE, ratio of oxygen transferred to the wastewater per unit oxygen blown by the aeration system, at standard conditions, %) and the net head loss across the membrane due the friction through the orifices, also known as dynamic wet pressure or DWP. In process water, the □ factor is introduced to correct for the effects of wastewater, defining □SOTE(%). These parameters vary inevitably due

to the fouling phenomena, with DWP increasing with time and SOTE decreasing. To account for the effects of fouling, a fouling factor F is introduced. Previously, we showed that the DWP increase is different for different materials, indicating different material properties and response with time in operation. Another indicator of diffuser performance is hence the pressure factor (ratio of DWP for used and new diffusers). This paper presents our 2-year diffuser study results and discusses the implications of our results on aeration energy footprint.

4F 4:40pm **You Don't Need to be Large to Make a Difference – A Small Community's Goal of Improving Effluent Quality While Reducing Energy Costs**

H. Schmidt, *MWH*; C. Mick, J. Manning, *City of North Port Utilities, North Port, Florida*

Recent societal pressures to reduce the costs associated with energy consumption and the related greenhouse gas emissions have created a driver that is an inconsistent with the traditional goals of water quality and environmental protection. The conflict between these goals is particularly compelling for wastewater treatment facilities (WWTFs) throughout the United States, as more stringent effluent requirements are being promulgated. In addition, to the stricter effluent requirements, influent loads and the type of biological treatment processes both play a considerable role of energy used at a facility. In general terms, it can be said that the greater the required level of treatment – the greater the energy demand. In most cases, we have found that many facilities over aerate, with no regard to how much air is actually required for the process in order to obtain adequate margin of safety against permit exceedences. The result is that the actual discharge concentrations from these facilities are well below the permitted discharge requirements, while a significant amount of energy is wasted in accomplishing this.

While energy issues energy issues are primarily a concern with large treatment facilities, there are much more utilities that treat less than 38,016 m3/day (10 MGD), and face this issue. For example, in Florida there are 2,059 domestic WWTFs statewide, and of these facilities there are only 57 (2.77%) WWTFs with a treatment rated capacity of greater than 38,016 m3/day (10 MGD). In most cases, the same can be said for other regions of the United States.

Poster **Roadmap for a Successful Pump Audit and Efficiency Improvement Program**

N. Andrews, G. Jones, *Brown and Caldwell*; D. Mathews, *Western Lake Superior Sanitary District*; B. Gehring, *Metropolitan Council Environmental Services*; R. Beebe, *Monash University and MCM Consultants*

Large pumping systems are second only to aeration systems as the largest energy consumer at wastewater treatment facilities, and are by far the largest energy users in collections systems and water utilities. The intent of this paper is to provide a roadmap for utilities that wish to initiate a pump audit and efficiency improvement program.

The U.S. EPA recently issued a widely-circulated manual entitled, "Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities." (USEPA, 2008) This guidebook relies on the "Plan- -Do-Check-Act" model for energy management. The framework of the "Plan-Do-Check-Act model is generally applicable to improving the energy efficiency of existing pump stations. This roadmap seeks to improve the usefulness of the "Plan--Do-Check-Act" model by making it specific to the pump efficiency improvement process.

Poster **Aeration System Design for Energy Savings**
M. Gray, S. Kestel, T. Stahl, *BioChem Technology, Inc.*

With the recent increases with energy cost and the requirements of Biological Nutrient Removal (BNR), the design and control of an aeration systems has become one of the most important parts of the design of the activated sludge process. A well designed aeration system can save significant amounts of energy and provide a stable BNR effluent by meeting the required dissolved oxygen set points at the lowest possible pressure. A poorly designed aeration system will bleed oxygen into the anoxic zones, lowering the potential denitrification capacity of the plant, and will waste power. The goal of the paper will be to describe the process of designing an aeration system and to present a case study of an advanced aeration control system based upon variable oxygen uptake rate.

TECHNICAL SESSION 5

Session 5: Algae

Monday, August 1, 2011 **Hyatt Conference Center Room 10CD**
1:45pm – 3:15pm **1.5 PDHs**

5A 1:45pm **Wastewater Nutrient Removal and Algal Biomass Production - An Energy Evaluation**
B. Sturm, *University of Kansas*; S. Lamer, *Bartlett & West, Inc.*

The potential environmental benefits of algal biodiesel production have recently been outlined in several life cycle analyses evaluating the energetic balance of the process. These virtual production analyses require a wide range of assumptions, including the addition of fertilizers and carbon dioxide to achieve high algal yields in open ponds. This paper presents an energy balance based on the microalgal production in four pilot-scale reactors (2,500 gallons each) fed with wastewater effluent from a conventional activated sludge process for six months. The pilot data was used to estimate an energy balance for processing the total average 12 million gallons per day processed by the wastewater treatment plant. The algal dewatering step consumes a significant amount of energy and therefore, several thickening and dewatering processes were compared. An energy offset was applied for removing nutrients with the algal reactors rather than the biological nutrient removal processes typically utilized in municipal wastewater treatment. The results show that biofuel production is energetically favorable for open pond reactors utilizing wastewater as a nutrient source even without an energy credit for nutrient removal. The direct combustion of algal biomass was also considered as an alternative to lipid extraction and biodiesel production as it may be a more viable energy source than biofuel production, especially when the lipid content of dry biomass (10% in this field experiment) is lower than the high values reported in lab-scale reactors (50-60%).

5B 2:05pm **Resolving Bottlenecks in Current Algal Wastewater Treatment Paradigms: A Synergistic Combination of Low-Lipid Algal Wastewater Treatment and Hydrothermal Liquefaction for Large-Scale Biofuel Production**

Y. Zhou, L. Schideman, Y. Zhang, G. Yu, Z. Wang, M. Pham, *University of Illinois*

A novel system for algal biofuel production was proposed, which integrates algal biomass production, wastewater treatment and hydrothermal liquefaction of biomass to bio-crude oil. A series of algae cultivation and hydrothermal conversion experiments were conducted, confirming several key characteristics of such system: 1) fast-growing low-lipid content algae can be produced using wastewater; 2) biomass produced in the system can be converted into usable biofuel though hydrothermal conversion process with a positive energy balance; 3) the system can leverage the nutrient content in the incoming waste-stream for maximum biomass production and carbon capture that is approximately 10 times the original mass of bio-waste. This process resolves the current major limitations to the economic feasibility of algal biofuels because high-lipid algae are not necessary and the energy for dewatering is minimized by the self-separation of liquefaction oil from wet biomass. Thus, this process would potentially completely replace petroleum imports using only waste inputs and carbon dioxide from the atmosphere. This is a new wastewater and bio-energy paradigm our world needs.

5C 2:25pm **Closing the Water-Energy-Nutrient Loop Using Anaerobic Membrane Biorector Coupled With Algae Photobioreactor**

A. Prieto, R. Bair, I. Cormier, D.H. Yeh, *University of South Florida, Tampa*

Recovery of resources has been steadily growing in the wastewater treatment industry. Biosolids are land applied and reclaimed water is piped throughout many municipalities. Methane recovery for energy production is a common practice at anaerobic digestion facilities throughout the developed world. Most “recovery” efforts result from convenient byproducts of the removal process, and are not the focus of technology development. However, with rising energy costs, depletion of mineral reserves, increasing fertilizer costs, and increasing population stress on resources, society is on the cusp of a paradigm switch where recovery of resources from wastewater is not only sustainable but also makes good business sense. Focused efforts to recover renewable resources such as clean water, energy, nitrogen and phosphorus, from sewage are now becoming the basis of new technology innovation.

TB 1 2:45pm **Energy Balance, Utilisation of Nutrients, and Uptake of Metals for Wastewater for Algae to Energy Production: An Algal Bioenergy Technology Assessment**

K. Baxter, G. Elsum, *Melbourne Water Corporation*; J. Poon, D. Austin, J. Mackie, B. Byers, *CH2M Hill*; S. Nayar, *South Australian Research & Development Institute*

Melbourne Water has developed a Greenhouse and Energy Strategy (GES) to achieve its stated organisational goals of being zero net greenhouse gas emissions by 2018 and boost the use or export of renewable energy to 100% of total energy used by 2018. An engineering analysis was conducted to determine feasibility of algal energy production at its facilities. Proven methods of algae biomass production, harvesting, and energy extraction were chosen for this analysis for methane and biofuels production. Analyses produced negative energy balances for proven technologies because of large parasitic energy demands inherent at various stages of

the process. In all cases carbonation of water with CO2 for autotrophic algae production was a large parasitic energy demand. Biofuel production requires heat for drying of biomass, which was also a large energy demand. Although somewhat speculative, mixotrophic production of methane appears to offer an opportunity to achieve a positive energy balance.

TB2 2:50pm **Harvesting Natural Algal Blooms for Concurrent Biofuel Production and Hypoxia Mitigation: Case Study of the Gulf of Mexico Situation**
C. T. Kuo. L. C. Lance, *University of Illinois at Urbana-Champaign*

This study assesses the net energy balance and economic benefits of harvesting environmental algal blooms and conversion of the harvested biomass into biofuels. An engineering model was developed to compare the energy efficiency of different harvesting methods and biofuel conversion techniques. Three different harvesting techniques plankton net trawling, traveling screen, and screw pump filtration are compared in terms of energy consumption and harvesting efficiency. Among the various conditions modeled, the most favorable harvesting condition was produced by a 750 kW fishing boat with a plankton trawling net for harvesting algae biomass at 0.5 m/s harvest speed and harvesting from the surface to 0.5 m depth in the ocean. When harvesting a highly eutrophic area (40 mg-chl/m3) under these conditions, we estimate plankton net trawling operation can collect 100 kg of dry algal biomass with 1 GJ of harvesting energetic consumption. Overall, the energetic analysis revealed that the entire harvesting and conversion process can achieve an energy “break-even point” if the chlorophyll concentration is above 55 mg/m3. We use the Gulf of Mexico hypoxic area as our case study site. Plankton net harvesting technology can harvest 23,313 metric tons in 3 month in the cost of $81,380,937. This result also suggests that vertical focusing technology can offset 98% of harvesting fuel consumption.

TECHNICAL SESSION 6

Session 6: Biogas Use and Methane Emmission as a Greenhouse Gas (GHG)

Monday, August 1, 2011 **Hyatt Conference Center Room 11**
1:45pm – 5:15pm **2.75 PDHs**

6A 1:45pm **Coordinating Utility Billing Rates to Maximize the Benefit from Onsite Energy Generation and Combined Heat and Power Systems**
B. Lisk, *Hazen and Sawyer*; D. White, J. Dodson, *City of Durham, North Carolina*; C. M. Bullard, *Hazen and Sawyer*

Reducing energy costs is becoming a major priority for many water and wastewater treatment facility owners. The recent economic downturn, rising energy costs, and increasingly stringent treatment regulations are among the many factors driving the need to reduce water and wastewater treatment energy usage and costs. Utilizing onsite power generation systems such as biogas fueled combined heat and power (CHP) systems to reduce energy costs by offsetting purchased electric power and manage demand are increasingly used in the water and wastewater industry. While, these systems can reduce energy costs, the full economic benefit is often not realized if the system design, the system operation strategy, and the electric utility billing rates are not fully understood and coordinated. The objective of this paper is to describe how the economic benefit from an on-site power generation systems heavily depends on the electric utility billing rate structure and to show concepts to maximize the benefit from these systems. To illustrate these concepts, this paper will present hypothetical and actual case

studies showing the economic relationship between the on-site power generation system capacity, operation and the electric utility rate structure.

6B 2:05pm A Systemic Look at Energy Optimization - Balancing Aeration Demands and Digester Gas Utilization to Provide Energy Savings and Carbon Footprint Reduction

J. Rohrbacher, B. Lisk, C. Szoch, *Hazen and Sawyer*; J. Whitaker, R. Wichser, T. Frederick, *Rivanna Water and Sewer Authority*

The Rivanna Water and Sewer Authority operates the 57 ML/d (15 mgd) Moores Creek WWTP in Charlottesville, Virginia. The facility is under construction and start-up to convert from a conventional nitrification activated sludge process to a five-stage enhanced nutrient removal process. Residuals from the treatment plant are thickened and stabilized via anaerobic digestion prior to dewatering. The existing facility relied on gas engine-driven aeration blowers equipped with a waste heat recovery system to provide hot water for digester and building heating. The engine-driven blowers routinely utilized natural gas to supplement digester gas to produce sufficient hot water for digester heating, resulting in excessive aeration and inefficient energy utilization. Four alternatives were evaluated to optimize digester gas utilization and improve aeration energy efficiency. The existing aeration blowers were replaced with high-speed direct-drive centrifugal blowers, and a combined heat and power (CHP) system for electrical power generation from digester gas was installed. The CHP/digester heating system will allow for seasonal digester gas optimization and provide substantial savings in purchased natural gas and electrical power while reducing the facility's carbon footprint. The energy improvements will also enhance nutrient removal performance by eliminating digester heating's dependency on operation of the aeration blowers.

6C 2:25pm Micro-constituents in Digester Gas: Sweating the Small Stuff

C. M. Bullard, B. R. Lisk, S. A. Hardy, *Hazen and Sawyer*

Increasingly wastewater treatment facilities that utilize anaerobic digestion are examining biogas beneficial use projects for energy recovery that transcend the current, and most common, practice of only capturing heat energy for process heating and flaring surplus biogas. Utilization of digester gas (DG) in energy recovery devices (e.g., hot water boilers, reciprocating internal combustion engines and microturbines) can be impacted by not only gas quantity but increasingly by gas quality. Digester gas quality considerations must include an evaluation of the major constituents (e.g., methane and carbon dioxide) to determine the overall energy content; however, the minor constituents (e.g., hydrogen sulfide and siloxanes) can most greatly influence the economic viability and mechanical reliability of a biogas beneficial use project.

Specifically, results of single event on-site DG sampling for eight (8) different wastewater treatment facilities for both major and minor constituents are presented. These results are derived from plants ranging in design capacity from 15 to 75 million gallons per day (MGD) covering a wide range of other site specific operational criteria (e.g., digester residence time, primary/secondary sludge blend, etc.) all operating conventional mesophilic anaerobic digesters. Furthermore, results of multiple sampling events at a single wastewater treatment facility are presented. These results indicate significant variation exists in micro-constituent content between wastewater treatment facilities and that significant temporal variability exists between samples collected at a single wastewater treatment plant. Digester gas treatment options for removal of moisture, particulates, hydrogen sulfide and siloxanes to meet gas quality requirements for downstream use in the digester gas utilization equipment are also discussed herein.

TB 1 2:45pm **Quantifying Fugitive Methane Emissions from Gas Flares: WERF's New Flare Efficiency Estimator**

A. Shah, M. Joiner, *Brown and Caldwell*; L. Fillmore, *WERF*; D. Checkel, *University of Alberta*; J. Willis, *Brown and Caldwell*; D. Handford, *University of Alberta*

A Flare efficiency estimator (FEE) is as part of a Water Environment Research Foundation (WERF) project U2R08 entitled "Methane Evolution from Wastewater Treatment and Conveyance" under WERF's Climate Change Program. The FEE is developed based on the work of the Flare Research Group at the University of Alberta (UOA) and it will help estimate the fugitive green house gas (CH4) emissions from the unprotected 'candlestick' flares for digester gas and landfill gas flares. WERF is planning to make the FEE available online for free for its subscribers as an online tool.

Details of the FEE are discussed in this paper including a brief overview of prior research on flares, WERF's approach for this research study, the calculation methodology, and a description of the user interface for the estimator tool. The FEE can be used to predict flaring efficiencies in variable operating conditions. Calculation method used for the FEE uses the gas composition, flare jet velocity, wind velocity and ambient temperature and pressure as some of the key input parameters.

The most widely accepted reference to estimate flaring efficiency, EPA's Emissions Factors and AP-42, recommends using a value between 98 to 100 percent (99 percent as a default) as flaring efficiency for the candlestick flares operating on landfill or digester gas. However, simply assuming 99 percent combustion efficiency can significantly underestimate the GHG emissions.

To demonstrate the use of the FEE to estimate fugitive GHG emissions, data from two wastewater treatment plants (WWTP), one from Georgia and another from Tennessee are presented as case studies. The FEE estimated flaring efficiencies of 94.5 percent and 96.6 percent for the WWTP in Georgia (80 mgd average daily flow) and the WWTP in Tennessee (100 mgd average daily flow), respectively. These lower efficiencies compared to the 99 percent flaring efficiency recommendations per EPA AP-42 amounted to approximately 522 MT CO2e/year and 488 MT CO2e/year of underreported GHG emissions for the WWTPs in Georgia and Tennessee, respectively.

TB 2 2:50pm **Resource Recovery of Restaurant Grease Trap Wastes at Dallas Water Utilities Can Provide Green Electricity**

J. Sober, T. Shimada, *Carollo Engineers*; J. White, M. Evers, R. Wagner, *Dallas Water Utilities*

Dallas Water Utilities (DWU) has identified multiple projects within their wastewater treatment plants (WWTPs) to support the Green Dallas Initiative for energy conservation and sustainability. In 2010, a new co-generation facility at the Southside Wastewater Treatment Plant (SWWTP) will be brought on-line. This facility will utilize digester gas for electricity production. As part of the Green Dallas Initiative, and to optimize the co-generation facility, the feasibility of adding high strength wastes to the anaerobic digesters at SWWTP to increase the digester gas production was evaluated.

6D 4:00pm Blowers, Generators, Digesters and the Energy Puzzle

G. Cressey, *Donohue & Associates*; J. Hung, C. Solberg, *Milwaukee Metropolitan Sewerage District*; M. Dierker, *Veolia Water Milwaukee*

The Milwaukee Metropolitan Sewerage District (District) faced numerous challenges at their South Shore Water Reclamation Facility (SSWRF). The aeration blowers and engine generators, the energy center of the facility, had become unreliable, threatening effluent compliance and chronically impacting the operating budget. Upgrading the facility required comprehensive planning and a complex design and construction. The project included evaluation of alternatives for digester gas engine generators, electric driven or gas engine driven aeration blowers, replacement and upgrade of the electric power supply and distribution system, replacement of a multitude of key support systems, construction of the new facilities while maintaining operation and permit compliance, and a new energy operation model.

6E 4:20pm Where Should the Biogas Go?

T. Kunetz, *MWRDGC*; E. Auerbach, S. McGowan, *Malcolm Pirnie, The Water Division of Arcadis*

The Metropolitan Water Reclamation District of Greater Chicago's (MWRD) Stickney Water Reclamation Plant (SWRP) has one of the largest municipal anaerobic digester complexes in the world. The SWRP processes an average of 2.8 million cubic meters per day (m3/d) (750 mgd) of influent wastewater, digests 390 metric tons per day (MT/d) (430 dtpd) of biosolids and produces 96,000 cubic meters per day (m3/d) (3,400 Mcf/d) of biogas from anaerobic digesters. This paper presents the methodology and results of evaluating various alternatives for the most effective utilization of digester gas at the SWRP.

6F 4:40pm Quantifying Methane Evolution from Sewers: Results fromWERF/DeKalb Phase 2 Continuous Monitoring at Honey Creek Pumping Station and Force Main

A. Shah, J. Willis, *Brown and Caldwell*; L. Fillmore, *WERF*

Collection systemwide methane (CH4) emission estimates are being developed from field sampling in DeKalb County, Georgia as part of Water Environment Research Foundation (WERF) project U2R08 - entitled "Methane Evolution from Wastewater Treatment and Conveyance." This task has been implemented in several phases of field monitoring and data collection. This paper presents initial findings of the Phase 2 of this task.

The goal of the first phase of the investigation was to determine if CH4 could be detected in the wet wells and forebays of a sanitary wastewater collection system. Instantaneous CH4 measurements at 65 pumping stations across the entire county were quantified during Phase 1. The results of that investigation documented that approximately 1,000 MT of carbon dioxide equivalents (CO2e) are emitted each year from CH4 evolution at pumping stations. While 1,000 MT CO2e/yr were quantified, significant sources of under reporting are thought to exist. Specifically, during Phase 1, gravity sewers and manholes where force mains discharge were not monitored.

During Phase 2, continuous monitoring for CH4 was conducted at the discharge of a 16-inch, 3.3-mile-long force main from the Honey Creek Pumping Station (HCPS) and at the enclosed wet well of the Stone Mountain Park Lift Station (SMPLS) that exhibited high Phase 1 CH4 measurements. Systems were monitored under normal operation for CH4 and hydrogen sulfide

(H2S) emissions. To study the effects of electron acceptor addition on the force main CH4 evolution, Sodium Nitrate (NaNO3) was also dosed at HCPS during Phase 2.

Overall, the results form the continuous monitoring during Phase 2 suggest that the collection systemwide emissions are likely considerably higher than the 1,000 MT of CO2e/year identified during Phase 1. It also suggests that force main discharge locations warrant additional investigation.

Poster **Improving Anaerobic Digestion Processes with Bioaugmentation: Case Study for Sustainable Bioenergy production from Aquaculture Wastes**

P. Li, L. Schideman, H. Wilkinson, *University of Illinois at Urbana Champaign*

Anaerobic digestion processes are typically operated such that natural selection determines the community of organisms that predominate in the reactor. However, it is possible to shift the naturally occurring community of organisms through bioaugmentation, which supplements the microbial population with particular species that have preferable characteristics and/or increases the fraction of organisms that are responsible for a rate-limiting step in the digestion process. In this study, we demonstrated improved performance of a bioaugmented anaerobic digestion system used to treat an aquaculture waste from the bottom of fish tanks, which primarily consists of fish feces and excess fish food. This waste stream has a high organic content as indicated by a chemical oxygen demand (COD) of 70,000 ± 5,000 mg/L, total solids content of 44,000 ± 3,000 mg/L, and volatile solids content of 33,000 ± 3,000 mg/L. Bench-scale experiments were conducted in both semi-batch mode and semi-continuous mode (also called sequencing batch) at mesophilic temperatures (i.e. 40□±2°C). In the semi-batch experiments, bioagumentation with a proprietary blend of facultative organisms increased the total methane yield (ml/g VSadded) by 18% and also increased the rate of methane production significantly. In the semi-continuous experiments, our results showed that bioaugmentation outperformed a non-augmented control run by 22%-35% in total methane yield at a hydraulic retention time of 16 days. Another advantage of bioaugmentation was hydrogen sulfide concentrations that were 13-22% lower than non-augmented control runs.

Poster **From Grease to Green: Two Case Studies of FOG Receiving, Co-Digestion and Combined Heat and Power Generation**

M. Van Horne, T. Bruton, S. Hardy, M. Bullard, H. Long, *Hazen and Sawyer*

Increasingly, wastewater treatment utilities are considering the dual benefits associated with fats, oils, and grease (FOG) receiving. Receiving this material can help to address the removal of a problematic material from the collection system by facilitating periodic grease trap cleaning and maintenance at food service establishments (FSEs) in their service areas. Through co-digestion of this material with traditional wastewater solids in anaerobic digesters, the utility can simultaneously realize benefits from increased digester gas production. Two case studies are presented, the F. Wayne Hill Water Resources Center (FWHWRC) in Gwinnett County, Georgia and the Henrico County (Virginia) Water Reclamation Facility (HCWRF), to demonstrate the unique driving factors, design concerns and economic benefits from receiving FOG for codigestion. The various drivers for the projects include both internal (collection and treatment system impacts from FOG, economics) and external (changing regulations, available grant funding opportunities) to the wastewater utility. Design concerns span the FOG receiving facilities, the use of existing anaerobic digesters for co-digestion and operation of the CHP system. Economic benefits include direct benefits from the electricity and heat produced by the CHP system and indirect benefits from the removal of the FOG from the collection and treatment systems.

TECHNICAL SESSION 7

Session 7: Innovative Alternative Energy Systems at Wastewater Treatment Plants

Monday, August 1, 2011 **Hyatt Conference Center Room 10CD**
4:00pm – 5:15pm **1.25 PDHs**

7A 4:00pm **The New Hampshire DES Quantitative Assessment of Energy use for Aeration in Lagoons and Equalization Basins**

H. K. Hudnell, *University of North Carolina at Chapel Hill,/ SolarBee, Inc*.; D. Green, *Public Works Department*; R. Vien, *Pittsfield Water Department*; S. Butler, *Water and Sewer Division, Town of Exeter, New Hampshire*; G. Rahe, *Public Service of New Hampshire*; B. A. Richards, J. Bleth, *SolarBee, Inc.*

Electrical-grid powered aeration is used in most pond-based systems and equalization basins at activated sludge wastewater treatment plants to provide the mixing and oxygenation that enables bacteria to digest organic-matter. Oxygen also is needed in the near-surface water of all ponds and basins to provide an “odor cap” by oxidizing malodorous sulfur compounds, preventing their release to air. Much more aeration typically is needed to mix than oxygenate the wastewater. This imbalance causes an operational inefficiency in that grid-power is used to supply more oxygen than needed. The U.S. Environmental Protection Agency concluded that the use of solar-powered circulation (SPC) technology reduces the need to aerate, operational costs, and greenhouse gas emissions associated with electrical power generation. However, the Agency did not quantify electrical, water quality, or other parameters. The New Hampshire Department of Environmental Services directed a 3-site study to quantify the ability of SPC to replace some or all aeration while maintaining good effluent water quality.

Water quantity and quality, odor event, and kilowatt-hour consumption and expenditure data were collected 1 year prior to, and 2 years during, SPC treatment at pond-based treatment plants in Pittsfield and Exeter, and at the activated sludge treatment plant in Rochester. Final effluent water quality was maintained, no effluent violations or odor events occurred, and sludge buildup was minimal during the SPC study period. Electricity usage and costs declined by about 38% in Pittsfield and Exeter, and by about 87% in Rochester. Payback periods ranged from 1.9-3.7 years.

SPC improved operational efficiency at the plants by reducing grid-power consumption while processing objectives were met. The 25-year expected lifetime of SPC units with minimal maintenance requirements indicated long-term reductions in operational expenses and greenhouse gas emissions.

7B 4:20pm **Energy Recovery from Residuals – Comparing Anaerobic Digestion withCombined Heat and Power to Drying Gasification**

M. Abu-Orf, B. Stinson, G. Davies, T. Goss, P. Marija, *AECOM Water*; S. Amad, R. Taylor, D. Belschner, F. Hartz, *Washington Suburban Sanitary Commission*; L. Hentz, *Atkins*

During the summer of 2010, the Washington Suburban Sanitary Commission began a study comparing different biosolids management options at the Seneca, MD and Piscataway, MD Waste Water Treatment Plants with a focus on energy recovery from biosolids through the methods of drying followed by gasification and anaerobic digestion with combined heat and power generation. Both plants currently manage their biosolids with lime stabilization and Class B beneficial use. The study was set up as a three phase approach consisting of identifying and screening technologies, performing a detailed economic and noneconomic analysis of the short listed options and finally developing a concept design report for the selected option. Samples from both plants were analyzed for both energy potential and digestibility leading to the finding that the Seneca sludge was not suitable for conventional mesophilic anaerobic digestion alone. Several drying and gasification alternatives were screened but only close coupled systems were short listed for further analysis. Multiple anaerobic digestion configurations and pretreatment technologies were also screened leading to a short list of conventional mesophilic anaerobic digestion at Piscataway WWTP; acid-gas phase digestion for both WWTPs; 2PAD technology for both WWTPs and a combined digestion facility at Piscataway with thermal hydrolysis pretreatment. A detailed economic analysis led to drying and gasification along with a regional thermal hydrolysis and anaerobic digestion being the most favored options. Future work includes expanding the study to compare additional regional options in conjunction with other plants in Prince George's and Montgomery counties.

7C 4:40pm **Utilizing Existing Wastewater and Water Infrastructure for Mico-hydropower Generation: Pacific Northwest Case Studies**

J. Belknap Williamson, *City of Gresham, Oregon*; P. Oveson, *Brown and Caldwell*

As energy prices rise and emissions of greenhouse gases from non-renewable energy sources become an increasing concern, water and wastewater utilities can be part of the solution by generating small hydropower in conjunction with existing infrastructure. This paper presents opportunities for developing hydropower and highlights the methods and results of feasibility studies for developing small hydropower for the Cities of Gresham, Oregon and Oregon City, Oregon as well as Midway Sewer District, Washington.

TB1 5:00pm **Hydrokinetic Energy Harvester Application at Wastewater Treatment Facility Outfall, Renewable Energy from a Previously 'Hard to Get' Source**

M. Curtis, *Fuss & O'Neill, Inc.;* J. Douglas, *eGen LLC*

Improving the energy and operational efficiency of wastewater treatment plants is gaining national attention. Many plants have implemented energy reduction programs where they replace pumps, motors, lighting and other facilities with energy efficient equipment.

TB2 5:05pm **Biofuels from Wastewater: State of the Industry**
F. Sarmiento, *Greeley and Hansen*; N. Turner, *BlackGold Biofuels*; C. Wilson, *Greeley and Hansen*; D. Craig, *CDM*

The WEF Bioenergy Subcommittee has appointed a new technology Task Force charged with helping inform the wastewater industry at large and, where beneficial to the industry, promoting the growing trend in recovering resources from wastewater streams in the form of Biofuels. The Task Force defines a "Biofuel" as materials created from wastewater treatment byproducts that can be used as an energy source. These materials generally conform to an existing national quality specification and are viewed as a saleable or fungible commodity by external markets.

The Biofuels Task Force has developed a "State of the Industry Update" to provide an overview of emerging trends and identify benefits, challenges, and future pathways of new energy and resource recovery solutions for wastewater treatment byproducts. This update serves as an introduction to biofuel production from wastewater treatment byproducts. There are a number of different byproducts of the wastewater treatment process that fall under the umbrella of "Biofuels" and can be categorized into one of the following three main categories: Biogas & Biomethane, Dried Wastewater Solids, and Biodiesel.

The purpose of this technical paper and presentation will be to define the current state of our industry's production of biofuels and describe the growth potential of this trend as the "wastewater" industry continues to evolve into a "resource recovery" industry. Each of the above listed biofuels will be explained including descriptions of the technologies driving their growth, case studies of where they are being used successfully, lessons learned from these installations, as well as the challenges and barriers to rapid deployment and production of biofuels across the industry.

TECHNICAL SESSION 8

Session 8: Energy Recovery

Tuesday, August 2, 2011 **Hyatt Conference Center Room 10 AB**
8:30am – 10:00am **1.5 PDHs**

8A 8:30am **Using Septage to Accelerate Energy Generation in a Bioreactor Landfill**
X. Zhao, T. Soong, M. Subbarayan, *CTI and Associates, Inc*.; M. Williams, *County of St. Clair, St. Clair, Michigan*; K. Larsen, *County of Oakland, Waterford, Michigan*; J. Ridgway, *H_2Opportunities*

Residential septage is an on-going wastewater challenge for municipalities. Conventional methods of septage disposal – land application and waste water treatment plants – can result in surface water pollution, overloading of plant processes, and increased energy consumption. This paper presents a case history of an innovative (patented) technology that improves the management of both septage and municipal solid waste (MSW) to avoid these problems.

This septage bioreactor landfill technology provides accelerated renewable energy generation while extending the life of an operating landfill. Mixing septage with MSW creates a "win-win" combination - residential septage is safely disposed and treated and MSW decomposition (bio-

stabilization) and methane generation is accelerated. A septage bioreactor landfill project was developed to demonstrate the feasibility of this technology. This project included the construction and operation of a full-scale demonstration landfill cell. Landfill operations are conducted in an engineered and controlled manner that limits both groundwater pollution and air pollution.

After four years of operation, monitoring results show that septage addition has dramatically increased the methane generation rate in the septage bioreactor landfill, making it possible for the owning municipality to construct a landfill gas-to-electricity facility. The electricity generated from this facility will be used to power on-site operations and sold to a local utility, generating revenue for the owner. Also, leachate collected from the bioreactor cell is comparable to conventional landfill leachate, demonstrating that this technology also offers a viable (and environmentally sound) method for septage disposal and treatment.

8B 8:50am **Deep Well Injection of Bio-Slurry Demonstration Project for Renewable Energy Generation and Carbon Sequestration**
O. Moghaddam, *City of Los Angeles*; M. Bruno, *GeoEnvironment Technologies*

The Terminal Island Renewable Energy (T.I.R.E.) Project is the nation's first full scale application of deep well injection technology to convert wastewater residuals (biosolids and brine) into a renewable energy source (high purity methane) while simultaneously sequestering greenhouse gases. A slurry mixture composed of digested sludge, trucked wetcake, and reverse osmosis treatment brine is injected into deep subsurface sand formations more than 5000ft beneath the City of Los Angeles Terminal Island Wastewater Treatment Plant. At that depth the earth's natural high temperature biodegrades the organic mass into methane and carbon dioxide. The carbon dioxide dissolves as a liquid (due to the high pressure) into the native formation brine and is permanently sequestered. Relatively high purity methane collects for potential use as a renewable fuel. The process provides enhanced high temperature treatment at relatively low cost, and reduces pollution and greenhouse gas emissions associated with offsite truck transport. During the first 30 months of the project, more than 100 million gallons of slurry have been injected. The process is now managing 100% of the residuals output from the Terminal Island Plant and about 20% of the residuals output from the Hyperion Treatment Plant.

8C 9:10am **Pioneering Energy Resource Recovery on Food Waste at Gills**
M. Perinpanayagam, C. Balendhran, A. Dale, M. Falk, D. Reardon, *HDR Engineering*

Gills Onions, the nation’s largest fresh-cut onion processor, pioneered an engineering marvel that takes their previously discarded onion waste and converts into energy by way of anaerobic digestion and fuel cell technology. This landmark project won Gills the American Consulting Engineers Council (ACEC) 2010 National Grand Conceptor Award.
Gills Onions processes nearly 363 metric tons of onions per day and generates one third of it as wastes: peels, tops and tails. Historically, the waste was land applied at Gills Onions farming fields and resulted in multiple issues: offensive odors from fields, soil acidification, growth impairment, pests, potential ground water contamination, expensive and labor intensive waste hauling, air pollution from diesel engines, traffic control, muddy soil and waste piling up at processing facility during raining season. Gills Onions expended nearly $400,000 a year on this inconvenient, unsustainable, expensive and labor-intensive waste disposal method and realized the need for reducing the amount of waste going out of their processing facility.

TB1 9:30am **EBMUD's Journey to Becoming a Net Electricity Producer**
A. Chakrabarti, J. Hake, D. Gray, V. De Lange, E. McCormick, *East Bay Municipal Utility District*

The East Bay Municipal Utility District (EBMUD) Main Wastewater Treatment Plant (MWWTP) has been producing renewable energy on site since 1985 and has more than doubled the amount of energy produced since 2002, from over 2 megawatts (MW) to over 4 MW. It is anticipated that the MWWTP will become one of the first publicly-owned treatment works (POTWs) in North America to produce more electricity than it consumes on an annual basis. Becoming a net electricity producer is a result of both reducing on-site demand and increasing on-site generation. Since the California energy crisis of 2000/2001, a number of demand reduction projects, both large and small, have been implemented. More significantly, high-strength organic waste co-digestion has increased biogas production and electricity generation. In order to utilize the additional biogas and reduce flaring, the on-site power generation facility is being expanded to increase the electrical production capacity from 6.5 MW to 11 MW. For several reasons, the MWWTP will continue to both import and export power from the electrical grid, even once it becomes a net electricity producer. Several key challenges as well as the boundaries of the analysis are described and additional energy inputs for future analyses are considered.

TECHNICAL SESSION 9

Session 9: Modeling Systems

Tuesday, August 2, 2011 **Hyatt Conference Center Room 10CD**
8:30am – 12:00am **2.75 PDHs**

9A 8:30am **Hourly Energy Usage Simulation Techniques For Evaluating Digester Gas CHP System Costs and Savings**
V. Smith, J. Gorgan, *Greeley and Hansen*

Combined Heat and Power (CHP) systems are superior to other digester gas utilization systems in their ability to reduce utility costs and carbon emissions. Economic viability of digester gas-fired CHP is a function of many plant specific variables, foremost of which are electric and gas utility rates, building and process heating (and cooling) loads, digester gas impurities, and digester gas production. These and other utility, system, and plant specific data impacts on digester gas energy recovery system economics are presented, discussed, and evaluated using both simple and sophisticated energy modeling techniques including a method of hourly energy calculations.

Some noteworthy findings are the greatly superior return on investment, compared to CHP alternatives, of heating-only systems in plants with significant facility heating loads, and the general need for monetary incentives, both capital and operating, to lower economic hurdles to cogeneration implementation.

9B 8:50am Whole Plant Modeling to Optimize the Biogas Production in Anaerobic Digesters

D. Dursun, J. Jimenez, J. Bratby, *Brown and Caldwell*

Anaerobic digestion is a complex system of biochemical and physical processes. Due to the complexity of the process, it has traditionally been treated as a black box system, and optimization has been based on experience or trial and error methods. However, simulation modeling can be a useful tool for process understanding and optimization of this process unit operation. This study aims to assess the use of a calibrated and validated simulation model in order to evaluate biogas production capacity and potential of wastewater treatment plants to offset energy costs.

The results from the validation studies showed that the biogas production could be predicted by using the General Activated Sludge - Digestion Model (ASDM) built in BioWin™ process simulator. Sensitivity analysis indicated that the hydrolysis rate has tremendous effect on the model predictions and this may have to be modified during the model calibration to predict plant performance. Furthermore, the biogas production proved to be highly affected by the characteristics of the anaerobic digester's influent. The effects of design and operational parameters on the performance of biogas production were also assessed by using a calibrated and a validated model. Overall, this study concluded that an integrated anaerobic digestion simulation model can be utilized to simulate biogas production and to optimize the design and operational parameters of the digesters.

9C 9:10am Membrane Bioreactor Process Modeling and Optimization by Artificial Neural Network and Integrated Bioprocess Models

J. Chen, R. Luo, *Nanyang Technological University*; S. Mu, Z. Zhang, M. Andersen, *DHI-NTU Research Center and Education Hub*; P. Jørgensen, *DHI Denmark, Horsholm, Denmark*

The energy efficiency of Ulu Pandan MBR plant is optimized by Artificial Neural Network (ANN) and bioprocess models. The ANN model predicts the dependence of the energy consumption per unit permeate product on operating parameters. The input variables for the ANN model are the volume of membrane scouring aeration, the volume of bioprocess aeration, the volume of mixed liquor transferred into the MBR system, and the volume of treated water produced. The input variables are used by the ANN model to predict the dependent output variable, energy consumption per unit permeate product water (kW-hr/m3). The ANN model results correlate well with operating data. An integrated bioprocess model based on the Activated Sludge Model is developed that includes the effects of sludge retention time (SRT), bound extracellular polymeric substances (EPS), and soluble microbial products (SMP). The bioprocess model investigates the impact of SRT on biological parameters in the bioreactor. The bioprocess model predictions of the key performance indicator, concentrations of volatile suspended solids (VSS) in the bioreactor, agree well with experimental results.

9D 10:45am WERF's Comprehensive Energy Analysis and Tool for WWTPs (CHEApet) Undergoes Testing and Enhancements for Holistic Assessments of Energy and Carbon Footprints

R. Forbes, T. Johnson, G. Crawford, *CH2M Hill*; L. Fillmore, *WERF*

The development of the Carbon Heat Energy Analysis Plant Evaluation Tool (CHEApet) by the Water Environment Research Federation (WERF) was in response to the need for a modeling

tool that unifies prior WERF research regarding quantifying and managing energy consumption. CHEApet was created under WERF's Optimization Challenge to model performance and energy consumption of waste water treatment plants (WWTPs).

Energy consumption, chemical use, treatment process emissions, and biosolids management options all contribute to a facility's carbon footprint. Use of CHEApet can establish the baseline of a WWTP's carbon footprint by which to measure future improvements as well as alternatives being considered. The results will allow users to identify and exploit opportunities for energy and resource recovery, which will save costs and reduce the carbon footprint of wastewater treatment and biosolids management.

9E 11:05am Optimal Operational Strategies for Energy Savings at a 5 MGD Full Scale Sequencing Batch Reactor Wastewater Treatment Plant
V. Subramanian, *Dewberry*; W. Clarkson, J. Veenstra, *Oklahoma State University*

Energy and solids processing account for 40% of the total operation and maintenance costs in wastewater treatment facilities. High volatility in energy prices, rising concerns for greenhouse gas emissions, and budget constraints on municipalities make energy reduction a main priority at most wastewater treatment facilities. Energy reduction through process optimization is a viable option, particularly for under loaded wastewater treatment plants. In this study, a suitable operational strategy to reduce energy consumption was developed for an 836 m3/h (5.3 MGD) full-scale SBR wastewater treatment plant through process simulations. The developed operational strategy takes into account the current influent flow conditions and operational practices and intends not to make major, drastic modifications. The results revealed that the implementation of the operational strategy could produce energy savings of $610 per reactor per year for reducing 5 minutes of aerated react time in a cycle with a potential for total energy savings up to a maximum of $26,352 per year for four reactors at the plant.

9F 11:25am Collection of Energy Consumption Data from the Operation of Decentralized Wastewater Systems
B. Toth, B. Douglas, D. Braun, *Stone Environmental, Inc.*

Energy monitoring technologies were researched and tested by a project team Stone Environmental, Inc. for use in a Decentralized Wastewater Management Demonstration Project near Greenwood Lake, New York. The team found that energy consumption monitoring technologies for onsite wastewater systems could be described in four categories: pump timer calculations, consumer monitoring devices, professional-grade data loggers, and customized control panel or sub-meters. Of the technologies researched for this study, a consumer or "in-home" monitoring device was selected for its cost, open platform data collection, and the effectiveness with which it could encourage positive changes in energy consumption habits.

TECHNICAL SESSION 10

Session 10: Energy Efficiency Program Offerings for the Water-Wastewater Industry

Tuesday, August 2, 2011 **Hyatt Conference Center Room 11**
8:30am – 10:00am **1.5 PDHs**

10A 8:30am **A Binational Energy Efficiency Program Initiative to Support Water and Wastewater Treatment Facilities**
J. Burgess, *Consortium for Energy Efficiency*

Energy efficiency program administrators in the United States and Canada work together through the Consortium for Energy Efficiency (CEE) to develop and adopt unified program approaches to advance the market for premium efficiency technologies, and to assist their customers to use energy more efficiently. Today, CEE membership includes more than 130 organizations operating energy efficiency programs in forty-six US states and eight Canadian provinces. Since 2007, overall efficiency program budgets in the US and Canada have increased from $3.7 billion to more than $7.5 billion in 2010.

While it may sound counterintuitive for electric and gas utilities to encourage customers to use less of their "product," there are good reasons why public policy in many states strongly supports energy efficiency programming. First, in order to meet future demand for power, electric and gas utilities need to balance supply and demand. Through ratepayer funded energy efficiency programs, electric and gas utilities are looking to reduce demand first, because reducing demand is almost always more cost-effective than increasing supply. Energy efficiency is generally the most cost-effective way to meet future demand for energy, and much less expensive than building new power plants.

In those forty-six states where program administrators are required by legislation to employ energy efficiency, they collect funds, identify programs, and deliver a target amount of cost-effective energy savings every year. These program targets are rising rapidly in many states, even as much of the “low-hanging fruit”—the most common and cost-effective measures—are becoming standard practice. New minimum energy performance requirements in state building codes and federal product standards have a similar effect for many common efficiency measures. For these reasons, program administrators are seeking untapped opportunities in new sectors and end use systems.

10B 8:50am **Innovative Energy Efficiency Programs to Improve the Statewide Water and Wastewater Sector**
S. Marpicati, *Malcolm Pirnie, the Water Division of ARCADIS*; A. Santos, *Red Oak Consulting, A Division of Malcolm Pirnie*

New York State’s water and wastewater sector is making progress in energy efficiency thanks to three innovative programs: the Focus on Municipal Water and Wastewater Facilities Program, the Statewide Energy Assessment and the Waste Water Efficiency Program.

TECHNICAL SESSION 11

Session 11: Energy Conservation

Tuesday, August 2, 2011 **Hyatt Conference Center Room 10AB**
10:45am – 12:00pm **1.25 PDHs**

11A 10:45am Case Study of Energy Efficient, Sustainable Improvements and Technologies Implemented at Wastewater Treatment Plants
B. Sibiga, F. Nerone, *Wendel Companies*

The goal to operate economically sustainable wastewater treatment facilities has pushed entities throughout New York State to identify and implement energy efficient facility and technology improvements. This paper will paper will provide a case study of results from projects and programs at nine wastewater treatment systems. The paper will provide energy savings, construction costs and return on investment information on technologies including aeration diffuser upgrades, blower upgrades, dissolved oxygen and pumping control systems, digester mixing systems, anaerobic digester gas collection, belt press upgrades and replacement, lighting upgrades, HVAC upgrades and energy management systems.

11B 11:05am Paying for Themselves An Evaluation of Turbo Blower Life-Cycle Costs
W. Schilling, A. Turriciano, *CDM*

Many municipalities are identifying ways to reduce energy consumption at their wastewater treatment plants (WWTPs), to reduce operating costs and conserve resources. Aeration is typically the highest energy demand at WWTPs, consuming up to 60% of the overall power usage. Therefore, some municipalities have started replacing aging blowers with high-efficiency turbo blowers, resulting in substantial power savings. Two case studies in which turbo blowers were either temporarily or permanently installed at a WWTP are examined in this paper. Data collected during the studies were used to quantify the energy cost savings and calculate payback periods associated with installation of the turbo blowers. In the case studies, installation of the turbo blowers studies resulted in a 32% – 38% energy savings. Calculated payback periods for the two case studies were 6 years and 8 years for equipment costs only, and 12 years and 14 years for total installation costs.

11C 11:25am Evaluation of Potential Energy Savings through Aeration Reduction in Aeration Tanks at the Stickney WRP
J. Moran, H. Zhang, C. O'Connor, R. Dring, *Metropolitan Water Reclamation District of Greater Chicago*

Nearly half of the total electricity usage at a secondary wastewater treatment plant is in the activated sludge process. The majority of the electricity usage is for aerating the mixed liquor to provide dissolved oxygen (DO) for treatment. The amount of aeration in the aeration tanks of the Stickney Water Reclamation Plant is even more than for a typical treatment plant because the aeration tanks are used to raise the DO to a target of 8 mg/L at the end of the aeration tanks to meet the NPDES permit requirement for DO of 6.0 mg/L or greater in the final effluent. A field sampling study was conducted to measure the DO concentrations at key locations in the process to assess the efficacy of using the aeration tank to meet effluent DO requirements. The

date collected in the study indicated that DO loss due to endogenous respiration in the final settling tanks was consistently roughly 2.7 mg/L regardless of the DO concentrations entering the tanks. DO concentrations increased because of turbulence caused by flow over the weir aeration and in the effluent channel; the amount of DO increase through the final settling tanks was 1.75 mg/L in the Phase I study and 1.95 mg/L in the Phase II study; the DO increase appeared to be inversely related to the DO concentration in the middle of the final settling tanks. For the sake of energy savings, the optimal DO set point at the end of aeration tanks is slightly above 7 mg/L, if aeration tanks are the only means for raising DO. However, more significant energy savings may be achieved by maximizing the weir aeration in the final settling tanks, utilizing more efficient ways of raising DO in the final effluent channel and lowering DO set point at the end of aeration tanks.

TB1 11:45am Janesville WWTP Upgrade Emphasizes Energy Saving Improvements

J. Kemp, *AECOM*; D. Lynch, T. Wilson, *City of Janesville*

Energy efficiency and improved utilization of available energy resources were essential elements of the City of Janesville's Wastewater Treatment Plant (WWTP) upgrade and expansion plan. Using 2008 data prior to the expansion, the WWTP's purchased energy as electricity and natural gas was 285.9 kWh/ML (1082 kWh/MG), placing them well above the 25th percentile of 356.7 kWh/ML (1350 kWh/MG) for WWTPs in efficiency1. In order to maintain or exceed this performance following expansion, energy goals were established early in the design process that included: no net increase in energy purchased, incorporation of at least one renewable energy generation system, LEED or Energy Star certification, and use of solar energy.

To date, the project's replacement of two aging biogas generators with microturbines has resulted in a 58 percent average increase in monthly electricity produced for comparable gas production at the WWTP and reduced maintenance costs. Integral heat recovery from the microturbines has thus far completely eliminated the requirement of supplemental natural gas-fired boilers to maintain digester temperature. The installation of a 16.65 kW solar photovoltaic system on the WWTP administration building produces additional electricity which is sold back to the utility at a premium rate. Improvements including high efficiency aeration blowers, variable frequency drives, digester and gas storage upgrades, and efficient lighting and HVAC systems continue to improve overall process efficiency as they come online. Upon completion of the project, system and total process optimization will yield additional efficiency improvements.

TECHNICAL SESSION 12

Session 12: Using Automation and Instrumentation to Reduce Energy Consumption

Tuesday, August 2, 2011 **Hyatt Conference Center Room 11**
10:45am – 12:00pm **1.25 PDHs**

12A 10:45am A Change in Control Strategy Reduces Power Consumption at Colorado Springs Utilities

R. Lagrange , *Retired from Endress+Hauser*; J. Hardison, B. Hoyt, *Colorado Springs Utilities*; J. Beabout, *Beabout Company*; M. Hill, *Endress+Hauser*

The JD Phillips wastewater plant at Colorado Springs Utilities commenced operations in 2008. Designed for the treatment of 20 MGD the actual flow is 8 MGD. The secondary treatment has three passes. The A pass is used for phosphorus removal and partial denitrification. Passes B & C are used for nitrification. The plant wants to insure compliance to its varying discharge permit while reducing costs.

Due to high ammonia influent concentration and a deficiency in BOD it was soon apparent that the plant needed improvements: low alkalinity created some pH excursions outside the discharge permit. Also, energy usage was high. In 2009, a source for additional carbon was found and instruments to measure ammonium, nitrate and pH were installed.

Multiple phases have already been implemented and further improvements remain possible. A step by step approach changed the way aeration and denitrification are controlled.

In the initial phase the measurement of Dissolved Oxygen was used to control the aeration of the B and C passes. The set points were 2.5 mg/l in pass B and 1.8 mg/l in pass C.

In a second phase presented at WEFTEC 2010 the DO set point in the B and C passes were driven by the concentration of ammonia. Savings in energy and chemicals related to the addition of whey, partial denitrification and the use of ammonia measurement were reported.

In the phase reported now, the B pass air flow is now controlled directly based on ammonia. The internal recirculation is driven by the nitrate concentration in the C pass. The air flow to the C pass is controlled to maintain a minimum dissolved oxygen concentration at the end of the effluent channel

As a result of those changes in control, additional energy savings have been achieved. Close to 20% savings normalized for flow and ammonia load.

12B 11:05am **Advanced Automation at the San Jose/Santa Clara Water Pollution Control Plant Helps to Save Almost a Million Dollars in Annual Energy Costs**

B. Yerrapotu, *San Jose/Santa Clara Water Pollution Control Plant*; A. Ekster, *Ekster and Associates*; S. Colby, *San Jose/Santa Clara Water Pollution Control Plant*

San Jose/Santa Clara Water Pollution Control Plant (Plant) is a 167 MGD tertiary wastewater treatment facility located in the middle of the Silicon Valley. Plant operating budget is $39.3 M/year; a significant portion of this budget is spent on energy costs which total approximately $3.1 M/year for natural gas, $1.9 M/year for electricity, and $1.2 M/year for landfill gas purchased from a neighboring landfill. In an effort to contain the rising energy costs, the Plant has been continuously improving energy efficiency of operation for the last 25 years. This paper is describing the latest iteration of these efforts that helped to save over a million dollars in annual energy costs. Most of these savings were achieved by implementing sophisticated automation strategies and innovative technologies.

12C 11:25am **Reducing Energy Consumption of UV Disinfection Systems by Measuring %UVT**

B. Dabkowski, *Hach*; M. Lunn, G. De Kock, *City of Grand Rapids*, Michigan; J. Ingleright, *Hach*

Ultraviolet Disinfection systems are becoming more commonplace in the United States as the preferred means of wastewater disinfection before the effluent is discharged. UV disinfection systems can consume between 14 and 23% of a wastewater plant's power budget, so finding methods to reduce energy consumption are critical. One strategy is to modulate the ultraviolet dose based upon three factors: flow, a water quality measurement known as percent ultraviolet transmittance, and lamp power—a strategy called 'dose pacing'. The City of Grand Rapids, Michigan implemented dose pacing several years ago, and comparing data from January 1, 2010 to October 16, 2010 showed that a flow pacing strategy could cost up to 190% more than a dose pacing strategy.

TECHNICAL SESSION 13

Session 13: Water and Energy from the Energy Utility Perspective

Tuesday, August 2, 2011 **Hyatt Conference Center Room 10AB**
1:45pm – 5:30pm **3 PDHs**

13A 1:45pm **Future Projections of Water Demands for Energy**

J. Macknick, R. Newmark, K. Hallett, *National Renewable Energy Laboratory*

The power sector is the largest user of freshwater in the U.S. The current portfolio of electricity generating technologies in the U.S. has highly regionalized and technology-specific requirements for water. Water availability differs widely throughout the nation. As a result, assessments of water impacts from the power sector must have a high geographic resolution and consider regional differences. The U.S. electricity portfolio is likely to evolve in coming years, shaped by various policy and economic drivers on both the national and regional level,

which will impact power sector water demands. Analysis of future energy scenarios that incorporate technology options and constraints as well as different policies can provide useful insights about likely changes to the technology mix and the nation's water resources. More specifically, both national- and regional-level water consumption and withdrawal implications. Utilizing the Regional Energy Deployment System (ReEDS) model, a national electricity-sector capacity expansion model with high geographical resolution, we explore the potential development of the U.S. electric sector over the next two decades and examine the associated impacts on water resources.

13B 2:15pm **Water-Energy Nexus: The Arizona Experience**
D. Newman, *Brown and Caldwell*; S. Eden, M. Lamberton, J. Gelt, *University of Arizona*

The intrinsic connection between water and energy resources has become a topic of considerable discussion and interest in the past few years. The Southwest is a region particularly sensitive to water-energy relationships with its semi-arid environment, high rates of growth and ongoing drought conditions. Due to these growing demands for both water and energy, Arizona water resource managers are in a perpetual search for additional sources. The water-energy nexus involves many trade-offs and the solutions are both dynamic and not always clear-cut. These linkages complicate planning and policy making, as decisions that conserve one resource may have detrimental impacts on the other. This paper takes the form of a narrative on the Arizona experience with water-energy questions.

13C 2:45pm **West-Wide Analysis of the Energy-Water Nexus**
V. Tidwell, B. Moreland, C. Castillo, H. Passell, *Sandia National Laboratories*

The western U.S. is home to many of the nation's fastest growing cities. Accompanying this growth is the increasing demand for water for municipal/industrial supply as well as for expanding thermoelectric power production. This competition over new water demands is playing out in some of our nation's driest watersheds. To better understand the energy-water nexus in the West a coordinated analysis is being undertaken by federal and state agencies, the power industry, NGOs and other interested stakeholders. A key product will be an integrated Energy-Water DSS to enable planners in the Western and Texas Interconnections to analyze the potential implications of water stress for transmission and resource planning. Working with Western Electricity Coordinating Council, Electric Reliability Council of Texas, Western Governors Association, and the Western States Water Council and utilizing this Energy-Water DSS a wide range of transmission planning scenarios will be simulated and evaluated. Data, models, scenario analyses, and insights derived from this effort will provide a significantly improved body of evidence for policy making at local, state and federal levels.

13D 4:00pm **Energy-Water: Missouri River and Its Use as Cooling Water with A Particular Look at Nebraska**
J. Li, *United States Department of Energy*

Nebraska is midway between upper and lower stream states on the Missouri river, and the state's thermal power unit cooling and generation would be impacted by lower quantities of water released from the dam at Gavin Point, in an extreme drought and non-navigation year scenario. In accordance with the March 2006 revised Missouri river management manual, minimum-service navigation/lower water release from Gavins Point is triggered during a period of prolonged drought (when the combined reservoir level of the six dams/reservoirs upstream

falls short of a threshold for a normal release). During the last drought of nine years (2000-2008), seven (2002 and beyond) were minimum service navigation years. Minimum service navigation or water level insufficient for full navigation does not necessarily mean insufficient water for meeting cooling needs. This study examined the potential impact of a lower water release from Gavins Point Dam to thermal power production in Nebraska and the region under historical conditions and in an extreme drought scenario. Up to now, cooling water has not led to implemented deratings at thermal power production in Nebraska and the region. However, insufficient water for cooling in an extreme drought scenario and a non-navigation year will likely cause not only implemented deratings but also regional energy reliability issues.

13E 4:30pm **Electric and Waste Water Utility Collaboration Examples from California's Capital: SMUD and SRCSD**
K. Ave, *Sacramento Municipal Utility District*

The Sacramento Regional County Sanitation District (SRCSD) and the Sacramento Municipal Utility District (SMUD) have a long history of mutually beneficial research and development and operational project collaborations. While their physical boundaries and the regions they serve are similar, the two districts are each governed by unique, publicly elected boards of directors with distinct organizational missions and operations. SMUD's ownership of the Upper American River Project (UARP), a nearly 700MW hydroelectric power generation system, give it a close perspective on energy and water issues that impact the Sacramento Valley. SRCSD is the largest inland discharger in California and therefore plays a key role in Northern California water quality issues. The agencies have overcome institutional obstacles and collaborated on a number of past projects with important economic and environmental benefits to the Sacramento region. More operational and joint research projects are at various stages of the planning pipeline. This paper discusses the current policy and regulatory priorities of each organization, past joint projects, and the potential future collaborative efforts under joint exploration.

13F 5:00pm **Georgia Comprehensive Statewide Water Management Plan: Forecasting Statewide Energy Sector Water Demands Through 2050**
M. Horrie, W. Davis, *CDM*; C. Mueller, G. Behrend, *Georgia Environmental Protection Division*

Georgia has embarked on an ambitious, comprehensive water resources planning effort aimed at meeting the state's future water resource needs through 2050. In 2005, the thermoelectric energy sector was responsible for 63 percent of surface water withdrawals, and 9 percent of surface water consumption in the state. Therefore, energy sector water demand is integral in planning for the future of Georgia's water resources.

Under the direction of the Georgia Department of Natural Resources, Environmental Protection Division (EPD), and in collaboration with an energy sector ad hoc group composed of representatives from the power industry and the Georgia Environmental Finance Authority (GEFA) state agency, CDM worked to develop a statewide water demand forecast for energy production. This paper and presentation will describe the methodological approach used to develop a state-level energy sector water demand forecast through 2050, as well as the forecast results, data gaps, challenges and unknowns in developing such a forecast.

Future statewide power needs were modeled based on the historical relationship of state population and electric utilities' power generation in Georgia from 1990 to 2008. Water

withdrawals and water consumption vary by type of power-generating unit and cooling system. The water needed to meet the projected statewide energy demands was forecasted using an analysis of the actual rates of water withdrawals and consumption per unit of power generated for power plants in Georgia, utilizing four common power-generation processes. The energy sector ad hoc group also provided insight regarding the likely trends in development of future thermoelectric generating capacity in the state through the next decade and beyond.

The results of the forecast are presented under two future power needs scenarios, along with a discussion of how these results may be incorporated into regional water plans. Future energy sector water withdrawals are forecasted to increase modestly. Water consumption for power production is forecasted to steadily increase as Georgia's energy needs continue to grow and a greater portion of the state's energy needs are met by facilities with cooling tower technologies.

TECHNICAL SESSION 14

Session 14: Sustainability and GHG Issues

Tuesday, August 2, 2011 **Hyatt Conference Center Room 10CD**
1:45pm – 5:30pm **3 PDHs**

14A 1:45pm **Confronting Climate Change: An Early Analysis of Water and Wastewater Adaptation Costs Through 2050**
K. Freas, L. van der Tak, J. Kepke, P. Pasteris, P. Karney, *CH2M Hill*

Climate change is here now and will likely alter the water cycle; affecting where, when, and how much water is available. Utilities responsible for providing water and wastewater services will clearly be affected by these impacts for their 20- to 40-year infrastructure planning horizons. Climate change impacts include, but are not limited to: (a) increased severe precipitation events (e.g., flood, drought), (b) increased water scarcity; (c) changes in snow melt patterns, and (c) sea level rise. Green and gray infrastructure adaptations to address impacts on water and wastewater management already are available, and will be refined over time. Through 2050, we estimate that the infrastructure and operations and maintenance costs for U.S.-based drinking water and wastewater services to adapt to climate change (above expected replacement costs) will range from $448 billion to $944 billion.

14B 2:15pm **Reducing the Carbon Emissions and Cost of Municipal Infrastructure Through Industrial Ecology**
S. Salter, *Farallon Consultants Limited*

The results of a 2010 study resource recovery completed by a cross-functional team1 of specialists in ecology, engineering, economics, and governance in Vancouver, Canada are described. The Integrated Resource Recovery Study, Metro Vancouver North Shore Communities
(referred to in this paper as the North Shore Study) modelled the value of reclaimed water, electricity, and heat that could be recovered from solid waste, and liquid waste, and industrial waste heat in an integrated manner. Modelling was based on research into actual sources of liquid and solid waste, and markets for the resources that could be recovered from these sources. The results of the study suggest that an integrated approach to recovering value from

waste could reduce the community's greenhouse gas emissions by 23% to 27%. In addition, revenues from sales of recovered heat, water, fertilizer and greenhouse gas credits could significantly reduce the cost of wastewater treatment and solid waste management to taxpayers.

14C 2:45pm Wastewater Treatment Nutrient Removal and Energy/GHG Nexus

M. Falk, D. Reardon, J. Neethling, *HDR Engineering*; A. Pramanik, *WERF*

The implementation of increasingly stringent nutrient discharge permits, namely nitrogen and phosphorus, has largely focused on receiving water quality and has ignored the corresponding impact on treatment sustainability. This report was prepared to provide a bench-top analysis on the balance between nutrient removal and sustainability. The objective is to determine if a point of “diminishing returns” is reached where the sustainability impacts of increased levels of nutrient removal outweigh the benefits of improved water quality. Five different hypothetical treatment trains at a nominal 10 mgd flow were developed with variable treatment objectives: Level 1 (base plant; 30 mg/L BOD; 30 mg/L TSS), Level 2 (8 mg N/L; 1 mg P/L), Level 3 (4-8 mg N/L; 0.1-0.3 mg P/L), Level 4 (3 mg N/L; 0.1 mg P/L), and Level 5 (<2 mg N/L; <0.02 mg P/L). Given that sustainability is a broad term, emphasis was placed on the following parameters while comparing the treatment levels: GHG emissions, a water quality surrogate that reflects potential algal growth, capital and operational costs, energy demand, and consumables (e.g., such as chemicals, gas, diesel, etc.)

The parameters were evaluated independently. The results suggest that a point of diminishing return was reached for all sustainability parameters at Level 4 (3 mg N/L; 0.1 mg P/l) or greater. The GHG emissions values ranged from 4,260 to 12,950 CO2 equivalent metric tonnes per year (CO2 eq mt/yr) as follows: Level 1 (4,260), Level 2 (5,600), Level 3 (6,600), Level 4 (7,580), and Level 5 (12,950). The 70 percent increase from Level 4 to 5 is attributed to sidestream reverse osmosis (RO) plus RO reject management required to meet the stringent level. The primary contributors to GHG emissions are energy related (aeration, pumping, mixing) at upwards of 65 percent total GHG emissions. The GHG emissions increase from Level 3 onwards relates to chemicals demand (e.g., external carbon source, metal salt, and polymer) to compliment biological limitations and filtration requirements. The water quality surrogate, algal production, showed that 95 percent potential algal savings is achievable for from Level 1 to 3. To remove an additional 4 percent (total 99 percent removal with respect to Level 1) translates to a nearly doubling of GHG emissions (Level 3 to 5). As for cost, the capital increases 70 percent from $7.9 million to $13.3 million from Level 1 to 2, followed by a nearly tripling of cost when moving from Level 1 to 5. The operational cost discrepancy between levels is more pronounced than capital with a 600 percent increase from Level 1 to 5 ($222/MG treated to $1,365/MG treated, respectively). Rather than focus our attention strictly on point source dischargers that require Levels 4/5 treatment, a combination of Level 3 treatment complimented with best management practices on non-point sources might be a more sustainable approach at achieving comparable water quality.

14D 4:00pm Changing Paradigms: From Wastewater Treatment to Resource Recovery

G. Daigger, *CH2M Hill*

In spite of the availability of implementable technologies and approaches, adoption of energy reduction and energy and nutrient recovery options by the used water profession has been slow. This occurs for a number of reasons. Among them are the siloed nature of the educational and regulatory systems, the professional organizations, and the relevant institutions. Codes and standards also inhibit relevant changes. Economics have not historically encouraged greater

energy and nutrient recovery, but this factor is changing. Procedures for analyzing evolving and innovative technologies and approaches compared to more conventional options often contain biases against their adoption. Systematic barriers are also inherent in the innovation process, including the time required by the technology learning curve and by the adoption process. Understanding and addressing these barriers can lead to more rapid adoption of new, beneficial technologies and approaches, creating significant societal benefits.

14E 4:30pm **Lessons Learned in Sustainability Reporting at the Metropolitan Sewer District of Greater Cincinnati**

A. Ramage, L. Ritter, *CH2M Hill*; M. Lodor, *Metropolitan Sewer District of Greater Cincinnati*; B. George, *Greater Cincinnati Water Works*

Private corporations have been reporting sustainability performance for over two decades, using frameworks such as the Global Reporting Initiative (GRI) guidelines (GRI, 2000). However, for U.S. public utilities and municipal organizations, sustainability reporting is relatively new. In 2010, the Metropolitan Sewer District (MSD) of Greater Cincinnati retained CH2M HILL sustainability experts to compile and publish the utility's first comprehensive sustainability report. The multiple goals of the effort included establishing a framework for measuring sustainability performance, aligning sustainability goals with organizational strategy and the goals of a federally mandated wet weather control program, measuring baseline sustainability performance, educating stakeholders about sustainability, and improving stakeholder relations. The methodology used by the MSD/CH2M HILL reporting team included six steps that met MSD's goals for the report and led to successful, on-time publication: (1) Identifying best practices in sustainability reporting, (2) Engaging stakeholders, (3) Developing tailored sustainability performance indicators, (4) Collecting baseline performance data, (5) Compiling and reviewing report drafts, and (6) Distributing the report. A primary outcome of the reporting project was a set of customized sustainability indicators – in the triple bottom line areas of operational and environmental performance, social and community performance, and financial and risk performance – by which MSD can consistently and meaningfully report its sustainability performance over time. In addition, the report showed the alignment of sustainability goals and indicators with MSD's 2009-2011 strategic plan. MSD's experience in this new area of utility management provides many insights and lessons learned that other utilities can use to streamline their efforts sustainability performance reporting.

14F 5:00pm **Veolia's Water Impact Index, A New Tool for Water Footprinting**

E. Pinero, *Veolia Water North America*; JB. Bayart, *Veolia Environment Research and Innovation*; F. Bénichou, J. Grimaud, *Veolia Water North America*; E. Aoustin, *Veolia Environment Research and Innovation*

In order to better understand and manage water resources, the need for calculation methods and metrics has been largely recognized. Although impacts of water use could be expressed as a combination of indicators (i.e. aquatic ecotoxicity, eutrophication, scarcity, volume abstracted); there is a need for a composite stand-alone indicator that incorporates multiple variables. Veolia's new Water Impact Index (WII) is one variation of such as indicator- the first indicator enabling a comprehensive assessment of the impact of human activity on water resources. With this tool, for any product or process, the physical water balance is weighted by a quality index and a water stress index. This methodology is rooted in life cycle concepts and methodologies, taking into account both direct but also indirect water uses of any process. The index has been tested in what Veolia believes to be the first-ever simultaneous analysis of water and carbon on a major metropolitan area's water cycle. Results will be discussed.

Poster **Energy Footprint Analysis of Orange County Sanitation District's Operations**

R. Sobhani, L. Jiang, A. Chau, *University of California, Irvine*; J. Brown, E. Torres, Y. Shao, *Orange County Sanitation District*; D. Rosso, *University of California, Irvine*

The Orange County Sanitation District (OCSD) is one of the largest utilities wastewater in the United States, with a combined average flow treated exceeding 200MGD in dry days, and serving several million inhabitants of the Orange County, CA basin. OCSD owns and operates two treatment plants (Plant 1 in Fountain Valley, CA; Plant 2 in Huntington Beach, CA), inclusive of three biological processes: activated sludge (ASP) and trickling filters (TF) at Plant 1, high-purity oxygen (HPO) at Plant 2. Also, part of Plant 1 effluent (approximately 60MGD) is currently sent to the neighboring OCWD plant for water reuse, and the remaining effluent (on average, exceeding 20MGD) is sent to Plant 2 for ocean discharge. Both plants are undergoing expansion. The OCSD Plants operate on-site co-generation at both facilities. Co-generation, on average, supplies 65-70% of the total energy drawn, the remaining being imported.

This study presents the time-dependent energy footprint analysis of OCSD's operations. Our dynamic models output results as time-series with same frequency as available process data. This study is one of the components of our 2-year project to develop carbon and energy footprint models for these large treatment plants. The results presented help furthering our understanding of the role of all process components in energy footprint models. Also, our model benefits the wastewater treatment community at large by providing a valuable tool for modeling, simulation, and prediction of energy footprint in dynamic conditions.

TECHNICAL SESSION 15

Session 15: Pretreatment Methods for Enhancing Anaerobic Digestion

Tuesday, August 2, 2011 **Hyatt Conference Center Room 11**
1:45pm – 3:15pm **1.5 PDHs**

15A 1:45pm **Empirical Modeling for Effects of Emerging Pretreatment Methods on Anaerobic Digestion of Pulp Mill Biosolids**

N. Mehdizadeh, C. Eskicioglu, A. Milani, M. Saha, *University of British Columbia Okanagan Campus*

Effects of microwave and ultrasound pretreatment methods were investigated on solubilization and anaerobic digestion of waste sludges from a pulp mill wastewater treatment plant (WWTP). Batch anaerobic digesters were used to stabilize pretreated waste activated sludge (WAS) and mixed sludge (primary sludge + WAS). Results on effects of sludge type (WAS and mixed sludge), microwave temperature (in a range of 50-175oC), sonication time (15-90 min), and anaerobic digester temperature [mesophilic (35 ± 2oC) and thermophilic (55 ± 2oC)] were investigated on sludge solubilization and methane production in multi-level factorial statistical designs. Analysis of variance (ANOVA) showed that all the main effects (microwave temperature, sludge type and digestion temperature) and two-way interactions had significant (p-value < 0.05) effects on cumulative methane production relative to control (not pretreated) digesters (CMPr) at high microwave temperatures (i.e., 150 - 175oC). On the other hand, at lower microwave temperatures (i.e., 50, 75, and 100oC), pretreatments did not significantly

improve the CMPr. During the sonication pretreatment, sonication time and digestion temperature significantly affected the CMPr with a p-value < 0.05. Variance analysis also determined that, for both pretreatment methods, the most important factor affecting the sludge solubilization, indicated by relative to control soluble to total chemical oxygen demand ratio (SCOD/TCODr), was the sludge type. To select a pretreatment method and the operational condition that maximize both the solubilization and methane recovery, a Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method was applied and it was concluded that mesophilic anaerobic digestion of WAS irradiated at 125oC resulted in optimal pretreatment scenario with SCOD/TCODr and CMPr of 6.1, and 1.7, respectively.

15B 2:15pm **The Next Generation of Thermal Hydrolysis: Exelys™ - A Continuous Process for Maximizing Biogas Production**
N. Gurieff, J. Bruus, S. Hoejsgaard, J. Boyd, M. Kline, *Veolia Water Solutions and Technologies*

Biosolids are the largest potential energy source for a wastewater treatment facility, and therefore need to be utilized as effectively and efficiently as possible. Enhanced anaerobic digestion is now the performance benchmark for biogas production, with thermal sludge hydrolysis being recognized as the most effective pre-treatment. However, traditional batch thermal hydrolysis systems are energy and capital cost intensive. A truly continuous thermal hydrolysis system, Exelys™, has been developed to overcome these shortcomings while maintaining a high level of effectiveness. Exelys™ has undergone full scale pilot testing in Denmark and there is now a full scale demonstration plant operational in Denmark. Key results from the pilot testing and demonstration plant will be presented in this article. The results indicate that Exelys™ is just as effective as batch thermal hydrolysis with regards to operational conditions, hydrolysis effect, biogas potential enhancement and sterilization effect. The results also show that Exelys™ is much more energy efficient than batch processes. Overall, the results indicate that Exelys™ has the potential to become the cornerstone of any energy producing wastewater treatment facility.

15C 2:45pm **Economic Benefits of Enhanced Anaerobic Digestion: A Survey**
J. Banaszak, *OpenCEL*

This paper summarizes anaerobic digestion performance for more than 30 wastewater treatment facilities around the world. The data set may be unique in that it captures many details of plant performance and costs from a large number of diverse facilities. In addition, economic models for the expected benefits of adding sludge pretreatment technology are developed for each facility. Given the range of starting conditions, the expected benefits from adding pretreatment varies widely. This paper summarizes the data and draws cost/benefit conclusions regarding pretreatment and beneficial biogas use. The key finding from this work is that anaerobic digestion, as is currently practiced, is only somewhat successful at completely capturing the energy value in wastewater solids. Based on conservative assumptions, none of the plants in this study are currently achieving more than 40% VSR for the WAS fraction. Using an energyefficient pretreatment technology offers substantial operational and financial benefits and is critical to change anaerobic digestion performance. Although the expected performance benefits are site specific, the weighted-average payback for all the plants studied was less than 3 years. The primary benefit from adding pretreatment technology is reducing the mass of biosolids that require handling, storage, hauling, and disposal. Thus, biosolids hauling and disposal costs are a key driver for achieving economic benefits from a pretreatment technology. Beneficial use of additional biogas produced by enhanced digester performance is the second main benefit for achieving economic benefits. In certain geographic areas where electrical costs

are more than 3 times equivalent natural gas costs, combining pretreatment technology with cogeneration equipment could improve the economic benefits considerably.

TECHNICAL SESSION 16

Session 16: Climate Ready Water Utilities: Helping Build Climate Resilience in the Water Sector

Tuesday, August 2, 2011 **Hyatt Conference Center Room 11**
4:00pm – 5:30pm **1.5 PDHs**

16A 4:00pm **EPA's Climate Ready Water Utility Initiative**
J. Whitler, *U.S. EPA*; T. Quintanilla, *Metropolitan Water Reclamation District of Greater Chicago*; M. Ampleman, *Oak Ridge Institute of Science and Education;*J. E. Tao, *CSC Science, Engineering, and Mission Support*

Climate change impacts pose a daunting challenge to drinking water, wastewater, and stormwater utilities' (i.e., the water sector's) ability to fulfill their public health and environmental missions. Extreme weather events, sea level rise, shifting precipitation and runoff patterns, temperature changes, and resulting changes in water quality and availability contribute to a complex puzzle of climate change challenges that have potentially significant implications for the sustainability of the water sector. While the potential effects of climate change on water and wastewater utilities have been well documented, there have not been focused efforts to build the capacity of the water sector to adapt to climate change.

The EPA established a Climate Ready Water Utilities (CRWU) initiative to respond to the climate change challenges facing the water sector. Through a collaborative process informed by water sector partners and other federal programs, the CRWU initiative has adopted the mission of helping water utilities prepare for climate change by providing a clear understanding of climate science and adaptation options. Recognizing the remaining uncertainties in climate projections, particularly precipitation and sea level rise, CRWU promotes adaptive planning and has developed decision support tools for water utilities. Despite this uncertainty, climate change impacts have the potential to compromise the ability of water systems to meet their public health and environmental missions, necessitating the integration of climate considerations into long-term utility planning and investments. Through CRWU and other efforts, EPA is helping water sector utilities take initial steps towards identifying no- and low-regrets adaptation strategies and establishing climate resiliency.

16B 4:30pm **EPA's Climate Resilience Evaluation and Awareness Tool (CREAT)**
M. Ampleman*, Oak Ridge Institute of Science and Education*;
J. Whitler, *U.S. EPA*; J.S. Fries, *CSC*

Climate change will impact the water sector and is important to consider in all aspects of drinking water and wastewater utility operations and planning. The challenge of climate change partially stems from the evolving nature of climate science and the uncertainty inherent in climate projections. Despite this uncertainty, the slow turnover time of water utility infrastructure and the severity of climate change impacts require that climate considerations be more fully integrated into long-term utility planning and investments. In response to this need, the EPA has

developed a risk assessment tool, the Climate Resilience Evaluation and Awareness Tool (CREAT) for incorporating climate science into long-term utility planning. As a risk assessment tool, CREAT offers users both top-down and a bottom-up frameworks for (1) considering climate science projections (2) identifying vulnerable assets, (3) analyzing the effectiveness of adaptation measures, and (4) preparing reports for long-term planning. The tool has been piloted at major water utilities and is now available for free download on the EPA's Climate Ready Water Utilities website. Through an upgrade to the tool, the EPA plans to provide an energy efficiency module, enhanced scenario based planning, extreme events analysis, and other resources for developing climate readiness for water and wastewater utilities.

16C 5:00pm **Water Utility Response to Climate Change and Engagement with the EPA Climate Ready Water Utility Initiative**
Quintanilla, J. Kozak, S. O'Connell, C. O'Connor, *Metropolitan Water Reclamation District of Greater Chicago*; J. Whitler, *U.S. EPA*; M. Ampleman, *Oak Ridge Institute of Science and Education*

Climate change impacts pose a variety of operational and infrastructure challenges to the water sector; water and wastewater utilities in different regions are responding in different capacities. The Metropolitan Water Reclamation District of Greater Chicago (MWRD) has been at the forefront of climate change awareness, greenhouse gas emissions monitoring, and energy efficiency. MWRD has also contributed to adaptation planning across the water sector by participating in a Climate Ready Water Utilities (CRWU) Working Group of the National Drinking Water Advisory Council (NDWAC). Through the participation of Assistant Director of Maintenance and Operations, Antonio Quintanilla, MWRD has helped build out the concept of a climate ready water utility and has offered guidance to the EPA in implementing a CRWU initiative. Through the development of an Adaptive Response Framework, the CRWU Working Group has advanced the water sector's ability to prepare for and respond to climate change. MWRD's ongoing efforts towards energy efficiency and their approach towards greenhouse gas monitoring offer a compelling case study for water sector response to climate change.

TECHNICAL SESSION 17

Session 17: Energy Management Planning for Water/Wastewater Utilities

Wednesday, August 3, 2011 **Hyatt Conference Center Pullman Room**
8:30am – 11:30am **2.75 PDHs**

17A 8:30am **Case Studies in Utilizing a Decision Support System for Sustainable Energy Management**
S. Conrad, *Simon Fraser University*; J. Geisenhoff, T. Brueck, M. Volna, *EMA Inc.*

This paper summarizes the development and piloting of a decision support system (DSS) tool to address sustainable energy management in the water/wastewater industry. The DSS was developed as part of the Water Research Foundation project 4090 "Decision Support System for Sustainable Energy Management," co-funded by the Water Environment Research Foundation. The work in this paper represents a 17 utility, international cooperative project with the aim to help utilities evaluate financial, environmental, and social issues associated with

energy management options, while considering the supply, operational, and demand side of energy management.

17B 8:50am Common Sense Approaches to Energy Reductions at a Small Wastewater Utility
C. Williams, *Angola Wastewater Treatment*

With flat revenue and increasing operational costs, the Angola Wastewater Treatment Utility was required by its Mayor to develop a contingency plan to reduce the operating budget by 10%. Developing this contingency plan would ultimately require cutting personnel and non-essential services that Utility customers were accustomed to receiving. As the Utility began looking into areas where efficiencies could be made, the U.S. Environmental Protection Agency (US EPA) and the Indiana Department of Environmental Management (IDEM) offered an invitation to the Angola Wastewater Utility to participate in a regional Pilot Energy Management Program. Involvement in this program has helped the Utility better understand how it uses energy and how it can be controlled. Within two years of its participation in the Pilot Project, the Angola Utility has significantly reduced its overall electrical consumption and related energy costs.

17C 9:10am Sustainable Energy Gains: Implementing Energy Management Systems at Indiana Water and Wastewater Treatment Utilities
J. Opie, *U.S. EPA*

U.S. EPA Region 5 and the Indiana Department of Environmental Management (IDEM) have partnered to implement a systems approach to energy management at 8 Indiana wastewater and 2 drinking water utilities. The 2009-2011 Indiana Energy Management Pilot Project is helping municipalities reduce energy use and utility costs by developing customized energy management plans for each facility.

TB1 9:30am Energy Management Pays Off: An Overview of Energy Management Planning Successes around the USA
J. Turgeon, J. Horne, *U.S. EPA*; M. Snow, *University of Massachusetts, Lowell*

Over the last several years, EPA has made a national effort to address the issues of high energy use – and its resulting costs and environmental impacts – in the municipal water/wastewater sector. EPA released the guidebook to energy management planning, and implementation Ensuring a Sustainable Future, in 2007. 2008. The Guidebook is based on a Plan-Do-Check-Act management systems approach to help utilities make sustainable decisions to improve energy efficiency and reduce costs. The agency's ENERGY STAR program added the ability to benchmark municipal wastewater treatment plants using its Portfolio Manager software the same year.

TB2 9:35am **Energy Management at Philadelphia Water Department: From Concept to Reality**

S. Tarallo, *Black & Veatch*; P. Kohl, *Philadelphia Water Department*; F. P. Aristiguieta, M. Kleveter, A. Nikolic, P. Scanlan, P. Thomson, *Black & Veatch*

The Philadelphia Water Department (PWD) is a water, wastewater, and stormwater utility providing service within the City of Philadelphia, Pennsylvania, and on a wholesale basis to several neighboring communities. PWD's procurement cost for energy including electric, natural gas, and fleet fuels exceeds $20,000,000 per year, or roughly 7% of total operation and maintenance costs. The rates that electric utilities can charge for generation of electricity have been capped on the eastern side of Pennsylvania since the mid-1990s. The rate caps will lift in January 2011 and electric rates are anticipated to rise. This will have the dual effect of increasing costs, but also impacting the economics of traditionally more expensive renewable energy alternatives.

In the spring of 2009, the City of Philadelphia initiated a comprehensive sustainability initiative, Greenworks Philadelphia. Greenworks Philadelphia is a multi-faceted plan focused on the future environmental, social, and economic well-being of the City with the vision to make Philadelphia the greenest city in the United States by 2015.

Driven primarily by economic realities of anticipated increases in energy costs and guided by civic leaders' development of aggressive sustainability goals, the PWD initiated development of a strategic energy plan to establish a validated program of energy conservation and renewable energy generation initiatives. This paper will describe energy management principles, tools, and methods and discuss their application for development of PWD's strategic energy plan. It will also present results from the PWD plan with a focus on the practical development and implementation of large-scale energy management programs.

17D 10:15am **Implementing A Sustainable Energy Efficiency Improvement Program At DC Water**

R. Atoulikian, *MWH Americas*; E. Jolly, *DC Water*; B. Wellens, R. McGuckin, G. Simon, *MWH Americas*

Operating pressures faced by utilities require both an increased focus on fiscal responsibility and cost reductions, combined with higher and ever increasing levels of environmental quality standards. This puts a greater pressure on utilities to improve their operational efficiencies and optimize the performance and operation of their facilities, saving energy and making the utility more environmentally sustainable.

Implementing a sustainable energy efficiency improvement program starts with an energy audit, conducted for DC Water, one of the largest municipal water/wastewater utilities in the US. An energy audit is a process typically used to evaluate a utility for efficiency improvements, and to identify savings opportunities. Savings can be significant and payback periods very attractive. In this project annual savings of over $3M with an average payback of approximately 5 years were identified. However, achieving the desired results starts with developing an existing baseline for current energy consumption.

17E 10:35am Energy Management and Sustainability Goals Shape The Lowell Regional Wastewater Utility's Future

J. Drake, *CDM*; M. Young, *Lowell Regional Wastewater Utility*

As one of the first national municipal entities to be certified under the International Organization for Standardization (ISO) 14001 program, the Lowell Regional Wastewater Utility (LRWWU) in Massachusetts takes great pride in its vision to be a leader in environmental management system (EMS) approaches and energy conservation, and to promote a sustainable strategy for wastewater collection, treatment and management.

During its initial plan, LRWWU focused on energy reduction, reducing its annual energy consumption by 30 percent through active engagement of energy-saving procedures developed by staff and construction of wastewater treatment facility modifications. Energy-saving efforts include motion detectors for lighting, power correction capacitors, conversion of direct drive motors to variable frequency drives, more energy-efficient motors and conversion of its mechanical aeration system to a fine-bubble system.
In 2007, LRWWU initiated a comprehensive energy audit of its collection and treatment system facilities, which included a review of plant-wide energy management procedures, processes and procedures to look for energy savings, potential renewable energy sources, and adoption of green and sustainable strategies and technologies. This audit facilitated LRWWU's participation in the Massachusetts Energy Management Pilot Program – a program that is providing communities with technical and financial assistance for the identification and implementation of energy efficient opportunities at treatment facilities.

17F 10:55am How Cincinnati is Making Major Energy Efficiency Improvements in Wastewater Treatment Operations by Employing a Systems Analysis Approach

R. Welsh, T. Lu, D. Linn, *Metropolitan Sewer District of Greater Cincinnati*

The Metropolitan Sewer District of Greater Cincinnati (MSDGC) serves a population of approximately 800,000 people in a service area that includes the city of Cincinnati and most of Hamilton County. The district is responsible for conveying and treating an average of 192 million gallons per day (MGD) of wastewater and it operates seven major treatment plants. The primary mission of MSDGC is to deliver responsive, customer-focused wastewater treatment services to its ratepayers. In recent years MSDGC has made significant strides towards the goal of reducing the energy required to treat wastewater within the district. The objectives and benefits of this ongoing effort include reduced economic burdens on the ratepayers, increased long-term sustainability of the metropolitan area, and a reduction of the overall carbon footprint of the district. This paper serves to highlight the experiences and successes that MSDGC has had in its efforts. The advances this municipality has made through plant optimizations, plant upgrades and innovative design solutions will most definitely provide useful information for other municipalities, both large and small.

Poster Planning and Developing Energy Focused Environmental Management Systems for Wastewater Treatment Facilities

J. McCaughey, *Narragansett Bay Commission*

Municipal Wastewater Treatment Facilities (WWTFs) throughout the United States play an important role in protecting human health and the environment. These facilities are designed and operated to reduce the environmental impacts of municipal wastewater (BOD, nutrients, solids, etc.) on local receiving waters and to protect the health of the communities served. The

various processes used for collecting and treating wastewater however can and do create other environmental impacts primarily through the release of greenhouse gasses from the large consumption of expensive fossil fuel generated electricity.

Using EPA's "Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities", modeled on the ISO 14000 Environmental Management System Plan-Do-Check-Act process, a group of Rhode Island WWTF professionals are actively working together to identify and implement energy improvements for all Rhode Island municipal WWTFs through the development and implementation of an Energy Focused Environmental Management System.

This Energy Focused Environmental Management System is being developed by the Rhode Island WWTF Energy Roundtable; made up of various representatives from the nineteen WWTFs located in the State of Rhode Island. With the guidance of a professional quality management development team, Roundtable members meet on a regular basis to share information on establishing more efficient energy management practices at their facilities, measuring and benchmark their energy use, and identifying and assessing potential "Energy Efficiency Measures." This paper discusses the strategies and methodologies used to coordinate the development and implementation of this statewide WWTF Energy Focused Environmental Management System.

TECHNICAL SESSION 18

Session 18: Zero Net Energy Facilities and the Future of Wastewater Treatment

Wednesday, August 3, 2011 **Hyatt Conference Center Room 11**
8:30am – 11:30am **2.75 PDHs**

18A 8:30am **Resource Recovery and Municipal Wastewater Treatment: Modeling of a New Approach**

O. Schraa, *Hydromantis Environmental Software Solutions, Inc*.; P. Sutton, *P.M. Sutton & Associates, Inc.*; R. Goel, H. Andres, *Hydromantis Environmental Software Solutions, Inc*.

A municipal wastewater treatment flowsheet concept has been developed which achieves goals of energy sustainability and water and nutrient recovery, while minimizing residual solids production and the release of GHGs. The new flowsheet detailed here integrates established biological and physical-chemical process systems in a unique fashion which allows for conversion of the organic carbon in the wastewater to methane, the removal and recovery of phosphorus and nitrogen from the wastewater, and the production of water suitable for reuse. A model of the new flowsheet has been developed in GPS-X and helps provide confidence in the validity of many of the claimed advantages of the new flowsheet. The modeling results imply that 80 percent of the wastewater COD can be shunted to the anaerobic digestion step of the flowsheet and the flowsheet can reduce residual solids production by 45 percent in comparison to conventional methods. The new flowsheet has a significant advantage over conventional treatment with respect to the treatment plant energy balance. It is estimated the new flowsheet will reduce the energy required for treatment plant operation by over 99 percent. The energy balance implies a potential to generate energy in the treatment of municipal wastewater provided a more energy efficient MBR membrane system specific to this low SRT application

can be developed. The results of a model-based sensitivity analysis suggest that the expected limitations in adsorption, bioflocculation, and hydrolysis at low SRTs, the wastewater characteristics, and the FP pretreatment system performance are all significant in determining the level of COD shunting and should be confirmed at pilot-scale or full-scale.

18B 8:50am Energy Management - Towards Energy Neutral Wastewater Treatment

L. Fillmore, *WERF*; A. Shaw, L. Stone, S. Tarallo, *Black & Veatch*

Energy consumption is typically the second or third largest item in a wastewater utility's operations and maintenance budget and has been trending steeply upwards in both quantity and unit cost. The recent economic recession has placed additional financial burdens on wastewater utilities as they strive to meet increasingly stringent discharge requirements with aging infrastructure in need of repair and replacement. Energy conservation, on-site generation, and renewable energy are becoming increasingly important to wastewater utilities as energy policy, energy economics, and actions to mitigate climate change converge with the need to meet higher standards of wastewater treatment.

Energy is a cost item that utilities can control through practical approaches and proven technologies. Many utilities are beginning to reduce grid-connected energy consumption at their facilities through a variety of energy demand and on-site energy production measures. Technology advancements combined with operational best practices are bringing into focus the real possibility of achieving energy neutral wastewater treatment. The Water Environment Research Foundation (WERF) is implementing research programs to develop and deploy new practices, technology, and information to help wastewater treatment facilities achieve this challenging but realistic goal of net energy neutrality.

Applying fundamental concepts of energy conversions and net energy balance at wastewater treatment plants, this paper describes the methodology by which the typical net energy gap was determined for wastewater treatment plants in the U.S. The paper addresses the energy efficiency best practices, technologies, and future research required for wastewater treatment plants to close the gap and achieve energy neutrality.

18C 9:10am A Case Study of a Large Wastewater Treatment Plant Demonstrating an Integrated Approach to Climate Change

A. Chakrabarti, J. Hake, V. De Lange, E. McCormick,
East Bay Municipal Utility District

Before climate change was a hot topic, the East Bay Municipal Utility District (EBMUD) was already working to reduce greenhouse gas (GHG) emissions from its Main Wastewater Treatment Plant (MWWTP) by generating renewable energy and producing recycled water. Over the past decade, EBMUD has implemented additional efforts through innovative projects to further reduce its contribution to GHG emissions. These projects include diverting organic wastes from landfills, producing biodiesel from brown grease and ensuring beneficial reuse of all biosolids produced. EBMUD's comprehensive approach to climate change includes these mitigation strategies, as well as monitoring, impact and vulnerability assessments, and adaptation planning. EBMUD is also actively engaged with policy makers and regulators in climate change discussions as they pertain to wastewater treatment plant operations.

TB1 9:30am **Sustainable Wastewater Management: Energy and Nutrient Resource Recovery**

D. Whitlock, T. Datta, Z. Erdal, G. Daigger, *CH2M Hill*

The intent of this paper is to delineate the technologies related to energy and nutrient recovery from wastewater treatment plants. Considering the process flow diagram of a typical wastewater treatment plant, these efforts focus on various areas that require specific attention to achieve the resource recovery goals. There are two broad categories of resource recovery; energy recovery and nutrient recovery, with focus on the liquid and solids treatment as follows:

1) Energy Recovery from Municipal Wastewater Treatment Plant
    a) Anaerobic Technologies for Biogas Recovery from Solids Stream
    b) Biogas-fueled Energy Recovery System
    c) Thermal Processing of Biosolids with Energy Recovery
    d) Energy Recovery from Liquid Stream

2) Nutrient Recovery from Municipal Wastewater Treatment Plants
    a) Phosphorus
    b) Ammonia
    c) Organic Carbon

TB2 9:35am **Using an Integrated Approach to Developing Sustainability Guidelines and Performance Targets for a New College Campus**

B. Douglas, B. Toth, *Stone Environmental, Inc.*; C. Barraclough, W. P. Lucey,*Aqua-Tex Scientific Consulting Ltd.*; B. Bradley, *Stone Environmental, Inc.*

In 2010, the College of the Desert focused the development of a new community college campus on the goal of creating a practical example of sustainable design. The West Valley Campus, located in Palm Springs, California, is currently being designed using an integrated approach, through which independent planners, designers, and contractors will work using a common framework to create a uniquely integrated sustainable facility that will become a living laboratory for teaching and learning. The integrated campus design process was developed to enable the campus to mitigate, and adapt to, climate change by potentially having a lower water and energy demand when compared to a series of parallel green design elements.

Two documents are central to the framework of the Integrated Design Campus Plan. The Sustainability Guidelines were completed in January, 2010, followed by the Performance Targets in July, 2010. These two documents were created by a diverse team of professionals representing the fields of planning, design, engineering, ecology, scientific research, and architecture. This team shared a singular vision of creating a framework to provide guidance for current and future phases of campus development that move beyond the current sustainability paradigm of living within available resources. The strategy adopted here was for designing a holistic campus to mimic desert ecology, emphasize resource conservation and efficiency, the recovery of wastes, and adaptation to climate change.

18D 10:15am **Are They Wastes or Resources the MMSD's Journey Continues**
D. Dineen, *Donohue & Associates*; D. Jensen, P. Topczewski, *Milwaukee Metropolitan Sewerage District*; D. Zitomer, *Marquette University*; W. Marten, *Donohue & Associates*; M. Dierker, *Veolia Water Milwaukee*

The Milwaukee Metropolitan Sewerage District (MMSD) is facing many of the challenges common to all wastewater utilities; reduced loading to the system, reduced revenues, increasing energy costs, and the public's desire for sustainable practices. Trucked high strength waste co-digestion can help to address each of these challenges. The MMSD has conducted research on waste co-digestion and a small scale operation for the past 10 years. The MMSD gained additional first-hand knowledge of successful co-digestion programs and has decided to leverage this knowledge along with their own research to expand their program on an accelerated schedule. A successful high strength waste co-digestion program will support many of the MMSD's sustainability goals.

18E 10:35am **Achieving Zero Net Energy Utilization at Municipal WWTPs: The Gloversville-Johnstown Joint WWTP Experience**
R. Ostapczuk, P Baskette, C. Dassanayake, J. Smith, *Malcolm Pirnie, Inc*.; G. Bevington, *Gloversville-Johnstown Joint Wastewater Treatment Facility*

Electricity constitutes between 25 and 40 percent of a typical wastewater treatment plant's (WWTP) operating budget (New York State Energy Research & Development Authority, 2008) and is second typically to only labor costs. In the 1970's the United States Environmental Protection Agency (US EPA) began promoting energy conservation in WWTPs through the Grants Regulations and Procedures, Revision of part 40 CFR 30.420-6 (US EPA, 1978) which required recipients of grant monies to participate in the National Energy Conservation Program. Since that time, energy conservation at WWTPs has been advanced by electrical utilities, additional federal and state agencies, and utilities with a progressive vision or facing a financial crisis. Today, the vision is not only energy conservation at WWTPs but achieving net zero energy utilization at WWTPs. This paper summarizes a case study of a WWTP that is striving for energy self-sufficiency.

18F 10:55am **The Energy-Neutral and Carbon-Neutral Plant of the Future: The WERF Optimization Program**
G. V. Crawford, *CH2M Hill;* L. Fillmore, *WERF*; D. Katehis, J. Sandino, *CH2M Hill*

The primary goal of the Water Environment Research Foundation (WERF) Optimization Program is to develop an approach that will allow the wastewater sector to achieve its treatment goals while reducing the expenditure of energy and other resources by 20% or more. During the last four years, the Program has focused primarily on energy management and energy-neutrality, while at the same time also considering sludge production, resources recovery and carbon footprint minimization in order to identify solutions that are both sustainable and optimal. This paper will report WERF energy management research that has been completed in four areas: Wastewater Treatment Plant (WWTP) best practices in Europe including the energy-producing Strass im Zillertal plant in Austria; WWTP best practices in North America; a visioning of the WWTP of the Future that considers plant-wide energy conservation and recovery measures that will allow energy self-sufficiency; and the creation of a web-based tool called CHEApet that allows utilities to evaluate energy reduction opportunities at any plant.

Poster **The Short Pipe Path – Safe Water, Energy & Nutrient Recovery**
N. J. Ashbolt, *USEPA*

The step-by-step refinement of our urban water systems has yielded unsustainable, centralized urban water services in many developed regions of the world. These large systems also provide the wrong role model and promote conservative thinking for the rapidly developing regions of the world. Population growth, particularly in the water scarce regions on every continent, makes current water-based sanitation unsustainable for most of us. Also, the provision of sanitation and drinking water consumes considerable energy, whereas the biodegradable organic matter within wastewater contains over ninetimes as much energy as typically used to treat wastewater in developed regions. Energy savings could be further extended, along with intensive animal production 'wastes', by conserving the imbedded energy in wastewater-nitrogen through agricultural reuse, along with recovery of our finite fossil phosphate (known general availability 60-150 years). Household water conservation could easily reduce demand by 70% compared to today's US-use, through local water reuse and other innovations available that dramatically reduce water used to flush toilets, wash cloths and irrigate gardens. The new paradigm in urban water management needs to be based on the principle of source-separation of 'waste' streams, which provides for an array of options for nutrient and energy recovery, as well as the local supply of water fit-for-purpose. Such changes are not just reliant on new technology; indeed, major hurdles to change result from the current dispersed governance of water services and lack of full-scale demonstration of novel systems. A framework developed and used in Sweden and Australia to aid the realignment of urban water services is presented, along with what research questions arise from this new water paradigm.

TECHNICAL SESSION 19

Session 19: Developing and Implementing a Joint Agenda for Energy and Water Efficiency

Wednesday, August 3, 2011 **Hyatt Conference Center Field Room**
8:30am -10:00am **1.5 PDHs**

In late 2010, fifty experts from the energy and water fields, including many working primarily on the water-energy nexus participated in a workshop to assist in developing a joint agenda for energy and water efficiency. A draft blueprint and policy agenda document will be completed and circulated for comments in early 2011.

At the session, panelists from the convening organizations behind the blueprint process and participating organizations will describe the process, the opportunities identified, and actions underway or planned to make progress on efficiency issues of joint importance to the energy and water communities.

Session Speakers Include:

James McMahon, Lawrence Berkeley National Laboratory
Ed Osann, Natural Resources Defense Council

TECHNICAL SESSION 20

Session 20: General Sustainability and Energy

Wednesday, August 3, 2011 **Hyatt Conference Center Field Room**
10:15am – 11:30am **1.25 PDHs**

20A 10:15am **Membrane Bioreactors for On-site Wastewater Treatment and Recycling at The Visionaire, NYC**
P. Knowles, E. Clerico, Z. Gallagher, L. Shuler, *Natural Systems Utilities LLC*

This study considered ways to optimize the integration of an in-building Water Treatment and Reuse System (WTRS) to maximize opportunities for potable water conservation while minimizing associated system costs and carbon footprint. The studied WTRS is installed at The Visionaire, a Platinum LEED certified residential tower block in Battery Park, New York City that has approximately 900 residents. The WTRS is designed to treat 95,000 liters per day and incorporates a Membrane Biological Reactor (MBR) with subsequent disinfection and roof-water capture. Reclaimed water is used for toilet flushing, cooling tower make-up and irrigation. From May 2010 to March 2011, the WRTS saved 8 mega liters of potable water and reduced water utility bills at The Visionaire by over $25,000. Per capita potable consumption at The Visionaire was reduced by 27% in comparison to a conventional building. Operation of the WTRS required that pH was kept below 7.0 to discourage calcium phosphate precipitation in the cooling tower condenser. To maximize water reuse in the cooling tower it was required to halt the continuous hypochlorite disinfection strategy so that conductivity in the cooling tower was kept within limits. Power usage at this scale was approximately 380 kWh/day, of which approximately 50% was consumed by the MBR blowers. Beyond reducing potable water consumption, it is recommended that similar systems be installed to serve entire blocks rather than single buildings, or to achieve a reuse footprint of 380,000 liters per day, so that these systems become competitive with conventional supply and treatment from a carbon footprint and operational cost standpoint.

20B 10:35am **Energy Savings through Performance Contracting at Wastewater Treatment Plants**
J. Dickstein, *Black &Veatch*; T. Appleman, *Upper Occoquan Service Authority*; D. Clough, *Energy Systems Group*; M. Hanna, *Black & Veatch*; B. Owsenek, U*pper Occoquan Service Authority*; S. Tarallo, P. Thomson, *Black & Veatch*

The cost of energy has become an increasing concern to water and wastewater utilities. Economic drivers, combined with general industry concerns about energy supply reliability, climate change, and sustainability have encouraged many utilities to consider alternative project delivery methods to finance desired energy efficiency and renewable energy projects. One such alternative delivery method is the Energy Performance Contract.

Energy performance contracting has been applied most actively by Energy Service Companies (ESCOs) to implement building efficiency improvements at institutional facilities: universities, schools, hospitals, and government buildings. It has been only within the past five years that

municipal water and wastewater utilities began using this alternative delivery method to implement energy efficiency improvements at their treatment plants.

An Energy Performance Contract is a contractual arrangement with an ESCO that allows a wastewater utility to finance energy-saving capital improvements – usually over a 10 to15 year term – with a guarantee from the ESCO that the cost savings from energy efficiency improvements will meet or exceed annual payments covering all activity costs related to the project or bundle of projects. As a result, the capital projects can be financed through the wastewater utility's operations and maintenance budget, and in some states, outside the utility's debt limit. The guarantee provided by the ESCO through the Energy Performance Contract allows for greater flexibility in financing method, reduced risk to the wastewater utility, and potentially reduced financing costs. It is primarily a means for the wastewater utility to help secure financing, fund projects without up-front monies from capital budgets, and to implement energy-saving capital projects at reduced risk.

20C 10:55am Municipal Wastewater Treatment Facility Energy Reduction Studies: The Ultimate Aeration Plan

A. Poole, D. Wold, *Baxter & Woodman, Inc.*

Since 2008, the authors have performed energy audits of aeration systems at over twenty Illinois wastewater treatment plants (WWTPs). Despite the impacts of the current economic downturn on municipal budgets, the audit results have already contributed to motivating several WWTP owners into proceeding with aeration energy efficiency improvement projects. One of these projects, a simple replacement of a positive displacement blower with a high-speed direct-drive turbo with air bearings, has been operational for over two years and has achieved the desired energy use reduction. A more comprehensive aeration system retrofit, involving blowers, diffusers, and controls, has been in successful operation since before the audits started. An even more comprehensive retrofit, additionally including a complete replacement of all air mains and installation of complex controls, is now in substantial completion of construction and expected to be operational in time for the August 2011 conference. Still more projects by Baxter & Woodman varying in complexity and delivery method are currently in planning, design, or construction, and include one of the first installations in the U.S. of rotary screw compressors, as part of a project to convert from anaerobic to aerobic digestion.

The presentation will summarize the audit results and their use for screening of potential activated sludge and aerobic digestion aeration system improvement projects for probable cost-effectiveness and swift payback. The plant dataset is a modest size. Consequently, it requires a focus on plant and aeration fundamentals rather than on statistical analyses. The results and the discussion should prove useful to WWTP owners in the region by illustrating the screening of potential improvements for inclusion in more detailed studies or implementation designs.