Water & Wastewater Technology Portfolio

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PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

Public Interest Energy Research Program Mission

The Public Interest Energy Research (PIER) program supports public interest energy RD&D that will help improve the quality of life in California by bringing environmentally safe, affordable and reliable energy services and products to the marketplace.

PIER PROGRAM OVERVIEW

Program annually awards up to $80 million to conduct the most promising public interest energy research by working with private & public RD&D organizations, businesses, utilities and universities. Since 1997 PIER has invested $450 million in RD&D. It operates 7 programs.

PIER Industry, Agriculture & Water (IAW) Energy Efficiency RD&D is one of the programs.

PIER Investments in Water /Energy Nexus

PIER Covers Many Facets of Water/Energy Nexus

- Electricity Use in Water treatment & Transportation
- Water for Electricity Generation
- Water for Irrigation & Environmental Sustainability.

Today's Presentation Limited to the PIER Investments for Energy Efficiency for Water & Wastewater Treatment

Drivers for Water Investments

- Demand Response
- Dwindling Potable Water Sources
- Impact of Climate Change
- Increasingly Stringent Health Regulation

How are the funds Invested

- Through Grants & Contracts
- Recipients: Universities, Industry Associations, Utilities and Private Companies
- Presentation Discusses Various Projects Totaling $ 4 million

AMERICAN WATER WORKS ASSOCIATION RESEARCH FOUNDATION (AwwaRF)

(note: On 01/01/09 AwwaRF new name is Water Research Foundation)

1. Zero Liquid Discharge and Volume Minimization for Inland Desalination
2. Development of a Utility Energy Index to Assist in Benchmarking of Energy Management for Water and Wastewater Utilities
3. Assessing Risks and Benefits of Drinking Water Utility Energy Management Practices
4. Water Consumption Forecasting to Improve Energy Efficiency of Pumping Operations
5. Evaluation of the Dynamic Energy Consumption of Advanced Water and Wastewater Treatment Technologies
6. International Desalination Research
7. Desalination Facility Design and Operation for Maximum Energy Efficiency

Zero Liquid Discharge and Volume Minimization for Inland Desalination

- **The research objective is to develop a treatment process that reduces the cost and energy consumption for inland desalination with zero liquid discharge (ZLD). The technical approach involves alternating applications of reverse osmosis (RO) with precipitation processes designed to remove the least soluble salts under conditions of controlled mixing, salt seeding, chemical addition, residence time, temperature and potential of hydrogen (pH). After removal of salts that limited recovery in the primary RO, brine is treated in a secondary RO for further product water recovery and brine volume reduction.**

- **$250,000 PIER funds, $590,000 total with match funds**

Development of a Utility Energy Index for Benchmarking Energy Use for Water and Wastewater Utilities

- The project will produce industry-wide energy performance metrics to describe the performance of water and wastewater facilities, which will subsequently be incorporated within a comparison framework (benchmarking tool) to facilitate internal and external comparisons within and among facilities nationwide.

- **$125,000 PIER funds, $333,000 with match funds**

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Assessing Risks and Benefits of Drinking Water Utility Energy Management Practices

- The objective of this project is to develop, demonstrate, and convey a practical risk-benefit decision framework to:

  1. Enable water utilities to identify and assess the risks and benefits of a broad array of energy management options including both energy supply and energy demand alternatives; and to

  2. Apply practical risk management tools to help them select, explain, and implement suitable energy management and risk mitigation practices.

- **$300,000 PIER funds, $533,000 with match funds**

Water Consumption Forecasting to Improve Energy Efficiency of Pumping Operations

- The objective of this project is to provide water utilities the best available options for short term water consumption forecasting. The project will provide information on various techniques, performance data, benchmarks, selection criteria, and functional requirements to assist utilities in evaluating and selecting the best forecasting techniques.

- **$188,000 PIER funds, $491,000 total with match**

Evaluation of the Dynamic Energy Consumption of Advanced Water and Wastewater Treatment Technologies

This project has three objectives:

1. The first objective is to quantify the actual and theoretical energy consumption of selected water and wastewater advanced treatment technologies.
2. The second objective is to evaluate the factors that affect energy consumption.
3. The third objective is to identify energy optimization opportunities in selected treatment technologies while maintaining treatment performance.

- **$188,000 PIER funds, $333,000 with match**

International Desalination Research

- A lack of awareness of ongoing or past desalination research and development (R&D) results in inefficiency in the planning and implementation of new R&D efforts and technologies. R&D efforts outside the United States is especially less known than R&D conducted domestically. Researches in the United States would benefit from a comprehensive, searchable database of international desalination R&D information and existing plant design and operating information.

- The project team will inventory, collate, review and evaluate a full range of relevant desalination related literature, policies and practices. The project approach closely coordinates simultaneous paths to compile and critically examine the needed information, to review the latest published and unpublished information including technical papers and presentations, peer-reviewed literature, academic theses and dissertations, environmental impact reports and assessments, and incorporate the latest information available from ongoing research and development projects.

- **$90,000 PIER funds, $309,000 total with match**

Desalination Facility Design and Operation for Maximum Energy Efficiency

- The work performed under this project will evaluate energy consumption by desalination facilities treating various source waters including brackish water (surface and ground water), seawater, and wastewater. The project will focus on planning, design, and operational issues that affect energy consumption in desalination processes that are readily available for implementation, and will identify means of improving energy efficiency. The effort includes: (a) Literature review for identifying viable desalination technologies that can be readily implemented and factors affecting energy consumption, and (b) a survey of desalination facilities, specifically focused on energy issues, with detailed evaluation (including site visits as needed) for selected utilities.

- **$225,000 PIER funds, $570,000 with match**

Southern California Edison

- Development and Demonstration of Digital System for Control and Monitoring of Oxygen Transfer Efficiency Measurements

- Self-Audit Of Wastewater Treatment Processes To Achieve Energy Optimization, Phase 1

Development and Demonstration of Digital System for Control and Monitoring of Oxygen Transfer Efficiency Measurements

- The purpose of this project is to develop and demonstrate a new portable, lightweight, digital automated system for the accurate monitoring and control of the oxygen transfer efficiency (OTE) measurements in the wastewater treatment industry. This new small and light-weight piece of equipment will encourage activated sludge wastewater treatment facilities to conduct OTE measurements in-house on a regular basis with minimal technical expertise. This will result in reduced energy consumption for aeration and decrease the operating costs of wastewater treatment plants in California.

- **$1 million PIER funds, $2 million with match**

Self-Audit Of Wastewater Treatment Processes To Achieve Energy Optimization, Phase 1

- The proposed research is to develop benchmarking software to self-audit plant operations. Mathematical models will be developed for specific unit operations and then combined into a single model to determine optimum interaction. Actual facility data will be input into the software to compare with the mathematical model to evaluate energy savings, conduct life-cycle analysis, and make recommendations to improve energy efficiency. This project is a two year project in two phases. Phase 1 will develop a mathematical model for primary and secondary treatment only. Phase 2 will follow a similar track for one year to develop a mathematic model for nutrient removal, disinfection, and sludge processing including digestion.

- **$300,000 PIER, $600,000 with match**

WateReuse Foundation

The following five projects have been approved by the Commission, but have not been solicited

$650,000 PIER funds, $650,000 WRF match

1. Renewable energy, peak power management, and optimization of advanced treatment technologies to reduce greenhouse gases at water reuse and desalination facilities
2. Assess water use requirements and establish water quality criteria needed for application of reclaimed waters and water reuse in energy, power, and biofuels production
3. Evaluating Emergency Planning under Climate Change Scenarios
4. Evaluation and optimization of existing and emerging energy recovery devices for desalination and wastewater membrane treatment plants
5. Implications of future water supply sources on energy demands

Renewable energy, peak power management, and optimization of advanced treatment technologies to reduce greenhouse gases at water reuse and desalination facilities

Objective

There are three objectives to this project for facilities that utilize water reuse and desalination processes:

- Increase the use of renewable energy sources.
- Develop management strategies to reduce peak power use.
- Optimization of advanced treatment technologies to reduce CO2 emissions.

Assess water use requirements and establish water quality criteria needed for application of reclaimed waters and water reuse in energy, power, and biofuels production

Objective

Determine the application potential and requirements for using reclaimed and other non-conventional waters in the production of electrical power, energy, and befouls. Establish water quality criteria for use & reuse in the different aspects of energy, power, and biofuels production, including biomass feedstock production and pre-processing:

- Thermal power plant cooling
- Power plant flue gas scrubbing to reduce greenhouse gas (GHG) emissions
- Biomass feedstock production
- Biomass feedstock pre-processing (dewatering/separation, etc.)
- Bioenergy processing (anaerobic digestion, gasification, co-firing, combined heat & power)
- Biofuels processing (ethanol, biodiesel, green diesel, butanol, other emerging befouls)

Evaluating Emergency Planning under Climate Change Scenarios

Objective(s):

- To better understand the role of water reclamation and reuse under climate change scenarios.
- To develop a methodology for assessing climate change-related risk to water utilities.
- To demonstrate the methodology using real data.

Evaluation and optimization of existing and emerging energy recovery devices for desalination and wastewater membrane treatment plants

Objective

Energy recovery devices, including pressure exchangers and turbines, are used in order to lower overall energy consumption associated with membrane systems. This project will assess the different types of currently available and emerging energy recovery devices, applications, and performance. A guidance manual will be produced to help utilities using membranes for desalination and wastewater treatment processes to select an appropriate energy recovery device.

Implications of future water supply sources on energy demands

Objective

To provide a projection of the energy requirements resulting from shifts in future water supply sources, population increases, and increased water conservation efforts. As water supplies from traditional sources are depleted (e.g. surface water, ground water), new sources must be developed (e.g. reclaimed water, seawater). Consequently, the energy demands associated with the transport of the surface water or pumping of groundwater may be shifted to treat the new water sources. This project will attempt to quantify the effects on energy requirements from the following three issues:

1. Changes in the energy requirement associated with the shift in water supplies;
2. Savings in energy required as more aggressive water conservation efforts are implemented;
3. Change in energy requirement associated with the increase in population (by 2030).

The Following Projects Have Been Proposed for Commission Approval, Expecting a Contract by April 2009

1. **Water Research Foundation (formerly Award):** Advancing Process Optimization in the Water Industry to Include Energy Efficiency and Control of Green House Gas Emissions ($425,000 PIER, $425,000 match)

2. **UC Irvine:** Energy Reduction in Membrane Filtration Processes through Optimization of Nanosuspended Particles Removal ($125,000)

3. **UC Davis:** Demonstration of a Vortex Technology for Wastewater Disinfection with UV Light ($150,000)

Energy Reduction in Membrane Filtration Processes through Optimization of Nanosuspended Particles Removal

- The objective of this proposal is to perform field and bench studies to evaluate the role of nanoscale materials on membrane filtration efficiency, and identify ways to improve energy efficiency through removal/mitigation of nanoscale particles.

- **$125,000**

Demonstration of a Vortex Technology for Wastewater Disinfection with UV Light

- The proposed contract will demonstrate an alternative UV treatment system that will eliminate the problems with traditional designs. The technology consists of creating a strong vortex inside a vertical tube, where the water will swirl upward around a core of air. The UV lamp is outside the tube, eliminating the fouling problem. The tube is light weight Teflon with high UV transmissivity, and the vortex brings the water close range to the lamp, reducing the intensity and energy costs requirements. The centrifugal force of the vortex separates sediments that settle to the bottom of the tube, where they cannot impede the UV radiation and increase energy requirements. This technology has been demonstrated on a laboratory scale and is ready for pilot testing for scale-up.

- **$150,000**
- Vortex Video

Advancing Process Optimization in the Water Industry to Include Energy Efficiency and Control of Green House Gas Emissions

- Identify the energy-savings potential system-wide that would result in a reduction of GHG's and create a link between effective system optimization and effective GHG control.
- Document the relationships between optimized distribution system practices and GHG and provide linkages to GHG reductions.
- Adapt the existing EWQMS software to include elements of GHG control, pressure management, leakage control, reservoir management, and pump station efficiency.
- Develop pilot demonstration projects that document energy savings and GHG reductions by applying the modified EWQMS protocols.

- **$425,000**