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2009 CLARKE PRIZE HIGHLIGHTS TECHNOLOGIES TO OBTAIN RENEWABLE ENERGY FROM WASTEWATER

FOUNTAIN VALLEY, Calif. – Promising new technologies to generate clean, renewable forms of energy, such as electricity and hydrogen, during the treatment of wastewater were highlighted at the Sixteenth Annual NWRI Clarke Prize Lecture and Award Ceremony, held by the National Water Research Institute (NWRI) of Fountain Valley, California, on Thursday, July 9, 2009, in Newport Beach, California.

The Clarke Prize Lecture was given by environmental biotechnologist Bruce E. Logan, Ph.D., Kappe Professor of Environmental Engineering at The Pennsylvania State University, who was selected as the 2009 NWRI Athalie Richardson Irvine Clarke Prize recipient for outstanding achievement in water science and technology.

The Clarke Prize was established by NWRI in 1993 to recognize outstanding research scientists in water and wastewater. Mrs. Joan Irvine Smith, daughter of the late Athalie Richardson Irvine Clarke, presented Logan with a medallion and $50,000 award.

Logan's lecture, entitled *Energy Sustainability of the Water Infrastructure*, emphasized the need for water infrastructure (such as treatment plants and agricultural operations) to become energy sustainable during a time in which climate change and increasing global demands for energy and water may affect the availability of water resources. He pointed out that 4 to 5 percent of the electricity produced in the United States is used to power water infrastructure. In California alone, 19 percent of the state's electricity is used toward water-related services.

One way to attain energy sustainability, suggests Logan, is to exploit a previously unused energy source: the organic matter (or, decaying compounds) present in various domestic, animal, and food wastewaters. According to Logan, the energy that can be harvested from organic matter in wastewaters is estimated to be equal to the electrical energy currently used for our water infrastructure.

During the lecture, Logan discussed three technologies his laboratory is researching that use natural bacteria to break down organic matter during the treatment of wastewater, producing both electricity and treated effluent. These bioreactor technologies include:

- Microbial fuel cells (for bioelectricity production).
- Microbial electrolysis cells (for hydrogen or methane production).
- Microbial desalination cells (to remove salts from water without the need for electricity).

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***Microbial fuel cells (MFCs)* –** An MFC captures energy similar to how energy is generated and captured when humans eat food. Our bodies break organic matter into simple molecules that are oxidized, releasing electrons. The cells in our bodies capture and store energy from those electrons. Then we dispose of the electrons by breathing air, where the electrons combine with oxygen and form water. MFCs do the same thing, using bacteria to break down the organic matter and generate electricity, then capturing the electricity by keeping the bacteria separate from a source of oxygen. Consequently, organic matter in the wastewater is removed, resulting in clean water, and useful power is produced.

***Microbial electrolysis cells (MECs)* –** An MEC is a modified MFC that excludes oxygen for the purpose of producing hydrogen or methane gas as the energy product. According to Logan, the energy recoveries in MECs can be substantial. For instance, the energy efficiency relative to electrical energy input for one particular MEC was 221 percent; in theory, electrical energy efficiencies can exceed 900 percent, making this an effective method of capturing energy as hydrogen gas.

***Microbial desalination cells (MDCs)* –** An MDC is also a modified bioreactor that uses the voltage produced by bacteria to remove salt from water, thereby desalinating it. The advantages of this process are many: it does not require electricity, can be used for wastewater or any source of biodegradable organic matter, and can generate enough electrical energy for water pumping and other processes.

As these are emerging technologies, it is yet unknown how efficient and economical they will be for wastewater treatment and energy production. Therefore, noted Logan, it is critical that we continue to research and develop them in our efforts to explore new methods for water conservation and treatment. The current water infrastructure in the United States is aging; maintaining and replacing it with treatment technologies that can self-generate energy should be a goal to reduce the energy and costs of operating wastewater treatment plants.

Logan is the sixteenth recipient of the NWRI Clarke Prize. He has taught courses in water and wastewater treatment at Penn State since 1997. He also established and directs the Penn State Hydrogen Energy (H_2E) Center, which is dedicated to developing and promoting the use of hydrogen-based technologies.

Copies of the 2009 Clarke Lecture may be downloaded at NWRI's website at www.nwri-usa.org/laureates.htm.

A 501c3 nonprofit, the National Water Research Institute (NWRI) was founded in 1991 by a group of California water and wastewater agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect the freshwater and marine environments through the development of cooperative research work. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

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