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# Energy Opportunities in Wastewater and Biosolids

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The energy potential contained in wastewater and biosolids exceeds by ten times the energy used to treat it, and can potentially meet up to 12% of the national electricity demand. That's enough to power New York City, Houston, Dallas and Chicago annually.

U.S. wastewater treatment plants currently produce only a small quantity of the energy they need. In order to broaden new energy creation, so that every community can take advantage of the opportunities, the wastewater sector must develop and deploy new practices, technologies and information in wastewater and biosolids management research. The work requires substantial and immediate investments to support efforts in President Obama's goal of ensuring that 10 percent of the United States' electricity needs come from renewable sources by 2012 and 25 percent by 2025.

Water and wastewater treatment operations have the potential to be net energy producers; they represent three percent of the total electricity consumption in the United States. Wastewater treatment utilities in the U.S. consume an estimated 21 billion kilowatt hours per year, enough to power New York City including the metro area including Nassau-Suffolk and Orange counties for a year.

Some of the world's best performing wastewater treatment plants can produce 100 percent of the energy they need to operate. These plants optimize their operations, implement resource recovery and reuse options, and employ new technologies. An essential component of their self sufficiency is recovering energy and resources from biosolids or sludge.

Without a concerted effort to help wastewater treatment facilities become net energy producers they will continue to demand substantial energy to operate. As regulations become increasingly stringent, facilities must use more advanced treatment resulting in increased energy consumption. Since electrical energy demand represents 30 percent of a typical wastewater utility's operational costs, responsible municipal utilities are exploring energy and resource recovery opportunities throughout the plant.

## Wastewater energy potential is tremendous

Researchers have measured the energy content of raw wastewater samples and determined that it exceeds the electricity requirements for treatment by a factor of 9.3 to 1. That means that domestic wastewater, which has organic matter with embedded energy content, contains almost ten times the energy needed to treat it.

Researchers can calculate the energy available nationally from domestic wastewater, in wastewater solids, or producible as biogas. They estimate the energy embedded in wastewater, and the relative percentage of the U.S. national energy needs that may be met by renewable and embedded energy from all wastewater sources (including solids fraction), to be between 2 and12% of the national electricity demand.

The potential is tremendous - although with limitations, it is technically feasible to recover energy from sludge. While emerging technologies are promising, none of the processes available today can yet fully extract all the energy available in wastewater without further investment in their research and development.

WERF is funding research that is developing new technologies, such as reconfiguring the microbial-based treatment processes to function as a microbial fuel cell and generate current. More robust investment in this research would expedite concepts proven in laboratory settings to be scaled up to pilot or even demonstration scale. Researchers are also examining physical, mechanical, biological, and chemical processes that can contribute to energy recovery or reduce energy demand.

## Biosolids management can produce energy now

Today, wastewater treatment facilities can generate some energy by producing a dewatered or dried product to burn at a power-generating station or cement plant; or by anaerobic digestion and generation of biogas, which is methane. Most of large wastewater treatment plants have some type of heat energy recovery, either from combined heat and power co-generation or incineration processes. The 16,583 publicly owned wastewater treatment facilities in the U.S. produce over 64 pounds of biosolids per person, every year. The U.S. produces 7.2 million metric tons of "dry solids" – biosolids with the water taken out of it – annually. Currently, plants incinerate or landfill 45 percent of the biosolids, and treat and land apply 49 percent. Research investments in approaches to maximize energy recovery from this great untapped potential would cut back the amount of biosolids incinerated or landfilled and improve the United States energy security.

As of 2004, 1006 public wastewater facilities used anaerobic digesters (digestion without air) to process biosolids, producing methane gas. Nineteen percent of wastewater plants with anaerobic digesters generate power with digester gas (biogas). The biogas is a source of heat or a source of fuel for direct-drive combustion engines to make steam in boilers, or plants can sell it. The other 81 percent of wastewater facilities waste the biogas by using the common practice of flaring or burning their emission without heat or energy capture. Further research tailored to these facilities which flare their emission would maximize their energy capture and minimize waste.

### *Some of the biosolids-to-energy technologies...*

Improved knowledge through research is needed to capture more of the energy in wastewater biosolids, optimize biogas production or capture energy from biosolids by other means. The production of biogas can be improved by co-digestion (adding organic waste products from other sources to increase gas production); solids pre-treatment technologies (also to increase gas production), and by better anaerobic digestion (often by thermophilic, or heat requiring, and phased digestion processes). Plants can augment the efficiency of energy conversion from biogas by improving gas treatment (to remove contaminants and concentrate the gas), improving engines to generate more power and/or electricity with reduced emissions, and improving the adaptability and cost-efficiency of using biogas as a renewable fuel (in Stirling engines, fuel cells or through the methane market). Investment in research to improve on these approaches will expedite wider use and dissemination amongst treatment plants of varying sizes and capabilities.

Physical, thermal, and biologic processes can recover energy from biosolids. While these approaches are less understood than anaerobic digestion of wastewater solids, researchers are confident they will provide additional means to recover energy. New technologies or approaches that are gaining acceptance include thermal solidification, fermentation, wet air oxidation, gasification, pyrolysis and some proprietary processes, such as Supercritical Water Oxidation. Many of these technologies or approaches have only been demonstrated in laboratories or at a small scale and more research are necessary to make them mainstream solids management options.

Pyrolysis is a technology that likely has application at wastewater biosolids handling facilities. This technology transforms carbon-based material or waste, in the absence of air and at temperatures around 600°C, into a substance called "char." Char can be gasified into a product called syngas, a combustible mixture of carbon monoxide and hydrogen, or it can be further processed into biodiesel. It can also be burned directly. The syngas and biodiesel products can co-generate power from combustion engines with recovery of heat and power. The Stamford (Connecticut) wastewater facility is building one of the newest applications of the gasification technology for wastewater solids. It estimates that if all of the wastewater treatment plants nationwide used gasification technology, the output would power two million households per day. Research investment is needed to tap this great resource.

### Research will turn promising ideas into reality

Wastewater treatment operations are essential to the protection of the environment and public health. They are also agents of innovation and can help achieve the goals of energy self sufficiency and greenhouse gases reductions as set forth by President Obama. However, substantial investment in research is necessary. To capture and use energy from wastewater and its resulting biosolids, investments of some $100 million must be made in research over the next 10 years that will:

1. improve the utilization of biogas to produce energy ($20 Million);
2. identify and develop the emerging biosolids- to- energy technologies which show the greatest promise so that wastewater facilities can understand and cost-effectively utilize them ($30 Million); and
3. Explore concepts that extract energy from wastewater, such as microbial fuel cells, or produce or utilize other energy byproducts from wastewater like hydrogen or nitrous oxide ($50 Million).

Potential energy resources, in the form of wastewater, are available in every community across America. Investment in research can make that energy available.

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