A Clear Commitment to America's Waters

Renewable Energy Recovery Opportunities from Domestic Wastewater

Request:

The National Association of Clean Water Agencies (NACWA) urges Congress to include ***biogas and solids produced in the wastewater treatment process*** in the definition of renewable biomass contained in pending energy legislation intended to wean America off its dependence from fossil fuels. By doing so, the municipal wastewater treatment sector can help states meet requirements under a Renewable Electricity Portfolio Standard.

Background:

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 these opportunities, the wastewater sector should be part of the nation's efforts to promote renewable energy sources. 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.

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. Wastewater treatment facilities can generate 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 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. That leaves only six percent for other purposes such as energy production.

Technologies Used by Wastewater Treatment Plants to Generate and Recover Energy

Energy can be recovered from domestic wastewater in several different ways. This document covers the ways that energy can be recovered, briefly describes the technologies used, and their status (common, innovative or emerging in the future from research being conducted today). While many of these technologies are mature technologies and used by some utilities, the potential is much greater than current rates of utilization. Including biogas and solids produced in the wastewater treatment process in a national renewable electricity portfolio standard would rapidly increase utilization of these technologies throughout the sector.

Mature technologies underutilized by the wastewater treatment sector include:

- **Anaerobic Digestion** - An established technology to process biosolids is anaerobic digestion which produces biogas (methane). Just like with biogas, the methane from anaerobic digestion of wastewater is used to generate electricity, heat or power. The biogas can be used to generate electricity. The technologies used to co-generate electricity from biogas include internal combustion engines, external combustion engines (Stirling), micro turbines, and fuel cells (emerging). The engines also generate heat which can be recovered. Biogas can also be used to produce heat required for treatment or to operate boilers. This is

mature technology and commonly used. However, as of 2004, 1006 public wastewater facilities out of a total of 16,583 facilities used anaerobic digestion but only 19% of these facilities recapture the methane and use it for energy production.

- **Hydraulic Head Loss -** Energy in the form of hydraulic head loss is available in most wastewater systems. This is the energy from water stored at a higher level as it flows to a lower level. Turbines are used to convert the energy from flowing water to electric current. A few treatment plants, such as San Diego, CA, can use large turbines to capture this energy and produce electricity. A more recently popular technology, applicable in more systems, are micro (mini hydro) turbines which use low head loss to generate electric current. This is mature technology and available for widespread use.

- **Thermal Energy** - Energy in the form of thermal energy can be extracted from most domestic wastewaters as the temperature of the water is warmer than the air and ground. Heat pumps are used to extract this energy which can be used by the wastewater treatment facility to offset their demand for heat. This technology works best in cold climates, and has been used in Scandinavia. Some applications are underway in the US (Aspen, CO). This is mature technology but not yet commonly used in the U.S.

- **Biosolids Incineration** - Solids are removed from domestic wastewater in the treatment plant. Several types of technologies can be used to recover energy from these solids. Dry solids can be burned or incinerated. This is an established technology but new designs make this process more efficient and reduce the need for additional energy sources to keep the process going. In most new applications and retrofit incinerator designs, there is the ability to recover heat. This is mature technology and commonly used, but still considered underutilized.

- **Biogas as Fuel** - Recently, biogas generated by the wastewater treatment process has been sold to natural gas suppliers and used to fuel vehicles retrofitted to run on natural gas. Biogas can be used to run direct drive engines which power pump, etc. but do not produce electricity. This is mature technology but not commonly used.

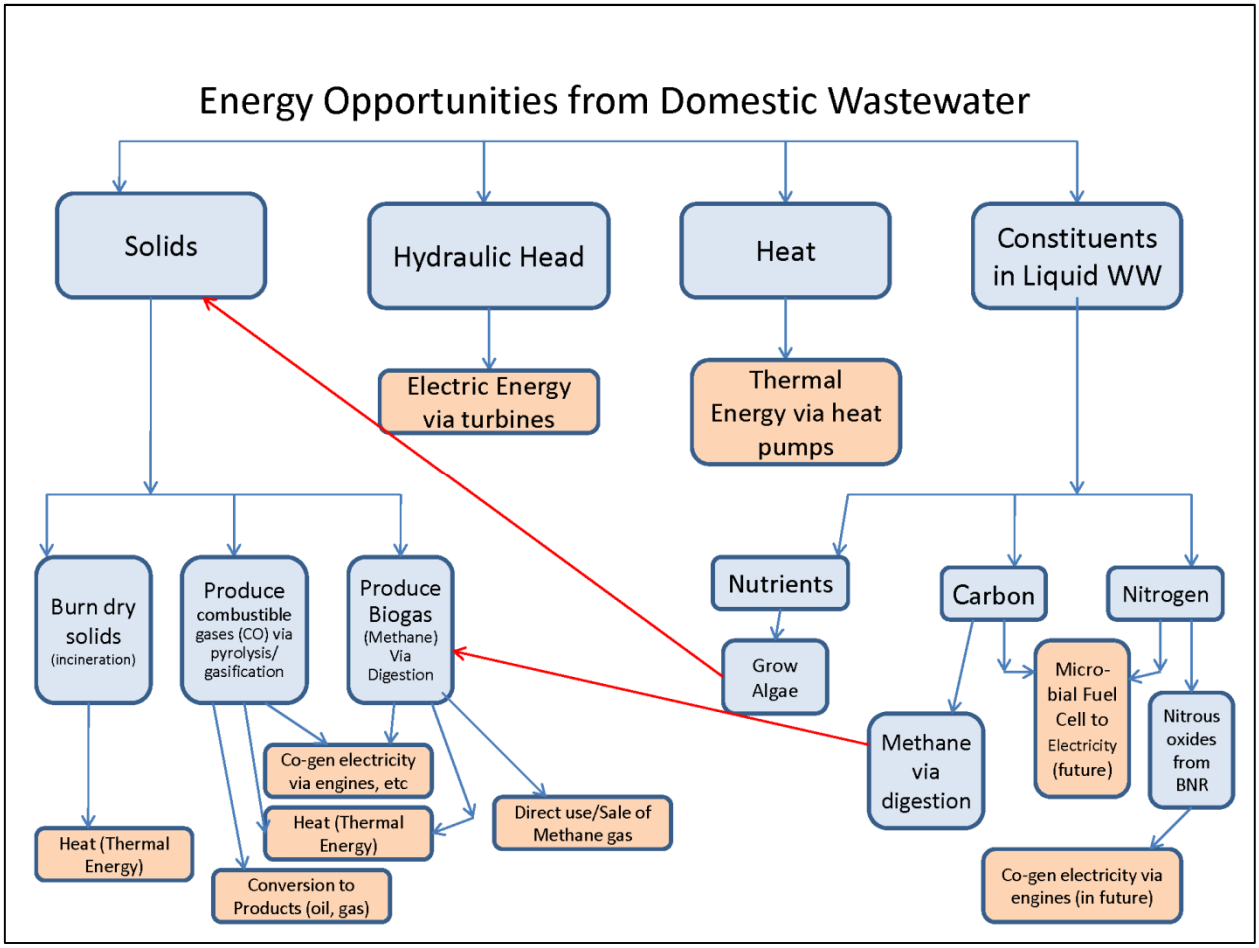
- **Gasification** - New technologies are on the market that convert wastewater solids to combustible gases through *pyrolysis* or gasification. These gases are carbon-based but are not methane. Gasification is the transformation of solids under high temperatures into a carbon-rich substance called "char", which is subsequently gasified producing a gas called syngas that can be used as fuel to generate electricity and heat. Pyrolysis is a process used to produce oil from sludge. These combustible gases can be used in engines to generate electricity similar to the process for biogas. Heat can be generated and recovered. Sometimes these gases can be used as feedstock to produce combustible products such as oil and syngas.

Emerging technologies that require more research:

- **Nutrient-rich Algae** - The constituents in wastewater also have energy recovery potential, but little has been done beyond the research stage at this time. The nutrient- rich effluent can be used to grow algae. The algae can be harvested and used to generate fuel feed stocks. Sunnyvale, CA, harvests algae and co-digests the algae with other solids to generate biogas. This is emerging technology that still requires research and development.

- **Microbial Fuel Cells** - A new technology emerging from laboratory research is the microbial fuel cell. A small amount of electricity is released during microbial transformation of both carbon and nitrogen compounds in wastewater during treatment. New advances in nanotechnology allow this energy to be recovered. This is an emerging technology and there are no full scale applications yet, but it looks promising.

- **Nitrous Oxide Capture from Biological Nitrogen Removal for Power** - Biological nitrogen removal processes are based on microbial conversions that release nitrous oxide as a byproduct. It may be possible to capture the nitrous oxide emitted from these processes and burn the nitrous oxide to generate additional power or electricity. This technology is also in the research stages and has not been applied at any treatment facility.



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The National Association of Clean Water Agencies (NACWA) is the leading advocate for national policies that advance clean water and a healthy environment. NACWA represents the collective interests of over 300 American clean water utilities – dedicated public servants and true environmental champions that treat eighty percent of all sewered communities. For nearly 40 years, NACWA has been the clean water community's voice in Washington.

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