RENEWABLE ENERGY RESOURCES: Banking on Biosolids

NACWA

A Clear Commitment to America's Waters

Acknowledgements

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I. INTRODUCTION

Over the past decade, there has been increased interest in establishing national policies that promote renewable energy in the United States, as well as an increase in the development of renewable energy projects across the country. Recently, President Obama set a goal that the United States will obtain 10 percent of its electricity from renewable sources by 2012, rising to 25 percent by 2025. Congress is currently debating legislation that would require that up to 20 percent of electricity be generated by renewable energy sources by 2020.

This interest in renewable energy has been driven by a combination of fuel price spikes, climate change concerns, public awareness, and advancements in renewable energy technologies. Recent policies and project development efforts have been focused primarily on renewable energy sources derived from wind, solar, hydro-electric, geothermal, and biomass. With very few exceptions federal and state definitions of biomass do not include biosolids despite their widespread availability.

Biosolids and biogas derived from biosolids, however, should be considered renewable energy resources. The energy value from biosolids (the solid material derived from the process of treating wastewater) can be an important component of the country's renewable energy portfolio. Numerous technologies provide a means for wastewater utilities to reduce their energy consumption and recover energy by using biosolids. While these technologies are proven and available, broad application of the technologies is hindered by financial, technological, public perception and awareness, and legislative barriers.

Biosolids and biogas derived from biosolids should be considered renewable energy resources. The energy value from biosolids can be an important component of the country's renewable energy portfolio.

As a nation, we must invest in emerging energy conversion technologies, and shift our cultural mindset to view biosolids as a viable energy resource rather than as a waste to be regulated. Changing past perceptions and increasing awareness of biosolids — what they are, the quality of the product, the energy recovery methods that can be employed, and the energy products that can be produced — is an important step towards sustainability and developing a portfolio of energy solutions for our nation's energy independence. Federal and state legislation should consider biosolids as a renewable energy source and should be adaptable so that the resulting policies and regulations can easily encompass new sources and technologies as they are developed.

This paper discusses the types of energy products that can be produced using biosolids; the technologies used to convert biosolids to energy use; the status of state law to create incentives for the use of biosolids as a renewable energy source; barriers to widespread adoption of these technologies and policies; and recommendations to promote greater use of biosolids as a sustainable, renewable energy resource for the United States.

II. BIOSOLIDS: A RESOURCE FOR SUSTAINABLE ENERGY

To make inroads towards sustainability and energy independence on a national scale, the federal government should create the conditions wherein wastewater treatment agencies can better seize the opportunity to capture biosolids energy and convert it to a marketable product. Facilities can capture biosolids energy using, in essence, the thermal and anaerobic digestion equipment and processes that may already exist onsite, or by employing additional processes designed to enhance energy production. Capturing this renewable energy available at wastewater treatment facilities translates into lower operational costs and reduced greenhouse gas emissions. The U.S. Environmental Protection Agency (EPA or Agency) instituted a program that seeks to reduce the environmental impact of electrical power production by promoting the use of Combined Heat and Power (CHP) in different sectors, including municipal wastewater treatment plants. The CHP Partnership estimates that 2.3 million metric tons of carbon dioxide emissions annually — equivalent to 430,000 cars — could be offset if existing wastewater treatment plants (with capacity over 5 million gallons per day [mgd]) that employ anaerobic digestion installed energy recovery facilities.[1,2] Harnessing the energy from biosolids offers energy security, a reduced dependence on fossil fuels, and lowered greenhouse gas emissions for our nation.

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IIa. Biosolids — Organic Byproduct of Wastewater Treatment

According to EPA, more than 16,500 publicly owned wastewater treatment works (POTWs) in the United States treat over 40 billion gallons of wastewater each day, generating over eight million dry tons of biosolids annually.[3] For the purposes of this paper, biosolids are the primary and waste-activated organic matter (solids) that is removed from wastewater. Biogas, an energy source derived from biosolids through the digestion process at wastewater treatment plants, is comprised of methane and carbon dioxide (CO_2). Biogas can be used for process heating, and can provide numerous other benefits when coupled with CHP systems, such as displacing fossil-fuels normally purchased for facility needs, increasing power reliability for the plant, and providing renewable fuel for green power programs. While biogas is a very broad term that can include biomass-derived gas, or gas from the anaerobic digestion of animal or food waste, the use of the term biogas in this paper refers to the gas derived from the wastewater anaerobic digestion process. Biosolids are managed by POTWs in a number of ways, including land application as fertilizer, distribution and marketing (includes pelletizing, composting, and soil amendment), incineration, landfilling, or surface disposal (Figure 1).

Biosolids are the primary and waste-activated organic matter (solids) removed from wastewater. Biogas, an energy source derived from biosolids through the digestion process at wastewater treatment plants, is composed of methane and carbon dioxide (CO_2).

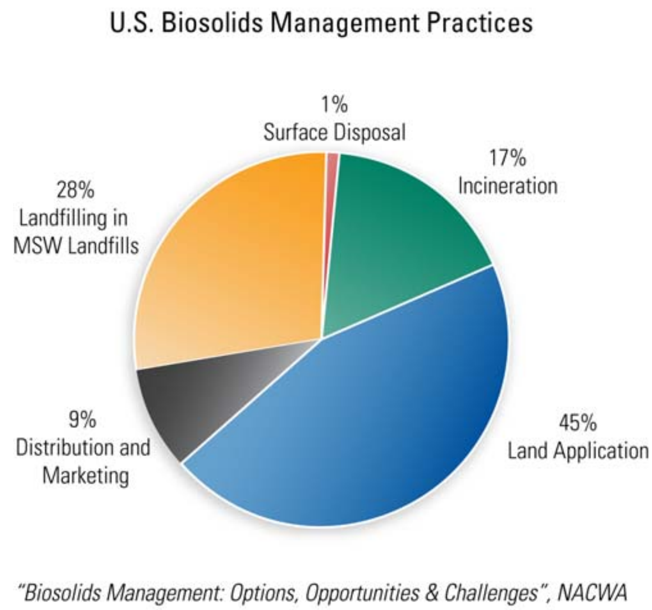


Figure 1. U.S. Biosolids Management Practices

Appendix 1 provides an overview of biosolids management and the risk-based regulatory structure under which that management takes place.

IIb. Biosolids– An Alternative Energy Source

Unprocessed biosolids typically contain approximately 8,000 British thermal units per pound (Btu/lb) on a dry weight basis (2.3 kWh/lb), which is similar to the energy content of low-grade coal. A Btu is the most common unit used to measure the heat content of fuels, and represents the amount of energy required to raise the temperature of one pound of water by one degree Fahrenheit. The energy available from biosolids and other energy sources is shown above. For comparison, the average daily residential energy use in the U.S. is 31 kWh per home[4], which would require the energy equivalent of 13.4 lbs of biosolids.

1 pound of dry biosolids	8,000 Btu
1 kiloWatt hour of electricity	3,412 Btu
1 cubic foot of natural gas	1,028 Btu
1 cubic foot of biogas	600-700 Btu
1 cord of wood	20 million Btu

The potential for energy recovery from biosolids is a function of their composition, which is a mixture of organic (volatile) matter, inorganic matter (inert material) and associated water. The composition of biosolids may vary, and the energy recovery method and corresponding energy products must be compatible with the characteristics of the biosolids. Fairly typical proportions of volatile organic matter and inert material in biosolids are shown in Figure 2.

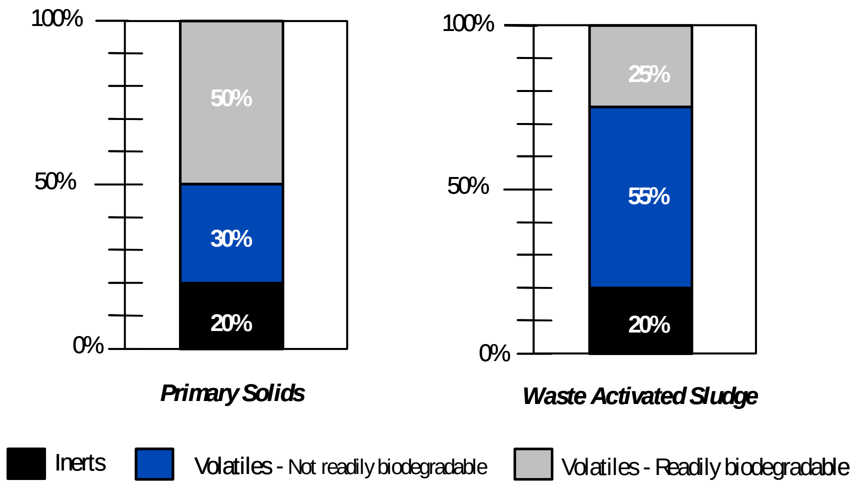


Figure 2. Composition of Raw Primary and Waste Activated Solids (Collectively Biosolids)

The energy content of biosolids is embedded in the volatile solids portion which, for the purpose of this discussion, is subdivided into two components: volatile organic matter that is readily biodegradable, and that which is not (this distinction will be discussed further in Section III). Although the composition of biosolids may vary from facility to facility, biosolids characteristics at individual POTWs are consistent, predictable, available, and sustainable. Additional refinements in process operating conditions and biosolids quality indicators will come to light as utilities continue to optimize their existing energy practices, and as technologies that harness the energy in biosolids advance.

III. BIOSOLIDS ENERGY RECOVERY METHODS – PROVEN, AVAILABLE, AND EMERGING

As the country evaluates alternative fuels, biosolids can be a viable fuel source burned in place of coal or other fossil fuel. Similarly, biogas, the methane product released when biosolids undergo anaerobic decomposition, can also be a replacement for fossil fuels. Energy recovery technologies at wastewater treatment plants are proven, and the number and variety of emerging recovery technology options are increasing dramatically. There are two primary energy pathways for energy recovery: *biodegradation* and *thermal conversion*. The potential for the recovery of energy and resources from wastewater biosolids is dictated by numerous drivers, such as the quality of, and markets for, the biosolids and energy products, as well as regulatory and public perceptions that influence the choice of recovery options. The characteristics of the end products of biodegradation and thermal conversion are significantly different. Thermal conversion oxidizes the organic matter in the biosolids, leaving behind only the inert (ash) fraction. Anaerobic digestion consumes the majority of the readily biodegradable organics in the biosolids, but leaves a larger mass/volume of biosolids for use or disposal. An overview of the various biosolids and energy products from the biodegradation and thermal conversion pathways, along with the corresponding energy recovery technologies, are shown in Figure 3.

	Treatment Process	Energy Product	Energy Use	Biosolids Product	End Uses
Biodegradation	Anaerobic Digestion	• Biogas • Fuel Gas	• Process Heat • Power Generation • Vehicle Use or Natural Gas Replacement	• Class B Cake	• Land Application • Land Reclamation
Thermal Conversion	Incineration Co-Combustion	• Heat	• Process Heat • Power Generation	• Ash	• Landfill
	Thermal Drying – Gasification	• Syngas • Fuel Gas	• Process Heat • Power Generation • Vehicle Use or Natural Gas Replacement	• Ash	• Landfill
	Pyrolysis – Thermal Drying	• Bio-oil • Dried Fuel	• Process Heat • Alternative Fuel		
	Thermal Drying (alone or in combination with above)	N/A	N/A	• Dried Biosolids	• Land Application • Land Reclamation • Distribution & Marketing • Alternative Fuel

Figure 3. Biosolids Energy Pathways, Processes, and Products

IIIa. Energy Recovery Pathway – Biodegradation and Biogas Generation

Anaerobic Digestion

Anaerobic digestion is one of the most widely used solids processing technologies. In anaerobic digestion, only the readily biodegradable portion of the volatile solids in biosolids is decomposed by microorganisms in the absence of oxygen, which produces biogas (refer to Figure 2). The gas is primarily composed of methane (60-65 percent) and CO_2 (30-40 percent). Biogas is a valuable resource that has been used traditionally to heat the digesters and, at many treatment facilities, to generate power. Biogas is an opportunity fuel, meaning gas generation requires no additional cost if the anaerobic digester used to produce the gas is already in place. Biogas can be collected and converted to electricity using onsite power generation equipment. Additionally, heat can be recovered from the power generation units in the form of hot water or steam (combustion turbines only) to heat the digesters, facility buildings, or other processes that require heat. Overall efficiency of gas utilization can approach 75 to 80 percent if all of the recovered heat is used.

Power generation from biogas has widespread use at treatment plants, especially in areas with high electric rates, such as in California and the northeastern U.S. Large plants can generate significant power. As an example, the Orange County Sanitation District in California treats a flow of 213 mgd and generates 9.3 megawatts (MW) of power using biogas. At an average plant flow of 130 mgd, the Metro Wastewater Reclamation District in Denver, Colorado, generates up to 5 MW supplying 40 percent of the treatment plant's total electrical needs.

In California, 59 percent of plants with flows greater than 38 ML/d (10 mgd) recover biogas.

The opportunity for CHP exists when a wastewater treatment plant employs anaerobic digestion. The biogas that flows from the digester can be used as fuel to generate electrical power using engine generators, turbines, or fuel cells. The heat generated during the power production process can be used for building heating or cooling, or in the treatment process itself. An analysis completed by the CHP Partnership found that if CHP were installed at all 544 wastewater treatment facilities in the U.S. (facilities that have influent flow rates greater than 5 mgd and that operate anaerobic digesters), then approximately 340 MW (340,000 kilowatt hours) of electricity could be generated – enough to power 261,000 homes.[5,6]

Biogas collection and use technologies have steadily improved over the years, and energy recovery from biogas is now regarded as one of the more mature and successful waste-to-energy technologies. Unlike thermal conversion technologies, anaerobic digestion is economically viable even for small- to medium-scale wastewater treatment facilities. Typically, anaerobic digestion is a good fit for plants that include primary clarification, which is common in plants larger than 5 to 10 mgd.

Anaerobic Digestion with Pretreatment

The desire to improve the sustainability of their operations has also led a number of wastewater utilities to explore options to increase biogas generation from their anaerobic digesters. There is growing interest in several emerging technologies that are focused on improving the digestibility of waste activated sludge (WAS), by breaking open, or lysing, the bacterial cells, making them more amenable to conventional digestion. Cell lysing technologies include thermal hydrolysis, mechanical disintegration and electrical pulse treatment. While no facilities in the U.S. use thermal hydrolysis or mechanical disintegration, more than 30 installations in Europe have implemented these processes. Based on the limited experience to date, it appears that WAS pretreatment has the potential to more than double the readily biodegradable fraction in WAS, resulting in improved volatile solids reduction and gas production in the digesters. The resulting biogas production can be 30 to 60 percent greater than without pretreatment. Enhanced

Pretreatment can potentially increase biogas production by about 30-60 percent.

volatile solids reduction in the digesters also translates to decreased quantities of stabilized biosolids to manage. While not strictly digestion pre-treatment, another option to increase biogas production is to add several feedstocks to biosolids (known as co-digestion). The most commonly used feedstock is fats, oils and grease wastes (obtained mainly from restaurants and local food preparation plants). This practice can increase biogas production by as much as 30 percent.

IIIb. Energy Recovery Pathway – Thermal Conversion

Biomass thermal conversion technologies, such as incineration, gasification, and pyrolysis, are shown in Figure 4. The entire volatile fraction of the biosolids is either completely or partially oxidized during the thermal conversion energy pathway (refer to Figure 2 for both the "readily biodegradable" and the "not readily biodegradable" fractions). Energy can be recovered from the heat liberated during the oxidation or, in some technology versions, from gaseous or carbon-based solid residue end-products.

Incineration is a well-established thermal conversion technology for biosolids processing. Several other thermal technologies, such as gasification and pyrolysis, are becoming more viable as methods for biosolids energy recovery. Most thermal conversion technologies have a minimum solids production threshold of approximately 50 dry tons per day to be economically viable. While thermal conversion processes have traditionally occurred at the POTW site, biosolids can be dried and transported to off-site facilities, such as power plants or cement kilns, to be combusted in place of coal or to augment coal use.

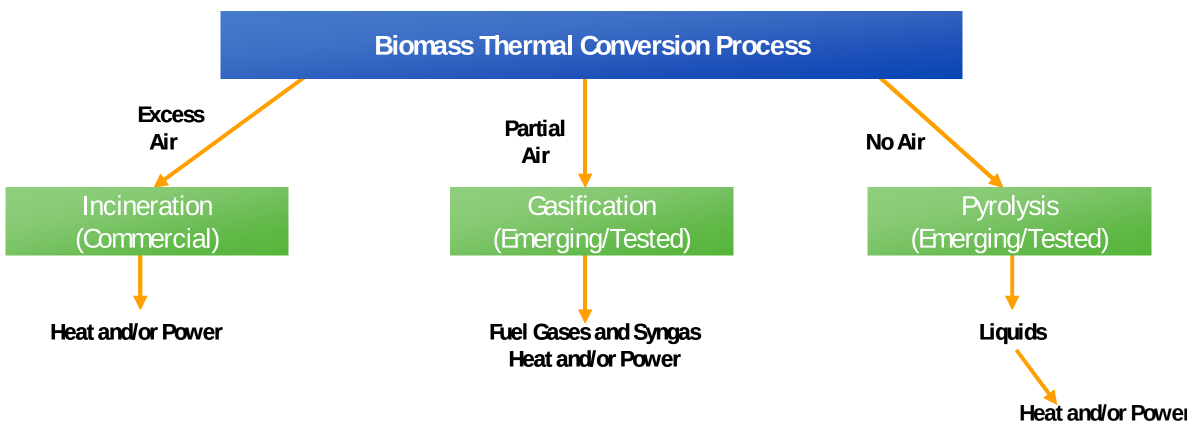


Figure 4. Biomass Thermal Conversion Technologies

Incineration

Incineration of biosolids is the most common thermal process; however, its potential for energy recovery is underused. In this process, the biosolids are burned in a combustion chamber supplied with excess air (oxygen) to form mainly carbon dioxide (CO_2) and water (H_2O), leaving only inert material (ash). Emissions are treated to remove pollutants and meet the requirements set forth by applicable federal and state regulations. Heat can be recovered from the off-gas and can be used for process heat or to generate power using steam turbines. The incineration process with energy recovery (illustrated using a fluidized bed incinerator (FBI), one of the major types of biosolids incinerators) is shown in Figure 5.

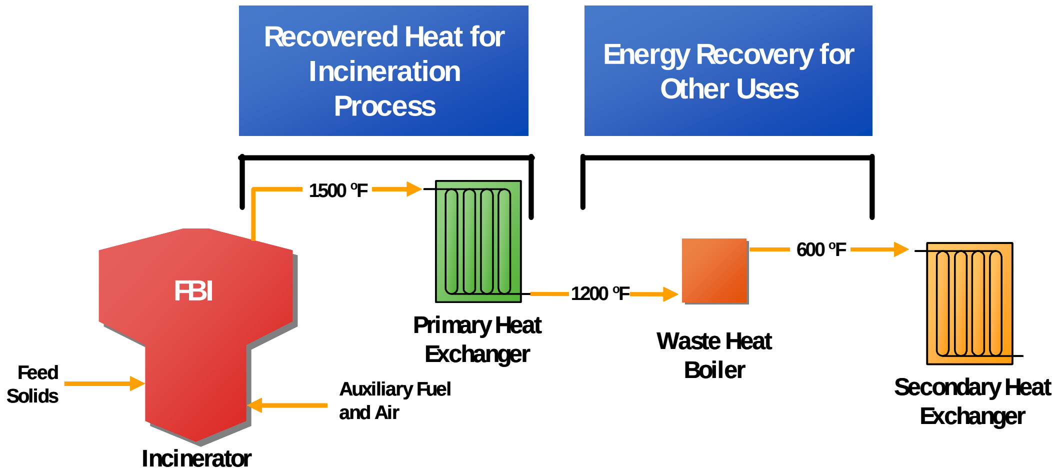


Figure 5. Fluidized Bed Incineration (FBI) Process with Energy Recovery

In addition to onsite incineration processes, dried biosolids are also suitable for co-firing in power plants that use coal or biomass (at about 5 to 20 percent of a plant's fuel input), with limited modification to the power plants.

Incineration with power generation has been successfully implemented by the Metro Wastewater Treatment Plant in St. Paul, Minnesota. The plant has a 3.5 MW generation capacity, which reportedly reduces the plant's greenhouse gas emissions by approximately 18 percent on average.[7] A number of other incineration facilities – including the Northeast Ohio Regional Sewer District's Southerly Plant in Cleveland, Ohio, and the Water Pollution Control Facility in Hartford, Connecticut – are in design to implement power recovery with expected generation capacities of 2.0 and 0.8 MW, which will provide 20 percent and 40 percent of the facilities' energy needs, respectively.

Gasification

Gasification, a relatively new technology, involves the chemical reaction of carbon in the volatile organic fraction of biosolids with air, oxygen, steam, carbon dioxide, or a mixture of these gases at elevated temperatures (500-1400°F). The products of the process include heat (which can be used to generate power and process heat) and syngas (synthetic gas). In contrast to combustion processes (incineration) that work with excess air, gasification processes operate at oxygen-starved conditions, with only enough oxygen added to generate heat to drive the chemical reactions. The gasification process is shown in Figure 6.

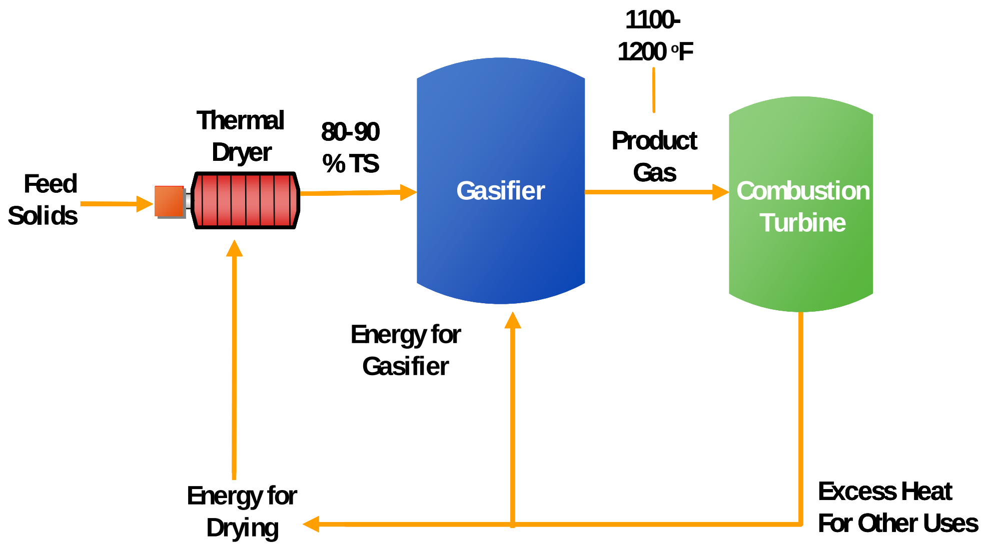


Figure 6. Gasification Process with Energy Recovery

The chemical composition of the end products and the energy content are affected by the gasification agent (air, oxygen, or steam), the gasifier operating temperature and pressure, and feed characteristics (type, dry solids, and volatile solids. An example of the gases generated and the potential uses are shown below:

Energy Type	Energy as a Percentage of Natural Gas	Use
Low energy gas	10-27	Gas turbine fuel, boiler fuel
Medium and high energy gas	27-94	Hydrogen production, fuel cell feed, chemical and fuel synthesis
Substitute natural gas	>94	Directly substitute for natural gas with no additional treatment

Dry material, such as wood or green waste, can be co-mingled with the biosolids to meet the required energy characteristics. Alternatively, the system may include a thermal drying step upstream to facilitate target feed solids concentration, and a portion of the energy from the gasification process can be used to dry the feed material.

At this time, a gasification facility for biosolids treatment is operating in Sanford, Florida, and a demonstration system is under construction in Stamford, Connecticut. Biosolids gasification is expected to result in significant energy recovery, but these types of systems are still in the early stages of implementation and will need to be proven over time.

Pyrolysis

Pyrolysis uses high pressure and temperature in the absence of oxygen to decompose the organic material in biosolids into gas, liquid (bio-oil), or char, which is a combustible carbon-based material formed by the incomplete combustion of organic material. There are two categories of pyrolysis: slow pyrolysis and fast pyrolysis. Slow pyrolysis does not produce bio-oil, whereas fast pyrolysis does. Pyrolysis typically occurs at temperatures lower than incineration or gasification.

A single commercial application of the pyrolysis process currently in use is the SlurryCarb™ installation in California. It operates at a temperature of about 840°F. The reaction, which is controlled just short of pyrolysis, alters the molecular structure of the solids and releases CO_2, thus reducing the mass of the solids by approximately 40 percent. The resulting "carbonized" solids are made into a slurry that is thermally dried and pelletized to a solid fuel, called E-fuel, which can be combusted directly in pulverized coal boilers, gasifiers, fluidized bed incinerators, or used off-site as an alternative fuel. While pyrolysis has limited application to date, the potential energy recovery is promising. Projected energy balances of the California installation indicate a net energy production of 2,100 kWh/ton dry solids.[8]

> Bio-oil, a product of the pyrolysis technology, can be used to produce thermal energy for industrial processes and to heat buildings and water.

IIIc. Opportunities for Energy Recovery Are Hindered

The lack of financial incentives and support at the federal level represents the largest impediment to broad and supported application of biosolids and biogas energy recovery technology. While the technologies available for energy recovery from biosolids are rapidly advancing, only a few full-scale installations of many of the thermal conversion-related options are operational. Because the process efficiencies, energy losses, and site-specific conditions vary, owners of POTWs, as stewards of public monies, are often understandably reluctant to implement emerging technologies without predictable results. Further, biosolids technologies are classified differently from state to state, which impedes progress because POTWs must meet permitting requirements that can vary from state to state and region to region.

These technologies have gained interest in some parts of the country, most notably in locations with high purchased electrical rates. Outside of these areas, however, utilities are not driven by the same forces, and are consequently less aware of, and motivated to, implement technologies that generate renewable energy and reduce greenhouse gas emissions.

Financial and Technological Impediments and Actions

Providing wastewater services requires substantial energy at a high cost to utilities, but utilities that use biosolids digestion and incineration lack financial incentives to invest in expensive new facilities that would enhance the self-generation of energy and reduce the need for purchased energy. According to NACWA's *2008 Financial Survey*, operation and maintenance accounts for, on average, 41 percent of a utility's total expenditures, with electricity costs composing an average of over 10 percent of the total costs.[9] From 2004 to 2007, electricity costs per million gallons treated rose 32 percent,[10] and the average electricity cost is now $166 per million gallons treated. A small percentage of wastewater treatment plants in the United States already tap the energy embedded in biosolids; the vast majority, however, do not. According to EPA, there are several hundred wastewater treatment plants in the U.S. that have anaerobic digestion capabilities. Despite the onsite technology to capture and use digester gas, only a small percentage of these plants use digester gas for heating or electricity generation.[11]

In addition to beneficial use of biogas, some POTWs use thermal conversion technologies to capture and reuse the excess process heat. For example, utilities are able to reduce their external energy consumption and energy footprints by turning the excess heat from incinerator exhaust gases into high pressure steam that is then used in plant processes and to comfortably heat buildings. Although some POTWs may co-generate electricity to maximize recovery from biosolids, older operating facilities exist that were not originally designed and constructed to recover energy, and thus require upgrades.

Biosolids represent a wellspring of potential energy, and yet current renewable energy practices and policies preclude the ability to fully recover the energy inherent in biosolids and reap the associated benefits of reduced greenhouse gases.

To alleviate financial impediments, a clear framework that renders energy derived from biosolids eligible for premium pricing would drive new applications of conventional technologies, as well as spur deployment of emerging technologies. POTW owners that are reluctant to implement technologies with little full-scale operating and cost history would benefit from financial incentives. Increased availability of grants or other financial incentives for large-scale trials and implementation would expand the experience base, increase understanding and awareness, and reduce the risk associated with newer technologies. At the same time, standardizing definitions and permitting requirements from state to state would reduce the risk and the cost of implementing newer technologies.

In 2007, 222,115 thousand kilowatt hours of electricity were generated in the U.S. using biosolids.

Perception and Awareness Impediments and Actions

Even in regions with heightened awareness of many types of renewable energy and sustainability processes, biosolids technologies are not viewed as favorably as other renewable technologies. Biosolids technologies are not generally considered “advanced” or “low-emission” technologies.

Perception and awareness of biosolids energy recovery technologies and applications can be increased through public outreach, industry-based education, and incentive programs. Some wastewater treatment industry organizations have initiated actions to gain an understanding of awareness impediments. As an example, the Water Environment Research Foundation (WERF) is planning to research impediments to generating energy from biogas, including gathering input from POTW focus groups. However, WERF has limited funds and many competing research requirements. Additional grants for renewable energy project implementation and funding for research would significantly increase the production of renewable energy and decrease greenhouse gas emissions.

IV. BIOSOLIDS IN RENEWABLE ENERGY POLICY

IVa. Current Legislation on Renewable Energy

Recent federal and state policies have been focused on primarily renewable energy sources derived from wind, solar, hydro-electric, geothermal, and biomass as solutions to the country's future energy needs. These policies define the resources and technologies that may qualify as a renewable resource for Renewable Energy Portfolio Standards (REPS). Additional revenue streams as well as special incentives and funding are available to projects that meet the REPS eligibility requirements.

In general, a REPS is a goal for electric utilities to obtain a certain amount of renewable energy to serve their customers. In order to achieve these goals, utilities often pay a premium to renewable energy producers for their energy or purchase Renewable Energy Certificates (REC) from producers to demonstrate compliance with the REPS. RECs—also known as green certificates, green tags, or tradable renewable certificates—represent the environmental attributes of the power produced from renewable energy projects and are sold separately from commodity electricity. Currently, 29 states and Washington, D.C., have enacted such standards for their utilities. This additional revenue helps support renewable energy project development.

> Wastewater biogas and biosolids are often overlooked as a potential renewable energy option in current policies despite their availability and energy value. Biosolids should be a renewable biomass fuel.

Wastewater biogas and biosolids are often overlooked as a potential renewable energy option in current policies, however, despite their availability and energy value. Biosolids should be a renewable biomass fuel, but have not been identified as such under various federal energy policies (such as the *American Recovery and Reinvestment Act* [*ARRA*] and the Federal Renewable Portfolio Standard and Carbon Cap-and-Trade) or in the majority of the State Renewable Portfolio Standards (RPS).

Under 26 USC §45 (Internal Revenue code, as amended by the ARRA), open-loop woody biomass is designated as a qualifying renewable energy resource. This classification of biomass often refers to wood byproducts or wastes that did not necessarily originate from a regenerating, managed forestry program. Thus, there are concerns regarding the sustainability of these resources over time and the emissions related to transporting the fuel. Nevertheless, the nation's policymakers have accepted open-loop biomass as renewable. By comparison, the supply of biosolids is consistent, predictable, and sustainable, and yet, biosolids continue to be omitted or not explicitly included in the energy dialogue of the nation.

These legislative omissions limit subsidies and financial incentives that the federal and state governments can provide to POTWs. The ambiguous definitions that guide the federal and state programs and policies surrounding renewable energy are discussed below.

American Recovery and Reinvestment Act (ARRA): The *ARRA* provides for a number of lucrative incentives to advance implementation of renewable technologies. Under the *ARRA* definition, many types of resources qualify for renewable energy incentives such as bonds, grants, and tax credits. Several 26 USC §45 definitions are often referenced in these federal incentive programs in specifying what are qualified "renewable resources." Unfortunately, the definitions pertaining to bioenergy resources do not directly address the definition for biosolids, biogas derived from other sources or wastewater treatment process (WWTP) biogas.[12]

Overall, whether biosolids and biogas generated from biosolids at POTWs are eligible for *ARRA* or other federal incentives remains ambiguous. At a minimum, the role of biosolids should be clarified under 26 USC §45.

Federal Renewable Energy Portfolio Standard: Implementation of a national renewable portfolio standard is nearing, yet the role of biosolids in these programs remains unclear. Under H.R. 2454, the *American Clean Energy and Security Act of 2009* (passed in the House in June, 2009), there are a number of categories that could support discussion of biosolids; however, biosolids are not directly addressed in the language, except in the case of "wastewater treatment gas".[13]

While animal waste and byproducts are clearly defined as a "renewable biomass", biosolids – which have similar characteristics – do not qualify for the same designation, even though biosolids can play a similar role in the country's energy portfolio. Instead, in this piece of important legislation, biosolids remain ambiguously defined.

State Renewable Energy Portfolio Standards (REPS). While the federal government is still contemplating a national renewable energy standard and carbon cap-and-trade programs, a majority of states have already moved forward in setting renewable energy targets. Some of these states are aware of biosolids' potential and either include biosolids and digester gas explicitly in their legislation, or allow biosolids to qualify for the state's REPS program.

- *Colorado REPS Biomass Definition:*
  "Biomass" means nontoxic plant matter consisting of agricultural crops or their byproducts, urban wood waste, mill residue, slash, or brush; animal wastes and products of animal wastes; or methane produced at landfills or as a by-product of the treatment of wastewater residuals.
- *Florida Draft REPS Definition:*
  "Biomass," means a power source that is comprised of, but not limited to, combustible residues or gases from forest products manufacturing, waste, or co-products from agricultural and orchard crops, waste or co-products from livestock and poultry operations, waste or byproducts from food processing, urban wood waste, municipal solid waste, municipal liquid waste treatment operations, and landfill gas.
- *Massachusetts REPS Definition:*
  "Eligible liquid biofuel" is further defined as a liquid fuel "that is derived from

eligible biomass fuel and that yields at least a 50 percent reduction in lifecycle greenhouse gas emissions relative to average lifecycle greenhouse gas emissions for petroleum distillate fuel…; or that is derived from waste feedstocks consisting of previously used or discarded…material resulting from…food service activities…Waste feedstock shall include, but not be limited to, waste vegetable oils, waste animal fats, substances derived from wastewater and the treatment of wastewater, or grease trap waste…"

- *California REPS Definition:*
  "Biomass" is defined as any organic material not derived from fossil fuels, including agricultural crops, agricultural wastes and residues, waste pallets, crates, dunnage, manufacturing, construction wood wastes, landscape and right-of-way tree trimmings, mill residues that result from milling lumber, rangeland maintenance residues, biosolids, sludge derived from organic matter, and wood and wood waste from timbering operations.

IVb. Legislation to Advance Renewable Energy

As a first step towards drafting legislation that defines biosolids as a renewable energy, legislators need to determine where biosolids would be addressed. Biosolids should be considered a "Renewable Biomass." The energy inherent in the biosolids products should be considered a biomass and a "renewable" energy source.

Using state REPS language as a starting point, legislators should broadly define biosolids and biosolids energy products to include current and emerging products; that is, the definition should include all energy-containing products deriving from wastewater treatment, such as residual solids, biogas, heat dried residuals, and products of energy-conversion technologies such as gasification and pyrolysis.

V. Conclusions

Wastewater treatment plants — and more broadly, the United States — have a vested interest in embracing renewable energy from biosolids. Renewable energy goals established by President Obama shine a light on technologies that establish sustainable, attainable energy recovery from biosolids. Wastewater treatment plants are primed to capitalize on available technologies. While biosolids represent a powerful energy option, energy recovery from biosolids is not without its challenges, as summarized below:

- Technological
  - Limited U.S. experience with thermal conversion-related technologies
  - Variations in permitting requirements and restrictions by state
- Financial
  - Lack of financial incentives and support
  - Limited support or implementation of premium pricing for biosolids-derived energy
  - Little full-scale operating and cost history for thermal conversion-related technologies other than incineration

- Legislative
    - Wastewater biogas and biosolids are often overlooked as a potential renewable energy option in these policies
    - Biosolids should be a renewable biomass fuel, but have not been identified as such under various federal energy policies
    - Definitions that guide the federal and state programs and policies surrounding renewable energy are inconsistent and ambiguous
- Public Perception and Awareness
    - Biosolids technologies are not viewed as favorably as other renewable technologies
    - Some utilities are less aware of and motivated to implement technologies that generate renewable energy and reduce greenhouse gas emissions

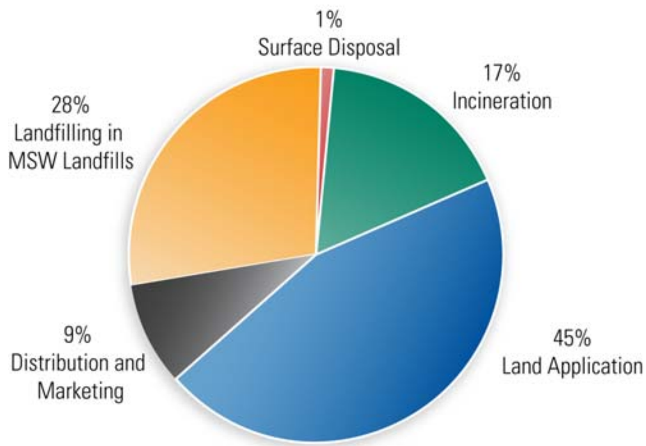
Broad-scale sustainability and energy stability are inextricably linked to legislation that recognizes and supports technological advances; innovative technology that facilitates renewable energy sources; and operator desire to apply the technology. The current impediments—technological, financial legislative, and public perception and awareness—can all be overcome. However, the speed at which we progress is influenced greatly by the actions of and policies established by federal, state, and local governments, as well as by the availability of financial incentives to encourage publicly-owned utilities to implement new technologies.

Renewable energy projects can be capital-intensive, and the decision to pursue such an option is often driven largely by nearer-term economics. Even accounting for the economic benefits of fuel/electricity displacement and carbon hedge, the payback period may be longer than some utility owners need to justify this type of capital investment. Thus, additional incentives are needed to spur more widespread development and deployment of CHP and other types of biosolids energy recovery projects. Such incentives are potentially available in the form of lower cost financing, grants, tax credits, and/or additional revenue sources provided by various "renewable energy" policy initiatives of the federal and state governments. Herein lays the importance of gaining recognition of biosolids as a renewable energy resource.

Appendix 1

Biosolids are managed by POTWs in a number of ways, including land application as fertilizer, distribution and marketing (includes pelletizing, composting, and soil amendment), incineration, landfilling, or surface disposal.

U.S. Biosolids Management Practices



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Based on statutory requirements under the Clean Water Act and key regulatory provisions in 40 CFR Part 257, biosolids production and use are governed by health-based standards set forth in 40 CFR Part 503 and by state and local laws. With the initiation of the EPA's pretreatment regulations in the early 1980s, and subsequent federal biosolids regulations, the quality of biosolids has improved, as reported in EPA's Targeted National Sewage Sludge Survey.[14] A 40-City Study (conducted in 1979 and 1980), examined the biosolids generated at 40 POTWs; the National Sewage Sludge Survey (conducted in 1989) summarizes testing conducted at over 200 wastewater treatment facilities. Both surveys showed that, in almost every case, concentrations for regulated metals decreased during the 1980s.[15]

More recent data compiled by the National Association of Clean Water Agencies (NACWA) show a continued trend of reduced concentrations of metals in municipal biosolids. For example, the Northeast Ohio Regional Sewer District (District) documents a substantial reduction in metal concentrations in its influent, effluent, biosolids, and incinerator exhaust gases. To assess the impact of the District's pretreatment program, the concentration trends for metals (cadmium, chromium, copper, lead, nickel, and zinc) were analyzed from 1980 to 2004. Since the inception of the pretreatment program at the District, metals have had a continued downward trend in treatment plant influents and effluents.[16] Similar improvements in biosolids quality have been documented at other wastewater treatment plants, including the Hyperion Treatment Plant in Los Angeles, California. Improvements such as these demonstrate the success of pretreatment programs in the U.S. and the need for a national strategy to maximize energy recovery and reuse at the Nation's POTWs.

Endnotes

[1] EPA established the Combined Heat and Power (CHP) Partnership in 2001 to encourage cost-effective CHP projects in the United States. The CHP Partnership is a voluntary program that promotes high-efficiency CHP technology, thereby reducing pollution created by less-efficient, large-scale utilities.

The CHP Partnership promotes CHP by fostering cooperative relationships with the CHP industry, state and local governments, and other relevant stakeholders.

[2] United States Environmental Protection Agency (USEPA), Combined Heat and Power Partnership, Opportunities for and Benefits of Combined Heat and Power at Wastewater Treatment Facilities. Page iii. (2006).

[3] USEPA, Office of Wastewater Management, Emerging Technologies for Biosolids Management, EPA 832-R-06-05, Page 1-1. (2006).

[4] U.S. Energy Information Administration, Independent Statistics and Analysis, Table 5, *http://tonto.eia.doe.gov/ask/electricity_faqs.asp#electricity_use_home* (2007).

[5] USEPA, CHP Manual, 2006.

[6] U.S. Energy Information Administration, 2007.

[7] Burrowes, P.; Borghesi, J.; Quast, D. The Twin Cities Sludge-to-Energy plant reduces greenhouse gas emissions, *WEFTEC Conference Proceedings*, San Diego, CA (2007).

[8] Kearney, R.; Bolin, K., The new SlurryCarb process under construction in Rialto, CA will convert biosolids to a renewable fuel, *WEF Residuals and Biosolids Conference Proceedings*, Philadelphia, PA (2008).

[9] NACWA, 2008 Financial Survey, A National Survey of Municipal Wastewater Management Financing and Trends (2008).

[10] NACWA, 2008 Financial Survey, 2008.

[11] USEPA, CHP Manual, 2006.

[12] 26 USC §45 (excerpts)
The term "open-loop biomass" means-- (i) any agricultural livestock waste nutrients, or (ii) any solid, nonhazardous, cellulosic waste material ...(I) any ... forest-related resources..., (II) solid wood waste materials..., but not including [emphasis added] municipal solid waste, gas derived from the biodegradation of solid waste, or paper which is commonly recycled, or (III) agriculture sources, including orchard tree crops, vineyard, grain, legumes, sugar, and other crop by-products or residues.

Landfill gas facilities. ...a facility producing electricity from gas derived from the biodegradation of municipal solid waste.

Trash facilities. ... a facility...which uses municipal solid waste to produce electricity.

[13] H.B. 2454 (excerpts)
Renewable Electricity – means electricity generated (including by means of a fuel cell) from a renewable energy resource or other qualifying energy resources.

Other Qualifying Energy Resource – means any of the following:
- (A) Landfill gas.
- (B) Wastewater treatment gas.
- (C) Coal mine methane used to generate electricity at or near the mine mouth.
- (D) Qualified waste-to-energy.

Qualified Waste-To-Energy – means energy from the combustion of municipal solid waste or construction, demolition, or disaster debris, or from the gasification or pyrolization of such waste or debris and the combustion of the resulting gas at the same facility, provided that—
- (A) such term shall include only the energy derived from the non-fossil biogenic portion of such waste or debris;
- (B) the Commission determines, with the concurrence of the Administrator of the Environmental Protection Agency, that the total lifecycle greenhouse gas emissions attributable to the generation of electricity from such waste or debris are lower than those attributable to the likely alternative method of disposing of such waste or debris; and

Renewable Biomass- means any of the following:
- (A) Materials, pre-commercial thinnings, or removed invasive species from National Forest System land and public lands ...
- (B) Any organic matter that is available on a renewable or recurring basis ..., including –
  - (i) renewable plant material, including--(I) feed grains; (II) other agricultural commodities; (III) other plants and trees; and (IV) algae; and
  - (ii) waste material, including--(I) crop residue;(II) other vegetative waste material (including wood waste and wood residues); (III) animal waste and byproducts (including fats, oils, greases, and manure); (IV) construction waste; and (V) food waste and yard waste.
- (C) Residues and byproducts from wood, pulp, or paper products facilities.

[14] USEPA, Targeted National Sewage Sludge Survey (2009).

[15] USEPA, Materials Characterization Paper In Support of the Advanced Notice of Proposed Rulemaking –Identification of Nonhazardous Materials That Are Solid Waste, Wastewater Treatment Sludge, Page 5, (2008).

[16] Dominak, Robert; Foley, Frank; and Lavin, Lita. Improvements in Biosolids Quality Due to EPA's Pretreatment and Biosolids Programs. (2006).

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