

Energy from Municipal Solid Waste:
A Renewable Energy Source
White Paper Submitted to Congress by ASME SWPD

EXECUTIVE SUMMARY

ASME SWPD Supports WTE - The Solid Waste Processing Division of the American Society of Mechanical Engineers supports national policies that encourage the recovery of energy from the controlled combustion of municipal solid waste (MSW), also called Waste to Energy (WTE).

Proven Technology - WTE is a proven, environmentally sound method that provides reliable electricity generation and sustainable disposal of post-recycling MSW. WTE technology is used extensively in Europe and other developed nations such as Japan.

WTE Reduces Greenhouse Gases - New policies to encourage WTE can have a sizable effect on reducing the nation's greenhouse gas emissions. In fact, the Department of Energy has estimated that wider use of the WTE technology can become one of our nation's four largest contributors to America's planned carbon dioxide reductions, accounting for as much as 15 percent of the total.

WTE Reduces Dependence on Fossil Fuel - New policies to encourage WTE can also have a meaningful impact in reducing dependence on fossil fuels and increasing renewable energy. Currently, the US WTE facilities provide more electricity than wind and solar combined by processing 28 million tons of waste. The nation currently landfills about 240 million tons of waste per year so there is significant potential to increase energy production from WTE. Every ton of MSW processed in a WTE facility avoids the mining of one half ton of coal or the importation of one barrel of oil. If all waste were processed in modern WTE facilities it could satisfy 3 to 4 percent of the country's electricity demand.

Additional Environmental Benefits of WTE -

- Complements recycling and reduces landfilling
- Preserves greenfield land
- Reduces truck traffic and associated emissions
- Recovers and recycles metals thus reducing mining operations

WTE Provides Clean Energy – WTE technology has significantly advanced with the implementation of the Clean Air Act, dramatically reducing all emissions. The EPA concluded WTE now produces electricity with less environmental impact than almost any other source.

Reliable Electricity – WTE offers two big advantages over other renewable electricity sources. It operates 24/7 to reduce base load fossil fuel generation and is located in populated areas where the power is needed the most.

ASME SWPD Recommendations:

- Include WTE in the federal Renewable Portfolio Standard.
- Consider the greenhouse gases benefits of WTE in climate change policy.
- Direct the EPA to consider “life cycle analysis” of waste disposal options and also to consider MACT type regulations on all emission sources.

Introduction

The American Society of Mechanical Engineers (ASME International) represents over 120,000 engineers and scientists who are engaged in every aspect of energy generation and utilization for the benefit of society. The Solid Waste Processing Division (SWPD) of ASME is dedicated to the recovery of energy and materials from the solids discarded by society and the environmental quality of technologies used in all aspects of waste management.

Municipal solid waste (MSW) is an unavoidable side product of human activities in all societies. Waste management is a particularly serious issue in the US because we consume an estimated 20 to 25 percent of the world's energy and materials and generate twice as much MSW per capita as other developed nations in the European Union and Japan. Therefore, there is a great need for waste reduction and recycling of materials. However, international and US experience has shown that after recycling there remains a large fraction of MSW to be disposed of.

The two proven means for disposal are burying MSW in landfills or combusting it in specially designed chambers at high temperatures, thereby reducing it to one tenth of its original volume. The heat generated by combustion converts water into steam that then can flow through a turbine to generate electricity. This process is called waste-to-energy (WTE). It recycles the energy and the metals contained in the MSW while most of the remaining ash by-product can be used beneficially for maintenance of landfills (in the US) or for road and other construction purposes (in the E.U. and Japan), a nearly "zero waste" solution.

The US WTE industry has existed for over thirty years and its technology has advanced continuously. For example, in the distant past, MSW combustion facilities of all types were considered a significant source of mercury and dioxin emissions. However, during the 1990's, the WTE industry implemented the new EPA regulations on Maximum Achievable Control Technology (MACT) and WTE boilers have become one of the cleanest sources of electricity and heat energy.

There are currently 88 WTE facilities in the US processing 28 million tons of MSW annually and generating 2.3 GW of electricity. Every ton of MSW processed in a WTE facility avoids the mining of one half ton of coal (14 million tons per year) or the importation of one barrel of oil (28 million barrels per year).

Regrettably, the Supreme Court Carbone ruling on "Flow Control" in 1996 opened the way for long distance transport of solid wastes to newly built giant landfills and stopped the growth of this useful energy producing technology in the US. Consequently, from 1995 through 2006, there were no new WTE plants built in this country. A more recent Supreme Court decision on Flow Control appears to restore the ability of communities to control the flow of wastes to such facilities.

In contrast to what was happening in the US, from 1995 through 2006, hundreds of new WTE facilities were built in the European Union, Japan, China, and other nations where landfilling is regarded as environmentally polluting and energy- and land-wasteful. In fact, in the years 2000-2007, the global WTE capacity grew at the rate of about four million tons of new disposal capacity each year. The growth of WTE in the European Union is partly due to a directive of the European Community that mandates that wastes containing over 5 percent combustible material shall not be landfilled in order to reduce landfill emissions of methane and other unhealthy, often carcinogenic, gases.

In the US, as major urban areas, such as New York City and Los Angeles, have run out of nearby landfill space, post-recycling MSW is increasingly being transported long distances to other states for burial. This has substantially increased the cost to landfill this MSW, and has also increased the associated environmental impact because of the emissions of transport vehicles to and from the landfills. It has also improved the environmental advantages of WTE vis a vis landfilling. As a result, some WTE facilities have recently begun to expand their capacity by adding new processing lines to their existing operations. These facilities are basing their requests for financing and permitting on their successful records of operation and environmental compliance.

The Conventional WTE Process

The conventional WTE combustion process is very much like the stoker burners in many coal- and wood-fired boilers. Waste is continuously fed onto a moving grate in a furnace where high temperatures are maintained. Air is added to the combustion chamber to ensure turbulence and the complete combustion of the components to their stable and natural molecular forms of carbon dioxide and water vapor.

It is interesting to note that combusting the biogenic fraction of MSW (about 65 to 70 percent of the carbon in MSW) does not result in additional greenhouse gas (GHG) emissions. WTE results in a GHG reduction because these waste materials decompose into nearly equal portions of carbon dioxide and methane gas if they are landfilled. Methane is 21 times more potent as a GHG than carbon dioxide.

The hot combustion gases released during the WTE process are directed through boilers to generate superheated steam that drives turbine generators that produce electricity. Exhausted steam can also be used efficiently for district heating and for industrial processing if those choices are available.

Energy Benefits of WTE

MSW is a fairly good fuel depending upon the moisture and energy content of the waste materials. Biogenic waste materials, or biomass, have low to medium energy content and variable moisture content. Synthetic materials such as plastics, synthetic textiles, etc. have a low moisture content and a high energy content. The belief that plastics combustion is toxic is rooted in our concern for safety during a house fire. Plastics are formed of long molecules of carbon, hydrogen and oxygen atoms. When partially burned, as in a house fire, the products of incomplete combustion can kill. However, under controlled combustion in a WTE boiler, these atoms reform as common carbon dioxide and water vapor, and any undesirable molecules are removed in the elaborate gas cleaning system that follows the boiler.

The thermal treatment of MSW can result in the generation of 550-600 kWh of electricity per ton of MSW combusted. European WTE facilities often recover another 600 kWh in the form of steam or hot water that is used for district heating. This additional energy recovery is not generally practiced in the US due to the absence of district heating systems. The corresponding savings in fossil fuel use range from one to two barrels of oil per ton of MSW.

Renewable Energy Source

Excluding hydroelectric power, only 2 percent of the US electricity is generated from renewable energy sources. A third of this renewable energy is due to WTE which at this time processes less than 10 percent of the US MSW, while nearly 60 percent is landfilled.

Energy from WTE plants in the US is greater than all wind and solar energy combined and is designated as renewable by the 2005 Energy Policy Act, by the US Department of Energy (DOE), and twenty three state governments. The DOE has estimated that wider use of this technology will be one of our nation's four largest contributors to America's planned carbon dioxide reductions, accounting for 15 percent of the total.

Environmental Benefits

In addition to its energy benefits, WTE avoids the conversion of greenfields to landfills. The 2,500-acre Freshkills landfill of New York City filled up in about fifty years. Under current practices, it would have filled in 20-25 years. Although the US is blessed with abundant land, the continuous use of land for landfilling is not sustainable, especially in the coastal areas that are experiencing the highest population growth.

Since WTE facilities are a point source of emissions, they have been subjected to very stringent environmental regulations. This is not possible for landfills which are dispersed sources extending over hundreds of acres. For example, EPA assumes that 25 percent of the landfill gas (LFG) is captured in landfills that are equipped for such capture. Other studies estimate the maximum LFG capture possible at 20 percent since, under current EPA regulations, landfills are not required to capture LFG during their first five years of operation.

Landfill gas contains about 50 percent methane which is 21 times more potent as a greenhouse gas than carbon dioxide. Comparative studies of WTE and landfilling have shown that for each ton of MSW combusted, rather than landfilled, the overall carbon dioxide reduction can be as high as 1.3 tons of CO₂ per ton of MSW when both the avoided landfill emissions and the avoided use of fossil fuel are taken into account.

WTE processing of MSW has the side benefit of reducing the transport of MSW to distant landfills and the attendant emissions and fuel consumption. It also reduces interstate truck traffic. Using U.S. Department of Transportation traffic statistics, an average of 7 deaths and over 40 serious injuries occur per year, based on the number of trucks required to transport New Jersey's two million tons per year of excess MSW to landfills in Pennsylvania, Virginia, and Ohio.

Diesel fuel consumption of trucking to and from landfills and by equipment used in the burial of MSW in landfills generate their own set of air emissions and other negative environmental impacts. All this energy consumption and diesel exhaust can be avoided by WTE facilities that use MSW as the fuel for generating electricity and steam energy at plants located near urban centers.

Material Recovery

Another beneficial effect of modern MSW combustion with energy recovery is material recovery. Using magnetic separators, the WTE industry recovers and recycles over 770,000 tons of ferrous scrap metal annually. Non-ferrous metals can also be removed through the use of "eddy current separators" that cause these materials to literally jump out of the remaining ash and into a recovery area. Metal processors sort this mixed metal into brass, aluminum, copper and other base metals. The remaining ash can be used in the construction and maintenance of landfills and as an aggregate in construction.

Policy Impediments To Using WTE Technology:

The progress of WTE in the US is impeded by three factors that can be corrected by federal legislation and action:

- Inequitable environmental regulations for various energy sources.
- Failure to consider all environmental factors when local community environmental decisions are made.
- Lack of support of local elected officials by federal agencies.

Flow Control

“Flow Control” had been one additional policy impediment to implementation of WTE technology, but that appears to have been resolved by a recent, clarifying Supreme Court Decision. Flow control is the authority needed by a municipality to direct the “flow” of its generated solid wastes into a disposal route chosen by the community, e.g., the local WTE facility. Normally, a community would need to issue bonds for any large WTE facility and employ flow control to have firm waste delivery contracts in place during the term of the bond issue.

When the US Supreme Court appeared to rule in 1993 that all existing attempts at such control were illegal under the Constitution because they restrained “commerce”, they eliminated the ability of a community to plan for the long term and to finance WTE facilities. In 2007, however, the US Supreme Court made a ruling in the "United Haulers" case that appears to restore the ability of local communities to finance long term revenue bond issues for these facilities. Moreover, the court recognized, for the first time, that Congress has, in RCRA, carved out a vital role for local government in the management of the nation's solid waste that appears to restore the ability of communities to control the flow of wastes to such facilities in order to assure the sustained good health of its citizens.

Uneven Regulations

WTE facilities have complied with very stringent EPA regulations, known as Maximum Achievable Control Technology (MACT), at an estimated cost of over one billion dollars. In addition, the Clean Air Act requires review of these stringent emissions limits every five years to determine whether lower limits are achievable regardless of how protective of public health the current limits are. Air pollution regulations for all forms of combustion processes should logically have the same health-based emissions limits. If it is dangerous from one type of facility, it is logically equally dangerous from another.

Failure to Consider all Factors

Anything we do makes pollution, even breathing, as we exhaust carbon dioxide in that process. Not making a decision can be the most polluting choice of all. Local communities are often willing to make tough decisions, even unpopular ones, when they know that it is the best choice when all factors are considered. Unfortunately, they are often cast by the news media and even the regulatory agencies, as making pollution instead of reducing pollution. Decisions to invest in WTE are often characterized as a bad choice because honest, forthright engineers concede that some small part of the emissions from the proposed plant is an unwanted pollutant. What is often missed is the resulting pollution from having no local disposal option. Long haul trucking to landfills causes serious exhaust pollution from the necessary fleet of trucks, the landfilling process, and the long term generation of gaseous pollutants from the digesting trash in the landfill.

Public decision makers need to consider all of the environmental factors that can result from choices of public services and facilities. The public needs to realize that every choice has its own set of results and consequences. The effects of the “whole picture” must be weighed for all the available choices, even the choice to do nothing (at least nothing organized).

For example, environmental impact statements for any such facilities (WTE, recycling, waste hauling, and landfilling) must include a life-cycle analysis of the environmental and energy impacts that will result from each option. Even recycling, though laudatory, has negative, as well as positive, environmental effects. The impacts of the failure to make any community “improvement” must also be weighed in the evaluation of choices.

Lack of Support of Local Elected Officials

The USEPA needs to begin to fulfill the role that the public expects of it. It must advocate for the best solutions to environmental problems, including the proper disposal of MSW. Sound science and not populist politics must be the basis for decision-making. EPA must promulgate a better understanding of the pros and cons that go with any solution, despite publicly held misconceptions which result in the perpetuation of landfilling. By means of public education, USEPA must lead in the development of environmental solutions. Since 2006 EPA has taken a more active role, for example by distinguishing in its annual reports between tonnages of MSW going to WTE and to landfilling, instead of lumping them together as “disposal”. Also, some EPA regions have taken a pro-active role in educating the public in the benefits of WTE. For example, EPA Region 2 organized a one-day seminar in Puerto Rico at which they educated the general public of the benefits of WTE vs landfilling, especially for an island where land is very scarce and precious. EPA has also re-instituted the hierarchy of integrated solid waste management, which places waste-to-energy above landfill disposal.

It is not conducive to the advancement in the US of a technology that is adopted by the most developed nations in the world, for federal agencies to sit back when misinformed “environmental organizations” oppose new WTE facilities, while beleaguered local officials labor to implement new facilities that will be good both for the environment and the pocketbooks of their citizens.

It is given that no one wants a new public facility of any sort near their homes, whether it is an airport, highway, water treatment plant and, least of all, a waste disposal facility. Environmental regulators who clearly know about the benefits of WTE should be seated next to local officials at public hearings where new facilities and technologies are discussed. EPA must join the uncomfortable, leadership position of countering irrational and unscientific claims. When EPA takes the back seat, the public reads their ostensibly neutral position as concern that the proposed facility will ruin their neighborhood.

Recommended Actions by Congress

The following actions are recommended by the American Society of Mechanical Engineers in order to advance the use of WTE technology in the US and reap the energy benefits of a homegrown, renewable energy source and of reduced local, regional, and global emissions:

- EPA must be directed by Congress to lead the effort to implement sound, scientifically and economically justifiable solutions to the nation’s very difficult environmental problems.

- EPA must be directed by Congress to re-examine and reconsider the level of regulatory limits required from all new sources of energy. MACT regulations have worked well for waste-to-energy facilities and they are equally able to control emissions from all other sources of combustion based energy production.
- Congress should enact legislation to make renewable energy credits available for WTE on a nation-wide basis under the definitions of green, or renewable energy.
- EPA must be directed by Congress to study and post notice regarding the effects of the "whole picture" and all the available choices when communities hold hearings regarding waste management decisions and options for waste management problem solution.

When these changes are made, the public will enjoy sorely needed new renewable, clean energy sources. They will also be well served by recovery of reusable materials, reduced truck traffic and highway congestion, less dependence on landfill for solid waste disposal, and less dependence on foreign sources of energy.

This paper is presently under review for approval by ASME International.