Navigation

Main page
Contents
Featured content
Current events
Random article
Donate to Wikipedia

Interaction

Help
About Wikipedia
Community portal
Recent changes
Contact Wikipedia

Toolbox

What links here
Related changes
Upload file
Special pages
Permanent link
Cite this page

Print/export

Create a book
Download as PDF
Printable version

Languages

العربية
עברית
日本語
Norsk (bokmål)
Suomi

Waste-to-energy

From Wikipedia, the free encyclopedia

Waste-to-energy (WtE) or **energy-from-waste** (EfW) is the process of creating energy in the form of electricity or heat from the incineration of waste source. WtE is a form of energy recovery. Most WtE processes produce electricity directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels.[1]

Contents

Spittelau incineration plant is one of several plants that provides district heating in Vienna.

Incineration [edit]

Main article: Incineration

Incineration, the combustion of organic material such as waste with energy recovery is the most common WtE implementation. Incineration may also be implemented without energy and materials recovery; however, this is increasingly being banned in OECD (Organisation for Economic Co-operation and Development) countries.[*citation needed*] Furthermore, all new WtE plants in OECD countries must meet strict emission standards.[*citation needed*] Hence, modern incineration plants are vastly different from the old types, some of which neither recovered energy nor materials. Modern incinerators reduce the volume of the original waste by 95-96 %, depending upon composition and degree of recovery of materials such as metals from the ash for recycling.[2]

Concerns regarding the operation of incinerators include fine particulate, heavy metals, trace dioxin and acid gas emissions, even though these emissions are relatively low[3] from modern incinerators. Other concerns include toxic fly ash and incinerator bottom ash (IBA) management.[*citation needed*] Discussions regarding waste resource ethics include the opinion that incinerators destroy valuable resources and the fear that they may reduce the incentives for recycling and waste minimization activities.[*citation needed*] Incinerators have electric efficiencies on the order of 14-28%.[*citation needed*] The rest of the energy can be utilized for e.g. district heating, but is otherwise lost as waste heat.

The method of using incineration to convert municipal solid waste (MSW) to energy is a relatively old method of waste-to-energy production. Incineration generally entails burning garbage to boil water which powers steam generators that make electric energy to be used in our homes and businesses. One serious problem associated with incinerating MSW to make electrical energy, is the pollutants that are put into the atmosphere when burning the garbage that power the generators. These pollutants are extremely acidic and have been reported to cause serious environmental damage by turning rain into acid rain. One way that this problem has been significantly reduced is through the use of lime scrubbers on smokestacks. The limestone mineral used in these scrubbers has a pH of approximately

8 which means it is a base. By passing the smoke through the lime scrubbers, any acids that may be in the smoke are neutralized which prevents the acid from reaching the atmosphere and hurting our environment. (Field) According to the New York Times, modern incineration plants are so clean that "many times more dioxin is now released from home fireplaces and backyard barbecues than from incineration."[4]

WtE technologies other than incineration [edit]

There are a number of other new and emerging technologies that are able to produce energy from waste and other fuels without direct combustion. Many of these technologies have the potential to produce more electric power from the same amount of fuel than would be possible by direct combustion. This is mainly due to the separation of corrosive components (ash) from the converted fuel, thereby allowing higher combustion temperatures in e.g. boilers, gas turbines, internal combustion engines, fuel cells. Some are able to efficiently convert the energy into liquid or gaseous fuels:

Thermal technologies:

- Gasification (produces combustible gas, hydrogen, synthetic fuels)
- Thermal depolymerization (produces synthetic crude oil, which can be further refined)
- Pyrolysis (produces combustible tar/biooil and chars)
- Plasma arc gasification PGP or plasma gasification process (produces rich syngas including hydrogen and carbon monoxide usable for fuel cells or generating electricity to drive the plasma arch, usable vitrified silicate and metal ingots, salt and sulphur)

Non-thermal technologies:

- Anaerobic digestion (Biogas rich in methane)
- Fermentation production (examples are ethanol, lactic acid, hydrogen)
- Mechanical biological treatment (MBT)
  - MBT + Anaerobic digestion
  - MBT to Refuse derived fuel

Global WTE developments [edit]

During the 2001-2007 period, the WTE capacity increased by about four million metric tons per annum. Japan and China built several plants that were based on direct smelting or on fluid bed combustion of solid waste. In China there are about 50 WTE plants. Japan is the largest user in thermal treatment of MSW in the world with 40 million tons. Some of the newest plants use stoker technology and others use the advanced oxygen enrichment technology. There are also over one hundred thermal treatment plants using relatively novel processes such as direct smelting, the Ebara fluidization process and the Thermo- select -JFE gasification and melting technology process.[5] In Patras, Greece, a Greek company just finished testing a system that shows potential. It generates 25kwatts of electricity and 25kwatts of heat from waste water.[6] In India its first energy bio-science center was developed to reduce the country's green house gases and its dependency on fossil fuel.[7]

Biofuel Energy Corporation of Denver, CO, opened two new biofuel plants in Wood River, NE, and Fairmont, MN, in July 2008. These plants use distillation to make ethanol for use in motor vehicles and other engines. Both plants are currently reported to be working at over 90% capacity. Fulcrum BioEnergy incorporated located in Pleasanton, CA, is currently building a WTE plant near Reno, NV. The plant is scheduled to open in early 2010 under the name of Sierra BioFuels plant. BioEnergy incorporated predicts that the plant will produce approximately 10.5 million gallons per year of ethanol from nearly 90,000 tons per year of MSW.(Biofuels News)

Waste to energy technology includes fermentation, which can take biomass and create ethanol, using waste cellulosic or organic material. In the fermentation process, the sugar in the waste is changed to carbon dioxide and alcohol, in the same general process that is used to make wine. Normally fermentation occurs with no air present. Esterification can also be done using waste to energy technologies, and the result of this process is biodiesel. The cost effectiveness of esterification will depend on the feedstock being used, and all the other relevant factors such as transportation distance, amount of oil present in the feedstock, and others.[8] Gasification and pyrolysis by now can reach thermal conversion efficiencies from of up to 75%, however a complete combustion is superior in terms of fuel conversion efficiency.[9] Some pyrolysis processes need an outside heat source which may be

supplied by the gasification process, making the combined process self sustaining.

Carbon dioxide emissions [edit]

In thermal WtE technologies, nearly all of the carbon content in the waste is emitted as carbon dioxide (CO_2) to the atmosphere (when including final combustion of the products from pyrolysis and gasification). Municipal solid waste (MSW) contain approximately the same mass fraction of carbon as CO_2 itself (27%), so treatment of 1 metric ton (1.1 short tons) of MSW produce approximately 1 metric ton (1.1 short tons) of CO_2.

In the event that the waste was landfilled, 1 metric ton (1.1 short tons) of MSW would produce approximately 62 cubic metres (2,200 cu ft) methane via the anaerobic decomposition of the biodegradable part of the waste. This amount of methane has more than twice the global warming potential than the 1 metric ton (1.1 short tons) of CO_2, which would have been produced by combustion. In some countries, large amounts of landfill gas are collected, but still the global warming potential of the landfill gas emitted to atmosphere in e.g. the US in 1999 was approximately 32 % higher than the amount of CO_2 that would have been emitted by combustion.[10]

In addition, nearly all biodegradable waste is biomass. That is, it has biological origin. This material has been formed by plants using atmospheric CO_2 typically within the last growing season. If these plants are regrown the CO_2 emitted from their combustion will be taken out from the atmosphere once more.

Such considerations are the main reason why several countries administrate WtE of the biomass part of waste as renewable energy.[11] The rest - mainly plastics and other oil and gas derived products - is generally treated as non-renewables.

Determination of the biomass fraction [edit]

Several methods have been developed by the European CEN 343 working group to determine the biomass fraction of waste fuels, such as Refuse Derived Fuel/Solid Recovered Fuel. The initial two methods developed (CEN/TS 15440) were the **manual sorting method** and the **selective dissolution method**. A detailed systematic comparison of these two methods has been recently published.[12] Since each method suffered from limitations in properly characterizing the biomass fraction, two alternative methods have been developed.

The first method uses the principles of radiocarbon dating. A technical review (CEN/TR 15591:2007) outlining the carbon 14 method was published in 2007. A technical standard of the carbon dating method (CEN/TS 15747:2008) will be published in 2008. In the United States, there is already an equivalent carbon 14 method under the standard method ASTM D6866.

The second method (so called **balance method**) employs existing data on materials composition and operating conditions of the WtE plant and calculates the most probable result based on a mathematical-statistical model.[13] Currently the balance method is installed at three Austrian incinerators.

A comparison between both methods carried out at three full-scale incinerators in Switzerland showed that both methods came to the same results.[14]

Although carbon 14 dating can determine with some precision the biomass fraction of waste, it cannot determine directly the biomass calorific value. Determining the calorific value is important for green certificate programs such as the Renewable Obligation Certificate program in the United Kingdom. These programs award certificates based on the energy produced from biomass. Several research papers, including the one commissioned by the Renewable Energy Association in the UK, have been published that demonstrate how the carbon 14 result can be used to calculate the biomass calorific value. By contrast the balance method delivers all required information, namely, the ratio between biogenic and fossil energy production, as well as relative and total biogenic and fossil mass and carbon fractions. Moreover it requires no additional measurements and is therefore easy to install at low costs.

Examples of waste-to-energy plants [edit]

According to ISWA there are 431 WtE plants in Europe (2005) and 89 in the United States (2004).[15] Below is a list of a few examples of WtE plants.

- Edmonton Municipal Waste-to-Ethanol gasification Plant fueled by RDF, scheduled for start of

construction by the end of 2009[16]

The following are examples of waste incineration WtE plants:

- Montgomery County Resource Recovery Facility in Dickerson, Maryland, USA (1995)
- Spittelau (1971), and Flötzersteig (1963), Vienna, Austria (Wien Energie)
- SYSAV in Malmö (2003 and 2008), Sweden (Flash presentation)
- Algonquin Power, Brampton, Ontario, Canada [17]
- Teesside EfW plant near Middlesbrough, North East England (1998)
- Edmonton Incinerator in Greater London, England (1974)

See also [edit]

- Biohydrogen production
- Biomass
- Cogeneration
- Energy recycling
- List of solid waste treatment technologies
- Manure-derived synthetic crude oil
- Refuse-derived fuel
- Relative cost of electricity generated by different sources
- Waste management

References [edit]

1. ^ NW BIORENEW
2. ^ Waste to Energy in Denmark by Ramboll Consult
3. ^ Emissionsfaktorer og emissionsopgørelse for decentral kraftvarme, Kortlægning af emissioner fra decentrale kraftvarmeværker, Ministry of the Environment of Denmark 2006 (in Danish)
4. ^ http://www.nytimes.com/2010/04/13/science/earth/13trash.html?scp=1&sq=trash&st=cse
5. ^ columbia university
6. ^ clean-tech-Greece
7. ^ clean-tech- India
8. ^ bionomic fuel
9. ^ *The Viability of Advanced Thermal Treatment of MSW in the UK*, 49 by Fichtner Consulting Engineers Ltd
10. ^ Themelis, Nickolas J. An overview of the global waste-to-energy industry, Waste Management World 2003
11. ^ [1], from the homepage of the UK Renewable Energy Association
12. ^ *The biogenic content of process streams from mechanical–biological treatment plants producing solid recovered fuel. Do the manual sorting and selective dissolution determination methods correlate?* by Mélanie Séverin, Costas A. Velis, Phil J. Longhurst and Simon J.T. Pollard., 2010. In: *Waste Management* 30(7): 1171-1182
13. ^ *A New Method to Determine the Ratio of Electricity Production from Fossil and Biogenic Sources in Waste-to-Energy Plants.* by Fellner, J., Cencic, O. and Rechberger, H., 2007. In: *Environmental Science & Technology,* 41(7): 2579-2586.
14. ^ *Determination of biogenic and fossil CO_2 emitted by waste incineration based on $^{14}CO_2$ and mass balances.* by Mohn, J., Szidat, S., Fellner, J., Rechberger, H., Quartier, R., Buchmann, B. and Emmenegger, L., 2008. In: *Bioresource Technology,* 99: 6471-6479.
15. ^ Energy from Waste State-of-the-Art Report, Statistics 5th Edition August 2006. International Solid Waste Association (ISWA)
16. ^ Edmonton Municipal Waste-to-Ethanol plant from the Enerkem web site.
17. ^ Algonquin Power Energy from Waste Facility from the homepage of Algonquin Power

Further reading [edit]

- Field, Christopher B. "Emissions pathways, climate change, and impacts." PNAS 101.34 (2004): 12422–12427.
- Sudarsan, K. G., and Mary P. Anupama. "The Relevance of Biofuels." Current Science 90.6 (2006): 748. 18 Oct. 2009 <http://www.iisc.ernet.in/currsci/mar252006/748a.pdf>.
- Tilman, David. "Environmental, economic, and energetic costs." PNAS 103.30 (2006): 11206–11210.

- "Biofuels News". Chemical Engineering Progress. . FindArticles.com. 18 Oct. 2009. <Http://findarticles.com/p/articles/mi_qa5350/is_200808/ai_n28083407>
- “Waste to Ethanol." Centurymarc. 2007. 10

External links [edit]

- Waste-to-Energy Research and Technology Council
- WtERT Germany
- LowCarbonEconomy.com
- Gasification Technologies Council

v · d · e **Topics related to waste management**

Anaerobic digestion · Composting · Downcycling · Eco-industrial park · Incineration · Landfill · Materials recovery facility · Mechanical biological treatment · Radioactive waste · High-level radioactive waste management · Recycling · Regift · Reuse · Septic tank · Sewerage · Upcycling · Waste · Waste collection · Waste hierarchy · Waste legislation · Waste management · Waste management concepts · Waste sorting · Waste treatment

Categories: Bioenergy | Waste management | Waste treatment technology