Eben Nyarko Kumi, *Univ Energy and Natural Resources*
Sakhi Shah, *Energy for Growth Hub*
June 2019

Waste-to-Energy: one solution for two problems?

Incinerating organic waste is the most common method of producing energy from municipal solid waste. While this approach is significantly more costly than landfills, waste-to-energy (WTE) can make economic sense in areas where there are energy deficits and/or a shortage of landfill space. Incineration plants use a range of technologies, including mass-burn, modular, and the less-common fluidized-bed technology (See Table 1).[1] These plants generally have high capex and operational costs, which explains low adoption in emerging markets.[2]

Where can WTE be used?

- Areas with an established waste management and collection system
- Consistent supply of solid waste, as treatment costs increase with shortages
- Regions with high energy demand/price to allow for cost of recovery from waste[3]

Benefits of WTE

- ***Electricity*** from WTE plants can range from very micro up to 30 MW installed capacity
- Generating electricity from incineration releases ***less*** CO_2, SO_2, NOx and mercury ***than coal and oil***[4]
- ***Landfill*** waste is reduced, as is the resulting ***leachate*** and ***methane*** from decomposing landfills
- Waste is a fairly ***reliable*** source of energy and production is typically predictable and low cost whereas fossil fuel prices can fluctuate dramatically

Downsides of WTE

- ***Air pollution*** can increase as scrubbing technologies are very ***expensive***
- Releases ***carbon*** from non-biodegradables which would otherwise be stored in landfill
- Ash and flue gas cleaning residues from incineration can also cause ***leachate*** problems if not properly disposed
- Generating electricity from incineration releases ***more*** CO2, SO2, NOx and mercury than ***natural gas or renewables***[5]

Conclusion

Waste incineration is an expensive method of electricity generation and has environmental trade-offs.[6,7] Recycling systems in the waste management chain prior to incineration adds even more cost. Nevertheless, WTE can be very useful in areas with limited space for landfill or where transport costs are high. Small islands and dense urban areas with high energy prices are especially suitable for WTE.

Case study: Reppie, Ethiopia

In March 2017, a landslide at one of Addis Ababa's overflowing landfills killed more than 110 people. To deal with the capital's burgeoning waste problem, the government of Ethiopia inaugurated Africa's first waste to energy plant in August 2018.[8] The facility, which cost over $100 million, will process 1400 tons/day to produce 25 MW of electricity.[9] This is about 85% of Addis Ababa's domestic waste which will generate the equivalent of 30% of the city's households' electricity use.[10] Reppie will bolster Ethiopia's energy security: it is expected to maintain consistent power supply when hydroelectric generation is affected by seasonal low river flows and climate change, and will replace diesel power plants used during power shortages.

Case Study: Accra, Ghana

Accra generates about 2,500 tons of waste per day, with a high collection rate and about two-thirds organics. Following the decommissioning of all open dumps, the only remaining option for waste disposal is the Tema Engineered Landfill, which is currently taking 1,500 tonnes/day (over twice the engineered limit). Additionally, power outages are still common in Accra and across Ghana. In early 2018 the Electricity Company of Ghana signed a PPP agreement to build a 60 MW WTE plant in Tema at a cost of $300 million.

Case Study: Lahore, Pakistan

Pakistan's National Electric Power Regulatory Authority (NEPRA) is building the country's first WTE plant in Lahore. It is a 40 MW system which will process 2000 tons of waste a day, a third of the municipal waste in Lahore.[11] It is expected to begin operation in 2022, and will cost an estimated $220 million. Waste related diseases cause over 5 million people deaths every year in Pakistan.[12] There is one safe landfill in Lahore which stores only a third of the waste produced in the city, so the WTE plant should reduce illness related to waste.[13] There may be more WTE plants built in coming years as NEPRA has announced a tariff of USD 0.10/kWh for WTE projects.[14,15]

Table 1: 3 Main Technologies types of Waste-to-Energy Plants

	Capacity & energy potential[16]	Waste specifications	Process
Mass burn -Most popular	2-3 units, each 50-1000 tons/day 1-30 MW	Does not need to be preprocessed. Needs local programs to remove household hazardous materials.	Waste is burned en masse, delivered by trucks and fed continuously through combustion chambers.
Modular -Communities/ commercial/ industrial applications	1-4 units, each 5-120 tons/day 0.1-2 MW	Does not need to be preprocessed. Needs local programs to remove household hazardous materials.	Uses multi-chamber design to more efficiently burn waste, reducing air pollution.
Fluidized bed -Limited existing applications	50-150 tons/day 1-3 MW	Need preprocessing - glass and metals removed. High recovery recycling systems with less paper and wood (typical of developing countries) can be used	A limestone bed is heated and the thermal capacity of the sand burns waste quickly and uniformly.[13] Bubbling, rotating and circulating fluidized beds are currently used.[17]

Endnotes

1. Solid Waste Management Sourcebook/1.5.2 System Types, www.unep.or.jp/Ietc/ESTdir/Pub/MSW/SP/SP5/SP5_2.asp.
2. Funk, Kip, et al. Waste Not, Want Not: Analyzing the Economic and ... National Renewable Laboratory, www.nrel.gov/docs/fy13osti/52829.pdf.
3. T. Rand, J. Haukol, U. Marxen. Municipal solid Waste Incineration: A Decision Maker's Guide. http://siteresources.worldbank.org/INTUSWM/Resources/463617-1202332338898/incineration-dmg.pdf
4. "Air Emissions from MSW Combustion Facilities | Energy Recovery from Waste." EPA, Environmental Protection Agency, archive.epa.gov/epawaste/nonhaz/municipal/web/html/airem.html.
5. O'Brien, Jeremy K. "Comparison of Air Emissions From Waste-to-Energy Facilities to Fossil Fuel Power Plants." 14th Annual North American Waste-to-Energy Conference, 2006, doi:10.1115/nawtec14-3187.
6. "Does Burning Garbage for Electricity Make Sense?" The Wall Street Journal, Dow Jones & Company, 16 Nov. 2015, www.wsj.com/articles/does-burning-garbage-for-electricity-make-sense-1447643515
7. World Energy Resources: Waste to Energy. World Energy Council. https://www.worldenergy.org/wp-content/uploads/2013/10/WER_2013_7b_Waste_to_Energy.pdf
8. Cambridge Industries Ltd., cambridge-industries.com/.
9. "Ethiopia's Waste-to-Energy Plant Is a First in Africa." UN Environment, www.unenvironment.org/news-and-stories/story/ethiopias-waste-energy-plant-first-africa.
10. Scott, Katy. "Waste-to-Energy Plant to Take on Ethiopia's Rubbish Epidemic." CNN, Cable News Network, 21 Aug. 2018, www.cnn.com/2018/08/21/africa/reppie-waste-to-energy-addis-ababa/index.html.
11. Shah, Sabir. "Lahore to Get 40MW Waste-to-Energy Plant in 22 Months." Thenews, TheNews International, 23 Nov. 2018, www.thenews.com.pk/print/397605-lahore-to-get-40mw-waste-to-energy-plant-in-22-months.
12. "Chinese Companies Joint Venture to Build 40MW Waste-to-Energy Plant in Lahore." Daily Times, 22 June 2018, dailytimes.com.pk/256601/chinese-companies-joint-venture-to-build-40mw-waste-to-energy-plant-in-lahore-2.
13. Fluidized-Bed Incineration System | Technologies and Products | EBARA Environmental Plant Co., Ltd., www.eep.ebara.com/en/products/incineration.html.
14. Waste-to-Energy Power Plant Approved. The Nation, 16 July 2018, nation.com.pk/17-Jul-2018/waste-to-energy-power-plant-approved.
15. "Decision of the Authority in Suo Moto Review..." National Electric Power Regulatory Authority - Pakistan. https://www.nepra.org.pk/Tariff/Upfront/Bagasse/UGTMSWPP-2018%20Determination%2010-07-2018%2010801-803.PDF
16. Potential based on Reppie facility, Ethiopia
17. Caneghem, J. Van, et al. "Fluidized Bed Waste Incinerators: Design, Operational and Environmental Issues." Progress in Energy and Combustion Science, vol. 38, no. 4, 2012, pp. 551–582., doi:10.1016/j.pecs.2012.03.001.