

Integration of Energy from Waste (EFW) in the Caribbean

Magnus Rundqwist
AEE – Von Roll
302 Reasearch Drive
Norcross, Georgia 30096
magnus.rundqwist@aee-vonroll.com

Abstract

The maximum environmental benefits from a new Energy from Waste (EFW) facility may require locating the new plant close to both the source of the waste and the potential energy customers. This paper will present design features that facilities to allow them to be located directly into a Caribbean environment while minimizing their impact on the community and often improving the quality of life for the surrounding communities.

Some of the additional benefits gained by locating an EFW facility on location in the Caribbean are;

- Minimizing the cost and the environmental impact of transporting the waste over distances by treating the waste where it is produced. This contributes to a reduction in number of trucks on the roads, a reduction in emissions from these trucks, a reduction in green house gas emissions with reduced transport fuel requirements, a reduction in the potential for odors and spills with shorter transport distances.
- Providing electrical generation at the point of consumption.
- Possible revenue from disposal fees from Cruise Ships.
- Producing shore protection /Concrete blocks ash handling.
- Reducing the dependence on imported Oil for electrical generation.
- Providing secure and well paying jobs for member of the community.
- Reducing the carbon foot print of the community as an EFW plant is considered a carbon sink and municipal waste is often classified as renewable energy.
- An EFW plant typically leads to higher recycling rate, both pre and post combustion.

Some of the specific measures that have been considered for a Caribbean EFW plant environment are architectural enhancements, more stringent noise and odor control, significant reduction or even elimination of visible plumes. An applicable case study included in this paper will be the Tynes bay facility in Bermuda.

Introduction

Energy from Waste (EFW) is getting growing acceptance worldwide as an important part of the waste treatment hierarchy reduce, reuse, recycle, recover and dispose, with EFW being considered part of “recover”. However, the traditional approach in North-America has been to locate EFW plants away from urban environment to either remote locations or to heavily industrialized areas. This approach tended to limit the potential of energy recovery to the production of electrical power. In Europe on the other hand, EFW plants were often built closer to the communities to take advantage of the potential for thermal energy sale in addition to electrical power generation. In the Caribbean the main interest of energy recovery is focused on power and remote locations are not an option.

Because many of the landfills in the Caribbean do not employ the necessary pollution control measures, they pose a serious threat to the environment and to public health. As waste decomposes, hazardous material could combine with rainwater, to form leachates, which enters and contaminates soil, surface water and groundwater. In addition to leachates, old and uncontrolled landfills also emit gaseous methane and carbon dioxide into the atmosphere.

EFW technologies have the potential to become an effective response to current challenges facing the Caribbean region with regard to pollution, scarcity of land, public health and the economy. This paper will review the benefits obtained by locating an EFW facility in the Caribbean, as well as the additional challenges that come with this type of location. A quick overview will be given of the proven technologies that already exist in the market place with numerous installations and long term commercial operating experience.

Benefits

Locating an EFW plant in the Caribbean as compared to the more traditional approach of land filling and exporting the waste brings several additional challenges, the most important being acceptance by the community surrounding the proposed new EFW plant.

An EFW plant in an island nation has the potential to bring significant benefits to the community. Some of these benefits are:

- Minimizing the cost and the environmental impact of transporting the waste over long distances by treating the waste where it is produced. This contributes to a reduction in the number of trucks and barges that results in a reduction in Green House Gas (GHG) emissions with reduced transport fuel requirements and a reduction in the potential for odors and spills with shorter transport distances.
- Providing electrical power generation at the point of consumption, offering more supply security to the community since they are not as exposed to the potential for breakdown of the transmission grid. An EFW plant can easily be designed to operate in island mode to maintain power in the neighborhood around the plant in the event of supply disruption on the transmission grid. Generating power at the point of consumption significantly reduces transmission losses compared to using electricity produced by power plants located far from the point of consumption.
- Providing revenue from disposal fees from Cruise ships. An average cruise ship accommodates on average over 3000 passenger and crew. Because of their capacity they generate a tremendous amount of waste. A Caribbean destination that could manage and offload the cruise ships waste could turn this into a significant revenue stream. With that said, the past difficulty for the larger ships to unload their waste and new regulations have led to that the newer larger cruise ships have their own

incinerators¹ and recycling systems for disposal of waste limiting the revenue possibility for the port.

- Producing shore protection or road bed material. The residual ash from the process can be used after being stabilized as roadbed material or concrete blocks that be used for shore protection and/or land expansion
- Reducing the dependence on imported fossil fuel for electrical power generation. Many of the Caribbean islands only source of power production is through fossil fuels.
- Providing secure and well paying jobs for member of the community. Regardless of the location of the treatment facility, the community pays for the costs to handle and treat the MSW. Having the facility located within the boundaries of the community keeps the economic value associated with these costs within the community.
- Reducing the carbon foot print of the community. In addition to the reduction in green house gases listed above (transportation, electrical power generation), an EFW plant is also considered a carbon neutral compared to landfilling MSW.
- An EFW plant typically leads to higher recycling rates, both pre and post combustion. It is well documented in both Europe and North-America that communities that have EFW plants also tend to have a higher level of recycling. “Back yard uncontrolled open burning” also decreases when disposal options exist. The development of a new EFW plant is typically combined with an overall waste management plan which includes more separation at the source. In addition, embedded ferrous and non-ferrous metals that are not practical to recycle prior to combustion of the associated organic material, are easily recovered from the ash stream, increasing the total portion of the waste recycled.

Challenges

Like any other power generation facility, an EFW plant located close to residential, office and retail areas should only have a minimal impact on the surrounding community. The main additional challenges involved in locating an EFW facility directly in an urban area fall under the categories of disrupting elements (traffic, noise, odors and emissions) and respect of the character of the neighborhood (architecture, visual impact of operations).

The reduction of potentially disrupting elements includes traffic management in and around the facility, noise abatement at the process equipment level and using more sound absorbing materials in the building construction, insuring that all potential odors are destroyed in the thermal treatment process by taking the combustion air from inside the building and maintaining the building under negative pressure. Respecting the character of the neighborhood may involve building and stack height restrictions, enhanced architecture and additional space inside the building for maintenance activities.

The acceptance of the public is maybe the biggest challenge today and often the public opposition is significant. In particular resident neighbors to a planned facility worry that the plants may increase ambient levels of dioxin, Mercury and other air pollutants. Public awareness programs through education and promotion initiated in the early planning stages can alleviate some concerns and shorten the overall project preplanning process.

Proven EFW technologies

Combustion is the dominant commercially viable EFW technology today. Gasification is distant second with only a few facilities in commercial operation primarily in Japan. Several alternative technologies are on the experimental and pilot stage. The 3 main combustion technologies used are grate systems, bubbling fluidized (BFB) bed and circulating fluidized bed (CFB) systems.

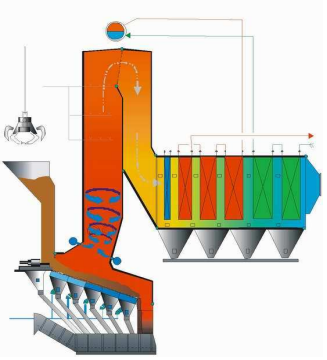
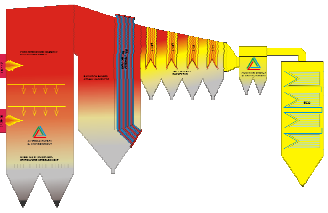
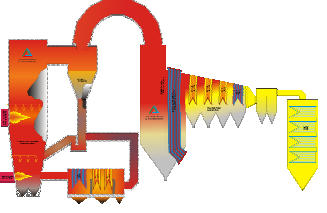
GRATE	BUBBLING FLUIDIZED BED	CIRCULATING FLUIDIZED BED
		
<p>6-16 MJ/kg (LHV)</p> <ul style="list-style-type: none"> • MSW Untreated • waste Industrial • Wood waste • Hospital waste • (co-firing) Sludge (co-firing) 	<p>3-20 MJ/kg (LHV)</p> <ul style="list-style-type: none"> • MSW Pretreated • Rejects • Sludge • Biomass • Wood waste 	<p>6-42 MJ/kg (LHV)</p> <ul style="list-style-type: none"> • MSW Pretreated • Rejects • Sludge (co-firing) • Biomass • Wood waste • Coal • Pet coke

Table 1. Overview of EFW combustion technologies

Grate

Grate combustion is the most thoroughly tested technology for thermal treatment of waste. There are over 1000 plants worldwide and the systems have been continuously optimized and upgraded to changing standards.

Today grate combustion is the most advanced technology in terms of environmental safety, reliability, flexibility and cost effectiveness.

At the heart of the system is the grate. Waste metered from a feed hopper is conveyed by the grate through the combustion chamber where it is burned, normally without additional fuels.

Primary combustion air is injected below the grate directly into the fuel; secondary air (mixed with recirculated flue gas in some designs) enters the secondary combustable chamber from above the grate. The burned-out slag is discharged at the end of the grate. The whole process, from waste metering to grate speed and air supply, is under continuous control to ensure optimum combustion. The grate stands out for its robust construction and its resistance to strongly heterogeneous waste. The steam generator located downstream of the combustion grate extracts energy from the hot combustion gases in the form for power generation

Flue gas treatment begins right in the combustion chamber, which is engineered to prevent most pollutants from being generated in the first place. Downstream components conform with fuel properties, residue disposal practices and emission limits. Customized concepts make it possible to guarantee emission levels far beyond those of the world's toughest pollution standards.

Fluidized Bed

Bubbling and circulating fluidized beds are also suitable for thermal treatment of pretreated waste. It features high thermal capacity and can handle a wide range fuels and heat values. A single system can treat waste with low and very high heat values. The fluidized bed can process other fuels such as biomass, sludge, coal and pet coke separately or together with waste.

The heart of the fluidized bed is the bed itself. The turbulence in the fluidized bed, combined with the scouring effect and the thermal inertia of the bed material provide for complete, controlled, and uniform combustion. The scrubbing action of the bed material on the fuel particles enhances the combustion process by stripping away the char layers that normally form around the fuel particle. This allows oxygen to reach the combustion material much more rapidly and increases the rate and efficiency of the combustion process.

These factors are the key to maximizing thermal efficiency, minimizing char, and controlling emissions. The high combustion efficiency in a fluidized bed makes it particularly well suited for problem fuels with high moisture contents and low heating values. In typical fluidized bed systems, the carbon emissions are inherently lower than those from conventional technologies for the following reasons: The low combustion temperature and the low excess air within the bed reduce the formation of nitrous oxides or NO_x. A further reduction can be achieved by installing a Selective Non-catalytic Reduction (SNCR) system which will meter urea or ammonia solution into the flue gas flow. The high combustion efficiency results in low carbon monoxide (CO) content in flue gases.

For fossil fuels containing sulfur, emissions such as SO_x may be reduced insitu within the boiler by adding lime to the bed, which normally eliminates the need for downstream DeSO_x flue gas cleaning systems. Most other emissions, which may result from specific fuels, can easily be handled by injecting reactive agents such as sodium bicarbonate and activated carbon into the flue gas and removing them in a baghouse filter or ESP.

Like for the grate system customized concepts make it possible to guarantee emission levels far beyond those of the world's toughest pollution standards.

Capital cost Energy from Waste

Capital cost for Energy-from-Waste systems will depend on the technology employed, location, plant capacity and the fuel. In the past, in North America, the primary reason is to solve disposal problems. This is now changing with tax incentives and a definition of waste as a renewable fuel. In the Caribbean the situations is a combination of disposal issues and power generation.

Energy from Waste industry facing challenges such higher capital and generation cost compared to conventional energy sources. Moreover, permitting delays and upfront costs are prevalent. Below table² is estimated cost for complete green field installations.

Technology	Capital Cost Installed \$/kWel.	Generation Cost (approx.) \$/kWh
Grate -MSW Waste	\$7-10,000	\$0.10
Fluidized Bed -RDF Waste (CFB)	\$5-7,000	\$0.08
Fluidized Bed -RF Waste (BFB)	\$4-6,000	\$0.08

Table 2. Estimated cost for new EFW facility

Notes:

Values based on North America (2009/2010). Large variations are possible depending on location. Not included in the cost numbers for the fluidized bed is the cost for the RDF processing plant and the potential disposal cost for the higher reject rate for the RDF processing stream.

Bermudas Tynes Bay Waste Treatment Facility

Bermuda today is the third most densely populated place on earth, with an estimated resident population of 3,301 permanent residents per square mile³. In addition, Bermuda is highly dependent on imported fuels for energy.

Several papers have been written about the Tynes Bay incinerator. The reason for this is really because Bermuda is an interesting example how a facility was being planned and built in an island setting. Going through all the hurdles of public opinion and overcoming logistic challenges of being on an Island.

In the 1980s, the government of Bermuda reoriented its waste management policies away from Land filling, instead focusing on incineration, recycling and composting. Bermuda was generating 80,000 tons of waste annually in the late 1980s. Additionally, the existing landfill posed significant environmental risks.

In 1987 the Bermuda Government engaged to procure and install an EFW plant. The local review process due to environmental concerns as well as the projects feasibility took several years. In 1991 Bermudas Ministry of Work started the project. As one of the most complex and critical projects ever undertaken by the Bermuda Government, the facility came on line in 1994.

The primary role of incineration in Bermuda's waste management plan is to reduce the volume of combustible waste to minimize the reliance on land filling as the primary means of solid waste disposal. A secondary and important function of the facility is to produce electricity for the facility and to export the excess to the local power company (BELCO) grid directly benefiting Bermuda's economy by reducing import of diesel fuel.

The facility is also proof to that an EFW in the community increases the awareness of waste and improves recycling. Tynes Bay offers recycling days⁴ for hazardous waste, electronics, batteries, fertilizers and oil.

The facility was designed with two separate streams each able to handle all of the Islands combustible waste. However, an annual increase of waste in the range of 3 to 5 %⁵ the facility frequently operates at full load.

Incoming waste is inspected and weighed prior to discharge into the refuse bunker. The waste is mixed to provide a reasonable homogeneous fuel before it goes into the furnace. The temperature is controlled by combustion air volume and the rate of feed through the furnace. The boiler produces superheated steam which is fed to a turbine generating about 4MW or a net excess of 2.5MW.

Interesting to mention is that after driving the turbine, the steam is condensed by a sea water cooling system and passed back into the boiler system.

Bottom ash that drops off the furnace grates and the fly ash removed by the electrostatic precipitators are transported to the quench tank. The combined wet ash is then conveyed to the ash bunker for storage the ash is weighed and the moisture content determined prior to mixing with cement to form ash concrete. This ash concrete is formed into one cubic meter blocks, which are used for shore protection and land reclamation at the Airport Waste Management Facility.

¹ www.shiptechnology.com

² Frost Sullivan N75C-14 March 2010

³ www.bermuda-online.org/enviro.htm

⁴ www.royalgazette.com

⁵ GTS Energy, Feasibility Study Proposal 2001