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A profitable alternative for waste

The potential of landfill waste for energy and income

White Paper

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A viable source for both energy and revenue are landfills through the utilization of power generation equipment from Cummins Power Generation Inc. To understand the factors involved including the use of landfill Methane gas, it is important to first gain an understanding of landfills and their operation.

Landfills are a common approach to waste treatment and management used around the world. This is an approach that brings opportunities in utilizing technologies that capture Methane gas and turns it into various forms of energy like electricity. The approach also prevents greenhouse gases from being emitted into the atmosphere and provides environmental, health and economic benefits.

LANDFILL GAS: COMPOSITION

Substance	Percentage
Methane	50%
Carbon dioxide	45%
Nitrogen	3.9%
Oxygen	.5%
Ammonia	.5%
Hydrogen	.1%

Figure 1:

The level of sophistication varies from dumps or pits on the outskirts of town to modern landfills. Modern facilities are located in areas where clay deposits and/or other natural features can buffer the environment from contamination.

In countries with waste management programs, waste is placed in common categories as follows:

- **Hazardous:** poses substantial or potential threats to public health or the environment.
- **Sanitary:** buried solid waste high in organic content originating from humans.
- **Inert:** stored, neither chemically or biologically reactive and will not decompose (sand, drywall and concrete).

Sanitary waste is the category in which there is the most potential for power generation with bioreactor landfills. These landfills rapidly transform and degrade organic waste in the upper sections of the landfill and collect Methane gas from lower sections.

This paper outlines the opportunity of using a bioreactor landfill as a methane source to produce sellable energy and outlines an example of an installed waste-to-energy application.

Converting methane gas into electric portfolios

Capturing methane gas has become more cost-effective and popular in the last decade making it a part of renewable energy portfolio. The most utilized approach is drilling wells into landfills and collecting the gas through pipes.

The methane gas is fed into a biogas digester for electricity generation by either a gas engine or turbine. The amount of electricity that can be generated is only limited by the size of the landfill and the quality of gas it generates.

Internal combustion engine generator sets are #1

Some of the reasons that reciprocating engine generator sets dominate existing applications are:

- **Proven technology:** gaseous fueled reciprocating engines are a mature technology.
- **Enhanced technology:** new low-Btu engine designs can operate at full-rated horsepower with a mixture of only 40 percent Methane.
- **Lower cost:** reciprocating engine generator set technology is significantly less expensive on an installed cost-per-kilowatt basis than combustion turbine technology.
- **Higher tolerance:** while not totally immune, there is a higher tolerance of landfill contaminants such as water vapor, ammonia, sulfur and siloxanes.

Worldwide internal combustion engines are used most often because they are efficient, cost effective and are usually a good match with the gas output of an average size landfill.

Methane's power potential

Across Europe, there are about 400 landfill plants, with Denmark, Germany and the Netherlands at the forefront. Denmark landfill plants have become both a mainstay of garbage disposal and a crucial fuel source. Landfill use has reduced the country's energy costs and reliance on oil and gas, benefited the environment, and lowered emissions. Denmark has 29 plants,



Figure 2: A waste-to-energy plant in Horsholm, Denmark.

serving 98 municipalities in a country of 5.5 million people, and 10 more plants are under construction.

In Great Britain, 48% of renewable gas and electricity production comes from landfill gas. About a third of the 500 landfill sites that take significant amounts of biodegradable waste have gas controls. Over 75 sites extract the gas for energy recovery. Approximately 110 MW of electricity is being produced from landfill gas in the UK.

The U.S. has also been actively participating with partner countries to produce landfill assessment and preliminary feasibility reports. Partners include Argentina, Brazil, Colombia, China, Ecuador, India, Mexico, and Ukraine, according to *Methane to Markets*. The Methane to Markets (M2M) Partnership is an international, public-private partnership of 20 countries with the goal of promoting near term, cost-effective development.

The number of landfill gas projects in the United States jumped from 399 in 2005 to 519 in 2009 according to the EPA. About two-thirds of the landfill sites generate electricity for on-site use or for sale.

Most newer renewable projects are developed and operated by independent power producers, and sold to utilities on a contractual basis. Current industries using landfill gas for power include auto manufacturing, chemical production, food processing, pharmaceuticals, cement and brick manufacturing, wastewater treatment, consumer electronics and products, paper and steel production, and prisons and hospitals.



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About the author

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Scottish landfill turns methane into money

Viridor Waste Management, one of the United Kingdom's largest operators of municipal landfills, manages a 193-acre site east of Edinburgh, Scotland. The facility disposes of thousands of tons of solid domestic waste daily from the city of Edinburgh and other nearby communities in a safe and environmental manner. Viridor uses four low-Btu gas generator sets from Cummins Power Generation and produces 7 MW of electricity from the methane created by decaying rubbish.

"Methane production from the landfill is a steady 4000 cubic meters per hour," according to Richard Turner, director of waste to energy, Viridor Waste Management. "Right now, the gas being collected is about 55 percent pure methane, and we're running the generators at full load, 24 hours a day, seven days a week."



Figure 3: The power plant consists of four 1,370 kVA GQMA low-Btu generator sets, PowerCommand Digital Master Control, low-voltage switchgear and heat exchangers from Cummins Power Generation.

"Normally, the output of the generators would be connected to the power grid and sold to a local utility," Turner explained. "However, because of the high voltage of the local utility lines, there was no cost-effective way we could connect to the grid at this location. Consequently, all of the 7 MW is sold directly to the nearby Lafarge Cement works. Cummins Power Generation helped design the 11 kV system that connects to the cement plant."

The system enables Viridor to invest in environmentally friendly waste-to-energy projects, generate electricity from landfill gas, sell it to the cement plant below the cost of power from the grid and still make money. Everybody wins according to Turner.

Conclusion

In conclusion, landfill harnessing Methane gas projects that generate power for countries, corporations and power providers will continue to grow in popularity as the population and their waste output continues to increase. The trend will also continue to be fueled by the focus upon improving emissions and by continued government incentive programs that offer rewards for landfill development, management and utilization.

The vast majority of waste-to-energy projects will also continue to use low-Btu reciprocating engine generator sets to produce electricity from Methane. These engine-generator systems, like those from Cummins Power Generation, have proven to be environmentally clean, reliable, durable and economical in a wide variety of landfill, garbage digester and coal bed methane projects.

For additional information about landfill energy systems or other energy solutions, visit www.cumminspower.com/energysolutions.



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