2006 UPDATE: THE STATE OF U.S. LANDFILL GAS UTILIZATION PROJECTS

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Introduction:

Municipal solid waste landfills are the largest source of human-related methane emissions in the United States, accounting for about 34 percent of these emissions. At the same time, methane emissions from landfills represent a lost opportunity to capture and use a significant energy resource. Landfill gas (LFG) is created as solid waste decomposes in a landfill. This gas consists of about 50 percent methane (CH_4), the primary component of natural gas, about 50 percent carbon dioxide (CO_2), and a small amount of non-methane organic compounds.

Instead of allowing LFG to escape into the air, it can be captured, converted, and used as an energy source. Using LFG helps to reduce odors and other hazards associated with LFG emissions, and it helps prevent methane from migrating into the atmosphere and contributing to local smog and global climate change. Landfill gas is extracted from landfills using a series of wells and a blower/flare (or vacuum) system. This system directs the collected gas to a central point where it can be processed and treated depending upon the ultimate use for the gas. From this point, the gas can be simply flared or used to generate electricity, replace fossil fuels in industrial and manufacturing operations, fuel greenhouse operations, or be upgraded to pipeline quality gas.

Using LFG for energy is a win/win opportunity. Landfill gas utilization projects involve citizens, non-profit organizations, local governments, and industry in sustainable community planning and create partnerships. These projects go hand-in-hand with community and corporate commitments to cleaner air, renewable energy, economic development, improved public welfare and safety, and reductions in greenhouse (global warming) gases. By linking communities with innovative ways to deal with their LFG, LMOP contributes to the creation of livable communities that enjoy increased environmental protection, better waste management, and responsible community planning.[1]

The U.S. Environmental Protection Agency's (EPA) Landfill Methane Outreach Program (LMOP) is a voluntary assistance program that helps to reduce methane emissions from landfills by encouraging the recovery and use of landfill gas as an energy resource. LMOP forms partnerships with communities, landfill owners, utilities, power marketers, states, project developers, tribes, and non-profit organizations to overcome barriers to project development by helping them assess project feasibility, find financing, and market the benefits of project development to the community. EPA launched LMOP to encourage productive use of this resource as part of the United States' commitment to reduce greenhouse gas emissions under the United Nations Framework Convention on Climate Change.

Types of Utilization Projects:

There are several ways to effectively utilize landfill gas for energy; however, the primary applications are electricity generation and direct use. The generation of electricity from LFG makes up about two-thirds of the currently operational projects in the U.S. Electricity for on-site use or sale to the grid can be generated using a variety of different technologies, including internal combustion engines, turbines, microturbines, Stirling engines (external combustion engine), Organic Rankine Cycle engines, and fuel cells. The vast majority of projects use internal combustion (reciprocating) engines or turbines, with microturbine technology being used at smaller landfills and in niche applications. Certain technologies such as the Stirling and Organic Rankine Cycle engines and fuel cells are still in the development phase.

Directly using LFG to offset the use of another fuel (natural gas, coal, fuel oil) is occurring in about one-third of the currently operational projects. This direct use of LFG can be in a boiler, dryer, kiln, greenhouse, or other thermal applications. It can also be used directly to evaporate leachate. Innovative direct uses include firing pottery and glass blowing kilns; powering and heating greenhouses and an ice rink; and

[1] www.epa.gov/lmop Landfill Methane Outreach Program website.

heating water for an aquaculture operation. Current industries using LFG include auto manufacturing, chemical production, food processing, pharmaceutical, cement and brick manufacturing, wastewater treatment, consumer electronics and products, paper and steel production, and prisons and hospitals, just to name a few.

Some additional uses include cogeneration (also known as combined heat and power or CHP) projects using LFG generate both electricity and thermal energy, usually in the form of steam or hot water. Several cogeneration projects have been installed at industrial operations, using both engines and turbines. The efficiency gains of capturing the thermal energy in addition to electricity generation can make these projects very attractive. Production of alternate fuels from LFG is an emerging area. Landfill gas has been successfully delivered to the natural gas pipeline system as both a high-Btu and medium-Btu fuel. Landfill gas has also been converted to vehicle fuel in the form of compressed natural gas (CNG), with a number of liquefied natural gas (LNG) and methanol production projects in the planning stages.[2]

Market Drivers- Electricity Projects

Recent passage by the U.S. Congress of the Energy Policy Act of 2005 (Act) will provide a boost to the development of LFG electricity projects. The Act provides a tax credit applicable to electricity generated from landfill gas. The Section 45 Production Tax Credit is worth 0.9 cents/kWh for electricity produced from landfill gas. To qualify projects must be placed in service by 12 December 2007. The tax credit is expected to be a major driver of new LFG electricity projects. Over 40 LFG electricity projects are currently underway and expected to be operational by December 2007.

Another market driver is state level Renewable Portfolio Standards (RPS). See Figure 1. There are 22 states and the District of Columbia that currently have this legislation, Colorado being unique as it was a ballot initiative in the 2004 election. RPS legislation requires that a utility doing business in a given state to purchase a percentage of their power from renewable sources, defined in the legislation. The states vary in percentage required, as well as time frame for compliance. However, all states do include landfill gas as a renewable source.

Green Power is another emerging trend. Almost one third of electricity consumers can choose their electricity provider and many consumers are choosing power providers that offer renewable energy. Like the RPS, landfill gas is an active part of green power programs and is an attractive option for power suppliers as not only does it meet their renewable commitments, it is generated 24/7 and available over 90% of the time. It currently services as the baseload renewable for many programs and is cost competitive at $.04-.06/ kWh for generation.

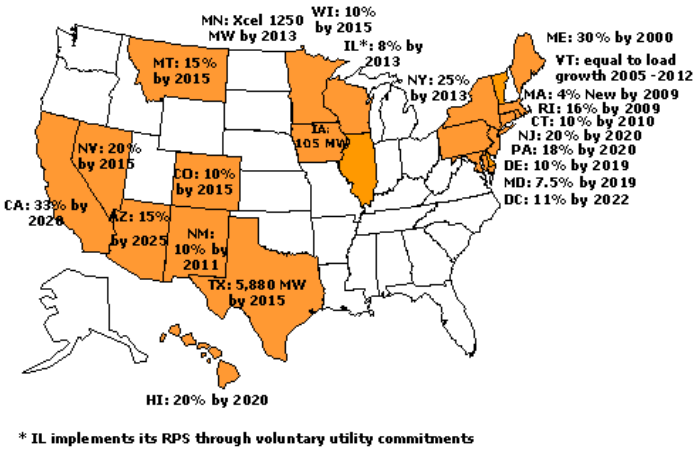

FIGURE 1: REF- http://www.pewclimate.org/what_s_being_done/in_the_states/rps.cfm

Market Drivers- Direct Use Projects

In the past two years, LMOP has seen a surge of interest in the direct use of landfill gas, primarily by corporate and industrial end users. The interest is fueled by both economic and environmental factors. Energy costs have been rising and energy markets are becoming increasingly more volatile, see figure 2 At the time of this writing, the Henry Hub and Nymex indicators showed the price of natural gas to be back to $5.60 per MMBTU but last year in the aftershocks of Hurricanes Katrina

[2] Ibid

and Rita prices were closer to $12-15/ MMBTU. Higher prices and possible supply interruptions not only encourage energy users to look for less expensive sources, but the high prices make the project economics more attractive. A perfect example is that high energy prices are making longer pipeline projects not only possible, but profitable. Five years ago, a pipeline project was generally thought to be economically feasible at 5 miles or less. In 2003, however, BMW developed an LFG project that involved the construction of a10 mile pipeline. In 2004, the Honeywell landfill gas project came on-line with a 23 mile pipeline, the longest in the U.S.

In the past year LMOP received over 20 requests from companies to look for landfills to help offset high fuel costs and/or meet environmental commitments. More interestingly, LMOP received several requests from companies seeking to locate a new facility near a suitable landfill. In March of 2005, the Birmingham Business Journal reported that one of the top three factors Jenkins Brick Company used when selecting a site for a new facility was "proximity……landfill gas that the company recycles into energy".

The economic benefits are certainly a powerful motivator but environmental stewardship and corporate social responsibility are also strong market drivers for landfill gas projects. Good corporate citizens are joining voluntary programs for greenhouse gas (GHG) reductions such as EPA's Climate Leaders program and the Chicago Climate Exchange. Climate Leaders is a voluntary EPA industry-government partnership that works with companies to develop long-term comprehensive climate change strategies. Partners set a corporate-wide GHG reduction goal and inventory their emissions to measure progress. The Chicago Climate Exchange® (CCX®) is a greenhouse gas (GHG) emission reduction and trading pilot program for emission sources and offset projects in the United States, Canada, and Mexico. The good corporate citizens are looking at landfill gas projects as a way of meeting their voluntary commitments. For example, General Motors, Interface, and SC Johnson have utilized landfill gas projects to help meet their EPA Climate Leaders GHG reduction goals.

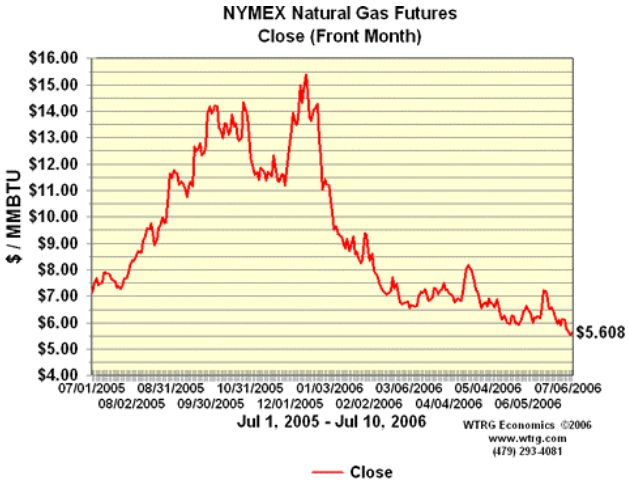

FIGURE 2: REF- http://www.wtrg.com/daily/gasprice.html

Environmental Benefits:

Reducing methane emissions has many important energy, safety, economic, and environmental benefits. First, because methane is both a potent greenhouse gas and has a short atmospheric lifetime, methane reductions can produce significant near-term results. In addition, methane is the primary constituent of natural gas. Producing energy from LFG can avoid the use of higher-emitting traditional fossil-energy resources such as wood, coal or oil. Combusting LFG generates fewer air pollutants than burning an equivalent amount of energy in the form of coal or oil, which avoids the generation and release of sulfur dioxide (a major contributor to acid rain), nitrogen oxides (contributors to smog), toxic pollutants, and carbon dioxide (a greenhouse gas). In fact, LFG is the only renewable energy source that, when used, directly prevents atmospheric pollution.

To illustrate this point, for example a 3 megawatt (MW) landfill gas electricity project starts up at a landfill with previously uncontrolled landfill gas would be equivalent to any of the following annual environmental benefits for 2005:

- Removing emissions equivalent to approximately 25,000 cars
- Planting 35,000 acres of forest
- Preventing the use of 304,000 barrels of oil

As of April 2006, there were 400 operational LFGE projects in 40 states preventing emissions of over 8.4 billion cubic meters of LFG (or 4.2 billion cubic meters of methane per year) or equivalent to powering over 725,000 homes and heating 1.2 million homes. In addition, these 400 LFGE projects generated 9 billion kilowatt hours of electricity and 74 billion cubic feet of landfill gas to direct-use applications. Moreover, they contributed to methane emissions reductions of 16.7 million metric tons carbon equivalent (MMTCE) or 61.2 $MMTCO_2E$.

Financial Incentives to Landfill Gas Projects:

A large barrier to landfill gas projects is financing the project due to high upfront capital costs or low electricity costs in some markets. At the federal level, the recent tax credit will help defray the cost of a select number of landfill gas electricity projects. At the state level, however, are a variety of financial incentives that will help projects move forward. There are several reasons why a state might promote landfill gas projects-diversifying the state's energy mix, renewable requirements, creating local economic growth, using local resources, and reducing environmental impacts from fossil fuels. The states are using s mix of incentives including low interest loans, grants and tax incentives. LFG projects have high capital expenditures so the financial feasibility of the projects is very sensitive to their costs of capital. By providing zero-or-low-interest rate loans, states are helping to overcome this barrier.

Grants that can be applied to the purchase, construction, and installation of LFG systems are another incentive some states are using. Pennsylvania's Energy Harvest Grant Program awards money to a variety of renewable energy projects, including landfill gas projects.

Exempting LFG utilization projects from state taxes is another powerful incentive to encourage new projects. For example, states have recently exempted equipment that generates energy from landfill gas from state sales and use taxes or from state property taxes. Maryland's Clean Energy Incentive Act is an example of a program to provide tax credits to facilities that produce energy from biomass (including landfill gas). Qualifying facilities can claim a credit on their state income taxes.

The Future of Landfill Gas Energy Projects:

The future for landfill gas energy projects is bright. We have seen a dramatic increase in projects over the past ten years. As noted earlier, there are now 400 operational project in the U.S. While these numbers are impressive, there is still significant opportunity for landfill gas energy development in the U.S. Currently EPA estimates that there are over 600 landfills in the U.S. that could economically support a project. Taken together these 600 landfills would have a generation capacity of over 1400 MW (or enough electricity to power over 1 million homes across the country) or could supply 725 million cubic feet per day or ~15,000 MMBtu/hr of gas to industrial and corporate end users. The total expected additional annual environmental benefits if all projects were developed is equivalent to removing the emissions from over 10.5 million vehicles on the road, or preventing the use of over 128 million barrels of oil.

In addition to the electricity and direct use projects discussed in this paper there are demonstration projects pushing the boundaries of traditional thought on landfill gas energy projects. For example an innovative use for landfill gas is vehicle fuel. In Burlington County New Jersey, Waste Management has collaborated with Mack Truck to run the truck on methane from landfill gas. The landfill gas has the carbon dioxide and NMOCs removed and sent back to the landfill flare for combustion. The resulting methane is used to fuel a natural gas rather than diesel engine on the trucks,

In Ohio, there is a project in process looking to produce methanol from landfill gas. Large scale greenhouses are looking at landfill gas as a fuel and pipelines for direct use projects are getting longer, 23 miles in 2004. The industry has made great strides in finding innovative was to use the landfill gas to provide both environmental and economic benefits. LMOP certainly sees that trend continuing into the future.

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Rachel is a Program Manager of the U.S. Environmental Protection Agency's Landfill Methane Outreach Program (LMOP), a voluntary program that encourages methane emissions reductions through the capture and beneficial use of landfill gas. Rachel's primary roles are to manage the New England/ Mid-Atlantic territory and LMOP's corporate outreach activities. Prior to joining the EPA, Rachel spent eleven years in the environmental safety and health field. Rachel is on the board of directors for the Women's Council on Energy and Environment