Landfill Methane

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Landfills are the third largest source of anthropogenic methane in the United States. According to the U.S. Environmental Protection Agency (EPA), landfill gas (LFG) comprises 17.7 percent of all U.S. methane emissions. Landfill methane in 2011 accounted for 103 million metric tonnes of carbon equivalent released into the atmosphere.[1] Methane is a short-lived climate pollutant with significant warming potential, and over a 20 year period, one ton of methane causes 72 times more warming than one ton of carbon dioxide (CO2). Consequently, the mitigation of methane from existing landfills provides important climate benefits.[2]

Mitigation of LFG can provide health benefits as well. Landfill gas is comprised of approximately 50 percent methane and 50 percent CO2, with trace levels of other compounds, including nitrogen, oxygen, hydrogen, and non-methane organic compounds (NMOCs) such as ammonia and sulfides. NMOCs include hazardous air pollutants that can increase the risk of cancer, cause respiratory issues, and produce strong and unpleasant odors.[3,4] To mitigate both health and environmental impacts, the EPA currently regulates LFG from very large municipal solid waste (MSW) landfills, which must capture and safely dispose of methane and NMOCs from LFG. This process is typically accomplished either by flaring the gas or by converting the gas into energy.

To encourage landfill operators and development partners to capture and harness LFG, the EPA created the Landfill Methane Outreach Program (LMOP) in 1994. As of October 2012, there are 605 operational energy projects in 48 states, and LMOP estimates that another 400 additional landfills are good candidates for energy projects. Together, the operational landfills produce approximately 15 billion kilowatt-hours (kWh) of electricity and 100 billion cubic feet of LFG for direct use annually. In 2012 alone, the amount of methane removed was equivalent to eliminating the CO2 emissions from approximately 240 million barrels of oil consumed.[5]

This paper will address projects that convert captured LFG into electricity, heat or vehicle fuels, and discuss how these projects can be cost-neutral or produce a profit. To more fully address climate and other environmental issues, it is important to reduce waste overall and expand composting and recycling programs. Cutting landfill disposal rates, however, does not address fugitive methane emitted from existing landfill waste. Capturing even a fraction of these emissions provides important climate and health benefits; converting the gas to energy offers economic savings, diversifies a community's energy portfolio, and lowers dependence on fossil fuels.

CURRENT REGULATIONS

EPA Regulations

The EPA's Landfill Methane Outreach Program is entirely voluntary, but the EPA does have the authority to regulate landfills and LFG through the Resource Conservation and Recovery Act (RCRA) and the Clean Air Act. The EPA established Criteria for Municipal Solid Waste Landfills under RCRA in 1991. As part of these regulations, MSW landfill owners and operators must line the bottom and the sides of the landfills, and place a final cap when the landfill is closed. This prevents waste leakage and groundwater contamination, and has the added benefit of reducing fugitive methane and NMOCs released into the atmosphere.[6]

The 1996 EPA Standards of Performance for New Stationary Sources (NSPS) and Guidelines for the Control of Existing Sources, created under the Clean Air Act, set emission standards for new and existing MSW landfills. The regulations apply to MSW landfills that have accepted waste since 1987 and contain more than 2.5 million metric tons or 2.5 million cubic meters of waste. These landfills must collect LFG emissions and can dispose of them either through open flaring or through other forms of controlled combustion. If landfill owners and operators choose to use a controlled combustion system to dispose of LFG, that system can be used to produce electricity or heat.[7,8] In 2003, the National Emission Standards for Hazardous Air Pollutants (NESHAP) extended these regulations to require the reduction of hazardous air pollutants from large landfills.

State Regulations

Under RCRA, all states are required to have regulatory agencies to oversee MSW landfills and ensure those landfills are in compliance with EPA regulations.[9] Within this framework, some states have chosen to create more stringent LFG regulations than are required by federal law. Notably, California regulates emissions from MSW landfills under the state's Global Warming Solutions Act, more commonly known as Assembly Bill (AB) 32.[10] Regulations on LFG came into effect in June 2010 and apply to MSW landfills with at least 450,000 tons of waste and an LFG heat input capacity of greater than 3 million British thermal units/hour (MMBtu/hr). Landfills affected by the regulations must collect LFG emissions – they have the option to flare the LFG, to use the LFG to produce electricity, or to route the gas to a treatment facility for sale.[11]

EPA LANDFILL METHANE OUTREACH PROGRAM

The EPA Landfill Methane Outreach Program (LMOP) is a voluntary program designed to facilitate the development of LFG projects, with an end goal of reducing national methane emissions. LMOP provides direct project assistance, and will assist landfill owners and operators with modeling LFG extracting possibilities, assessing the feasibility of possible projects, and preparing cost analyses of projects. Additionally, LMOP maintains a database of all interested partners and uses the database to connect landfill owners and operators to developers, end-users, utilities, community members, relevant non-profit organizations, and state permitters and regulators.[12]

To maintain relationships, LMOP brings together stakeholders through events and workshops that provide information on new technologies, financing strategies, and case studies of successful projects.[13] LMOP also hosts a Project Expo, where landfill owners and operators interested in energy projects can promote their sites to project developers. Since LMOP began holding the Project Expo in 2006, over half of the landfills featured have begun or completed energy projects.[14]

EXAMPLES OF LFG ENERGY PROJECTS

Projects can vary significantly depending on the size of the landfill, the energy end-user, and other factors.[15] Currently operational projects include:

1. Apex (50 million tons of waste) *Las Vegas, NV* – CC Landfill Energy LLC is building a plant that will produce 11 megawatts (MW) of electricity for NV Energy, a utility that serves approximately 2.4 million customers.[16]
2. Puente Hills (123 M tons) *Whittier, CA* – The largest LFG-to-electricity program currently in production, Puente Hills produces 50 megawatts, enough to power roughly 50,000 homes. Additionally, some of Puente Hills' gas is used to fuel garbage trucks.

3. Rumpke Sanitary (36 M tons) *Colerain Township, OH* – This landfill site hosts the largest landfill-to-gas facility in the world, recovering approximately 15 million standard cubic feet of LFG per day, which is then distributed by Duke Energy Corporation.

4. Newton County Landfill Partnership (19 M tons) *Brook, IN* – More than 1.1 million standard cubic feet of gas is captured from Newton County Landfill per day. The energy is used by a nearby factory to make egg cartons.[17]

5. Atlantic Waste (15 M tons) *Waverly, VA* – This site has in place a 20-mile pipeline to Honeywell's Hopewell plant. The landfill provides 20 percent of the energy used at the plant.[18]

COSTS AND FINANCING

Costs and Revenues from LFG Collection and Energy Production

The cost of an LFG project depends on a number of factors, including the size, location, and layout of the landfill. Major capital outlays include designs, permits, and installation; major operation and maintenance costs include parts and materials, financing, and administration. Typically, one million tons of landfill waste emit approximately 432,000 cubic feet of LFG per day, enough to produce either 0.78 MW of electricity or 216 MMBtu of heat.[19]

Approximately 70 percent of LFG projects generate electricity, primarily via internal combustion engines, gas turbines, and microturbines.[20] Costs vary, but internal combustion engines (ICEs) smaller than 1 MW typically cost $2,300/kW to install, with annual operation and maintenance costs of $210/kW, and ICEs larger than 800 kW typically cost $1,700/kW, with annual operation and maintenance costs of $180/kW. Revenue depends on electricity buy-back rates that are specific to local electric utilities, but typically range between 2.5 and 7 cents/kWh.

The vast majority of the remaining 30 percent of LFG projects involve direct use of the gas. Equipment for compression and treatment of the gas to remove non-methane trace compounds typically costs $960 per standard cubic feet per minute (scfm) of capacity to install. Annual operation and maintenance costs are an additional $90 per scfm of capacity. The major cost in direct use projects is the pipeline, which costs an average of $330,000 per mile to install, although maintenance costs are negligible. Revenue from direct use projects varies depending on location and agreements with the end-user, but typically range between $4.00 to $8.00 per MMBtu ($0.38 to $0.75 per megajoule).[21]

A small fraction of LFG energy projects produce pipeline quality gas. The majority of this high quality gas is used as an alternative vehicle fuel. One popular cost-effective option is to use the gas on-site to fuel vehicles that service the landfill.[22]

Investment Value of Projects

The return on investment for LFG projects depends on whether the landfill already has an LFG capture system installed under EPA or state regulations. For energy projects with capture systems in place, the outlay costs are relatively small. The EPA estimates that a privately owned and operated project with a 3 MW turbine would cost approximately $5.7 million to install and maintain, and would provide a net return of approximately $590,000 over a 15-year lifetime.[23] A direct-use project would have a significantly lower cost ($2.9 million) and a higher internal rate of return than the electricity project (57 percent compared to 14 percent), but direct-use projects remain less common because they require nearby facilities that can make use of the LFG.

Projects that do not already have capture systems installed cost significantly more to build. The EPA estimates that a privately owned and operated project with a 3 MW turbine and no previously installed capture system would cost approximately $8.5 million to install and maintain, and would lose approximately $3.5 million over a 15 year lifetime.[24] A direct-use project would have a significantly lower cost ($5.0 million) and would consequently have a positive net value for the project ($480,000).

Although electricity projects in landfills with no previously installed capture systems could be a net-loss in this scenario, these calculations do not account for tax credits and exemptions, carbon credits through a state or regional carbon exchange or cap-and-trade program, or the option to use the electricity on-site. With these additional revenue streams, projects with new capture systems can be profitable.

Variations in the price at which the electricity or gas is sold should be accounted for in calculating the revenue from a project. In all 29 states that have Renewable Portfolio Standards, LFG is included as a renewable energy source; LFG can, therefore, often be sold for a higher price than other energy.[25] Additionally, many projects produce electricity for use on-site. For those projects, the calculated rate should be based on the typically higher price at which the landfill buys its electricity.

Landfill gas projects also bring jobs to local communities. A typical 3 MW electricity project is estimated to directly create five construction jobs and indirectly create another 20 to 26 jobs through economic development. For a direct use project, a five mile pipeline would directly create at least seven jobs to complete the installation and would indirectly create another 17 to 22 jobs.[26]

Federal Incentives

There are a number of tax credits for which LFG projects can qualify. Projects that begin production by the end of 2013 and produce electricity for an unrelated third party can qualify for the Renewable Electricity Production Tax Credit (PTC), which provides a tax credit of 1.1 cents/kWh. Corporations may choose to take the Business Energy Investment Tax Credit (ITC) in lieu of the PTC. The ITC may be up to 30 percent of the cost of the project to the facility and does not require that the electricity produced be sold to a third party.[27]

Additionally, there are a number of loan programs from the U.S. Department of Energy, the U.S. Department of Commerce, and the U.S. Department of Agriculture that LFG projects can qualify for, depending on their location and the communities for which they provide services. LMOP can assist those interested in LFG projects and connect them to the most appropriate funding sources.[28,29]

For More Information:

Federal Funding Sources for Landfill Methane Projects

EPA Map and Database of Landfill Methane Projects in the United States

EESI Fact Sheet on Short-Lived Climate Pollutants

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The Environmental and Energy Study Institute (EESI) is a non-profit organization founded in 1984 by a bipartisan Congressional caucus dedicated to finding innovative environmental and energy solutions. EESI works to protect the climate and ensure a healthy, secure, and sustainable future for America through policymaker education, coalition building, and policy development in the areas of energy efficiency, renewable energy, agriculture, forestry, transportation, buildings, and urban planning.

This fact sheet is available electronically (with hyperlinks and endnotes) at *www.eesi.org/papers*.

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[20] Landfill Gas Energy A Guide to Developing and Implementing Greenhouse Gas Reduction Programs. U.S. Environmental Protection Agency and State and Local Climate Energy Program. 2012.
[21] "Project Economics and Financing." LFG Energy Project Development Handbook. U.S. Environmental Protection Agency. 2011.
[22] Gary Richardson. Waste to Wheels: Building for Success. Energy Vision. 2010.
[23] Specifically, the project would require a capital outlay of $5,150,800, with lifetime operation and maintenance costs of $526,317. Net return on the project over the course of a lifetime would be $587,078 and net payback would occur in the twelfth year. This assumes that the electricity would sell for 6 cents/kWh and that the operators would use a loan with a 20 percent down payment and 8 percent interest. A municipal owned and operated project would be able to use municipal bonds with lower interest rates, which would lead to a higher net payback. "Project Economics and Financing." LFG Energy Project Development Handbook. U.S. Environmental Protection Agency. 2011.
[24] Specifically, the project would require a capital outlay of $7,631,513, with lifetime operation and maintenance costs of $884,764. Net return on the project over the course of a lifetime would be -$3,508,256. This assumes that the electricity would sell for 6 cents/kWh and that the operators would use a loan with a 20 percent down payment and 8 percent interest. A municipal owned and operated project would be able to use municipal bonds with lower interest rates, which would lead to a higher net payback. "Project Economics and Financing." LFG Energy Project Development Handbook. U.S. Environmental Protection Agency. 2011.
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