7.4 Landfill Methane Utilization

Part Two: Clean Energy Best Practices for Local Governments							
6.0 Energy Efficiency	**7.0 Energy Supply**					**8.0 Transportation Technologies and Programs**	**9.0 Urban Planning and Design**
	7.1 Green Power Procurement	7.2 On-Site Renewable Energy Generation	7.3 Combined Heat and Power	7.4 Landfill Methane Utilization	7.5 Working with Utilities		

7.4.1 Overview

Many local governments across the United States are achieving energy, environmental, health, and economic benefits by utilizing technologies that capture methane (CH_4) from municipal solid waste (MSW) landfills, preventing it from being emitted to the atmosphere, and using it to produce various forms of energy, including electricity, boiler fuel, steam, alternate vehicle fuel, and pipeline quality gas (U.S. EPA 2008c). Landfill gas energy (LFGE) projects employ proven technologies to capture landfill gas (LFG), a product of solid waste decomposition in landfills that contains approximately 50% CH_4 and 50% carbon dioxide (CO_2), both of which are greenhouse gases (GHGs).[1] With a heating value of about 500 British thermal unit (Btu) per standard cubic foot (scf), LFG is a good source of energy.

Methane from Municipal Solid Waste Landfills

CH_4 is a hydrocarbon and the primary component of natural gas. It is also a potent GHG with a global warming potential more than 20 times that of CO_2. MSW landfills are the second largest source of man-made CH_4 emissions in the United States, accounting for about 23% of the country's CH_4 emissions in 2006. Despite its potency as a GHG, CH_4 has a relatively short atmospheric lifetime of 9-14 years, meaning projects that capture CH_4 from landfills offer a significant opportunity to mitigate atmospheric concentrations of CH_4 in the near-term.

Source: U.S. EPA, 2008b.

EPA estimates that as of December 2007, approximately 450 LFGE projects were operational in the United States. These projects generate nearly 1,380 megawatts (MW) of electricity per year and deliver 235 million cubic feet (ft^3) per day of LFG to direct-use applications. An additional 540 landfills present attractive opportunities for project development. If developed, these landfills have the potential to, based on EPA's Greenhouse Gas Equivalencies Calculator, generate an additional 1,280 MW of electric power or

EPA's Landfill Methane Outreach Program

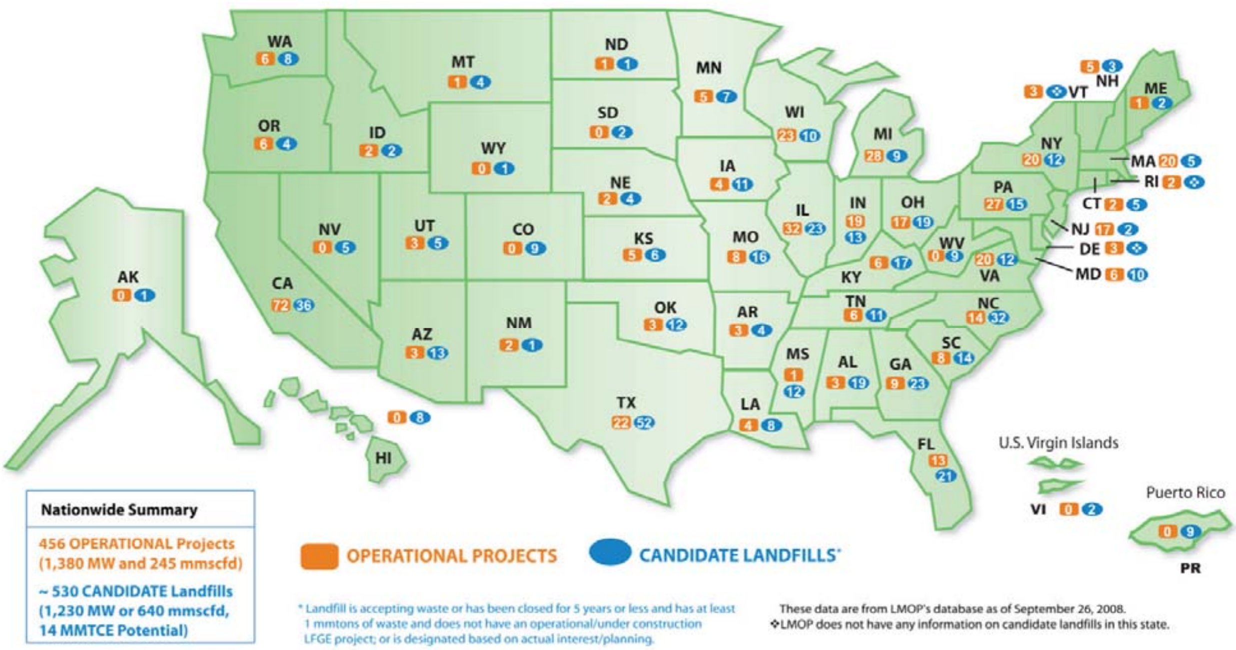
The EPA's Landfill Methane Outreach Program (LMOP) is a voluntary assistance program that helps reduce GHG from landfills by encouraging the recovery and use of LFG as a renewable energy resource. Launched by EPA in 1994, LMOP forms partnerships with communities, local governments, utilities, power marketers, states, project developers, and nonprofit organizations to overcome barriers to project development. For additional information, go to http://www.epa.gov/lmop/.

Source: U.S. EPA 2008c

[1] LFG contains approximately 50% CH_4 and 50% CO_2. Small amounts of non-methane organic compounds (NMOCs) and trace amounts of inorganic compounds comprise less than 1% of the mix (U.S. EPA 2008c). CO_2 that is emitted from LFGE projects is not considered to contribute to global climate change because the carbon was contained in recently living biomass and would have been emitted through the natural decomposition process.

665 million ft^3 per day of gas (U.S. EPA 2008d). The location of these operational and potential LFGE projects by state is illustrated in Figure 7.4.1.

Figure 7.4.1 Landfill Gas Energy Projects and Candidate Landfills



Source: U.S. EPA 2008d.

MSW landfills are owned either by local governments or the private sector. Similarly, the LFGE projects installed at local government-owned landfills can be owned and operated by the local government or a private developer hired by the local government – both operations are referred to as "LFGE project owner" landfills in this section.

Energy from Landfill Gas as a Green Power Source

Because of its superior environmental profile compared to conventional energy, EPA recognizes LFG as a green power source. For more information on green power, see Section 7.1, *Green Power Procurement.* For more information on generating renewable energy at local government facilities, see Section 7.2, *On-site Renewable Energy Generation*.

This section highlights the local government and community benefits of LFGE projects at local government-owned municipal landfills. It provides information on how local governments have planned and implemented LFGE projects to utilize CH_4, offers information on sources of funding, and presents case studies. Additional examples and information resources are presented in Table 7.4.2, *Landfill Methane Utilization: Examples and Information Resources*.

7.4.2 Benefits of Landfill Methane Utilization

Capturing LFG and using it as an energy source can produce significant energy, environmental, economic, and other benefits. Specifically, using LFG helps local governments to:

- *Demonstrate environmental leadership.* Using LFG, a green power source (see text box on page 2) can be an effective way for local governments to demonstrate environmental leadership and enhance community awareness of the benefits of clean energy development.
- The EnergyXchange project in Burnville, North Carolina, demonstrates community-level environmental stewardship. The project was initiated with an LFG collection system at the nearby Yancey-Mitchell Landfill. This action galvanized a community partner, Blue Ridge Resource Conservation & Development, to organize a Landfill Methane Task Force, which included more than 140 people from 40 agencies and organizations. The Task Force determined the end users for the LFG and identified operating partners and resources crucial to the project (EnergyXchange 2002). *Generate additional revenue:* Local governments can also earn revenue from selling LFG directly to end users or into the pipeline, or from selling electricity generated from LFG to the grid. Depending on who owns the rights to the LFG and other factors, a local government might also generate revenue by selling renewable energy certificates (RECs), trading GHG emissions offsets, and providing other incentives.

  An LFGE project in Catawba County's Blackburn Landfill in Newton, North Carolina, is expected to earn nearly $7 million over the project's lifetime and will allow the county to keep its tipping fee constant for the next 10 years (U.S. EPA 2005a).

- *Reduce emissions of GHGs.* MSW landfills are the second largest human-generated source of CH_4 emissions in the United States, releasing an estimated 30 million metric tons of carbon equivalent (MMTCE) in 2006 alone (U.S. EPA 2008b). An LFGE project can reduce CH_4 emissions from a landfill by between 60% and 90%, depending on project design and effectiveness (U.S. EPA 2008b). The annual GHG emission reduction benefits of a typical 3 MW electricity generation project using LFG equals about 16,000 tons of CO_2 a year, offsetting the consumption of almost 15 million gallons of gasoline or the equivalent of powering 1,900 homes. The annual GHG emission reduction benefits of a typical direct-use LFGE project using 1,000 scf per minute (scfm)[2] of LFG is nearly 14,000 tons of CO_2 a year, offsetting the consumption of approximately 13

Implications for the Environment

In addition to providing a continuous source of energy and improving local air quality, using LFG can significantly reduce GHG emissions. Since its inception, the LMOP program has helped 360 LFGE projects in the United States reduce landfill CH_4 emissions by a combined 28 million metric tons of carbon equivalent (MMTCE). In 2007, reductions from all operational LFG projects were equivalent to:

- Sequestering carbon from 24 million acres of pine or fir forest; or
- Removing the equivalent of the emissions of 19 million passenger vehicles for one year.

Source: U.S. EPA 2008b.

[2] Scfm is a volumetric measurement that indicates how many ft^3 of landfill gas pass a stationary point in 1 minute under standard conditions.

million gallons of gasoline or the equivalent of heating over 3,000 homes (U.S. EPA 2008f).[3]

> The Lanchester Landfill LFGE project in Narvon, Pennsylvania, is a 3,800 scfm project that has led to annual GHG reductions of 12,900 metric tons of carbon equivalents. These reductions are equivalent to planting 10,700 acres of pine or fir forests, removing the emissions of 8,600 vehicles, or preventing the use of 110,000 barrels of oil (U.S. EPA 2008g).

- *Improve air quality.* Collecting LFG to produce energy improves the air quality of the surrounding community by reducing emissions of criteria pollutants and hazardous air pollutants (HAPs) and minimizing landfill odors. Capturing and utilizing LFG directly avoids emissions of NMOCs, components of untreated LFG that can contribute to smog formation. In addition, using LFG can indirectly avoid emissions of several criteria pollutants, including sulfur dioxide (SO_2; a major contributor to acid rain), particulate matter (a respiratory health concern), nitrogen oxides (NO_x), and trace HAPs that would result from using fossil fuels in conventional energy generation (U.S. EPA 2008b).[4] CH_4 captured from landfills can be used as an alternative fuel that burns cleaner than traditional fuels.

> Denton, Texas, took advantage of LFG to improve its local air quality. In 2004 and 2005, air quality testing in Denton County reflected higher than acceptable levels of ozone concentrations. To reduce vehicle pollution from its fleet, the city established a public/private partnership to construct and operate a biodiesel fuel production facility powered by CH_4 gas from the city's landfill. The plant uses the landfill CH_4 as a fuel source for biodiesel production. As a result, the city reduced its emissions of criteria air pollutants and met federal air quality standards by using alternative fuels for a portion of its fleet (U.S. EPA 2006, U.S. Conference of Mayors 2007).

- *Reduce environmental compliance costs.* Current EPA regulations under the Clean Air Act (CAA) require landfills with capacities greater than 2.5 million milligrams (Mg) of MSW and NMOC emissions of 50 Mg per year to capture and combust LFG to prevent NMOCs from contributing to smog formation and threatening air quality. LFGE projects offer the opportunity to reduce the costs associated with regulatory compliance by turning pollution into a valuable renewable energy resource (U.S. EPA 2008b).

> In 1990, Glendale, California, was confronted with the challenge of complying with increasingly stringent environmental regulations governing the operation of power plants and landfills. The city reviewed its options, and implemented an LFGE project to deliver LFG to a local generating station and use it as a base fuel

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[3] Combusting captured CH_4 to generate electricity produces two byproducts: water and CO_2. CO_2 that is emitted from LFGE projects is not considered to contribute to global climate change because the carbon was contained in recently living biomass and would have been emitted through the natural decomposition process.

[4] LFG electricity generation systems, like all electricity generation combustion systems, generate some emissions of NO_x, a criteria pollutant that can contribute to local ozone and smog formation. Depending on the LFGE project, the NO_x emission reductions from the power plant may not completely offset the NO_x emitted from the LFG electricity project (U.S. EPA 2008b).

along with natural gas or fuel oil. The composition of LFG offered the opportunity to further reduce NO_x emissions during electric power generation. The city was able to simultaneously comply with the regulations, generate tangible environmental benefits, and lower costs to the consumer (Power Engineering 1995).

- *Increase economic benefits through job creation and market development.* LFGE project development can greatly benefit the local economy, e.g., a typical 3 MW LFG electricity generation project can employ more than 70 people (in full-time equivalents per year; U.S. EPA Undated). LFGE projects, which involve engineers, construction firms, equipment vendors, utilities, and end users, also create temporary jobs during the project construction phase. In addition, many materials and services are obtained locally. In some cases, new businesses (e.g., brick and ceramics plants, greenhouses, and craft studios) have relocated near an LFGE project to use the LFGE for their work (U.S. EPA 2008b).

Jackson County Green Energy Park

Jackson County, North Carolina, has developed a Green Energy Park that includes a biodiesel refinery, three professional blacksmith studios, and a series of greenhouses, and provides artisans with free LFG to fuel kilns and other studio equipment. In addition to achieving energy and environmental benefits, the project supports local businesses and is expected to add more than 20 jobs to the local economy when fully operational.

Source: Jackson County 2008.

- *Conserve land*. LFGE projects can enhance solid waste decomposition, increase landfill capacity, and mitigate the need to build new landfills or expand existing ones.

  LaGrange, Georgia, has achieved gains of 15% to 30% in landfill capacity as a result of an LFGE project initiated in 2001 (SGPB 2008).

  Riverview, Michigan, developed an LFGE project on a 212-acre landfill owned by the city. The LFG is used to create electricity with two gas turbines. The local utility purchases the electricity under a 25-year power purchase agreement. Benefits to the community from the closed landfill include its use as a wintertime skiing and recreation area and a future golf practice facility (U.S. EPA 2007h).

- *Create other benefits.* By linking communities with innovative ways to deal with their LFG, LFGE projects enjoy increased environmental protection, better waste management, and responsible community planning, all of which are top priorities for local governments (U.S. EPA 2008b).

  The CommunityTIES Project is a landfill gas development initiative that works with nearby counties in North Carolina to facilitate the development of community-based LFGE projects which generate local economic development. The statewide project is managed by the Appalachian State University Energy Center with funding from the GoldenLEAF Foundation, the North Carolina State Energy Office, and the Z. Smith Reynolds Foundation (CommunityTIESProject 2008).

LFG collection can also improve safety by reducing explosion hazards from gas accumulation in structures on or near the landfill (U.S. EPA 2008b).

7.4.3 Technologies for Converting LFG into Energy

A number of factors, including the availability of an energy market, project costs, potential revenue sources, and other technical considerations, can determine which technologies are most appropriate for a particular LFGE project. Technologies for converting LFG into energy include:

- *Electricity generation.* Approximately 70% of the LFGE projects currently in operation in the United States are used to generate electricity, either for on-site use or to sell to the grid (U.S. EPA 2008c). Electricity from LFG can be generated using a variety of technologies, including internal combustion engines, gas turbines, and microturbines, with two-thirds of LFGE electricity generation projects using internal combustion engines or turbines.[5] One million tons of landfilled MSW can produce an electricity generation capacity of 0.8 MW (U.S. EPA 2007a).

  > The Lancaster County Solid Waste Authority generates 3,200 kilowatts (kW) of electricity with the help of a partnership between the Authority and a local energy company, PPL Energy Services. The electricity is produced from two LFG-fired generators. Boilers capture waste heat to provide steam to the nearby Turkey Hill Dairy, a well known maker of ice cream and dairy products (U.S. EPA 2007f).

- *Direct use of LFG.* Direct use of LFG, which involves transmitting the medium-Btu gas via pipeline to be combusted by an end user, accounts for approximately 30% of all LFGE projects in the United States (U.S. EPA 2008c). LFG can be combusted by end users to fuel boilers, dryers, kilns, greenhouses, and other thermal applications. Current industries using LFG include automobile manufacturing, chemical production, food processing, pharmaceutical, cement and brick manufacturing, wastewater treatment, consumer electronics and products, and prisons and hospitals (U.S. EPA 2007a). One million metric tons of landfilled MSW can produce between 8,000 and 10,000 pounds of steam per hour when LFG is used to fuel a boiler (U.S. EPA 1996). The economics of an LFG project improve the closer the landfill is to the end user. The piping distance from an LFG project to its end user is typically less than 10 miles, although piping LFG up to 20 miles can be economically feasible, depending on the gas recovery at the landfill and the energy load at the end-use equipment (U.S. DOE Undated).

- *Combined heat and power.* One specific type of direct use of LFG is as a fuel source for combined heat and power (CHP) or cogeneration systems that generate both electricity and thermal energy. CHP systems can achieve substantially higher efficiencies than separate heat and power systems that do not use the waste heat produced in electricity generation. Thermal energy cogenerated by LFGE projects can be used for on-site heating, cooling, and/or process needs, or piped to nearby industrial or commercial users to provide a second revenue stream for the project (U.S. EPA 2008c).

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[5] Microturbine technology is sometimes used at smaller landfills and in highly specialized applications. Less common LFG electricity generational technologies include boiler/steam turbine applications in which LFG is combusted in a large boiler to generate steam, which is then used by the turbine to generate electricity; and combined cycle operations that combine a gas turbine, which combusts the LFG and a steam turbine, which uses steam generated from the gas turbine's exhaust to create additional electricity (U.S. EPA 2007h).

CHP is often a better economic option for end users located near the landfill or for projects where the end user generates both electricity and waste heat. For more information on CHP, see Section 7.3, *Combined Heat and Power*.

In Antioch, Illinois, the local high school is purchasing electricity and by-product heat from a nearby privately owned LFGE cogeneration project that uses 12 30-kW microturbines. Purchasing electricity and heat generated at the landfill saves the school nearly $100,000 annually in energy costs (RMT, 2008).

Additional Resources on CHP Applications

For additional information on CHP, see Section 7.3, *Combined Heat and Power,* and EPA's Combined Heat and Power Partnership at http://www.epa.gov/chp.

- *Alternate fuels.* Production of alternate fuels from LFG is an emerging area and can involve several technologies, including:

  - *Pipeline fuel.* Municipalities can deliver LFG to the natural gas pipeline system as both a high- and medium-Btu fuel. Upgrading LFG to produce high-Btu gas involves separating CH_4 from the CO_2 components of LFG. The separated CH_4 can be sold to natural gas suppliers or used in applications requiring high-Btu fuel. Although expensive, newly developing technologies are reducing the cost of these types of projects, which are ideally suited for larger landfills located near natural gas pipelines.

    In King County, Washington, the county is working with a project developer to produce pipeline quality natural gas from the LFG captured at the Cedar Hills Regional Landfill. The county expects to receive $1.3 million annually through a contract with a natural gas provider. Other benefits include an estimated annual reduction in CO_2 emissions about equal to the annual CO_2 emissions from 22,000 average passenger cars, and reduced GHG emissions of approximately 60% (King County 2007 and 2008).

  - *Vehicle fuel.* LFG can also be converted to vehicle fuel. Vehicle fuel applications involve using LFG to produce compressed natural gas (CNG), liquefied natural gas (LNG), or methanol. This process involves removing CO_2 and other trace impurities from LFG to produce a high-grade fuel that is at least 90% CH_4. Currently, CNG and LNG vehicles comprise a very small portion of automobiles in the United States, so there is not a significant demand for these vehicle fuels. However, with growing interest in alternative fuels, demand is expected to increase.

    The Sanitation Districts of Los Angeles use LFG from the Puente Hills landfills to make CNG as a vehicle fuel (U.S. EPA 2007i).

Denton, Texas – Biofuel Processing

LFG captured from the Denton, Texas, landfill is piped to a local biodiesel facility where it is combusted to heat renewable feedstock to produce B20 biodiesel (20% biodiesel, 80% diesel) fuel for the city's vehicle fleet, which will reduce the fleet's emissions of criteria pollutants by 12 tons annually. This facility is the only biodiesel production facility that is fueled exclusively by renewable energy.

Source: U.S. EPA, 2006.

7.4.4 Key Participants

A number of participants can play a key role in planning, designing, and implementing an LFGE project, including:

- *Local government officials and staff.* Local officials often begin the process of implementing LFGE projects. The mayor or county executive can play a key role in increasing public awareness of the benefits of LFG. Including LFG goals in a mayor's or county executive's priorities can lead to increased funding for LFG potential studies and/or projects. In other cases, LFGE projects are often initiated by city and county councils and/or staff. Securing support from city or county council members can be important for ensuring that LFG initiatives receive the resources necessary to produce results.

    Fairfax County, Virginia, developed a county-wide initiative that helped develop ah LFG project. The I-95 project includes nearly 200 CH_4 extraction system wells that are used to collect LFG. The captured gas is used to generate 6 MW of electricity, enough for about 5,000 homes. The gas is also sent to the nearby Norman Cole Wastewater Treatment Plant, where it is used as a medium Btu fuel in the sludge combustion process (MWCG 2006, Fairfax County 2007).

- *Developers.* While some local governments choose to self-develop LFGE projects, many hire outside developers to finance, construct, own, and/or operate these projects. Developers are typically private companies that specialize in the various stages of building, owning, and operating landfill projects. In many instances, the local government retains ownership of the landfill while the developer assumes ownership of the LFGE project.[6]

- *Regulatory and planning agencies.* LFGE project owners prepare applications for zoning or land use permits, air permits, and conditional use permits. LFGE project owners typically involve state environmental regulatory/permitting agencies, state energy agencies, and state public utility commissions early in the project planning process to ensure that all parties understand applicable environmental and land use requirements. In addition to state regulatory agencies, project owners often consult with county board members, local solid waste planning boards, and local zoning and planning departments. These partners are mainly involved during the permitting process of the facility. Project owners need to provide information showing that the project will meet emissions limits and other requirements, and will need to demonstrate compliance once the project becomes operational.[7]

- *Financial partners.* LFGE project owners sometimes work with financial partners (e.g., tax creditors, bankers, and accountants) that provide financial assistance, prepare tax credits, and track project finances. Tax creditors can assist LFGE project owners in applying for federal, state, or local renewable energy tax credits. Bankers can help LFGE project owners fund the

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[6] This section uses the term "LFGE project owner" to refer to either the local government or the developer it hires to construct and operate an LFGE project.

[7] Each state has different regulations and procedures for compliance and regulations. Some of these regulations can be found at: http://www.dsireusa.org.

LFGE project, and accountants assist by tracking finances and revenues for the LFGE project owner.

- *Professional partners.* LFGE project owners often obtain legal, marketing, or technical services for an LFGE project from a range of professional partners. For example, consulting engineers provide technical services to the LFGE project owner and can assist in designing and constructing the project and keeping the project in regulatory compliance. Lawyers draw up and review contracts for multiple purposes, including protecting the LFGE project owner from liability and establishing agreements between local governments and developers, end users, and other consultants or contractors. Lawyers might also review legal aspects of tax credits and project structures. Communications specialists or public information personnel can assist in fostering interaction with local residents, publicizing the environmental benefits of the LFGE project, and preparing educational materials.

- *Contractors.* LFGE project owners typically employ a variety of contractors to implement specific activities during the project planning, design, and implementation phases. Key types of contractors include (1) construction contractors building the facility; (2) generator manufacturers providing project owners with manufacturing data on generator equipment to help them determine which type of generator best fits the design and operating requirements of the LFGE project; (3) generation plant operators operating and maintaining the facility, and providing energy output data, testing data, and maintenance information to the project owner; (4) LFG treatment system manufacturers providing LFGE project owners with design and product specification assistance and working with the project owners, consultants, and end users to design, supply, and assemble the proper equipment to treat the LFG; (5) testing laboratories working with LFGE project owners to ensure that energy generation equipment does not emit higher levels than allowed by regulations and air permits; and (6) wellfield operators helping to ensure that the landfill is in compliance with local air permitting regulations and operating and maintaining the gas extraction wellfield, making tuning adjustments necessary to collect the LFG.

- *Energy service companies*. LFGE project owners sometimes work with energy service companies (ESCOs) that provide a comprehensive package of products and services to install, operate, and maintain LFGE projects.

  Little Rock, Arkansas, worked with an ESCO to construct an LFGE project at the city's landfill. As part of the services package, the ESCO monitors and maintains the project and its pipelines. In addition, the ESCO has helped the city reach an agreement with a local company to have a portion of the collected LFG piped to that company for use in a production facility (Little Rock 2007).

- *End users*. LFGE project owners often sell the energy generated by LFGE projects to end users, including business and industrial customers, for direct use in boilers, heaters, kilns, furnaces, and other combustion equipment at their facilities. Project owners also sell electricity generated on-site by the LFGE project to end users. Some end users can use LFG to produce their own electricity, as a feedstock for a chemical process, or for other purposes. In some instances, LFGE project owners work with potential end users when developing projects to tailor the project to meet the end user's energy needs.

In Little Rock, Arkansas, for example, the city entered into an agreement with a local business to capture LFG from the city landfill and pipe it for direct use at the company's production facility. The city benefits from the LFG sale revenues, while the business benefits from below-market rate gas prices (Little Rock 2007).

- *Utilities.* LFGE project owners sometimes sell LFG, or the electricity it generates, to local utilities.

  In Denver, Colorado, for example, the local government is partnering with the private corporation that manages the city-owned landfills to develop a 3.2 MW electricity generation plant that will supply electricity to the local utility (Denver, 2007). Whether investor-owned or municipally-owned, local utilities can use electricity generated from LFGE projects to meet renewable portfolio standards (RPS) that mandate specific percentages of renewable energy in a utility's supply.

- *Community partners.* When LFGE project owners apply for permits, community members express questions, concerns, or opposition to the proposed facility during a public comment period. Depending on the public comment results, permits are issued, modified, or rejected. Local governments often work with landfill neighbors, local businesses, and environmental and community organizations to address any community concerns early in the project development stage. Local governments can work with the community to design a project that complies with community zoning and other ordinances, and has environmental and economic benefits to the surrounding community.

  The CommunityTIES Project is an example of a community group established to work with counties in North Carolina to facilitate development of LFG-to-energy projects (CommunityTIES Project 2008).

7.4.5 Program Initiation Mechanisms

Mechanisms that local governments have used to initiate LFGE projects in their communities and promote the use of LFG as a renewable energy resource include:

- *Executive initiatives.* Mayors and county executives have been influential in initiating and promoting LFGE projects in their communities, helping sustain community support for LFGE projects and ensure that projects receive sufficient funding.

  Albuquerque, New Mexico, established a renewable energy initiative that included LFG as a priority. The city's most recent project is an LFG extraction system. This gas-to-energy system consists of a 70 kW microturbine that captures the LFG and produces electricity (Albuquerque 2008).

- *Renewable portfolio standards.* A number of local governments have adopted RPS that require municipally-owned electric utilities to use a certain percentage of renewable energy in their overall energy supply.

  The city council of Burbank, California, established a RPS requiring the Burbank Water and Power utility to use 20% renewable power by 2017. One component of the utility's strategy for meeting this goal is to use LFG captured at the local landfill, where two microturbines systems have been installed, with a total capacity of 550 kW (Burbank 2006).

- *Commitments to purchase LFG from private landfill owners.* A number of local governments are purchasing LFG energy products from private landfill or LFGE project owners. Some municipally-owned utilities are purchasing green power from private landfill owners and selling it to commercial and residential customers.

  In 2007, the city council in Anaheim, California, approved purchase agreements with two private LFGE project owners to obtain 30 MW of LFG-based electricity capacity for its municipally-owned utility, which has established a goal of increasing the amount of green power in its portfolio to 14% by 2010 (Anaheim 2007).

  For more information on purchasing green power products, see Section 7.1, *Green Power Procurement*.

7.4.6 Implementation Considerations

Local governments can consider a number of approaches to help them overcome barriers to implementing LFGE projects, including:

- *Evaluate site candidacy*. The first consideration for an LFGE project owner is to determine whether the landfill is a candidate for LFG recovery. In general, strong candidate landfills should contain at least 1 million tons of waste, have an average depth of 50 feet or more, and be open or closed within the last five years (these are general guidelines and there are exceptions). After this initial screening, the project owner determines LFG recovery rates. The EPA’s Landfill Gas Emissions Model (LandGEM) can provide a more detailed analysis of LFG generation potential (available at: http://www.epa.gov/ttn/catc/products.html#software). The LFGE project owner can also engage an engineering consulting firm to conduct a desktop feasibility study to assist with this task. In addition, LFGE project owners can consider the distance between the landfill and anticipated end users. The piping distance from an LFG project to its end user is typically less than 10 miles, although piping LFG up to 20 miles can be economically feasible, depending on gas recovery at the landfill and energy load at the end-use equipment (U.S. DOE Undated).

- *Weigh the options of different technologies*. As mentioned in Section 7.4.3, *Technologies for Converting LFG into Energy*, there are a number of different ways to convert LFG into energy. The best option for a particular landfill will depend on a variety of factors, including the availability of a market for energy, project costs, existence of a nearby end user, potential revenue sources, and other technical considerations. In general, the simplest and most cost-effective option is to sell a medium-Btu gas to a nearby customer for direct use – this requires minimal processing and is tied to retail gas rates rather than utility buy-back rates. Power production and sale to a nearby utility can also be a cost-effective option if utility electricity buy-back rates are attractive. Other options, such as upgrading LFG to a high-Btu product for injection into a natural gas pipeline, entail higher capital and treatment costs and may only be cost-effective for those landfills with substantial recoverable gas.

- *Consider whether to engage a partner.* Some local governments have the expertise, resources, and desire to lead the project development effort on their own. However, in many cases, choosing the right development partner can greatly improve the likelihood of a project's success. From a local government's perspective, there are three ways to structure the development and ownership of an LFGE project:

  - Develop the project internally, where the local government manages the development effort and maintains ownership control of the project

  - Team with a project developer who develops and builds the project

  - Team with a partner, where the local government works with an equipment vendor, an engineering/procurement/construction (EPC) firm, an industrial company, or a fuel company to develop the project and share the risks and financial returns.

  At the St. John's landfill project in Portland, Oregon, public and private entities worked together to develop an LFG project that pipes LFG from St. John's landfill to a nearby lime plant and uses it as a primary fuel source for three lime kilns. Metro, a Portland regional planning authority, worked with Portland Landfill Gas Joint Venture Partners, which included a cement company and an investment banking firm, to develop the project (U.S. EPA 2007j).

  In Pennsylvania, the Clinton County Solid Waste Authority searched for a way to control the gas generated by the Wayne Township Landfill. Wayne Township teamed with a neighboring steel company to develop an LFG project and share both risks and financial returns. Through this partnership project, the Authority provides 970 scfm LFG to the steel company to use as fuel in their furnace to reclaim railroad steel. This project has been a new source of revenue for the Authority and enabled the steel company to save on fuel costs (U.S. EPA 2007k).

- *Retain or sell renewable energy certificates.* RECs (also known as green tags, green energy certificates, or tradable renewable certificates) represent the environmental and other non-power attributes of electricity generated from renewable sources. They provide information about the generation resource (e.g. LFG), when the megawatt hour (MWh) was generated, and the location of the generator. It is important to note though, that while some states define RECs to include the environmental and climate benefits associated with the CH_4 destruction, others do not. In the latter case, the environmental benefit is captured separately and can be sold as a carbon offset.

  When renewable energy is generated, the RECs may be separated from the physical electricity and sold as a distinct product. The REC buyer gains the contractual rights to make an environmental marketing claim and the physical electricity – that is sold separately – becomes "attributeless" or "null power" (i.e., environmentally equivalent to the regional power mix). In making a REC claim, the buyer permanently "retires" the REC and it can no longer be sold.

There are two types of markets for RECs: the compliance markets created by state mandated RPS for retail electricity sales and a voluntary market driven by residential and business demand for zero emission electricity from renewable energy. Local governments can target the following purchasers of RECs from LFGE projects: (1) electric service providers, for compliance with state RPS or to supply a retail green power programs; (2) non-utility wholesalers and retailers, including REC marketers and REC brokers; and (3) retail customers (WRI 2003, U.S. EPA 2004).

> In 2008 in Massachusetts, the state RPS required electric retailers to acquire RECs from qualified renewable energy generation projects (including LFGE projects) to cover 3.5% of their 2008 sales. These RECs are being sold to the retailers through the New England Power Pool General Information System (NEPOOL GIS) for more than 4¢ per kilowatt hour (kWh), making them an excellent revenue stream for qualifying renewable energy generation project owners (MTC 2008).

Local governments that sell the LFGE they produce at their landfills sometimes choose to retain the RECs, allowing them to make an environmental marketing claim. For some local governments, keeping the RECs will help them meet the environmental goals they have established, such as reducing GHG emissions. Others want to simply say that the government is green-powered. Selling the RECs would transfer those rights to the REC buyer.

- *Consider voluntary GHG markets.* Members of voluntary carbon markets look to purchase credits to offset their GHG emissions. LFGE projects that capture and destroy or convert CH_4 can qualify as offset projects. The tons of CH_4 destroyed or converted can be traded on the market in terms of tons of carbon equivalent. For LFGE projects to qualify as offsets in today's voluntary markets, the destruction of CH_4 must be additional, meaning that the local government collects the LFG voluntarily (as opposed to collecting LFG to comply with federal regulations, such as EPA's New Source Performance Standards, NSPS)[8]. In addition, most markets require that the installation of the LFGE project be recent, although some buyers will accept offsets from LFGE projects installed as early as 1999. Companies active in voluntary markets include CCX, EcoSecurities, Evolution Markets, Element Markets, AgCert, Blue Source, and GE/AES. Trading emissions offsets can provide a potentially significant source of income for small- and mid-sized LFGE projects.

Lancaster County LFG Project with Turkey Hill Dairy

The Lancaster County Solid Waste Management Authority has a CHP project that supplies power to a nearby utility and steam (using waste heat recovery) to Turkey Hill Dairy. As a member of the Chicago Climate Exchange (CCX), the Authority has made a legally binding commitment to reduce its GHG emissions by 6% by 2010, using 2006 as a baseline.

Source: U.S. EPA 2007f.

[8] EPA promulgated the NSPS on March 12, 1996 under Title 1 of the CAA. The regulations target landfill gas emissions at larger landfills as it was determined these landfills produce the bulk of landfill gas emissions. The main purpose of the NSPS is to control NMOCs, which contribute to smog formation and contain trace carcinogens. For further information on these rules, see: http://www.epa.gov/ttn/atw/landfill/landflpg.html

King County, Washington, for example, is planning to upgrade the facilities at the Cedar Hills Landfill to be able to produce pipeline-quality gas to sell to a local gas provider. In addition to earning $1.3 million annually in gas sales, the county would retain the carbon credits and benefits associated with the LFG project (King County 2007 and 2008).

- *Determine interconnection standards.* In some cases, local governments may want to connect an LFGE project to the electricity grid. For example, the availability of interconnection standards can be an important factor for determining the feasibility of an LFGE project when there is excess energy supplied by the LFGE project. A number of factors drive interconnect issues, including the number of MW the developer wants to interconnect, the sizing and capacity surrounding distribution, the location of distribution substations, interconnect procedures, and regulations and utility requirements.

  In Prince Georges County, Maryland, Brown Station Road Landfill sends LFG to the nearby Prince George's County Correctional Facility to generate steam and electricity. The county has an interconnection agreement with the local utility to pay $1,000 per month for the utility to meter and distribute the generated electricity to the grid. The county also generates income by selling the RECs generated by the project. Since the project's inception, the county has received an average of $60,000 per month for electrical generation, although revenues have been variable due to fluctuations in market costs (U.S. EPA 2007b).

  For additional information on interconnection standards, see Section 7.3.6, *Combined Heat and Power, Implementation Strategies*.

- *Engage the community.* Many local governments have found that engaging the community can be a critical aspect of planning, constructing, and operating LFGE projects. Community partners typically include neighbors to the landfill, the general public, local businesses, and environmental and community organizations. It is important to engage these partners early in the project development phase. LFGE project owners can work with the community to address any concerns and to select a project that complies with community zoning and other ordinances and has environmental and economic benefits to the surrounding community.

- *Understand the community's role in permitting and compliance issues.* Unless there is significant opposition to an LFGE project, community partners are mainly involved in the permitting process. When LFGE project owners apply for required permits, such as air and zoning permits, community members can provide comments during the public comment period. For a detailed example on how to engage the community, see Section 7.4.9, *Case Studies: Yancey and Mitchell Counties, North Carolina – EnergyXchange Renewable Energy Center.*

The following steps provide a basic overview for local governments and other entities interested in developing an LFGE project (see text box on page 15).

Steps for Developing LFGE Projects

1. *Estimate LFG recovery potential.* Strong candidates for LFGE projects include landfills that: contain at least 1 million tons of MSW, have a depth of 50 feet or more, and are open or recently closed (U.S. EPA 2009a). In addition, the site should receive more than 25 inches of rainfall annually (U.S. EPA 2009a). EPA's LandGEM can provide a more detailed analysis of LFG generation potential (available at http://www.epa.gov/ttn/catc/products.html#software).
2. *Evaluate project economics.* Local governments can evaluate the economic potential for converting LFG by using EPA's *LFGCost* tool to help with preliminary economic evaluation, which includes public financing inputs (available at http://www.epa.gov/lmop/res/index.htm#5).
3. *Establish project structure.* Local governments can work with a developer or other partners. If a local government decides to work with partners, the terms of the partnership should be formalized in a contract that specifies which partner will own the gas rights and the rights to potential emissions reductions, and outlines partner responsibilities for design, installation, and operation and maintenance (O&M).
4. *Assess financing options.* Local governments can consider a number of financing options, including private equity financing, project financing, municipal bond financing, direct financing, lease financing, and public debt financing through institutional or public stock offerings. For more information, see Section 7.4.7, *Up-front Investment and Financing*.
5. *Negotiate energy sales contract.* Local governments can enter into contracts to sell LFG to end users. Negotiating sales contracts involves preparing a draft offer, determining utility or end user need for power or gas demand, developing project design and pricing, preparing and presenting a bid package, reviewing contract terms and conditions, and signing the contract.
6. *Secure permits and approvals.* The permitting process for an LFGE project may require six to 18 months (or longer), depending on the project's location and recovery technology. LFGE projects must comply with federal regulations relating to LFG emissions controls and control of air emissions from the energy conversion equipment. LMOP's State Primers provide information regarding state specific regulations and permits. See: http://www.epa.gov/landfill/res/primers.htm
7. *Contract for engineering, procurement, construction, and O&M.* Construction and operation of LFGE projects are often best managed by firms with proven experience. Contractors can conduct engineering designs, site preparation, plant construction, and start-up testing.
8. *Install project and start up commercial operation.* The final phase of implementation is to start commercial operations and engage the community in educational outreach programs.

Source: U.S. EPA 2002.

7.4.7 Up-front Investment and Financing

This section provides information on the costs of evaluating, constructing, and installing LFGE projects at local government-owned landfills and describes financing opportunities for addressing these costs.

Investment

In general, each LFGE project involves project evaluation, purchase and installation of equipment (capital costs), and the expense of operating and maintaining the project (O&M costs). This section describes the costs involved in project evaluation, collection system and flaring, electricity generation, direct LFG use, and other LFG uses.

LFGE Project Costs

LMOP has developed *LFGCost*, a tool to help with preliminary project economic evaluation. It is available at: http://www.epa.gov/lmop/res/index.htm#5.

- *Project evaluation costs.* The initial cost involved in implementing an LFGE project involves conducting a feasibility study to determine project potential. A typical desktop feasibility study involves gas recovery modeling, pro forma financial analysis, site visits, and an evaluation of end-use options. Engineering consulting firms can perform these studies, with costs ranging from $10,000 to $15,000 per study. A more detailed study involving further gas analysis (including tests for CH_4, hydrogen sulphide, or siloxanes) may cost an additional $10,000.

- *Collection system and flaring costs*. Gas collection and flaring system equipment gathers LFG to be combusted for electricity generation or to be distributed for direct use, and provides a way to destroy the gas when the project is not operating. If a collection and flare system already exists, it can be treated as a "sunk cost,"[9] and the project cost only needs to consider necessary modifications to the system. The typical LFG collection and flare system costs approximately $18,000 per acre for installed capital costs, with annual O&M costs of approximately $4,000 per acre (U.S. EPA 2009b).

- *Electricity generation project costs.* The most common technologies for converting LFG into electricity include internal combustion engines, gas turbines, microturbines, and small engines. Each technology is generally suited to a particular range in project capacity. Internal combustion engines, the most commonly used engines in LFGE electricity generation projects, tend to be used for projects in the 800 kW to 3 MW capacity range, while gas turbines are typically used for projects that have capacities of 3 MW or more (U.S. EPA 2009b). Microturbines and small internal engines are best suited for small projects in the 250 kW to 1 MW range or for projects with unique power needs (U.S. EPA 2009b). Table 7.4.1 illustrates typical capital and O&M costs for different electricity project options.

Considerations for Collection System and Flaring Costs

Collection system and flaring costs can vary depending on design variables. Key factors that influence costs include:

- For gas collection wells or collectors: depth of the waste and spacing of wells or collectors.
- For gas piping: gas volume and length of piping.
- For the condensate knockout drum: volume of the drum.
- For the blower: blower size.
- For the flare: flare type (enclosed or open, ground or elevated) and size.

Source: U.S. EPA 2009b.

[9] Sunk costs are defined as costs that have been incurred and that cannot be recovered to any significant degree.

Table 7.4.1 Capital and O&M Costs of LFGE Electricity Generation Projects			
Technology	**Optimal Project Size (capacity)**	**Typical Capital Cost ($/kW capacity)**	**Typical Annual O&M Costs ($/kW capacity)**
Microturbine	≤ 1 MW	$5,400	$350
Small Internal Combustion Engine	≤ 1 MW	$1,700	$180
Reciprocating Engine	≥ 800 kW	$1,300	$160
Gas Turbine	≥ 3 MW	$970	$110
Source: U.S. EPA 2009b.			

- *Direct-use project costs*. For direct use LFGE projects, costs vary depending on the end-user's requirements, but typically include expenses for the following components: gas compression and treatment systems to condition gas for end-user equipment, pipelines to transport LFG to end users, and condensate management systems for removing condensate along the pipeline. Typical costs for gas compression and treatment are about $260 per scfm with O&M costs of $111 per scfm. For gas pipeline and condensate management systems, the typical capital costs are about $52 per foot with negligible O&M costs (U.S. EPA 2009b).

  End users may need to modify their equipment to make it suitable for combusting LFG, but these costs are usually borne by the end user and are site-specific. However, modification costs are typically offset by cost savings as a result of purchasing energy at below-market rates.[10]

> **Planning for LFGE Project Success**
>
> In successful projects, local governments keep detailed records, are conservative about the energy potential from the landfill, review all pro forma statements, and assist the procurement process in any way possible, building public support and ensuring sound and efficient financial transactions. These steps minimize permitting delays and enhance public support, which help increase the attractiveness of the project to investors.
>
> Source: U.S. EPA 2009b.

- *Other project type costs*. In addition to electricity generation and direct use projects, there are other less common project options including CHP applications, leachate evaporation, vehicle fuel, and upgrade to high-Btu gas for sale to natural gas companies. These technologies are not as universally applicable as the more traditional LFG projects; however, depending on the specific situation, they can be very cost-effective.

Financing

A combination of different financing options may be the best approach for funding an LFGE project. Financing options available to LFGE project owners include:

- *Municipal bond financing*. For municipally-owned landfills or end users, the issuance of tax deferred bonds can be used to finance LFGE projects. This is the most cost-effective method

[10] EPA's LMOP program provides a boiler retrofit fact sheet to help end users understand the types of modifications required to use LFG in a boiler (see www.epa.gov/lmop/res/pdf/boilers.pdf).

of financing a project since the interest rate is often 1% or 2% below commercial debt interest rates and can often be structured for long repayment periods (U.S. EPA 2008e).

- *Direct municipal funding*. Often the lowest-cost financing available, direct municipal funding uses the local government operating budget to fund the LFGE project, eliminating the need for outside financing or obtaining partners and delays caused from their project evaluation needs. However, municipalities may not have sufficient budgets to finance a project. Additionally, public approval may be required for LFGE projects, which can increase the time required to complete a project.

  Fargo, North Dakota, financed an LFG collection and flare system to reduce odors from landfill operations. A neighboring company that processes oilseed recognized the energy potential and approached the city about using LFG in their boilers. The city and the oilseed processor split the cost of the 1.5-mile pipeline, and the oilseed processor financed the installation of dual-fuel burners and the new control system. The city will recover its capital expense through the sale of LFG (U.S. EPA 2007c).

- *Private equity financing*. This financing approach involves an investor who is willing to fund all or a portion of the project in return for a share of project ownership. Potential investors include developers, equipment vendors, gas suppliers, industrial companies, and often investment banks. For small projects without access to municipal bonds, private equity financing can be one of the better means of obtaining financing. This option typically has lower transaction costs and usually enables a local government to move faster on financing than with other options. However, private equity financing can be more expensive than other financing options. In addition, investors may expect to receive benefits from providing funding, such as service contracts or equipment sales, as well as a portion of the cash flow.

> **EPA's Landfill Methane Outreach Program Funding Resources**
>
> EPA's LMOP has developed a comprehensive funding guide that provides information about a broad range of types of funding options available for LFGE projects. The guide provides examples of successful funding approaches that can be replicated around the country to promote LFGE. The types of funding covered in the guide include grants, loans, tax credits and exemptions, and production incentives. Information about state RPS that include landfill gas as an eligible resource is also provided.
>
> For further information, see http://www.epa.gov/lmop/res/guide/index.htm.
>
> Source: U.S. EPA 2008e.

- *Project financing.* With this approach, often used for private power projects, lenders look to a project's projected revenues rather than the assets of the developer to ensure payment. The developer retains ownership control of the project while still obtaining financing. Typically, the best sources for obtaining project financing are from small investment capital companies, banks, law firms, or an energy investment fund. The main disadvantages of project financing are high transaction costs and the lender's high minimum investment threshold.

- *Lease financing*. For this approach, the project owner leases all or part of the LFGE project assets. This arrangement usually allows the transfer of tax benefits or credits to an entity that can best make use of them. Lease arrangements can allow for the user to purchase the assets or extend the lease upon completion of the lease. The benefit of lease financing is that it frees up the project owner's capital funds, while allowing the owner to maintain control of the project. Disadvantages include complex accounting and liability issues, and the loss of tax benefits to the project owner.

- *Renewable energy trust funds*. Some local governments have been awarded grants to fund LFGE projects through renewable energy trust funds administered by nonprofit organizations, state agencies, or other sources. The Renewable Energy Trust in Massachusetts is funded by a public benefits fund and administered by the Massachusetts Technology Collaborative.

  The Renewable Energy Trust provided the town of Barnstable with a $20,000 grant to evaluate the feasibility of powering a new town facility with LFG captured from the town's landfill (MTC 2005).

> **Database of State Incentives for Renewable Energy**
>
> The Database of State Incentives for Renewables & Efficiency (DSIRE) is another resource for funding and other incentives for LFGE projects. For more information, see http://www.dsireusa.org/.

- *Loans*. Local governments can obtain low-interest loans from federal or state agencies to finance LFGE projects.

  LaGrange, Georgia, for example, used a $1 million low-interest loan from the Georgia Environmental Facilities Authority, under the agency's Solid Waste Loan Program, to upgrade its landfill management equipment and to install a gas collection facility at the landfill (U.S. EPA 2008a).

- *Property and sales tax exemptions*. Exempting LFGE projects from state taxes is another powerful incentive to encourage new projects. Some states have exempted equipment that generates energy from LFG 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 LFG). Qualifying facilities can claim a credit on their state income taxes (MEA 2007).

7.4.8 Working with Federal, State, and Other Programs

A number of federal, state, and other programs can offer technical assistance and information resources to local governments.

Federal Programs

- *U.S. EPA Landfill Methane Outreach Program.* LMOP is a voluntary assistance program that helps reduce GHGs from landfills by encouraging the recovery and use of LFG as an energy resource. LMOP forms partnerships with communities, local governments, utilities, power marketers, states, project developers, and nonprofit 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. The program offers technical assistance, guidance materials, and software to assess a potential project's economic feasibility; assistance in creating partnerships and identifying financing; materials to help educate the community and the local media about the benefits of LFG energy; and networking opportunities with peers and LFG energy experts to enable communities to share challenges and successes. Table 7.4.2, *Landfill Methane Utilization: Examples and Information Resources,* provides additional information about LMOP's services.

Web site: http://www.epa.gov/lmop

- *U.S. EPA Green Power Partnership.* The EPA Green Power Partnership is a voluntary climate protection program that creates demand for electricity produced from renewable energy sources. Local government partners earn publicity and recognition, and are ensured of the credibility of their green power purchases. In addition, partners can receive EPA advice for identifying green power products and information on purchasing strategies. EPA also provides tools and resources that offer information on green power providers and calculate the environmental benefits of green power purchases. Through the Green Power Communities initiative, the Partnership recognizes cities, towns, and villages where local governments and their businesses and residents collectively purchase quantities of green power that meet EPA-determined requirements. To get started, the community's local government first becomes an EPA Green Power Partner and takes the lead with EPA on beginning a local community campaign.

  Web sites:

  http://www.epa.gov/greenpower/ (Green Power Partnership)

  http://www.epa.gov/greenpower/communities/index.htm (Green Power Communities)

- *U.S. EPA Clean Energy-Environment State and Local Program.* This program assists state and local governments in their clean energy efforts by providing technical assistance, analytical tools, and outreach support. A key resource for the Clean Energy-Environment program is the Clean Energy Resources Database, which provides planning, policy, technical, analytical, and information resources for state and municipal governments.

  Web sites:
  http://www.epa.gov/cleanenergy/
  http://www.epa.gov/cleanenergy/energy-programs/napee/resources/database.html
  (Clean Energy Resources Database)

- *U.S. EPA Combined Heat and Power Partnership.* The CHP Partnership is a voluntary program seeking to reduce the environmental impact of power generation by promoting the use of CHP. The Partnership works closely with energy users, the CHP industry, state and local governments, and other clean energy stakeholders to facilitate the development of new projects and to promote their environmental and economic benefits.

  Website: http://www.epa.gov/chp/

- *Methane to Markets Partnership.* The international Methane to Markets Partnership represents a 14-nation commitment to reducing CH_4 emissions. The Partnership provides a framework for voluntarily reducing CH_4 emissions and using captured CH_4 as a clean energy source. The Partnership brings private and public sector partners together to find effective ways to protect the environment and meet energy needs.

Web site: http://www.methanetomarkets.org/landfills/index.htm

- *U.S. Department of Energy (DOE) Green Power Network.* Local governments can obtain news and information on green power markets from the DOE Green Power Network. The Network's Web site provides information on green power providers, green power products, and federal, state, and local policies pertaining to green power markets, and contains an extensive library of papers, articles, and reports on green power.

  Web site: http://www.eere.energy.gov/greenpower/

- *U.S. DOE State Energy Alternatives Program.* This program provides state and local policy makers with information on renewable energy and energy efficiency opportunities. It provides assistance to local governments on technology and policy options and outlines the availability of different alternative energy resources in each state.

  Web site: http://www.eere.energy.gov/states/alternatives/

- *National Renewable Energy Laboratory).* The National Renewable Energy Laboratory (NREL) is the primary national laboratory for renewable energy and energy efficiency research and development. It provides local governments with information on existing and emerging technologies, including how to plan, site, and finance projects using renewable energy sources. NREL also provides information on developing rules and regulations for net metering and RPS for municipal utilities. The *NREL Natural Gas Vehicle Technology Forum* provides information on the basic technology behind using natural gas (including LFG) as an alternative fuel for vehicles.

  Web site: http://www.afdc.energy.gov/afdc/vehicles/natural_gas.html

State Programs

A number of states administer programs that provide assistance to local governments for planning, designing, and operating LFGE projects. State assistance often includes financial incentives, such as low interest loans, grants, and tax incentives. Grants that can be applied to the purchase, construction, and installation of LFG systems are another incentive some states are using.[11]

> Pennsylvania's Harvest Grant Program, for example, awards money to a variety of renewable energy projects, including LFGE projects (Pennsylvania DEP 2008).

[11] For more information on programs administered by specific states, see http://www.epa.gov/lmop/part/state.htm.

Other Programs

Other sources of information and technical assistance include:

- *Database of State Incentives for Renewables & Efficiency*. A project of the North Carolina Solar Center and the Interstate Renewable Energy Council (IREC), DSIRE provides information on federal, state, and local incentives for renewable energy and energy efficiency projects, including tax credits, loans, and grants. The database also provides information on state and local regulations pertaining to renewable energy purchases and on-site renewable energy generation, including overviews of state and local net metering rules, RPS, and requirements for renewable energy use at public facilities.

  Web site: http://www.dsireusa.org/

- *Interstate Renewable Energy Council*. IREC provides information and assistance to state and local governments for a number of renewable energy activities, including public education, procurement coordination, and adoption of uniform standards.

  Web site: http://www.irecusa.org/

- *Green-e Renewable Energy Certification Program*. Developed by the Center for Resource Solutions, Green-e is a voluntary certification and verification program for wholesale, retail, and commercial electricity products, RECs, and utility green pricing programs. Green-e certifies about 100 retail and wholesale green power marketers across the country. In addition, Green-e sets consumer protection and environmental standards for energy-related products. Local governments can seek certification from Green-e as purchasers of certified renewable energy, for which Green-e provides a label that can be displayed in government facilities.

  Web site: http://www.green-e.org/

- *Renewable Energy Policy Project*. The Renewable Energy Policy Project, created by the Center for Renewable Energy and Sustainable Technology, was developed to accelerate the deployment of renewable energy technologies and serves as a clearinghouse for information on renewable energy technologies and policies.

  Web site: http://www.repp.org/index.html

7.4.9 Case Studies

The following case studies describe two comprehensive LFG utilization projects initiated by local governments. Each case study describes how the program was started, key program activities, and program benefits.

DeKalb County, Georgia – Seminole Road MSW Landfill

The DeKalb County Sanitation Division is capturing LFG from the Seminole Landfill to generate electricity and address environmental challenges. Initiated in 2006, this self-developed project became one of the first suppliers of green power for the local utility's new green energy program.

Profile: DeKalb County, Georgia

Area: 270 square miles

Population: 750,000

Structure: DeKalb County is governed by seven elected county commissioners who set policies and appropriate funding, and an elected chief executive officer who administers day-to-day county operations. Management of the Seminole Landfill falls under the auspices of the county Sanitation Division in the Department of Public Works.

Program Scope: The Sanitation Division manages a 3.2 MW LFGE electricity generation system at the Seminole Landfill, which contains approximately 8 million tons of MSW. This system provides the local utility with more than 22 million kWh of green power annually.

Program Creation: County commissioners directed the Sanitation Division to request proposals.

Program Benefits: The LFGE project produces approximately 22.5 million kWh annually. Environmental benefits include annually avoiding an amount of emissions equivalent to what 3,300 cars produce in one year.

Source: U.S. EPA 2007d

Program Initiation

The County commissioners asked DeKalb County officials to develop a 3.2 MW LFGE facility, meet all regulatory requirements, and make it a showcase for LFG utilization. Additionally, the officials were asked to complete the project on an accelerated schedule without a third party developer. Solid waste officials responded to this challenge, met all criteria, and completed the project on schedule. Due to an innovative design, build, and operate procurement approach, the project was completed seven months after county commissioners approved construction (U.S. EPA 2007d).

Program Features

The LFGE project at Seminole Landfill was self-developed without the assistance of a third-party developer and with seamless interface with the existing flare system and wellfield infrastructure. The project uses two reciprocating engines with a combined capacity of 3.2 MW to produce electricity from a stream of captured LFG that reaches approximately 1,600 scfm. This stream of LFG is produced by approximately 8 million tons of MSW that have been collected since 1977.

The project includes a contract with a local utility through which the utility purchases green power produced from the captured LFG (22.5 million kWh annually for 10 years). The revenues from the green power sales will enable the county to recover the $5 million cost of the system in less than five years. The project raised $1.9 million in revenues between November 2007 and July 2008.

The showcase energy facility emphasizes education and offers tours about LFG utilization. The facility offers a screen where visitors can view real-time performance of the electricity generators, and displays a full circle mural that follows trash from its collection to the landfill to LFG generation, capture, and ultimately to providing electricity to the same residents and businesses from which the trash was collected (U.S. EPA 2007d, 2007e).

Program Benefits

In addition to providing a source of green power for the community (i.e., enough to power 2,000 homes annually), the program is expected to achieve annual emissions reductions of approximately 15,900 metric tons of CO_2 equivalent. Annual GHG reductions are equivalent to removing the emissions of 2,900 vehicles or avoiding the use of 36,900 barrels of oil (U.S. EPA 2007d).

Web site: http://www.epa.gov/lmop/proj/prof/profile/dekalbcountyandgeorgiapow.htm

Yancey and Mitchell Counties, North Carolina – EnergyXchangechange Renewable Energy Center

The EnergyXchange is a community-based organization in North Carolina that is currently utilizing LFG to provide energy to on-site glass blowing furnaces, a pottery kiln, and a greenhouse dedicated to preserving rare and native flora. The project is unique because it utilizes LFG from a landfill much smaller than what is typically considered to be commercially viable.

> **Profile: Yancey and Mitchell Counties, North Carolina**
>
> Area: Yancey County – 313 square miles; Mitchell County – 222 square miles
>
> Population: Yancey County – 18,000; Mitchell County – 16,000
>
> Structure: Both counties are governed by a board of elected commissioners. In both counties, these boards select a county manager to direct day-to-day operations.
>
> Program Scope: The EnergyXchange Renewable Energy Center was first developed adjacent to the Yancey-Mitchell Landfill. The success of this project has led to the development of a second project at the Avery County Landfill.
>
> Program Creation: An LFG collection system developed at the Yancey-Mitchell Landfill led to the creation of a task force to evaluate opportunities to use the captured LFG. The EnergyXchange project was initiated in 1999.
>
> Program Benefits: Artisans at the EnergyXchange facilities have saved more than $1 million in energy costs compared to purchasing energy from conventional sources. The environmental benefits of the project include reduced annual GHG emissions equivalent to the amount that 860 vehicles would produce in one year.
>
> Source: U.S. EPA 2005b

Program Initiation

The project at EnergyXchange was initiated when an LFG collection system was activated at the nearby Yancey-Mitchell Landfill. This action galvanized a community partner, Blue Ridge Resource Conservation & Development, to organize a Landfill Methane Task Force including over 140 people from 40 agencies and organizations. The Task Force determined the end uses for the LFG, identified operating partners, engaged local communities in the project, and identified resources crucial to project development (U.S. EPA 2005b).

Program Features

The EnergyXchange complex, which includes two craft studios, four greenhouses, three cold frames, a public gallery, and a visitor center, is located adjacent to a six-acre landfill and draws on the energy of a 37.5 scfm LFG flow. Water heated by LFG gas provides heat for a greenhouse where students learn how to propagate critical components of local ecosystems. Glass blowers fine tune their craft over flames fueled by LFG, and potters fire their wares in an oversized kiln, also fueled by LFG. In the visitor's center, citizens learn how LFGE projects save money and help the environment. The project showcases community collaboration: in addition to the Blue

Ridge Resource Conservation & Development Council, other partners include Natural Power and the North Carolina Department of Environment & Natural Resources (U.S. EPA, 2005).

Program Benefits

The efforts of EnergyXchange have demonstrated that LFG projects at small landfills can be beneficial and have shown the power of community partnerships. The savings to the artisans thus far exceeds $1 million compared to what they would have paid for traditional fuel sources. Artisans pay a nominal studio fee to receive an ample gas supply that is expected to power them for 15 years (U.S. EPA, 2005b).

The project's environmental benefits include annual GHG reductions of 4,400 metric tons of CO_2 equivalent, which is equal to the carbon sequestered annually by 1,000 acres of forest, removing the emissions of 810 vehicles, or preventing the use of 10,300 barrels of oil. Annual energy savings, which equates to heating 120 homes (U.S. EPA, 2005b).

Web site: http://www.epa.gov/lmop/proj/prof/profile/EnergyXchangechangerenewableene.htm

Resources

Table 7.4.2 Landfill Methane Utilization: Examples and Information Resources	
Title/Description	**Web Site**
Examples of Landfill Methane Utilization	
Akron, Ohio. In this direct use project, LFG from the Hardy Landfill in Ohio is providing 556 scfm LFG to the city's wastewater treatment plant.	http://www.epa.gov/lmop/proj/prof/profile/akronohwwtplfgenergyproje.htm
Albuquerque, New Mexico. At the city's Los Angeles landfill, LFG is captured and used to fuel an electricity-generating microturbine. The electricity is used to power the CH_4 extraction system and a groundwater treatment system. The remaining electricity is sold to the utility, as permitted by state interconnection and net metering rules.	http://www.cabq.gov/solidwaste/overview/cerro http://www.cabq.gov/envhealth/landfill.html http://www.cabq.gov/albuquerquegreen/green-goals/energy-and-emissions/waste-to-energy
Anaheim, California. In 2007, the Anaheim City Council approved agreements between the Anaheim Public Utilities and a private landfill owner to obtain 25 MW of LFG-generated electricity capacity.	http://www.anaheim.net/utilities/news/article.asp?id = 824
Antioch, Illinois. At 180 scfm, LFG is pumped from the adjacent H.O.D. Landfill (a former Superfund site) to 12 Capstone microturbines to provide heat and power to the high school in Antioch, Illinois.	http://www.epa.gov/lmop/proj/prof/profile/antiochcommunityhighschoo.htm
BMW Manufacturing LFG. At its South Carolina assembly plant, BMW is using gas from Waste Management's Palmetto Landfill to fuel four gas turbine cogeneration units (4.8 MW capacity) and recover 72 million Btu per hour of hot water.	http://www.epa.gov/lmop/proj/prof/profile/bmwmanufacturinglandfillg.htm

Table 7.4.2 Landfill Methane Utilization: Examples and Information Resources	
Title/Description	**Web Site**
Buncombe County, North Carolina. This county landfill is providing LFG to the Metropolitan Sewerage District of Buncombe County in Woodfin, North Carolina.	http://www.epa.gov/lmop/proj/prof/profile/buncombecountysludgedryin.htm
Chester County, Pennsylvania. In this innovative direct use project, the Chester County Solid Waste Authority's Lanchester Landfill is the first in Pennsylvania to serve multiple customers. The 13 mile pipeline serves several industrial customers, including Dart Container Corporation, Advanced Food Products, and L&S Sweeteners.	http://www.epa.gov/lmop/proj/prof/profile/lanchesterlandfillgasener.htm
Dairyland Power. This electric cooperative in Wisconsin teamed up with Ameresco to implement a 3 MW LFGE project from the Veolia ES Seven Mile Creek Landfill 2. Due to the success of this project, Dairy land expects to add two more LFG projects, adding a total of 8 MW of renewable energy to its portfolio.	http://www.epa.gov/lmop/proj/prof/profile/dairylandlfgenergyproject.htm
DeKalb County, Georgia. Solid waste officials in this Georgia county developed a 3.2 MW project utilizing power generated from the nearby Seminole County landfill. This is the first green power project for Georgia Power.	http://www.epa.gov/lmop/proj/prof/profile/dekalbcountyandgeorgiapow.htm
East Kentucky Power Co-op Green Power Program. The Bavarian Landfill located in Boone County, Kentucky went from a passive LFG system to an active system producing 3.2 MW of power in 1 year. The East Kentucky Power Cooperative (EKPC) initiated, developed, and financed the project at a cost of $4 million, from which the cooperative expects a 10-year payback.	http://www.epa.gov/lmop/proj/prof/profile/eastkentuckypowercoopgree.htm
Elk River, Minnesota. An LFGE project at the Elk River landfill uses a 525 kW system to generate 310,000 kWh per month. The city is selling the electricity to the local municipal utility.	http://www.epa.gov/lmop/res/elk.htm
Fairfax County, Virginia. In this self-developed project, LFG from the I-95 landfill provides power to the nearby Norman Cole Wastewater Treatment Plant.	http://www.fairfaxcounty.gov/dpwes/trash/dispmethrvc.htm
Fargo, North Dakota. To help solve an odor problem, the city installed an LFG collection and flare system. Cargill, Inc., the landfill's neighbor that processes oilseed, recognized the energy potential and approached the city about using LFG in their boilers. The partners collaborated to develop a direct-use LFGE project, showing the success that can come from public-private collaboration.	http://www.epa.gov/lmop/proj/prof/profile/cityoffargoandcargilllfge.htm
Jackson County, North Carolina. Jackson County has created an energy park that includes a biodiesel refinery, three professional blacksmith studios, and a series of greenhouses – all of which use LFG from the county landfill as a fuel.	http://www.epa.gov/lmop/proj/prof/profile/jacksoncountyncgreenenerg.htm

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Jefferson Parish, Louisiana. The Jefferson Parish Landfill provides 1,820 scfm LFG to Cytec Industries, a nearby chemical company. The LFG is provided via a 4.2 mile pipeline, which connects the landfill to the company's facility.	http://www.epa.gov/lmop/proj/prof/profile/jeffersonparishandcytecin.htm
Johnson City, Tennessee. An LFGE project at the 3.5 million-ton MSW landfill in Johnson City collects 1,500 scfm and distributes high Btu LFG to be used as fuel for a boiler and reciprocating engine, providing steam, power, and chilled water to a veterans administration hospital, several university buildings, and a local civic center.	http://www.epa.gov/lmop/proj/prof/profile/irisglenlandfillgasenergy.htm http://www.epa.gov/lmop/conf/11th/bollinger.pdf
Little Rock, Arkansas. Little Rock partnered with an ESCO to have an LFGE project installed at the city's landfill. The ESCO helped the city negotiate a purchase agreement with a local manufacturer for a specified quantity of LFG.	http://www.johnsoncontrols.com/publish/etc/medialib/jci/be/case_studies.Par.55152.File.dat/City%20of%20Little%20Rock%20PP.pdf
Orange County, Florida. The Orange County Solid Waste Department worked with several contractors to develop an LFGE project in 1998 at the county landfill. The county has entered into a 20-year contract through which a private company will own and operate the facility. The county earned $5 million in the sale of the LFGE project, and receives $400,000 annually for the rights to the LFG.	http://www.epa.gov/lmop/res/orange.htm
Palo Alto, California. Palo Alto, in an effort to secure larger quantities of green power for its own facilities and for its residents, worked with the local utility to have a third-party develop a 3.2 MW LFGE project at one of its landfills. The regional Water Quality Control plant uses a portion of the captured LFG to process wastewater, saving $250,000 annually on energy costs compared to purchasing the energy from the grid.	http://www.epa.gov/lmop/proj/prof/profile/alamedapowertelecomandpal.htm
Prince George's County, Maryland. The NASA Goddard Space Flight Center became the first federal facility to burn LFG to meet energy needs. LFG provides 100% of the facility's heating 95% of the time. The project includes a 5.5-mile pipeline that provides 1,480 scfm LFG from the Prince George's County, Maryland-owned Sandy Hill Landfill to NASA.	http://www.epa.gov/lmop/proj/prof/profile/nasagoddardspaceflightcen.htm
Prince George's County, Maryland. The Brown Station Road Landfill in Maryland has been sending LFG to the nearby Prince George's County Correctional Facility to generate steam and electricity. The county also sells green power to the local utility for sale on the grid.	http://www.epa.gov/lmop/proj/prof/profile/brownstationroadonsiteele.htm
Riverview, Michigan. The Riverview Energy Systems partnership developed an LFGE project at the Riverview Landfill in 1987. The city receives a percentage of the revenue that the LFGE earns from selling LFG to the local utility.	http://www.epa.gov/lmop/res/riverview.htm

Table 7.4.2 Landfill Methane Utilization: Examples and Information Resources	
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Wayne Township – Jersey Shore Steel. In this direct use partnership, the Clinton County Solid Waste Authority in Pennsylvania provides 970 scfm LFG to the Jersey Shore Steel Company to use as fuel in their furnace to reclaim railroad steel. This project has been a new source of revenue for the Authority.	http://www.epa.gov/lmop/proj/prof/profile/waynetownshiplandfillgase.htm
Wichita, Kansas. The Abengoa Bioenergy Corporation is using LFG from a Wichita landfill to fuel a boiler to produce ethanol.	http://www.epa.gov/lmop/proj/prof/profile/abengoabioenergycorporati.htm
Yancey County, North Carolina. The EnergyXchangechange Renewable Energy Center is a community-based organization in North Carolina established to demonstrate the responsible use of LFG as an energy source, serve artisans, and meet local energy needs. The six-acre landfill provides 37.5 scfm LFG to power nearby glass blowing furnaces, a greenhouse, and pottery kiln.	http://www.epa.gov/lmop/proj/prof/profile/EnergyXchangechangerenewableene.htm
Zeeland Farm Soya. Zeeland Farm Soya, a soybean processing facility based in Michigan, receives LFG from Autumn Hills Recycling and Disposal Facility.	http://www.epa.gov/lmop/proj/prof/profile/zeelandfarmsoyalfgenergyb.htm
Information Resources on Landfill Methane Utilization	
Adapting Boilers to Utilize Landfill Gas: An Environmentally and Economically Beneficial Opportunity. Using LFG in a boiler to create power is a common practice that requires minor technical adjustments to the boiler. This fact sheet details the retrofits needed to enable a boiler to operate efficiently using LFG.	http://www.epa.gov/lmop/res/pdf/boilers.pdf
Community Outreach. LMOP provides a brochure on how to engage the community in LFGE projects.	http://www.epa.gov/lmop/res/pdf/new_community_brochure.pdf
Feasibility of Implementing LFGE. This feasibility study was conducted for the town of Barnstable, Massachusetts. The town was evaluating the potential for an LFGE project to supply electricity to two schools and a Public Works Department facility.	http://www.masstech.org/Project%20Deliverables/GB_Barnstable_DPW_Final_Report.pdf
Follow the Steps to Landfill Gas Energy Project Development. This pamphlet describes a step-by-step guide to developing LFGE projects developed by the LMOP.	http://www.epa.gov/lmop/res/pdf/followthesteps3.pdf
Funding LFGE Projects: State, Federal, and Foundation Resources. This funding guide offers detailed information on innovative state, federal, and foundation funding resources available for LFG energy projects.	http://www.epa.gov/lmop/res/guide/index.htm
Garbage In, Energy Out – Landfill Gas Opportunities for CHP Projects. This article provides an overview of the benefits of and potential for using LFG in CHP applications.	http://www.cospp.com/display_article/307885/122/CRTIS/none/none/Garbage-in,-energy-out---landfill-gas-opportunities-for-CHP-projects/

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Jackson County Green Energy Park. This presentation provides an overview of the Jackson County, North Carolina Green Energy Park objectives and progress.	http://www.epa.gov/lmop/conf/10th/Muth.pdf
Landfill Gas as a Fuel for Combined Heat and Power. This article provides information on how LFGE projects can be used in CHP applications.	http://www.aeecenter.org/DivisionNewsletters/EEMI/Spring2007/landfill.htm
Landfill Gas Data. The Energy Information Administration tracks data on LFG production and usage in the United States.	http://www.eia.doe.gov/cneaf/solar.renewables/page/landfillgas/landfillgas.html
Landfill Gas to Energy. This brochure outlines the link between LFGE and sustainable environmental development.	http://www.epa.gov/lmop/docs/LMOPGeneral.pdf
Landfill Gas to Fuel. This Southern Legislative Conference paper provides an overview LFG activities in southern states, including existing projects and state financial and technical assistance.	http://www.csg.org/pubs/Documents/0801-Landfill_Gas_to_Fuel.pdf
Landfill Gas Trends in the United States. This article discusses evolving trends in LFG uses in the United States. The article provides information on market drivers that are motivating interest in LFGE projects.	http://www.jgpress.com/archives/_free/001417.html
Landfill Macroeconomics: Taking the Big Picture. This article describes recent trends in MSW disposal that have seen a decline in growth. The article examines the consequences of this slowing growth in MSW disposal for solid waste management.	http://www.mswmanagement.com/november-december-2006/landfill-macroeconomics-taking.aspx [
Landfill Methane and Clean Air Act Opportunities: Incentives from the Acid Rain Program. This brief document describes how incentives in the CAA can further enhance the cost-effectiveness of LFG projects.	http://www.epa.gov/lmop/res/pdf/lm_clean_air_act.pdf [
Landfill Methane Emissions Offsets. This CCX fact sheet provides information on how LFGE projects can produce financial benefits through voluntary emissions trading markets.	http://www.chicagoclimatex.com/news/publications/pdf/CCX_Landfill_Methane_Offsets.pdf
Landfill Methane Recovery and Use Opportunities. This fact sheet provides information on opportunities for LFGE projects to participate in the Methane to Markets partnership.	http://www.methanetomarkets.org/resources/factsheets/landfill_eng.pdf
Landfuel: Trends Driving the U.S. Landfill Gas Energy Industry. This article describes trends in LFG capture and use and highlights state and federal initiatives that promote continued development of LFGE project technologies.	http://www.waste-management-world.com/display_article/271247/123/ARCHI/none/none/Landfuel:-Trends-driving-the-US-landfill-gas-energy-industry/
LMOP LFGE Energy Project Profiles. The LMOP has collected information on a number of LFGE projects.	http://www.epa.gov/lmop/proj/prof/index.htm

Table 7.4.2 Landfill Methane Utilization: Examples and Information Resources	
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LMOP Online Toolkit. This toolkit includes tips on communicating the benefits of LFG energy projects and promoting LMOP participation for states and local governments.	http://www.epa.gov/lmop/toolkit
LMOP Partners and Endorsers. EPA's LMOP program provides information about its partners and endorsers.	http://www.epa.gov/lmop/part/index.htm
LMOP Publications. Many LMOP publications from fact sheets to software are available on LMOP's Documents, Tools, and Resources page.	http://www.epa.gov/lmop/res/index.htm
Map of Current Energy Projects and Candidate Landfills. This map is a good indicator of the successful use of LFG as an energy resource and the historical and potential growth of LFG projects in the United States.	http://www.epa.gov/lmop/docs/map.pdf
An Overview of Landfill Gas Energy in the United States. This LMOP presentation provides information on the deployment of LFGE projects around the country, as well as the benefits of LFGE in general.	http://www.epa.gov/lmop/docs/overview.pdf
Renewable Energy and Your Community: Landfill Gas-to-Energy. This paper was developed by the Massachusetts Technology Collaborative to provide an overview of community opportunities to employ LFGE projects.	http://www.mtpc.org/Project%20Deliverables/GP_CP_Berkshire_FinalLandfill.pdf
Solid Waste Disposal Trends. This article provides an overview of trends in solid waste disposal, including LFG recovery projects.	http://wasteage.com/mag/waste_solid_waste_disposal/
State LFG Primers. These primers, currently available for 12 states, explain state and federal environmental permitting processes, policies, and financial incentive programs for LFG energy projects.	http://www.epa.gov/lmop/res/primers.htm
State Partner Program Guide. This guide provides detailed information about the roles and responsibilities of state partners and the support provided by LMOP.	http://www.epa.gov/lmop/docs/state_partners.pdf
Trash to Treasure: Landfills as an Energy Resource. This article describes LFGE uses and market drivers and provides several project examples.	http://www.epa.gov/lmop/docs/3q06landfill.pdf
Turning a Liability into an Asset: A Landfill Gas to Energy Project Development Handbook. This step-by-step handbook describes the major aspects of LFG project development, including economic analysis, financing, choosing project partners, environmental permitting, and contracting for services.	http://www.epa.gov/lmop/res/index.htm (follow link to Project Development Handbook)
Tools for Landfill Methane Utilization	
LFGcost-Web – Landfill Gas Energy Cost Model. This tool can be used to evaluate the economic feasibility of an LFGE project.	http://www.epa.gov/lmop/res/index.htm#5

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LFGE Benefits Calculator. This LMOP tool can be used to estimate GHG emission reductions from LFGE projects.	http://www.epa.gov/lmop/res/calc.htm
Landfill Gas Emissions Model. This model helps estimate emissions rates from MSW landfills and can be used to estimate total LFG and CH_4 generation from a project.	http://www.epa.gov/ttn/catc/products.html#software
LMOP Interactive Conversion Tool. This tool can be used to convert LFG-related statistics (e.g., cubic feet per minute to standard cubic feet per day), and to estimate LFGE potential from an MSW landfill.	http://www.epa.gov/lmop/res/converter.htm

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