

PAINTING PROJECTS GREEN

LANDFILLS EXPAND ENERGY OUTPUT

HIGH fossil fuel prices and growing concern about global climate change are creating favorable conditions for landfill gas energy (LFGE) projects. Notably, endorsement of LFGE by Federal agencies and many states as a form of “green” power has enabled LFGE developers to earn premiums for electricity marketed through green power programs, and to benefit from expanded federal tax credits for renewable energy production. Because LFGE kills two birds with one stone — providing an alternative energy source at stable prices and reducing emissions of methane, a potent global warming gas — prospects are good for continued investment in conventional projects and for stepped-up R&D of advanced technologies.

Landfill gas, however, is not universally accepted as renewable. Critics argue that landfills are not sustainable because of their environmental and public health impacts, including air emissions, odors and potential groundwater contamination. Accordingly, they oppose providing incentives for LFGE projects that will improve landfills’ operating economics, which in turn could reduce tipping fees and undercut support for source reduction and recycling. Recently this debate has centered on bioreactor landfill technology, which composting supporters argue may reduce diversion of organic residuals from waste streams (see “Bioreactors and EPA Proposal To Deregulate Landfills,” January 2003, and “Composting and Organics Recycling Vs. Bioreactors: Another Perspective,” May 2003.) And because LFGE produces electricity at lower costs than other renewable fuels such as wind, some renewable energy advocates warn that investments in LFGE may slow the development of cleaner power sources.

Notwithstanding these concerns, many environmentalists support including LFG in green power offerings and renewable portfolio standards (for an overview of these measures, see “Renewable Energy Markets,” De-

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ember 2004, and “State Incentives for Biomass Electricity,” January 2005). Because of its typically lower costs, LFGE projects help to make green energy affordable. For example, the U.S. Environmental Protection Agency (EPA) is buying renewable energy credits (RECs) for its Washington, DC headquarters generated from a mix of 75 percent LFG and 25 percent wind power, which EPA chose because LFG electricity in the mid-Atlantic was cheaper than wind power, so the agency could get more RECs for its money.

In addition to offering affordable green power, burning LFG greatly reduces its toxicity and its contribution to global climate change (combustion converts the methane in LFG to carbon dioxide, which is 21 times less potent as a greenhouse gas), and electric power from LFGE projects often displaces power from fossil fuel-fired plants, reducing local air pollution. For advocates, the issue is not whether to use LFG for energy, but how to do so in a way that maximizes its environmental benefits at reasonable costs.

SCOPE OF LFGE PROJECTS

According to EPA’s Landfill Methane Outreach Program (LMOP), there were 381 operational LFGE projects in the United States as of mid-2005, and more than 600 additional landfills were good candidates for energy development. LFGE projects generate about 9 billion kilowatt-hours of electricity annually, plus roughly 200 million cubic feet per day of LFG for direct use in boilers and other facilities. Current projects are concentrated on the East Coast and in the industrial Midwest and California, while major potential exists in all of these regions and in the Southeast (see Table 1).

EPA touts LFG electricity as a “baseload renewable” for many green power programs, citing estimated levelized generating costs of \$45.67 per megawatt-hour for LFG compared to \$48.45 for wind, \$54.34 for geothermal energy, and \$140.71 for solar photovoltaic systems. As the agency notes, these

Table 1. Top states for LFGE development

Current Projects	Candidate Landfills
California (73)	California (46)
Illinois (36)	North Carolina (35)
Michigan (26)	Ohio (28)
Pennsylvania (22)	Illinois (25)
Wisconsin (18)	New York (23)
Ohio (18)	Alabama (22)
Texas (18)	South Carolina (22)
Massachusetts (17)	Pennsylvania (20)
New York (16)	Missouri (20)
Virginia (15)	Kentucky (18)
Indiana (15)	Florida (18)
	Georgia (18)

Source: EPA Landfill Methane Outreach Program

projects offer reliable power because LFG is generated around the clock, in contrast to intermittent energy sources like wind and solar power. EPA also spotlights other energy applications for LFG, including direct use in boilers, heating/cooling systems and greenhouses; combined heat and power generation; and conversion to alternate fuels such as methanol, compressed natural gas, and liquefied natural gas.

Electricity generation has traditionally accounted for about 65 percent of LFGE projects, according to LMOP program director Rachel Goldstein. These installations are concentrated in states where LFG is an eligible fuel under renewable portfolio standard requirements and generators can earn renewable energy credits. “But now, with the rising cost of natural gas, we are seeing increasing interest in direct use projects, especially at commercial and industrial facilities,” says Goldstein. “Some manufacturers are siting new facilities near landfills so they can use the gas for kilns or boilers.” Newer processes, such as using LFG for direct input into high-BTU pipelines, or converting it into alternative fuels, are beginning to attract attention as well (see “Advanced LFG Applications,” below).

MARKETING LFGE AS GREEN POWER

LFG qualifies as a renewable fuel in nearly all of the 27 states that have adopted some form of renewable portfolio standard (RPS) requiring power providers to generate a specified percentage of electricity from renewable fuels. Largely as a result of these measures, electricity from LFG is included in many green power offerings from regulated utilities and competitive power providers. Utility green pricing options and retail green power products that include landfill gas are currently offered in 30 states at price premiums ranging from 0.5 cents to 5 cents per kilowatt-hour above conventional power prices. Premiums for green power offerings derived solely from LFG average approximately 2 to 3 cents per kilowatt-hour.

LFGE projects also have benefited from several federal incentives. The Renewable Energy Production Incentive (REPI), passed

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as part of the Energy Policy Act of 1992, provided payments of up to 1.5 cents per kilowatt-hour (adjusted for inflation) to municipally- or cooperatively-owned landfills for the first ten years of operation. LFG facilities were a second-level priority under this program, which ended in 2003 and is generally viewed as having had a modest impact of LFGE development.

In contrast, many early projects were supported by the Section 29 tax credit, enacted to encourage energy production from non-conventional sources, which provided approximately \$1.10 per million Btu to LFG producers for both electricity and direct-use projects. Section 29 credits apply only to facilities placed in service by mid-1998, and the program is scheduled to sunset in 2007. More recently, in 2004 Congress broadened the existing Section 45 production tax credit for renewable energy to cover new fuels, including LFG. LFGE facilities placed in service by 2006 are eligible for a credit of 0.9 cents per kilowatt-hour for five years of operation.

Language in the Senate version of the pending energy bill would extend the Section 45 credit period to 10 years for projects placed in service by 2009. Testifying in May 2005 before the House Ways and Means Committee on behalf of DTE Biomass Energy, Inc. and the Solid Waste Association of North America, DTE president Curtis Ranger stated that an extension was essential to stimulate new LFGE development because these projects typically have long design, permitting and construction timelines. Ranger estimated that a three-year construction deadline extension would pro-



Methane from the Sandy Hill Landfill in Bowie, Maryland had been burned off in a flare until NASA officials at the Goddard Space Flight Center built an on-site purification plant. Wells (above) now draw methane out of the landfill, moving it to the processing plant (lower right) for renewable power generation.



vide enough lead time to build up to 150 new LFGE projects.

Many large organizations, including Honeywell, Owens Corning, Interface, General Motors, and NASA, have invested in LFGE through direct project development or green power purchases. Corporate investors see LFGE as an attractive source for several reasons according to Craig Hanson, project manager of the Green Power Market Development Group, a partnership between the World Resources Institute and 12 large commercial and industrial firms dedicated to building corporate markets for green power. The group has implemented or contracted for 62 megawatts of new green power projects and purchases since October 2003, including 21 megawatts from LFG.

“Landfill gas is cheaper than natural gas, especially at current prices, so by buying LFG for on-site direct use, businesses are hedging against future energy costs,” says Hanson. “And companies that have pledged to reduce their greenhouse gas emissions can substitute landfill gas for coal or natural gas that they would burn otherwise.” (Landfill gas is considered a carbon-neutral fuel, since combustion releases carbon that was recently sequestered by its organic source materials.) One project participant, carpet manufacturer Interface, has contracted with the city of LaGrange, Georgia to collect LFG at an uncapped landfill and pipe it 10 miles to Interface’s Kyle plant for direct use. This project will generate a double climate change benefit, first by collecting LFG that was not formerly controlled and then by using it to displace fossil fuel.

For power providers, considerations in favor of generating electricity from LFG include low cost and 24-hour availability, ac-

ording to Mike deAngelis, manager of the Sacramento Municipal Utility District’s advanced renewables and distributed technologies program. SMUD has more low-cost renewable options than many utilities, including wind, geothermal power, and small hydropower, but each of these fuels comes with associated challenges such as intermittency and transmission access. “We want diversity of renewable sources, and there are issues with every renewable technology,” says DeAngelis. Like many utilities, SMUD buys LFG electricity from the project operator and receives associated renewable energy credits (RECs) as a contract requirement. “If we don’t get the RECs, then it’s a brown source of energy and there’s no point in doing it,” notes DeAngelis.

ENVIRONMENTAL CONCERNS

Several organizations have warned that LFGE subsidies could make landfills more profitable at the expense of source separation and recycling programs. A 2003 Natural Resources Defense Council report, *Is Landfill Gas Green Energy?*, identified several factors that made LFGE projects more or less likely to succeed, including landfill size, quantity of waste in place, the presence or absence of a gas recovery system, access to municipal financing, and the possibility of displacing electricity purchases through on-site use of LFGE power.

The report found that on balance, using LFG for energy projects provided net environmental benefits over flaring in most cases. It recommended requiring LFG collection systems at all landfills that accepted organics; mandating LFGE projects at most landfills; and targeting subsidies to smaller landfills not currently required to collect LFG, as well as closed landfills and new LFGE projects. Other organizations, such as the Grassroots Recycling Network, advocate mandating energy recovery without providing subsidies.

NRDC senior policy analyst Nathanael Greene, a coauthor of the 2003 report, acknowledges that it has proved hard to fine-tune LFGE incentives to this degree. “These instruments are relatively blunt, and there is just not an appreciation of the potential long-term impacts associated with the incentives that these policies are putting on the ground. They’re broadly pointing in the right direction, and that’s good enough to a large extent for most of the environmental community, but the nuances get lost in the weeds.” Both the NRDC study and a 2001 analysis produced by Earth Track, Inc. for the National Recycling Coalition predicted that state RPS requirements were less likely than other programs to provide disproportionate subsidies to landfills, because RPS standards require LFGE projects to compete against other forms of renewable energy for market share and because a significant share of renewable energy premiums typically went to middlemen rather than to generators.

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ADVANCED LFG APPLICATIONS

While the most thermally efficient and cost-effective use for LFG is as a medium-Btu fuel (about 550 Btu per standard cubic foot) for direct use or electricity generation, dramatic increases in U.S. natural gas prices in the past several years have spurred interest in a number of emerging technologies with the potential to make LFG projects cleaner and more efficient. Areas of growing interest include:

- Electricity generation using microturbines, fuel cells, and specialized engines, and
- Conversion of LFG to alternative fuels such as methanol, ethanol, liquefied natural gas (LNG), compressed natural gas (CNG), or a high-Btu pipeline-quality gas.

Alternative electricity generation technologies are of interest because they produce lower air emissions (especially nitrogen oxides and carbon monoxide) than standard reciprocating engines, which represent the vast majority of current and planned LFG electricity projects. LFG must be pretreated before use in fuel cells or microturbines to avoid fouling and corrosion, but NRDC's Nathanael Greene sees this as a benefit: "Any options where the gas is cleaned up before it's burned are interesting and potentially superior to direct use. Treating the pollutants through tailpipe controls is more expensive and harder than doing it at the front end."

Internal combustion engines have traditionally been used for LFG projects starting at about 800 kilowatts, but microturbines and fuel cells are feasible options for smaller landfills because they can be installed in clusters, and units can be removed as LFG production decreases. Additionally, both systems generate excess heat that can

At the HOD landfill in Antioch, Illinois, treatment equipment (right) removes moisture and siloxanes from landfill gas, then compresses it. Gas is then piped one-half mile to the Antioch High School campus where it is burned as fuel in 12 Capstone C30 biogas microturbines (far right) — meeting most energy requirements for the 262,000 sq ft facility.



be captured for cogeneration. For example, a system powered by 12 Capstone Micro-Turbines uses LFG from the HOD Landfill in Antioch, Illinois to provide power and recovered heat to Antioch High School in Antioch, from the HOD Landfill. There meeting most energy requirements for the 262,000-square foot facility.

Approximately a dozen microturbine LFG facilities are currently in operation. EPA has funded several LFG fuel cell demonstration projects, and the Braintree Electric Light Department in Massachusetts has operated a 200-kilowatt fuel cell on LFG since 1999. Other power generation technologies such as Stirling-Cycle engines (which use an external heat source to heat and cool a sealed amount of working gas) and Organic Rankine Cycle engines (which use an organic fluid in a closed cycle to convert thermal energy into mechanical energy) are at the demonstration stage for LFG use.

Converting LFG to alternative fuels allows energy producers to separate methane and carbon dioxide into two product lines. Once methane has been cleaned and processed, it can be sold as high-Btu pipeline gas (about 1,000 Btu per standard cubic foot), or converted into other fuels for transportation uses. Roughly eight high-Btu projects are currently operating at U.S. landfills, with more projects planned. Sites in California, Pennsylvania, Texas, and British Columbia are operating or developing projects to make CNG and LNG from landfill gas.

In one sign of growing interest in advanced LFG technologies, several landfills have become central components of energy and small business complexes, some of which use landfill gas for multiple applications. One such center, the Burlington County, New Jersey Resource Recovery Complex, uses LFG for power generation with Capstone MicroTurbines, as well as for greenhouse heating and LNG production, and plans to add a fuel cell and an anaerobic digester (see "Landfill Gives Birth To Ecoindustrial Complex," December 2004). Another example, the Energy XChange Center in Burnsville, North Carolina, uses LFG from the Yancey-Mitchell Landfill to heat a campus that includes greenhouses and pottery and glass-blowing

ORGANICS BYPASS THE LANDFILL IN CENTRAL OHIO

THE SOLID WASTE Authority of Central Ohio (SWACO), the city of Columbus and a well-known organics recycling firm, Kurtz Brothers from Cleveland, are launching a project to divert food waste, yard trimmings and other organics from the Franklin County landfill. Under the plan, Kurtz Brothers will construct an anaerobic digester on the ground of a harness track south of Columbus called Scioto Downs. Manure from the track would be diverted to the digester instead of sending it to the landfill. In addition, Columbus would send up to 25,000 tons of biosolids from its sewage treatment plant to the project. Restaurant fats, oils and grease along with

food residuals would also be shipped to the digester — an estimated 100,000 tons of food waste now sent each year to the Franklin County landfill.

"This would be a great savings to us and the taxpayers of Franklin County," says SWACO Executive Director Mike Long. This is another example of how we continue to follow the three-E's of Environment, Energy and Economic Development as we reduce our reliance on landfills."

SWACO would extend its tax exempt status to revenue bonds that help Kurtz Brothers finance the project. The project is expected to be up and running in about a year. More details on the project will be reported in coming issues of *BioCycle*.



studios (LFG also is burned in the clay kiln and glass furnaces).

In June 2005, ground was broken for an \$18 million Green Energy Center that will be powered by the Franklin County, Ohio Landfill, operated by the Solid Waste Authority of Central Ohio (SWACO). By the end of 2005, the project aims to generate electricity using LFG in a microturbine to power SWACO's Headquarters, Education building, and Fleet Garage. In Phase Two, LFG will be cleaned and converted into CNG to fuel SWACO vehicles, saving an estimated \$100,000 annually in fleet fuel costs. In the third phase, project partner FirmGreen Energy will build a processing plant next to the landfill to convert LFG to methanol. FirmGreen has already signed a 10-year agreement to provide up to 6 million gallons of methanol annually to Mitsubishi Gas Chemical Company. ■

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