

# *An Overview of Landfill Gas Energy in the United States*



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Landfill Methane Outreach Program (LMOP)  
U.S. Environmental Protection Agency  
CTI Solid Waste Technology Symposium  
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## ***Think You're Having a Bad Day...***





## Agenda

- What is LMOP?
- Status of LFGTE Industry
- Benefits of LFGTE Projects
- LFGTE Project Incentives
- Case Studies
- LMOP assistance



## ***Why EPA is Concerned About Landfill Gas***

- Methane is a potent heat-trapping gas
- Landfills are the largest human-made source of methane in the United States, accounting for 24% generated in 2005
- There are many cost-effective options for reducing methane emissions while generating energy
- Projects reduce local air pollution and create jobs, revenues, and cost savings



## ***EPA's Landfill Methane Outreach Program***

- Established in 1994
- Voluntary program that creates alliances among states, energy users/providers, the landfill gas industry, and communities

*Mission: To reduce methane emissions by lowering barriers and promoting the development of cost-effective and environmentally beneficial landfill gas energy (LFGE) projects.*



## ***State of the National LFGE Industry (July 07)***

- At least 427 operational projects in 42 states supplying:
  - 10 million megawatt hours of electricity and 75 billion cubic feet of LFG to direct-use applications in 2006
- Estimated **Annual Environmental Benefits**
  - Planting **~20,000,000 acres of forest**, or
  - Preventing the use of **~170,000,000 barrels of oil**, or
  - Removing emissions equivalent to **~14,000,000 vehicles**
- Estimated **Annual Energy Benefit**
  - Powering over **780,000 homes** and heating nearly **518,000 homes**

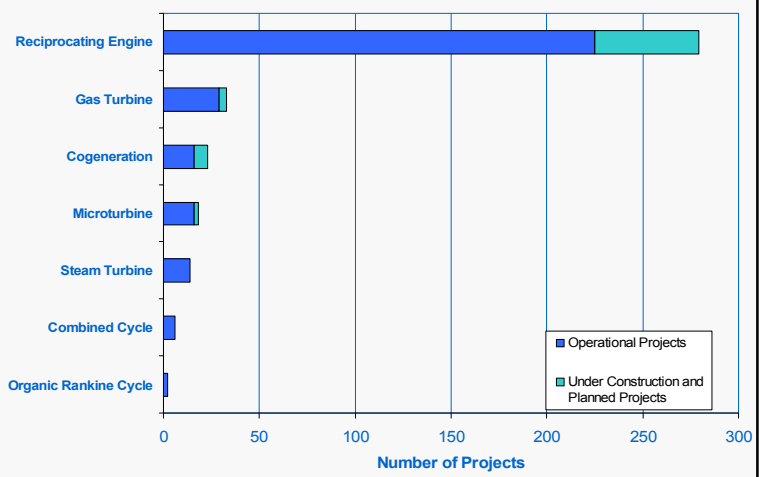


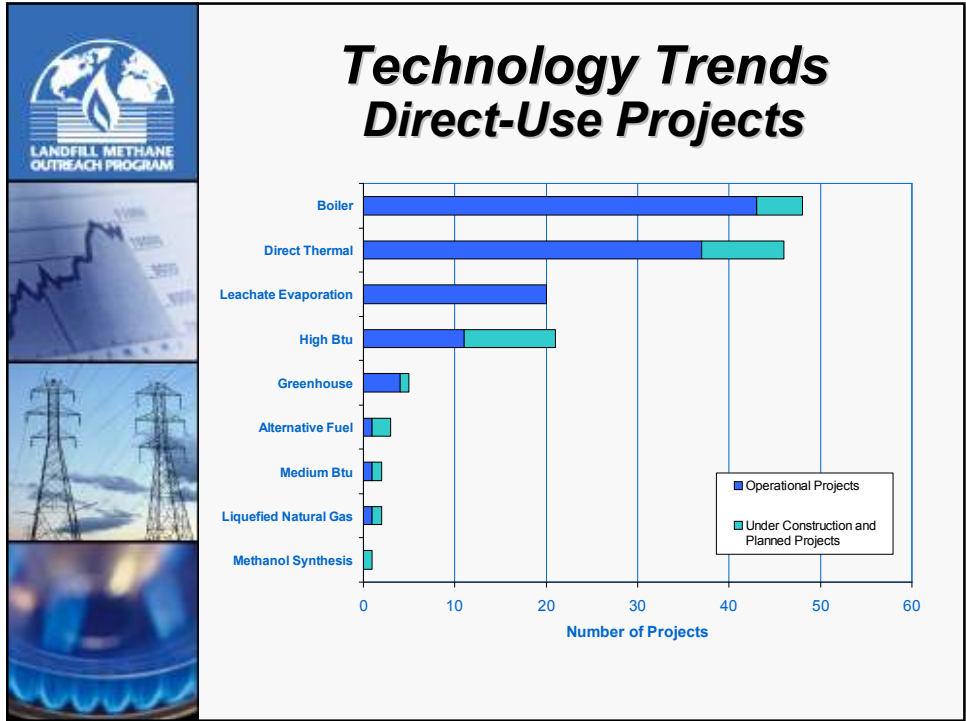


# Landfill Gas Energy Projects and Candidate Landfills



# Technology Trends Electricity Projects





**Diversity of Project Types  
Direct-Use of LFG**

- Direct-use projects are growing!
  - Boiler applications – replace natural gas, coal, fuel oil
  - Combined heat & power (CHP)
  - Direct thermal (dryers, kilns)
  - Natural gas pipeline injection
    - ◆ Medium & high Btu
  - Greenhouse
  - Leachate evaporation
  - Vehicle fuel (LNG, CNG)
  - Artist studio
  - Hydroponics
  - Aquaculture (fish farming)

**Greenhouse Burlington, NJ**

**Pottery Studio Sugar Grove, NC**

**LFG-fired Boiler Ft. Wayne, IN**



LANDFILL METHANE  
OUTREACH PROGRAM

## LFG Has Been Used to Help Produce...

<ul style="list-style-type: none"> <li>Aluminum</li> <li>Alternative fuels (biodiesel, CNG, ethanol, and LNG)</li> <li>Aquaculture (e.g., tilapia)</li> <li>Arts &amp; crafts (blacksmithing, ceramics, and glass)</li> <li>Biosolids (drying)</li> <li>Bricks and concrete</li> <li>Carpet</li> <li>Cars and trucks</li> <li>Chemicals</li> <li>Chocolate</li> <li>Consumer goods and containers</li> <li>Denim</li> <li>Electronics</li> </ul>	<ul style="list-style-type: none"> <li>Fiberglass, nylon, and paper</li> <li>Furthering space exploration</li> <li>Garden plants</li> <li>Green power</li> <li>Ice cream, milk, and tea</li> <li>Infrared heat</li> <li>Juice (apple, cranberry, and orange)</li> <li>Pharmaceuticals</li> <li>Pierogies and snack food</li> <li>Soy-based products</li> <li>Steel</li> <li>Tomatoes (hydroponic)</li> <li>Taxpayer savings and increased sustainability!</li> </ul>
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# LOOK WHO'S USING LANDFILL GAS!





































## ***LFGE in Michigan***

- Approximately 30 projects on-line
  - ~ 85 MW of generating capacity
  - ~ 5 million scf per day for direct-use projects
  - Environmental benefits equivalent to reducing oil use by ~1.1 million bbl per year
- 9 Candidate Landfills
  - ~8 million scf per day of potential LFG flow
  - Equivalent to heating 11,000 homes



## ***LFGE in Indiana***

- Approximately 17 projects on-line
  - ~ 42 MW of generating capacity
  - ~ 5 million scf per day for direct-use projects
  - Environmental benefits equivalent to reducing oil use by ~580,000 bbl per year
- 14 Candidate Landfills
  - ~ 19 million scf per day of potential LFG flow
  - Equivalent to heating 43,000 homes




## ***LFGE in Ohio***

- Approximately 17 projects on-line
  - ~ 37 MW of generating capacity
  - ~ 29 million scf per day for direct-use projects
  - Environmental benefits equivalent to reducing oil use by ~1 million bbl per year
- 22 Candidate Landfills
  - ~33 million scf per day of potential LFG flow
  - Equivalent to heating 74,000 homes



## ***LFGE in Pennsylvania***

- Approximately 24 projects on-line
  - ~ 84 MW of generating capacity
  - ~ 16 million scf per day for direct-use projects
  - Environmental benefits equivalent to reducing oil use by ~1.3 million bbl per year
- ~17 Candidate Landfills
  - ~25 million scf per day of potential LFG flow
  - Equivalent to heating 57,000 homes



## **Landfill Gas and Green Power A Winning Combination**

- Dual benefit → destroys methane and other organic compounds in LFG
- Offsets use of nonrenewable resources (coal, oil, gas) reducing emissions of
  - SO<sub>2</sub>, NO<sub>x</sub>, PM, and CO<sub>2</sub>
- LFGE is a recognized renewable energy resource
  - *Green-e*, EPA Green Power Partnership, 24 states, Sierra Club, NRDC
- LFG is generated 24/7 and projects have online reliability over 90%
- LFG can act as a long-term price and volatility hedge against fossil fuels



## **Benefits of LFGE Projects**

- Additional revenue stream for landfill owner/operators
- Creation of Jobs
- Expanded local economy
- Economic expansion/retention
- Positive public relations




## ***Potential Revenue Streams from LFGE Projects***

- Electric projects
  - Sale of electricity (4 - 6 cents/kWh)
  - Sale of Renewable Energy Credits (RECs)
    - ◆ Voluntary spot market ~ \$2.75/REC
    - ◆ Compliance market ~\$3.00 to \$57.00/REC
  - Premium pricing for renewable energy through RPS/RPG or voluntary green power markets
  - Tax credits & incentives
  - Clean Renewable Energy Bonds (CREBs)
- Direct-use projects
  - Sale of LFG
- Both
  - Greenhouse gas emissions trading
  - Energy cost savings




## ***LFGE Project Incentives***

- Renewable Portfolio Standards
- Renewable Energy Credits
- Sale of greenhouse gas offsets
- Tax credits
- Clean Renewable Energy Bonds



## **Renewable Energy Requirements**

- Renewable Portfolio Standard (RPS) – requires utilities to supply a percentage of power from renewable sources
  - 25 states plus District of Columbia have an RPS
- Renewable Portfolio Goal (RPG) – same as RPS but an objective not a requirement
  - 3 states have an RPG
- LFG is eligible as a renewable source in all RPS programs
- Pennsylvania has a RPS



## **Renewable Energy Credits**


- Renewable Energy Credits (RECs)
  - 1 REC = 1 MWh of renewable energy generation
- Consumers of RECs
  - Utilities – to meet RPS requirements
  - Companies - to reduce their environmental footprint
    - ◆ DuPont – 170 million kWh from biomass & LFG
    - ◆ Pitney Bowes – 10% of electricity from wind & LFG
    - ◆ Staples – 46 million kWh/year of RECs, 90% from biomass & LFG



## **Carbon and GHG Market Opportunities**




- Voluntary control of landfill gas (including beneficial use projects) can be a net supplier of greenhouse gas credits to various markets
- Chicago Climate Exchange (CCX) primary voluntary trading program in US
- Bilateral Markets (AgCert, BlueSource, EcoSecurities, Element Markets, Evolution Markets, GE/AES, Natsource, etc)
- Volume-weighted average price per tonne of CO<sub>2</sub>E in 2006 was \$4.10
  - *State of the Voluntary Carbon Markets 2007: Picking Up Steam. Ecosystem Marketplace – New Carbon Finance*
- Potentially significant source of income for small/mid-size LFGE projects



## **Federal Financial Incentives**

- Section 45 Tax Credit
  - Electricity generation ~ 1.0 cent/kWh
  - Placed in service by 12/31/08 (extended date?)
  - 5- or 10-year window for credits depending on placed-in-service date
- Clean Renewable Energy Bonds (CREBs)
  - National allocation of \$1.2 billion
  - Current issuance period of 1/1/07 to 12/31/08
  - In 2006, IRS granted issuance of 36 bonds for LFGE projects
- Renewable Energy Production Incentive (REPI)
  - Local/state government or non-profit electric co-op facilities
  - Online by 10/1/16
  - Payment for first 10 years of operation



## Incentives in MI, IN, OH, PA





- Check DSIRE Website for current incentive programs in your area

[www.dsireusa.org](http://www.dsireusa.org)




## Case Studies

- LFG Use for:
  - Alternate fuel production
  - Combined heat and power options
  - Multiple-use scenarios
  - Small-scale applications










## **Abengoa Bioenergy**

**Colwich, Kansas**





- Project started in September 1998
- DTE Biomass and LES Energy developed the project with City of Wichita and High Plains Corp.
- Approximately 4 mmscfd of landfill gas are collected, treated and compressed and then sent down a 11-mile pipeline to Abengoa plant
- Abengoa uses the gas to produce steam at its ethanol production plant
- Estimate offset 80% of natural gas needs
- Significant cost savings

## **CHP and Direct-Use Case Study BMW Manufacturing**





**Greer, SC**

*LMOP 2003  
Project of  
the Year*





*LMOP 2006  
Energy End User  
Partner of  
the Year*

- 9.5-mile pipeline from Palmetto Landfill to BMW
- 2003 – 4 KG2 gas turbines retrofitted to burn LFG
  - 4.8 MW of electricity generated and 72 million Btu/hr of heat recovered
- 2006 – Converted paint shop to utilize LFG in oven burners and for indirect heating
- LFG accounts for nearly 70% of BMW's energy needs
- BMW saves at least \$1 million/yr










### Direct-Use Case Study **Lanchester LF** Narvon, PA






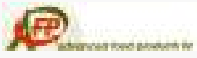


2005 LMOP  
Award Winner





- ✓ First LFGE project in PA to serve multiple customers – will eventually provide LFG to 4 direct end users
- ✓ Not regulated by PUC as a public utility!
- ✓ 13-mile pipeline through 75 easements and 35 road crossings





### Direct-Use Case Study **Lanchester LF** Narvon, PA (cont.)












- ✓ Public and Private Partnerships
- ✓ Granger Energy, Chester County Solid Waste Authority & PA DEP overcame economic & technical difficulties
- ✓ Three end users already using LFG in boilers, thermal oxidizers & ovens
- ✓ LFG fuels transport of itself – self-reliant project
- ✓ Estimated annual savings of \$300,000 in avoided electricity costs







*Direct-Use Case Study*  
**Jackson County Green Energy Park**  
 Sylva, NC

***Infrared Heaters***  
***Small Scale Applications***



- Used to heat storage and maintenance facilities
- Requires very little LFG to heat large spaces (10-20 cfm)
- 4 operational projects in the U.S.



## ***There Are Still Many Untapped LFG Resources***

- Currently ~560 candidate landfills with a total gas generation potential of 700 million cubic feet per day (~14,800 MMBtu/hr) OR electric potential of 1,370 MW (~11 million MWh/yr)
- If projects were developed at all these landfills, estimated
  - **Annual Environmental Benefit =**  
Planting ~16 million acres of forest OR removing the emissions from ~11 million vehicles on the road, and
  - **Annual Energy Benefit =**  
Powering 870,000 homes OR heating 1.5 million homes per year



## ***There Are Still Many Untapped LFG Resources (cont.)***

- ~490 landfills have a gas collection system but no energy project
  - Potential of 300,000 MMBtu/day or 1,000 MW
- ~100 landfills have an energy project and excess LFG available
  - Potential of 68,000 MMBtu/day or 240 MW
- ~1,000 landfills do not have a gas collection system
  - Potential of 240,000 MMBtu/day or 850 MW



## **LMOP Partner Tools and Services**

- Partnerships (over 620) and networking
- Newsletter and listserv
- Direct project assistance
  - Feasibility studies, end user searches
- Technical assistance resource
- LFG advocate
- PR/Ribbon cuttings



EPA Administrator Stephen Johnson  
 Jenkins Brick LFG Project Grand Opening  
 Moody, Alabama  
 October 2006

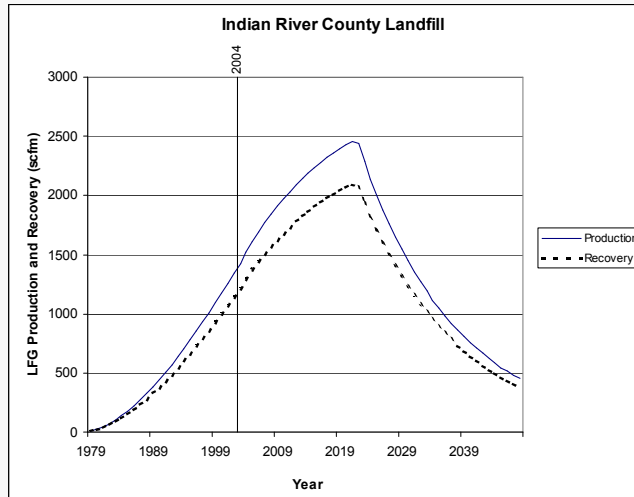


## **How Can We Work Together? Direct Project Assistance**

- Analyze landfill energy resources – gas modeling
- Identify potential matches – *LMOP Locator*
- Assess landfill and end user facilities
- Initial feasibility studies - *LFGcost*
  - Direct-use
  - Combined Heat & Power
  - Electric
- Identify applicable incentives



## Analyze Energy Potential from Landfill






## Identify Potential End-Use Opportunities





LANDFILL METHANE  
OUTREACH PROGRAM

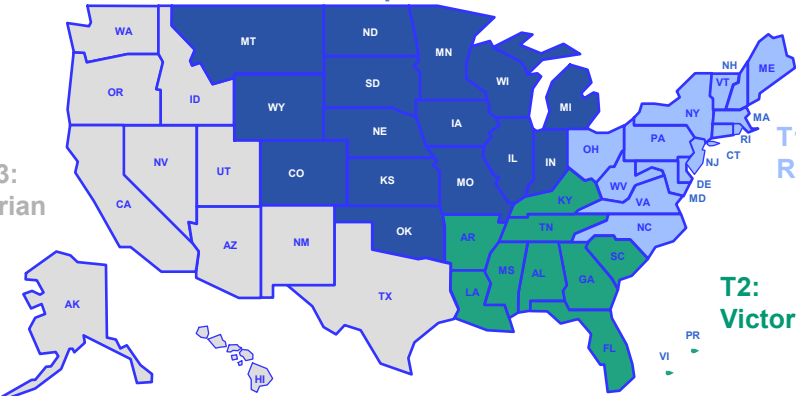
## Additional LMOP Tools and Services

- Project and Candidate Landfill Database
- Tracking of LFGE incentives and applicable programs
- State Workshops/Conferences
  - Working with State Partners & other key organizations
- Web Site (e.g., publications, software, database)
- **LMOP 11<sup>th</sup> Annual Conference, Project Expo & Partner Awards – January 9-10, 2008 in Washington, DC**

## For More Information

[www.epa.gov/lmop](http://www.epa.gov/lmop)

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