Encouraging the Recovery and Beneficial Use of Landfill Gas

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TCEQ Environmental Trade Fair and Conference

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Landfill Methane Outreach Program

U.S. Environmental Protection Agency

Agenda

- Introduction to LMOP
- Why LFGE Projects?
- LFG Applications
- Where are LFGE Projects?
- LFGE in Texas
- Barriers to Project Development
- How Can LMOP Help?

Landfill Methane Outreach Program (LMOP)

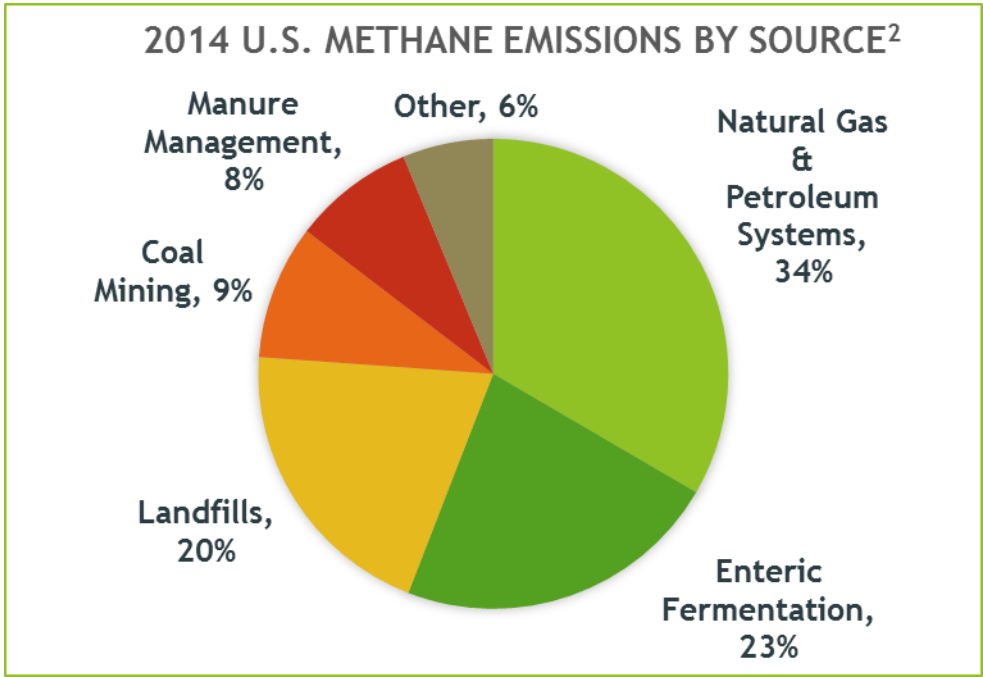
- Established in December 1994
- Voluntary program that creates partnerships among states, energy users/providers, the landfill gas (LFG) industry and communities

Mission: To work cooperatively with industry stakeholders and waste officials to reduce or avoid methane emissions from landfills by encouraging the recovery and beneficial use of biogas generated from organic municipal solid waste.

Why LFG Energy (LFGE) Projects?

Why the EPA is Concerned about Landfill Gas

- LFG is a by-product of the anaerobic decomposition of municipal solid waste (MSW)
- LFG contains about 50% methane, 50% CO_2, and a small amount of NMOCs
- Methane as a GHG is 28 to 36 times more effective than CO_2 at trapping heat in the atmosphere over a 100-year period[1]
- Landfills are the third largest human-made source of U.S. methane emissions, accounting for 20% of these emissions in 2014[2]



1. IPCC (2014). Fifth Assessment Report.
2. U.S. EPA (April 2016). Inventory of U.S. Greenhouse Gas Emissions and Sinks.

LFG Energy Benefits

Create local, renewable, and consistent energy

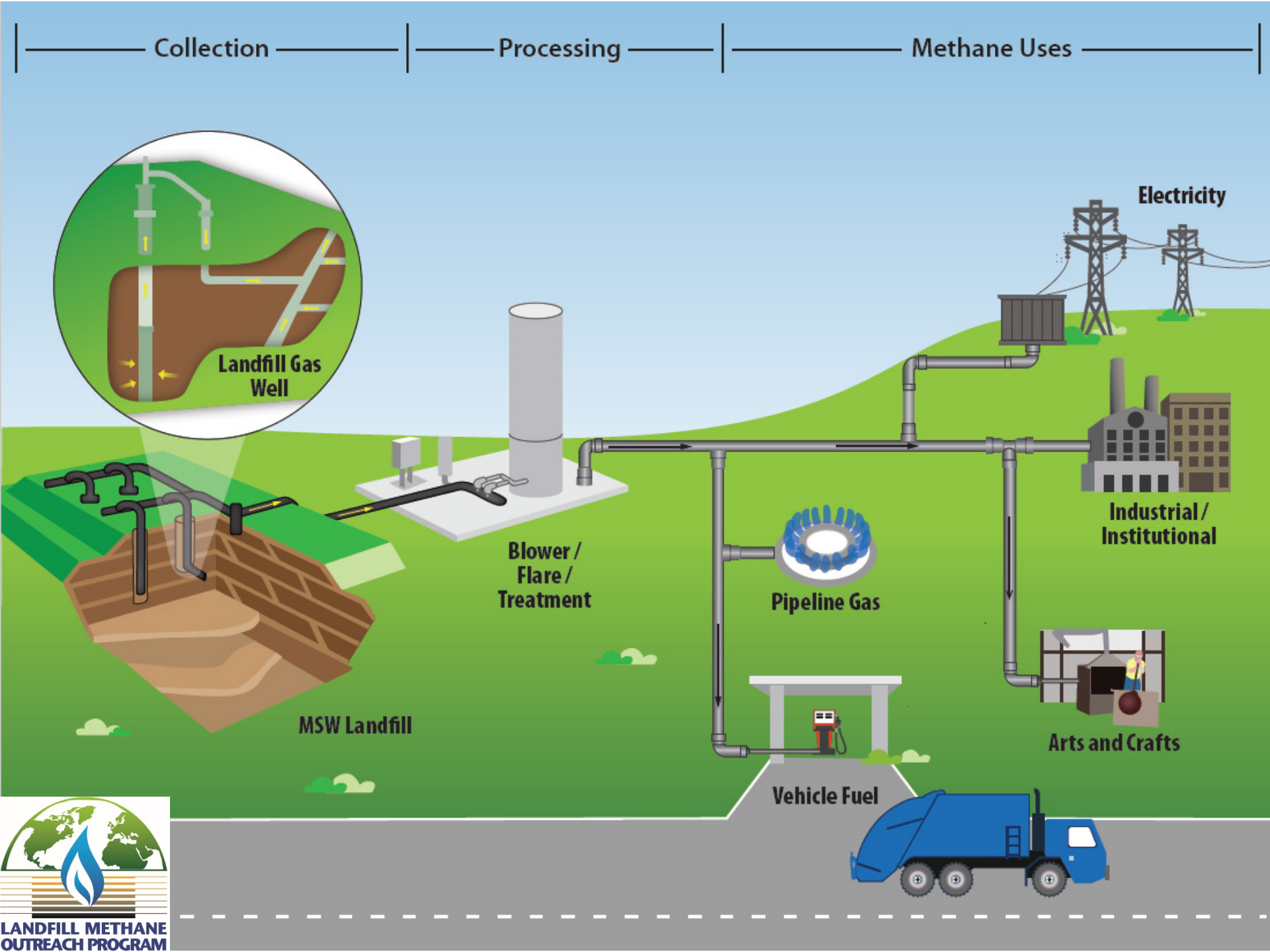
Generate revenue and jobs in the community

Reduce local air pollution and GHG emissions

$

Lead to health benefits

LFG Applications


Collection
Processing
Methane Uses
Landfill Gas Well
MSW Landfill
Blower / Flare / Treatment
Electricity
Industrial / Institutional
Pipeline Gas
Arts and Crafts
Vehicle Fuel
LANDFILL METHANE OUTREACH PROGRAM

Diversity of Project Types: Electricity Generation

Internal Combustion Engine (range from 100 kW to 3 MW)

Microturbine (range from 30 kW to 250 kW)

Gas Turbine (range from 800 kW to 10.5 MW)

Diversity of Project Types: Medium- & High-Btu

- Boiler applications – replace natural gas, coal, fuel oil
- Direct thermal (dryers, kilns)
- Greenhouse
- Infrared heaters
- Leachate evaporation
- Glassblowing, pottery, blacksmithing, hydroponics, aquaculture
- Ethanol production
- Natural gas pipeline injection
- Vehicle fuel (CNG, LNG)

Glassblowing
Jackson County, NC

Greenhouse
Jackson County, NC

Infrared Heater - Lorton, VA

Typical Electric Project: Costs & Benefits

- 3-MW, engine, 15-year project:
  - Total capital cost = ~$5.25 million
    - Excludes gas collection and flaring system costs
  - Annual operation & maintenance cost = ~$626,000/year
  - 6+ jobs
    - Additional during construction phase
  - $1.8 million direct economic benefits

[$2013 capital costs; O&M is the cost in the initial year of project operation (2014)]

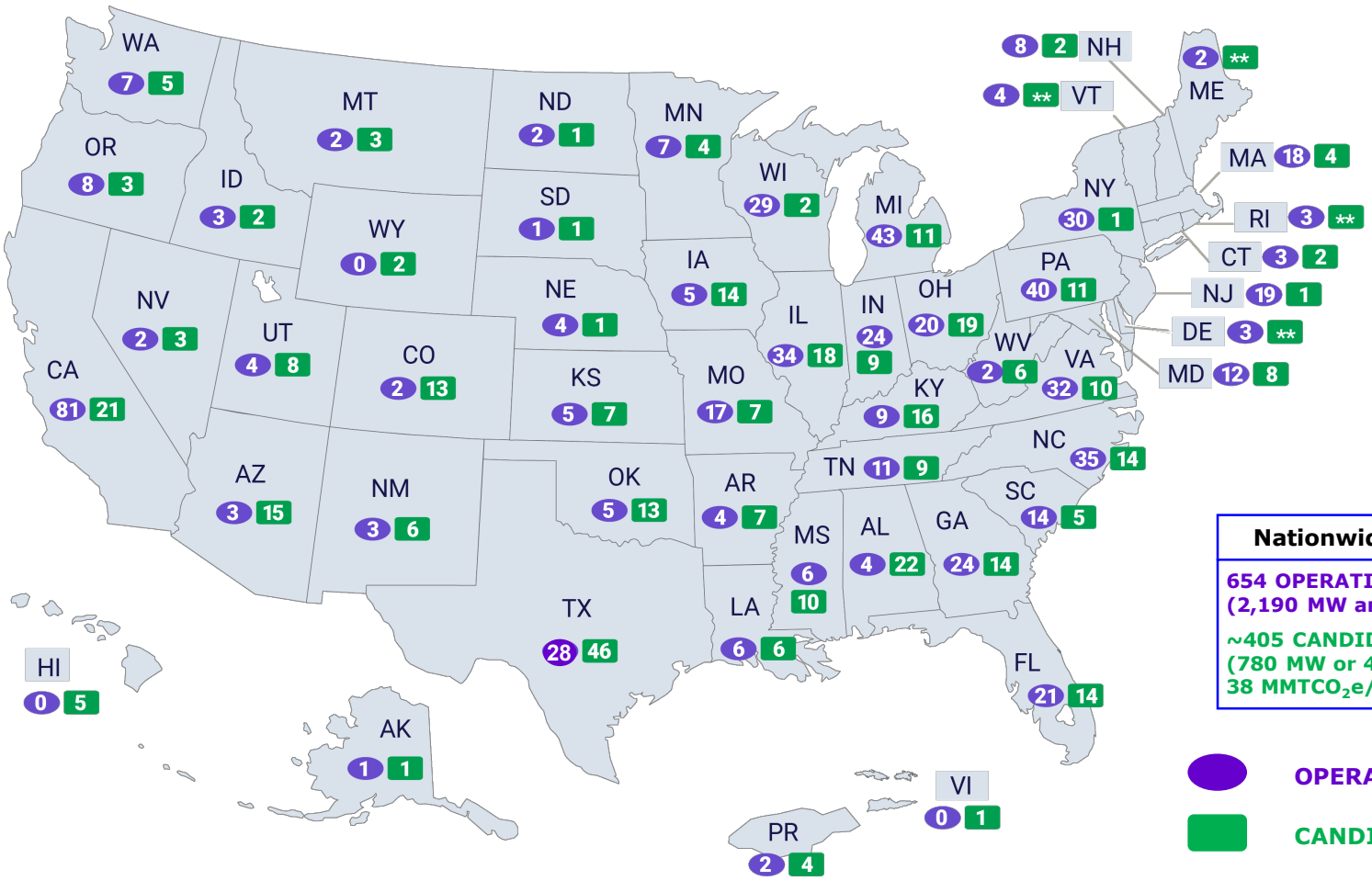
Typical Direct-Use Project: Costs & Benefits

- 1000-scfm, 5-mile pipeline, 15-year project:
  - Total capital cost = ~$3.5 million
    - Excludes gas collection and flaring system costs
  - Annual operation & maintenance cost = ~$144,000/year
  - 9.5+ jobs
    - Additional during construction phase
  - $1.3 million direct economic benefits

[$2013 capital costs; O&M is the cost in the initial year of project operation (2014)]

Where are LFGE Projects?

LFG Energy Project Development in the U.S.



Nationwide Summary

654 OPERATIONAL Projects (2,190 MW and 302 mmscfd)

~405 CANDIDATE Landfills (780 MW or 435 mmscfd, 38 MMTCO$_2$e/yr Potential)

OPERATIONAL PROJECTS

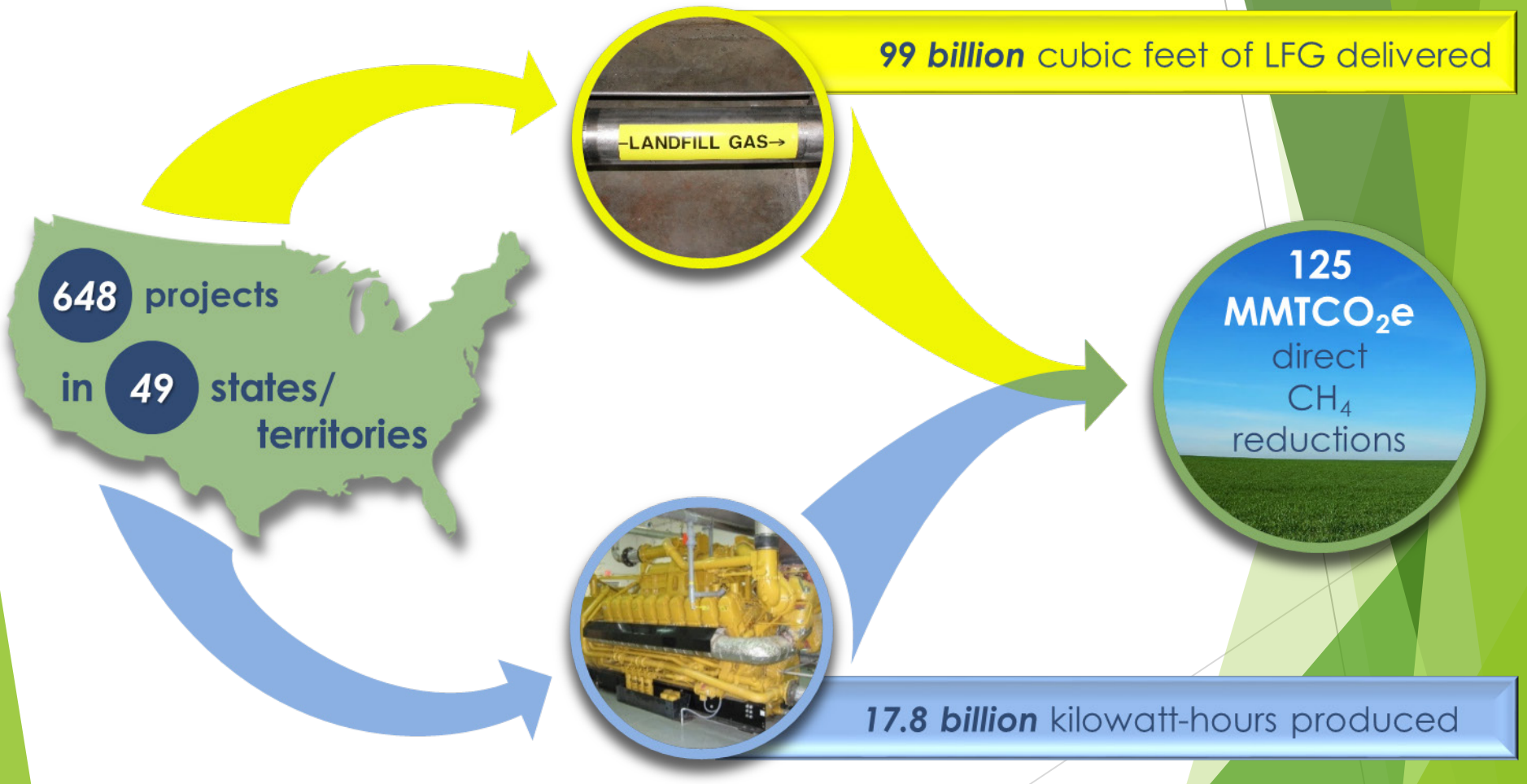
CANDIDATE LANDFILLS*

These data are from LMOP's database as of April 2017.

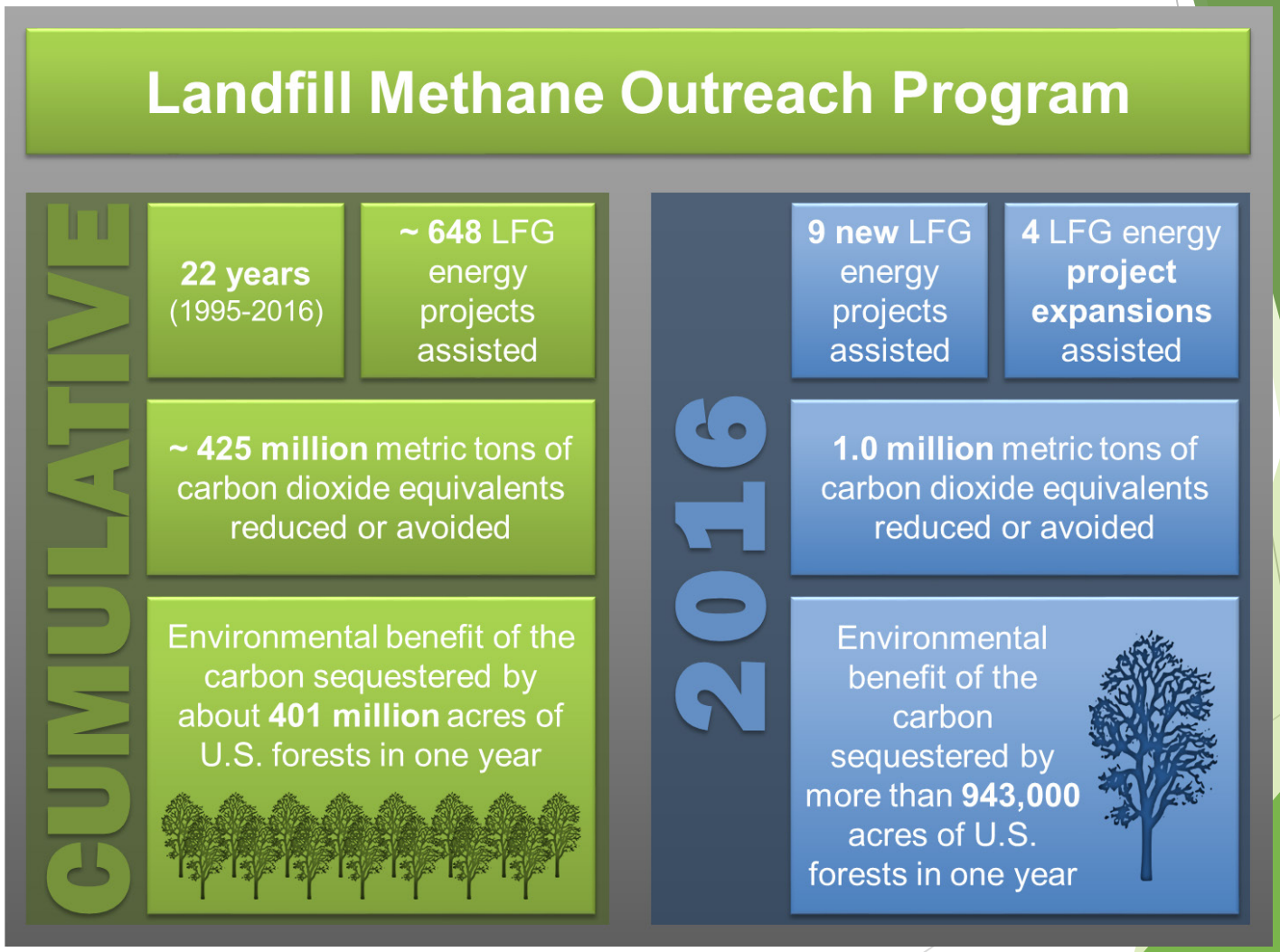
* Landfill is accepting waste or has been closed 5 years or less, has at least 1 mm tons of waste, and does not have an operational, under-construction, or planned project; can also be designated based on actual interest by the site.

** LMOP does not have any information on candidate landfills in this state.

Project Snapshot for 2016

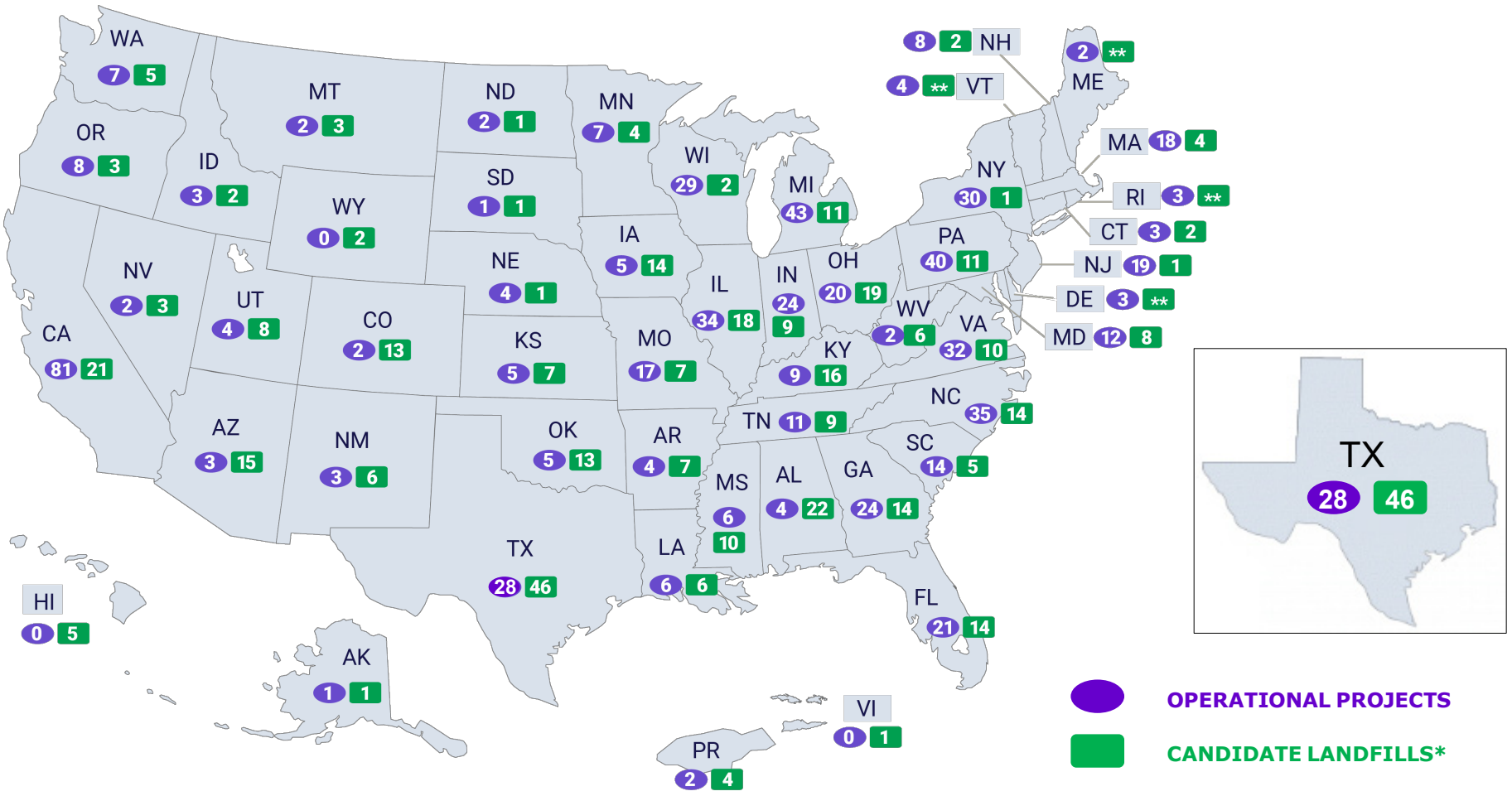


LMOP Accomplishments



LFGE Projects in Texas

LFG Energy Project Development in the U.S.



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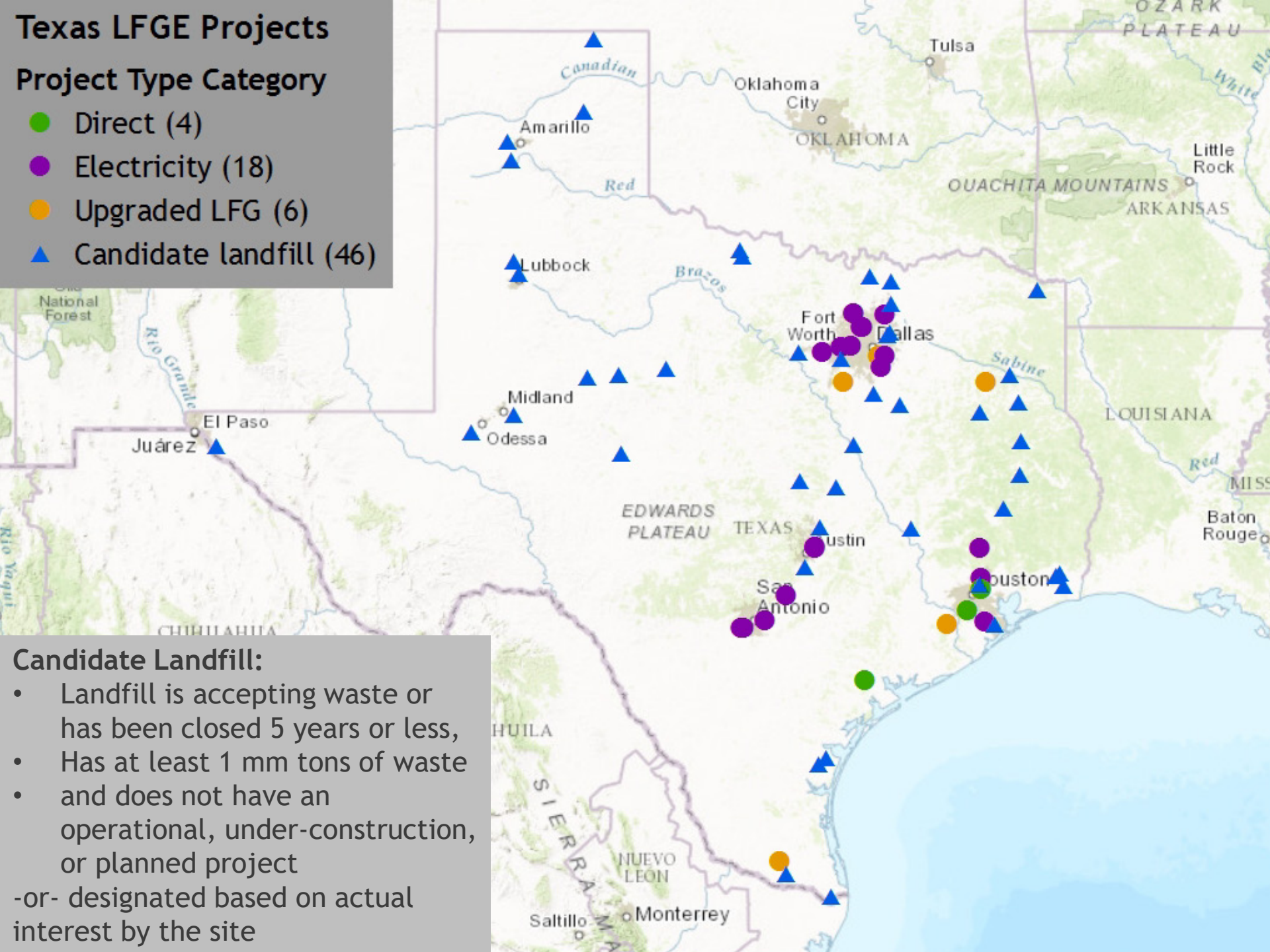
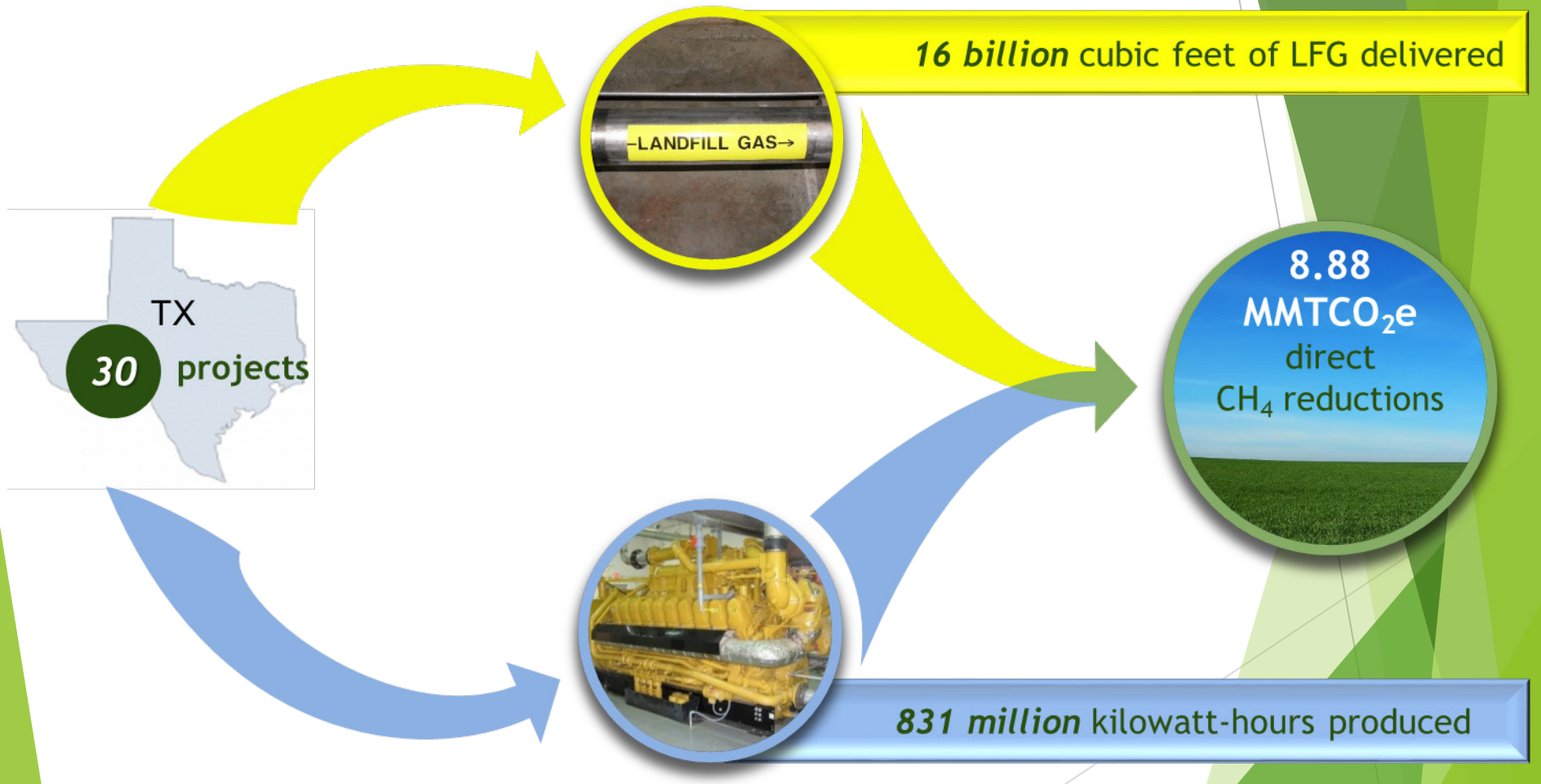

Texas LFGE Projects
Project Type Category
Direct (4)
Electricity (18)
Upgraded LFG (6)
Candidate landfill (46)
Candidate Landfill:
• Landfill is accepting waste or has been closed 5 years or less,
• Has at least 1 mm tons of waste
• and does not have an operational, under-construction, or planned project
-or- designated based on actual interest by the site
Tulsa
Oklahoma City
OKLAHOMA
Amarillo
Canadian
Red
Lubbock
Brazos
Fort Worth
Dallas
Midland
Odessa
El Paso
Juárez
Rio Grande
Sabine
LOUISIANA
Little Rock
OUACHITA MOUNTAINS
ARKANSAS
OZARK PLATEAU
White
EDWARDS PLATEAU
TEXAS
Austin
San Antonio
Houston
Baton Rouge
Red
National Forest
CHIHUAHUA
COAHUILA
SIERRA MADRE
NUEVO LEON
Monterrey
Saltillo

LFGE Projects in Texas (2016)



46 Candidate Landfills in Texas

If LFGE projects were developed at these landfills, together they could supply:

- 52 million standard cubic feet per day of LFG for direct use

-or-

- 94 MW capacity of electricity
  - Enough to power 56,000 homes

Barriers to Project Development

Revenue, Funding & Incentives

for the development of LFG energy

- Direct sale of LFG
- Sale of power generated from LFG
- Renewable Energy Certificates (RECs)
- RINs under Renewable Fuel Standard (RFS)
- California Low Carbon Fuel Standard credits
- Greenhouse gas reduction credits
- Renewable Electricity Production Tax Credit (PTC)
- Federal or state grants
- Low-cost bond programs
  - Clean Renewable Energy Bonds (CREBs)
  - Qualified Energy Conservation Bonds (QECBs)
- Loans
  - U.S. DOE Loan Guarantee program

Trends in the U.S. Solid Waste Industry

- States and municipalities are increasingly moving towards diversion of organic waste from landfills
  - ~26 states have laws that address landfilling organic waste
- Federal and local initiatives emerging to address/minimize food waste
- Growing and sustained interest in LFG to vehicle fuel
- LFG energy project development growth has slowed in recent years
  - 9 new projects and 4 expansions in 2016
  - Economic factors continue to challenge project financial feasibility

How Can LMOP Help?

LMOP Resources

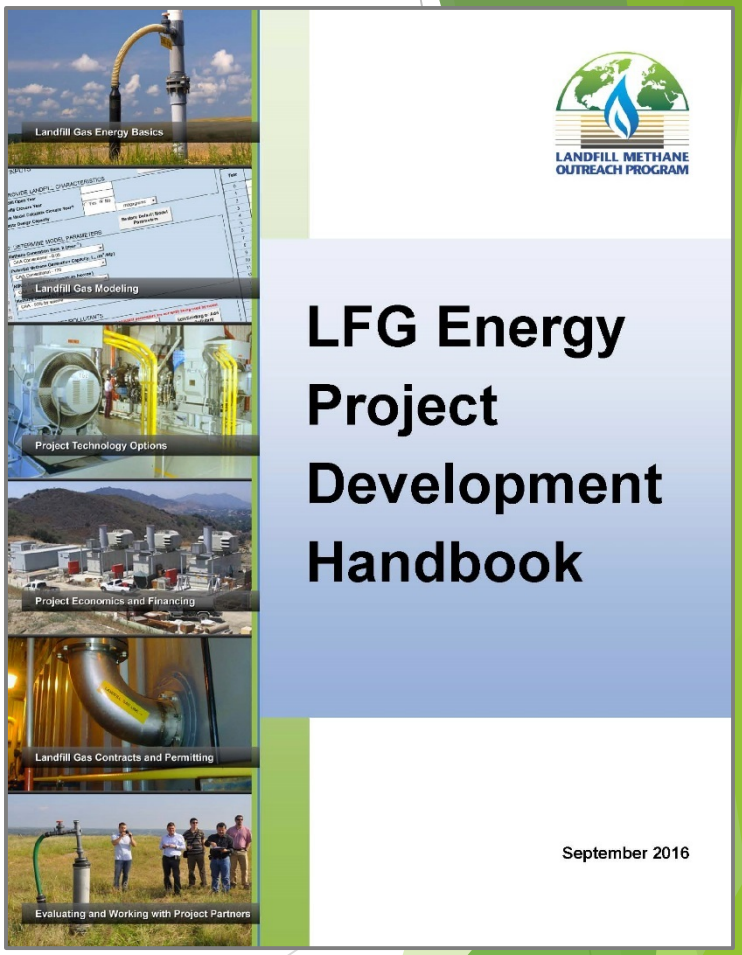
- Technical publications and tools
- Landfill and LFGE Project Database
- Network of 1,000+ Partners
- Webinars and other events
- Listserv messages

Key LMOP Resources

Project Development Handbook

Improve understanding to develop successful projects

- Provides project-specific considerations
- Helps stakeholders who are new to LFG energy projects
- Highlights useful online resources and successful LFG energy projects



Available at epa.gov/lmop

Key LMOP Resources

LFGcost-Web

Evaluate the initial economic feasibility of an LFG energy project

Version 3.1 released November 2016

Updated based on a 2015 peer review as well as other revisions

- Updated approach for calculating electricity revenue and avoided CO_2 grid factors based on regional electricity grids
- Added ability to enter user-defined project sizes without entering landfill waste data

Available at epa.gov/lmop

Key LMOP Resources

LMOP Landfill and LFG Energy Project Database

Download details about projects and landfills

Includes data for over 2,400 landfills in the U.S.

- Excel files cut the LMOP data in various ways to help you find what you are looking for
- Cross-references EPA's greenhouse gas reporting program (GHGRP)

	A	B	C	D	E	F	G	H	I	J	K
1	GHGRP ID	Landfill ID	Landfill Name	State	Physical Address	City	County	Zip Code	Latitude	Longitude	Ownership Type
2	1007341	1994	Anchorage Regional Landfill	AK	15500 E. Eagle River Loop Road	Eagle River	Anchorage	99577	61.293281	-149.60214	Public
3	1007341	1994	Anchorage Regional Landfill	AK	15500 E. Eagle River Loop Road	Eagle River	Anchorage	99577	61.293281	-149.60214	Public
4	1010389	11941	Capitol Disposal Landfill	AK	5600 Tonsgard Court	Juneau	Juneau	99801	58.3528	-134.4947	Private
5		10980	Central Landfill - MatSu Borough	AK	1201 N. 49th State Street Just off the Palmer-Wasilla Highway	Palmer	Matanuska-Susitna	99645	61.59	-149.21	Public
6	1005349	12216	Central Peninsula Landfill (CPL)	AK	46915 Sterling Highway	Soldotna	Kenai Peninsula	99669	60.44714	-151.10369	Public
7		10960	Kodiak Island Borough Landfill	AK	1203 Monashka Bay Road	Kodiak	Kodiak Island	99615	57.80874	-152.40761	Public
8	1004380	11020	Merrill Field Landfill	AK	800 Merrill Field Drive	Anchorage	Anchorage	99501	61.21266	-149.84012	Public
9	1006806	10961	South Cushman Landfill	AK	455 Sanduri Street	Fairbanks	Fairbanks North Star	99701	64.80476	-147.70085	Public
10		11000	Unalaska Landfill	AK	1181 Summer Bay Road	Unalaska	Aleutians West	99685	53.88463	-166.50657	Public
11		27	Athens/Limestone County SLF MSWLF	AL	Strain Road off Highway 31	Athens	Limestone	35611	34.7634	-86.9399	Public
12		16	Bishop Landfill Company	AL	379 Pleasant Grove Cutoff Road	Albertville	Marshall	35950	34.27823	-86.33707	Private
13	1004245	2005	Black Warrior Solid Waste Facility	AL	3301 Landfill Drive						
14		2006	Blount County/Nectar/Hayden LF & TS	AL	2390 Armstrong Loop						
15	1004415	2408	Brundidge Landfill	AL	515 Cleanwater Drive						

Available at epa.gov/lmop

Example Informational Materials

U.S. EPA Landfill Methane Outreach Program and Landfill Gas Energy

Creating partnerships and renewable energy across the country

January 2017

What is LFG?

Much of the waste we generate ends up in municipal solid waste (MSW) landfills. Landfill gas (LFG) is a natural byproduct of the decomposition of organic material within landfills, and contains about 50 percent methane (CH_4) and 50 percent carbon dioxide (CO_2). MSW landfills are the third-largest source of human-related methane emissions in the United States, accounting for approximately 18.2 percent of these emissions in 2014.[1] Methane is a potent greenhouse gas (GHG) 28 to 36 times more effective than CO_2 at trapping heat in the atmosphere over a 100-year period.[2] Learn more about landfill methane at epa.gov/lmop/basic-information-about-landfill-gas.

What is LMOP?

LMOP is a voluntary program that works cooperatively with industry stakeholders and waste officials to reduce or avoid methane emissions from landfills. LMOP encourages the recovery and beneficial use of biogas generated from organic MSW as it contains methane, a potent GHG and the primary component of natural gas. LMOP forms partnerships with communities, landfill owners and operators, utilities, energy users, states, project developers, tribes and nonprofit organizations to overcome barriers to project development. LMOP Partners are listed at epa.gov/lmop/about-partners-landfill-methane-outreach-program.

For more information about LMOP, program resources and LFG energy, see epa.gov/lmop.

What is LFG Energy?

Many cost-effective options exist to capture and destroy LFG by converting it into energy, thereby reducing methane emissions. LFG can fuel internal combustion engines, turbines, microturbines or other technologies to produce electricity. LFG is also used directly as an alternative to fossil fuels in equipment such as boilers, heaters and kilns, or is refined for use in vehicles or injection into natural gas pipelines. See examples of LFG energy projects at epa.gov/lmop/landfill-gas-energy-project-data-and-landfill-technical-data.

What are the Benefits of LFG Energy?

Communities with an LFG energy project enjoy a variety of benefits, including:

- Job creation, revenues and cost savings.
- Improved local air quality and reduced GHG emissions.
- Reliable local fuel source and less fossil fuel usage.
- Enhanced image as an innovative community.

Read more about the benefits of LFG energy at epa.gov/lmop/benefits-landfill-gas-energy-projects.

LMOP Assistance and Resources

Project Development Process.

LMOP offers several assistance options, including:

- LFG Energy Project Development Handbook
- Landfill and LFG Energy Project Database
- *LFGcost-Web* (cost model)
- Feasibility assessments
- Environmental benefits calculator
- Posters and flyers for ribbon cuttings (for Partners)

Financing LFG Energy Projects.

Securing funding can be a barrier to LFG energy project development. LMOP directs stakeholders to resources with information about pertinent funding mechanisms through its Resources for Funding LFG Energy Projects webpage at epa.gov/lmop/resources-funding-landfill-gas-energy-projects.

Networking and Information.

LMOP's partnerships create a vital network of landfills, states, communities and companies. LMOP provides information through:

- Partner listings
- Listserv email messages
- Webinars and workshops

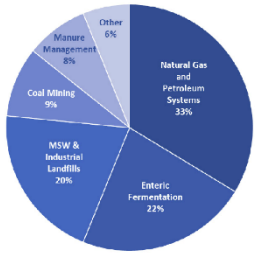
LFG Energy Is Truly Green

In 2014, methane accounted for about 10.6 percent of all U.S. greenhouse gases emissions from human activities.

LFG energy projects mitigate global climate change by preventing methane from escaping into the atmosphere. Instead, LFG is captured and used as a reliable, renewable energy resource.

Properties of Methane	
Chemical Formula	CH_4
Lifetime in Atmosphere	12 years
Global Warming Potential (100-year)	25

U.S. 2014 Methane Emissions, By Source



epa.gov/climatechange/ghgemissions/usinventoryreport.html

LFG and Green Pricing Programs

Green pricing programs offer premium rates for power provided from renewable energy resources. Many states require utilities to offer green pricing to customers, and utilities are increasingly offering green pricing options even without a legal requirement. At least 30 green pricing programs include LFG.[3] States may also adopt renewable portfolio standards (RPS) that specify the minimum amount of customer load to be supplied from eligible renewable energy sources. At least 37 states accept LFG energy in their RPS and renewable energy resource procurement goals.[4]

LFG is a good fit for green power programs for several reasons:

- LFG is recognized by energy certification programs as a renewable energy resource.[5]
- LFG can serve as a "baseload renewable", providing online availability exceeding 90 percent.
- Most states have landfills that can support LFG energy projects.
- Energy produced from LFG is one of the more cost-competitive forms of renewable energy.
- Several financial incentives exist, e.g., federal tax credits and state grants.

DSIRE® Green-e EPA GREEN POWER PARTNERSHIP

[3] U.S. DOE, Energy Efficiency & Renewable Energy. The Green Power Network. apps1.eere.energy.gov/greenpower/markets/pricing.shtml?page=o

[4] Database of State Incentives for Renewables & Efficiency (DSIRE). www.dsireusa.org.

LFG End User Success Stories

LFG energy projects provide significant cost savings and long-term, sustainable energy to end users. Examples include:

- **Coca-Cola's Atlanta Syrup Branch** facility gets nearly all of its energy in the form of electricity, steam and chilled water from green power generated at a nearby landfill, providing Coca-Cola with real energy savings. The project generates 48 million kilowatt-hours of green power per year.
- The **U.S. Navy** has saved approximately $1.3 million annually in utility costs at the Marine Corps Logistics Base in Albany, Georgia, since its first LFG cogeneration plant started up in 2011. This facility is made up of one dual-fuel engine generator, a heat recovery steam generator and two dual-fuel boilers.
- In 2012, **Gundersen Health System's** Onalaska Campus became the first energy-independent medical campus in the country by using LFG piped from the local landfill in La Crosse County, Wisconsin to power a generator. The electricity is sold to a local utility while the recovered waste heat supplies 100 percent of campus heat energy needs. Gundersen saves $100,000 annually in space heating and hot water costs.
- The **U.S. Department of Justice** obtains 80 percent of the electricity used by Federal Bureau of Prisons' Allenwood Correctional Complex from the combustion of LFG at the nearby landfill in Lycoming County, Pennsylvania.

[5] Green-e certification program for green power products (www.green-e.org) and U.S. EPA Green Power Partnership (www.epa.gov/greenpower).

Available at epa.gov/lmop

1,100 LMOP Partners

- Benefits of LMOP Partnership
  - Recognition of your commitment to renewable energy
  - Identification on LMOP website
  - Access to Partner network
  - Technical support
- Interested?
  - Fill out and submit an MOU (available on our website)

- Industry Partners: **766**
- Community Partners: **145**
- Energy Partners: **111**
- Endorser Partners: **39**
- State Partners: **39**

LANDFILL METHANE OUTREACH PROGRAM

How Can We Work Together?

- Facilitating information sharing
- Providing technical information
- Analyzing resource availability through LFG modeling
- Performing initial feasibility analysis using *LFGcost-Web*

LMOP Contact Information

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