

# LMOP and Landfill Gas Energy in the United States

Kirsten Cappel

U.S. Environmental Protection Agency  
Landfill Methane Outreach Program



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# Presentation Overview

- Introduction
- LFG Energy in the United States
- Trends in the U.S. Solid Waste Industry
  - 1. LFG energy projects
  - 2. Biogas to vehicle fuel
  - 3. Organic waste management
- Key LMOP Tools and Resources

# Introduction

## U.S. EPA's Landfill Methane Outreach Program (LMOP):

- Established in 1994
- Voluntary program that creates partnerships among landfill owners and operators, states, municipalities, energy users and providers, and the LFG industry and communities

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

# LMOP Partners (September 2017)

- Industry Partners: **776**
- Community Partners: **145**
- Energy Partners: **109**
- Endorser Partners: **39**
- State Partners: **39**

**More than 1,100 Partners**

## Benefits of LMOP Partnership:

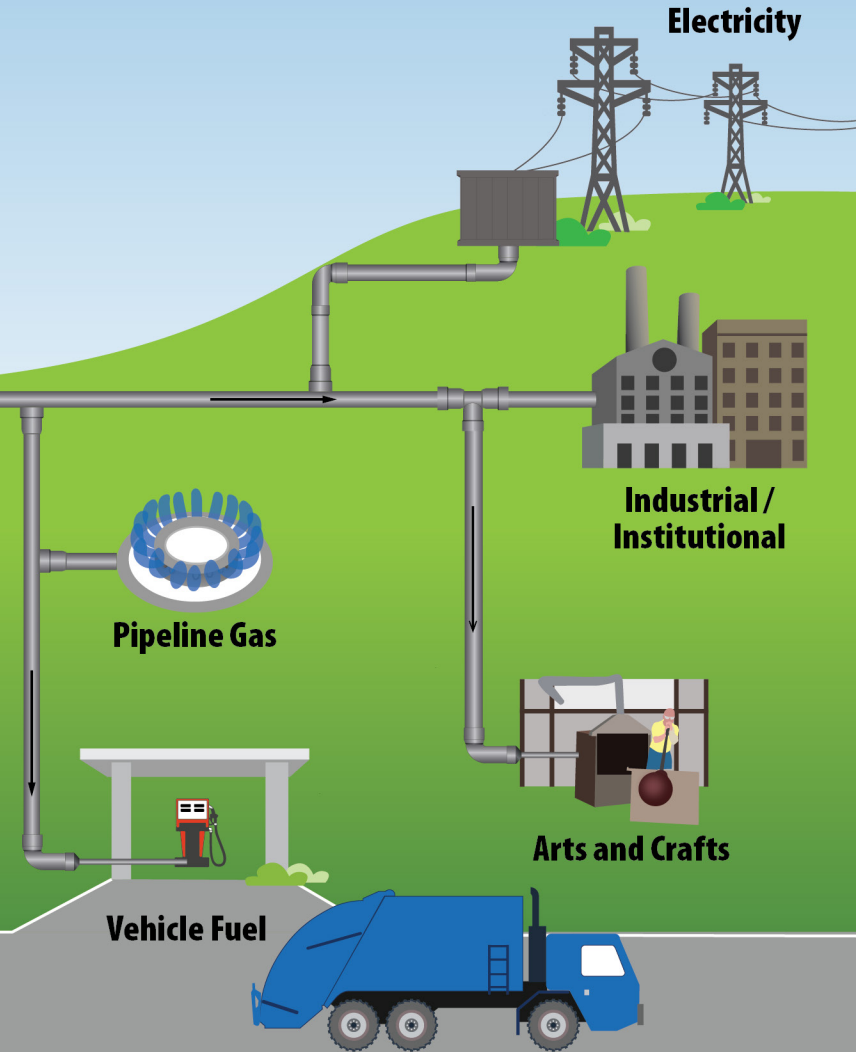
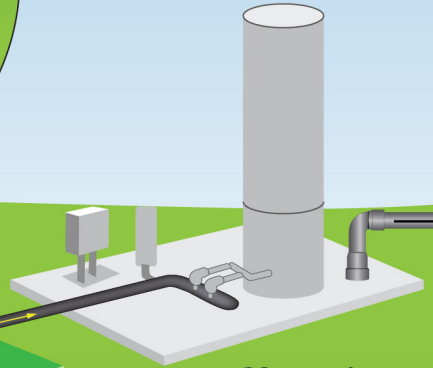
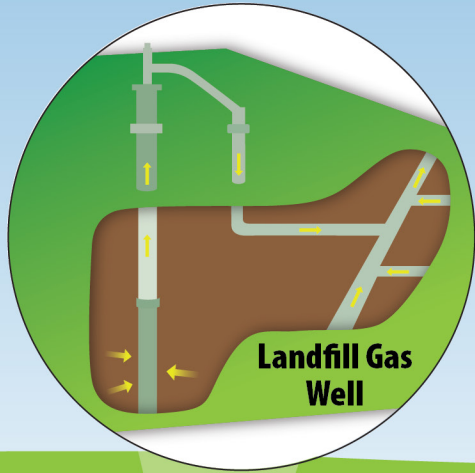
- Recognition for commitment to renewable energy
- Recognition on LMOP website
- Use of LMOP logo on Partner website (within guidelines)
- LMOP support for groundbreaking or ribbon cuttings
- Keep informed about new developments, events, and other LFG related information

To join the Partnership, visit our website at:  
[epa.gov/lmop/join-landfill-methane-outreach-program](http://epa.gov/lmop/join-landfill-methane-outreach-program)

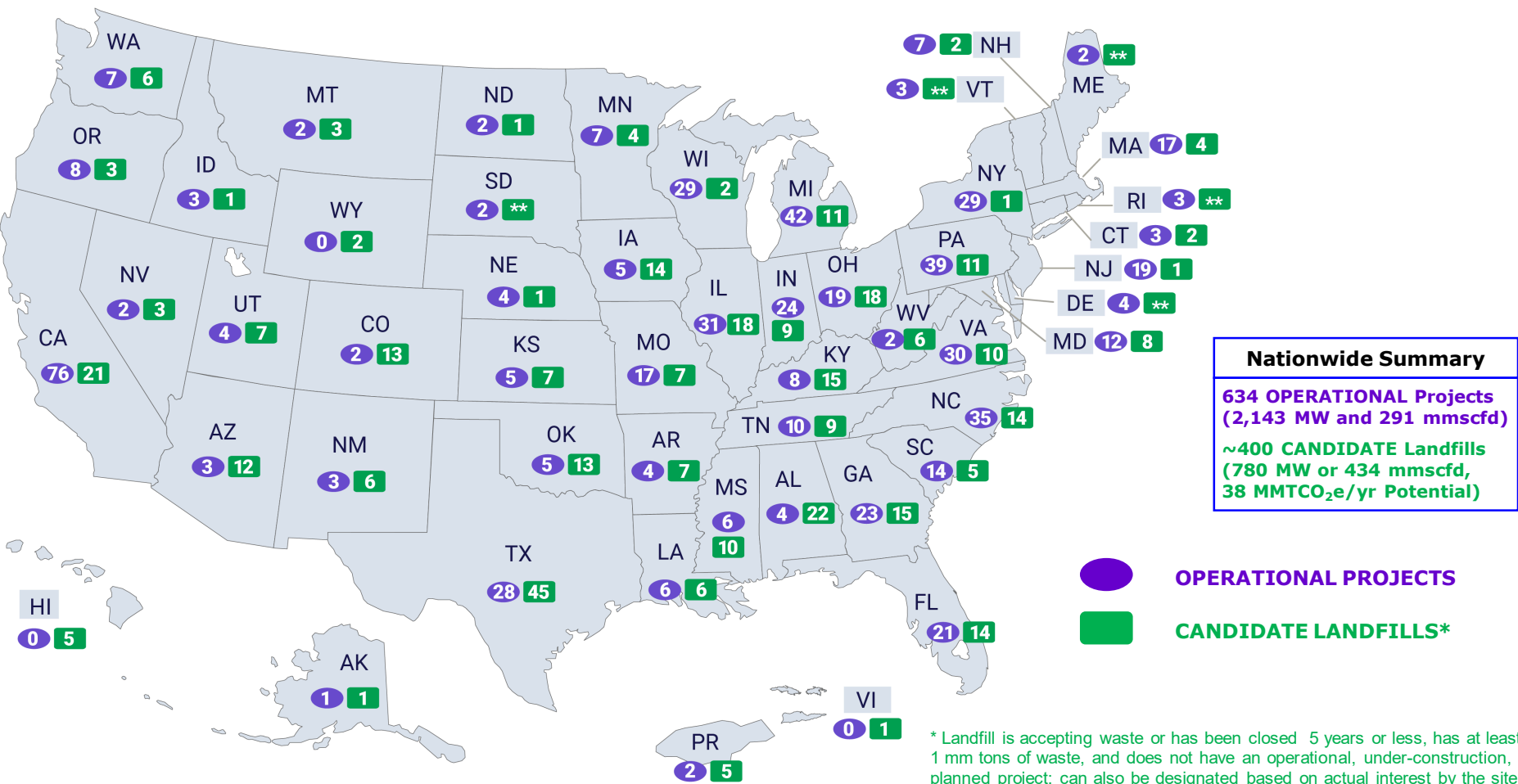
Collection

Processing

Methane Uses



# U.S. LFG Energy Project Development



**Nationwide Summary**

634 OPERATIONAL Projects  
(2,143 MW and 291 mmscfd)

~400 CANDIDATE Landfills  
(780 MW or 434 mmscfd,  
38 MMTCO<sub>2</sub>e/yr Potential)

**OPERATIONAL PROJECTS**

**CANDIDATE LANDFILLS\***

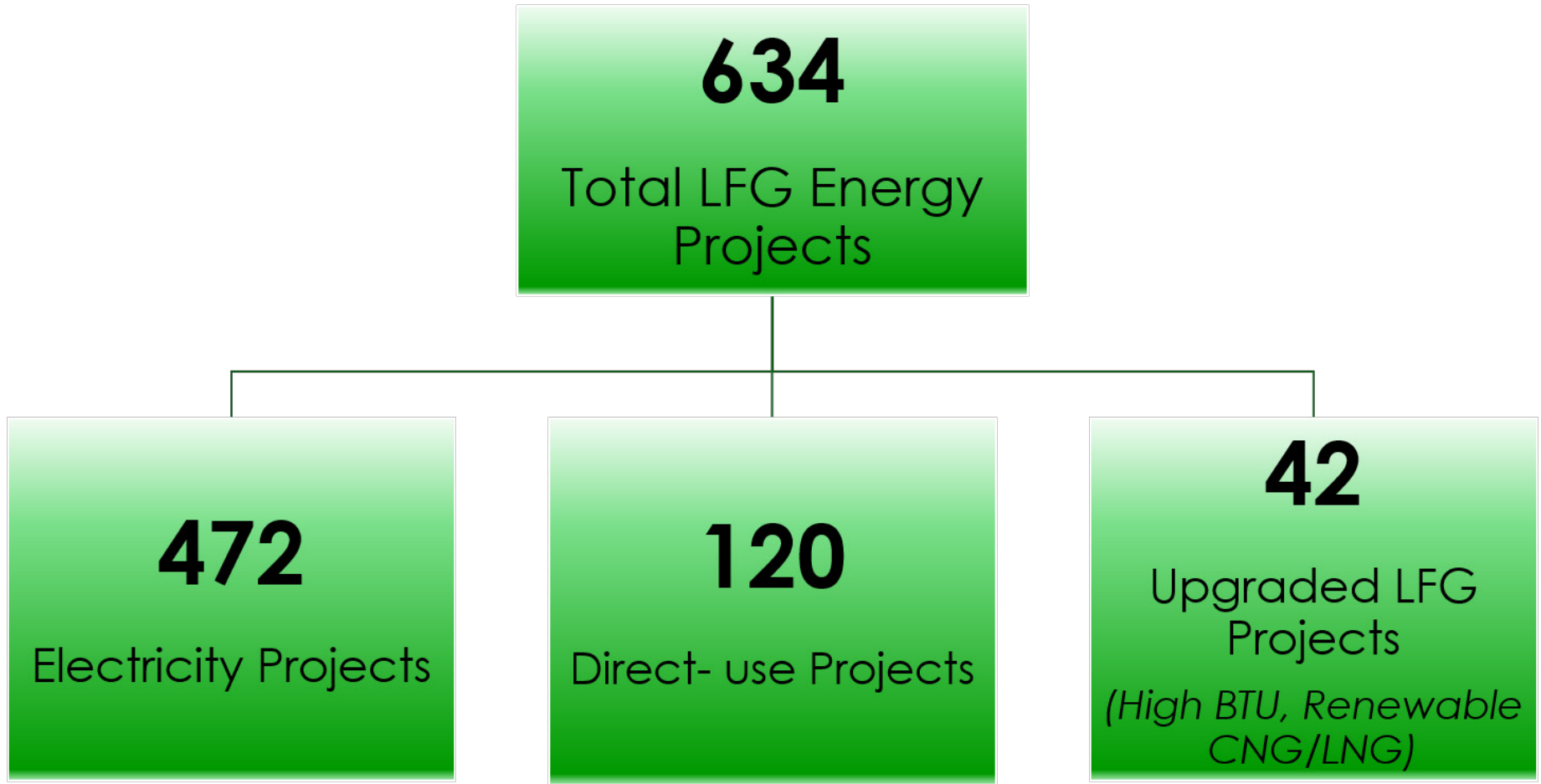
\* Landfill is accepting waste or has been closed 5 years or less, has at least 1 mm tons of waste, and does not have an operational, under-construction, or planned project; can also be designated based on actual interest by the site.

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

These data are from LMOP's Landfill and Landfill Gas Energy Database as of June 2017.

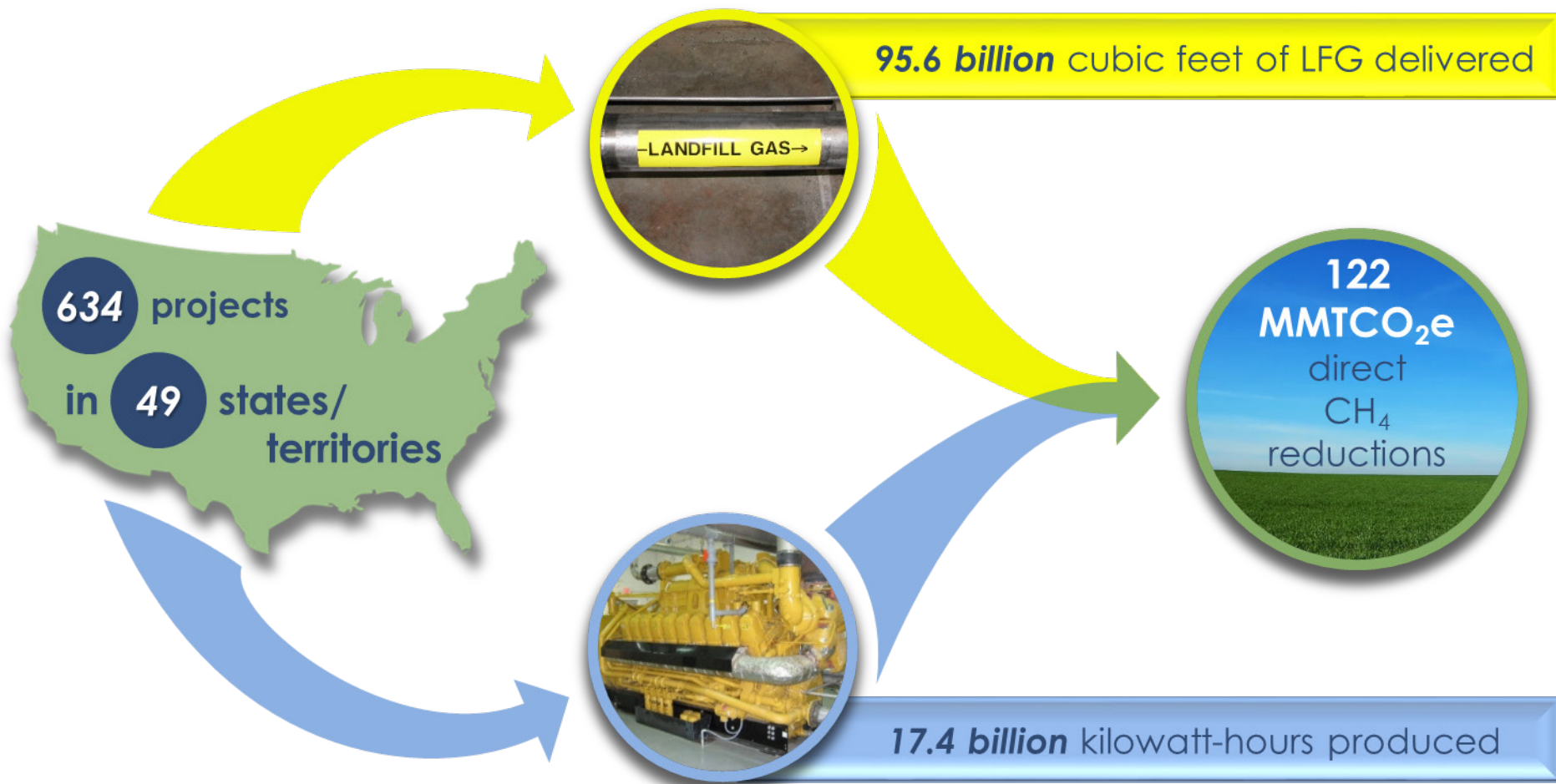


# U.S. LFG Energy Project Types



\*LFG energy project count from LMOP's Landfill and Landfill Gas Energy Database as of June 2017

# LFG Energy Project Snapshot for 2017



\*Estimated values are based on LFG energy projects operating in June 2017.



# LFG Energy Co-Benefits

Create local, renewable and consistent energy

Reduce local air pollution

Lead to health benefits

Generate revenue and jobs in the community and beyond

# 1: Trends – LFG energy projects

## LFG energy projects have changed over the last 10 years

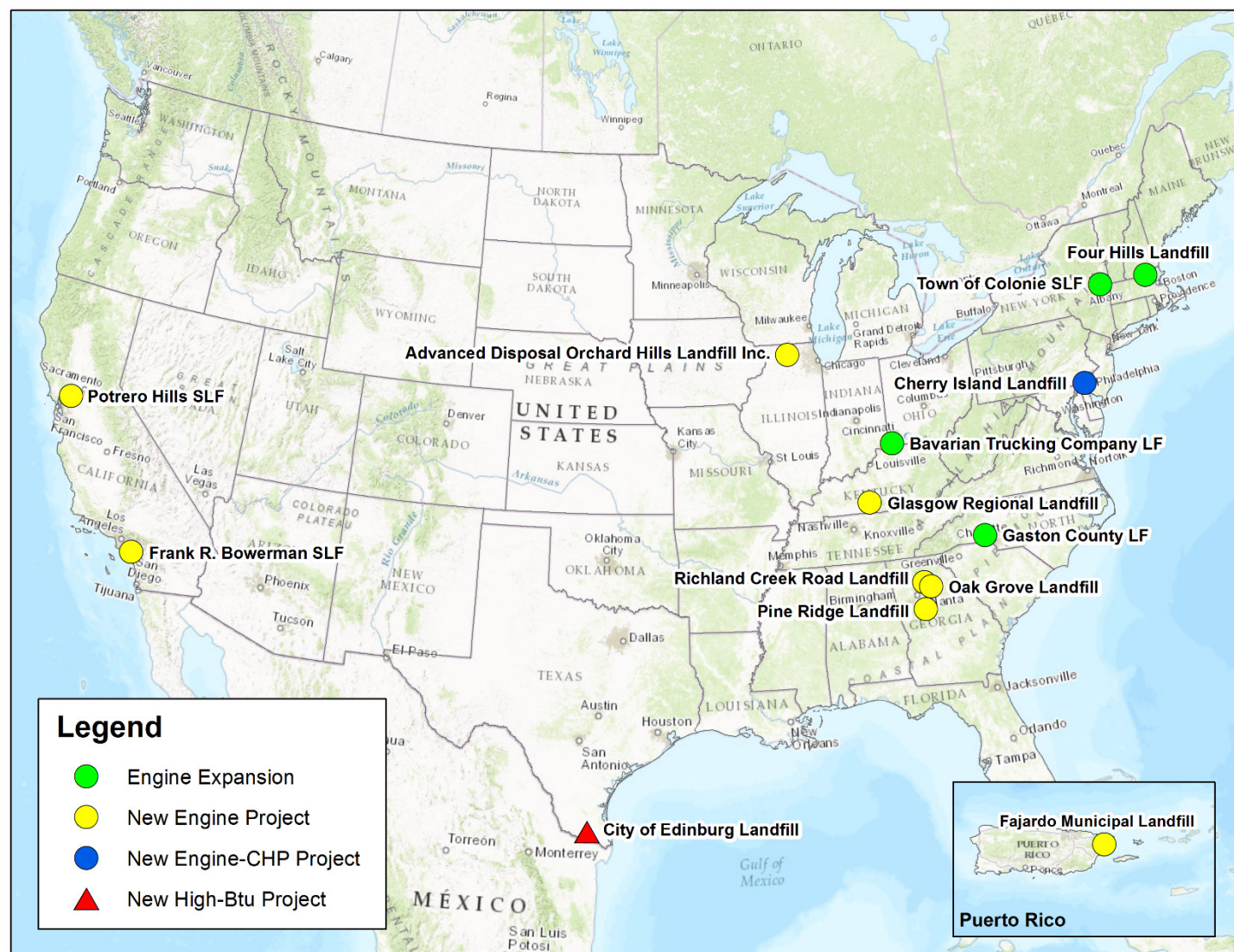
- Rate of new projects coming online each year has declined over the past several years

10 new projects and 4 expansions in 2016 – compares to:

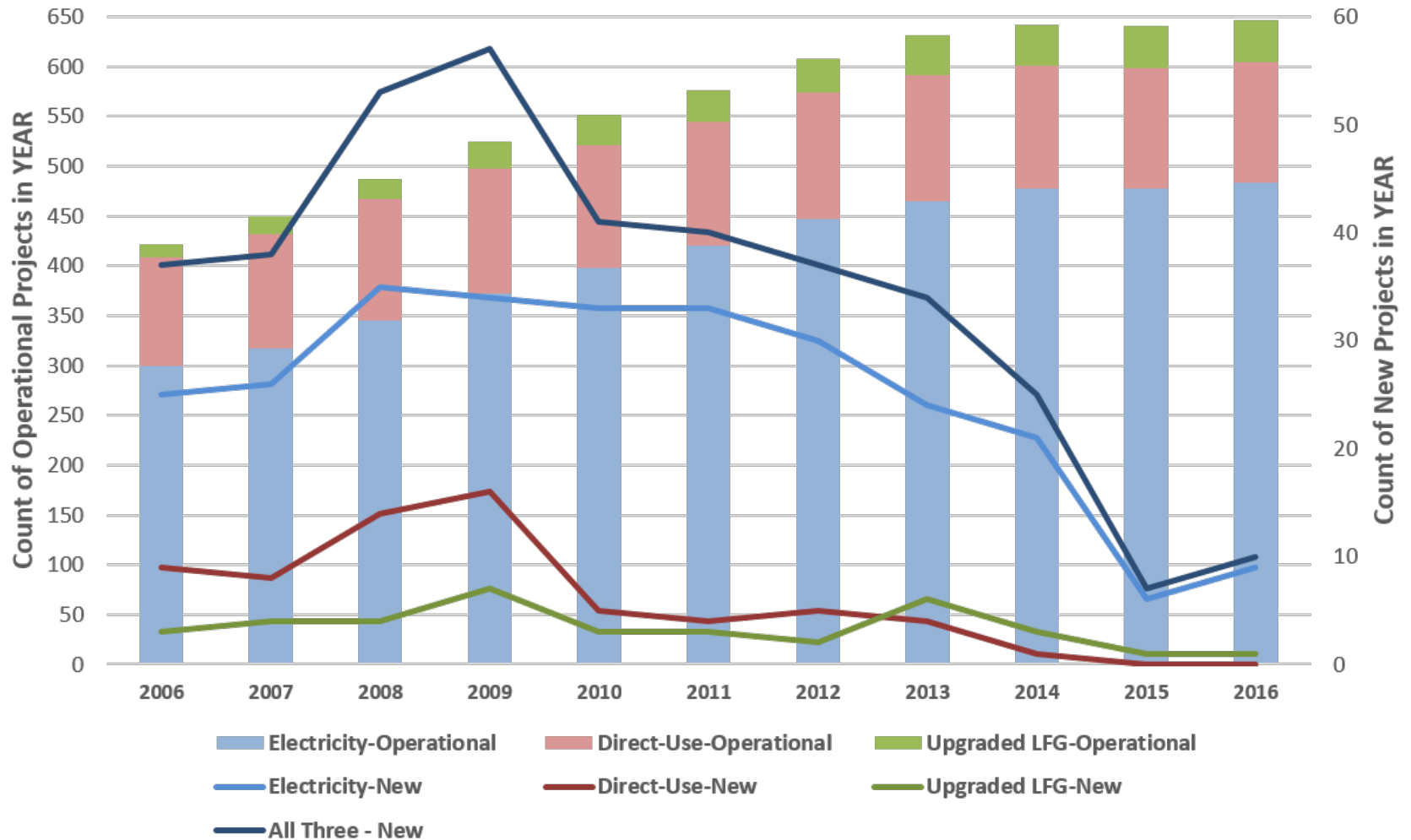
- 37 new projects and 12 expansions in 2006 (10 years)
- 57 new projects and 15 expansions in 2009 (peak)

- However, total MW output from electricity projects is still increasing - from 1,220 MW in 2006 to 2,160 MW in 2016 (net +940 MW)
- Direct use of LFG (e.g., boilers) has decreased
- Upgraded LFG flowing to pipelines and vehicles has jumped 168% over same 10-year timeframe

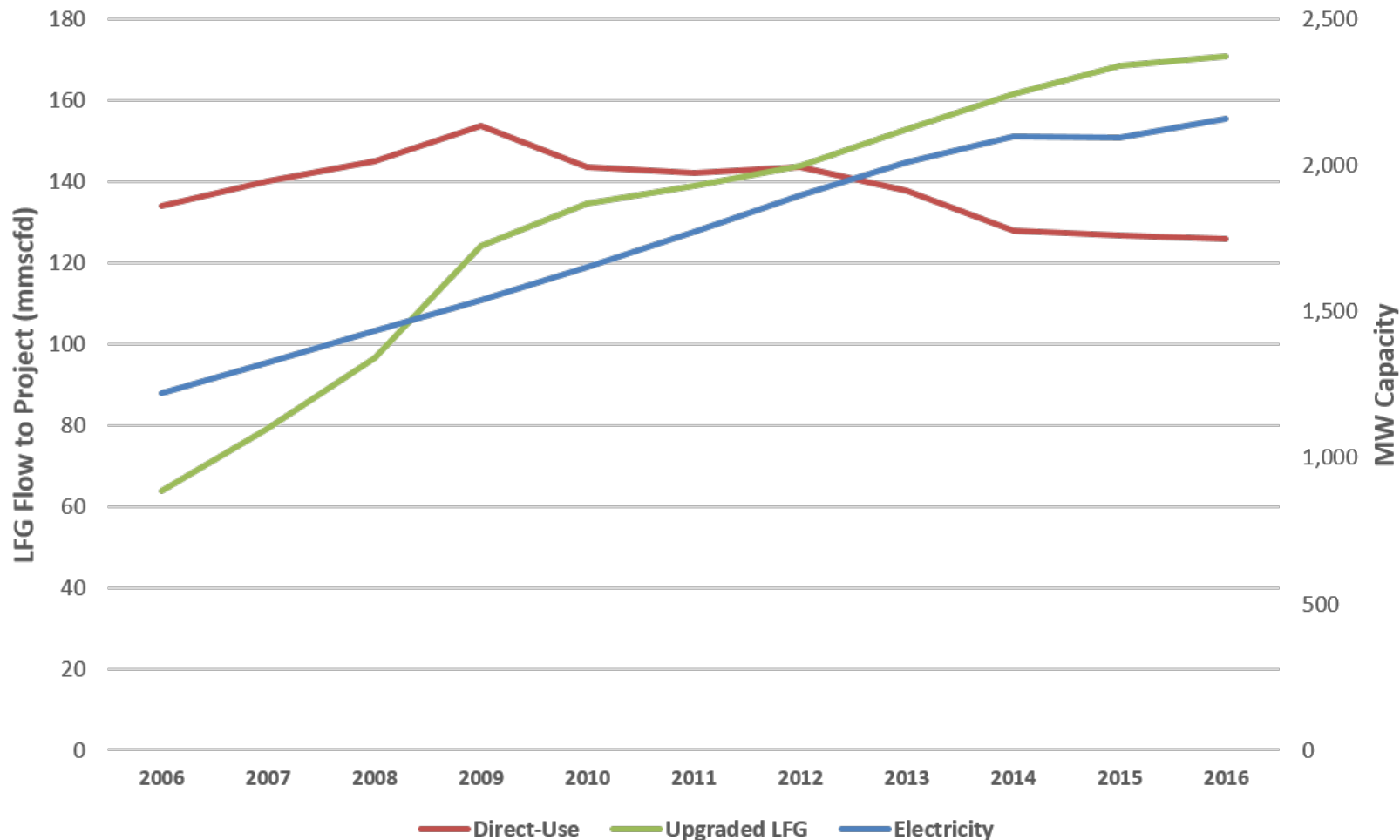
# New 2016 LFG Energy Projects/Expansions



# LFG Energy Project Growth: 2006-2016



# MW Output and LFG Usage: 2006-2016



# Factors Affecting New LFG Energy Projects

- Low natural gas prices / low electricity rates
- Permitting challenges and gas quality requirements
- Expiration of Section 45 production tax credit
- Interconnection logistics and costs
- Uncertainty about future LFG generation rates (e.g., organic waste diversion)

# 2: Trends – Biogas to Vehicle Fuel

## Growing and sustained interest in LFG to vehicle fuel

### ○ Currently:

- 6 operating onsite LFG-to-vehicle fuel projects and 6 planned
- 30 of the 36 operating high-Btu pipeline projects provide cleaned gas for creating vehicle fuel at other end of pipeline

### ○ Potential opportunities to grow:

- Landfills with operational project and excess LFG
  - ~65 have 100-1,000 cfm excess
  - ~20 have > 1,000 cfm excess
- Candidate landfills (with or w/o GCCS in place)
  - ~270 have 100-1,000 cfm LFG
  - ~80 have > 1,000 cfm LFG

\*Data from LMOP's Landfill and Landfill Gas Energy Database as of July 2017



# Incentives for LFG to Vehicle Fuel Projects

- Incentives for LFG to vehicle fuel projects
  - Both federal and state incentives exist to encourage biogas
    - Federal - Federal Renewable Fuel Standard / RINs
    - State - California Low Carbon Fuel Standard

RFS RIN – D3	CA LCFS
<i>Value Added (2016 average, \$/MMBtu)<sup>1</sup></i>	<i>Value Added (2016 Estimated Value, \$/MMBtu)<sup>2</sup></i>
<b>\$24</b>	<b>\$4.55</b>
<i>Values fluctuate; does not include costs associated with credit generation</i>	

1. "Renewable Natural Gas. The RNG Opportunity for Natural Gas Utilities" April 2017. MJB&A. <http://www.mjbradley.com/reports/renewable-natural-gas-rng-opportunity-natural-gas-utilities>.
2. California Environmental Protection Agency, Air Resources Board - Data Dashboard. <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>. Average credit price for January – June 2017 is \$87; assumed average carbon intensity for biomethane is 36 and EER = 0.9.



# Drivers for Vehicle Fuel Projects

- Corporate and municipal sustainability goals as well as county mandates can include CNG fleet conversions
  - Examples: UPS, Ryder, City of San Diego (CA), Atlanta (GA)
- Fuel cost savings (compared to diesel/gasoline)
- Local air quality benefits of RNG
  - Reduces criteria pollutant emissions
- Local natural gas distribution companies seeking low-carbon feedstocks in 20+ states with economy-wide GHG reduction targets
- Voluntary renewable natural gas credits (RNGCs)
- Technology efficiencies and advancements

# 3: Trends – Organic Waste Management

## States and municipalities are increasingly interested in diversion of organic waste from landfills

- Many yard waste bans went into effect in late 1980s/ early 1990s, but there is a more recent focus on diverting food waste
  - ~26 states have laws that address landfilling organic waste\*
    - 5 states (California, Connecticut, Massachusetts, Rhode Island and Vermont) ban food waste from landfills
    - 3 more states (Maryland, New Jersey and New York) are considering similar food waste bans
  - Local initiatives emerging to address/minimize food waste
    - ~200 communities offering source separated organic waste collection programs

*\*Represents states with any organic waste ban – yard waste, food waste, or other*

# Organic Waste Management Treatment

- Options for treatment of organic waste include:
  - **Compost:** aerobic decomposition by microorganisms into humus, a usable, soil-like byproduct
    - ~350 to 500 U.S. composting sites accept food waste
  - **Anaerobic Digestion:** decomposition process in the absence of oxygen releases biogas that can be captured and beneficially used and leaves an organic residue called digestate (also a usable byproduct)
    - ~100 to 150 U.S. AD facilities accept some sort of food waste (pre- or post-consumer)
- Examples of AD and composting co-located at landfills – some of these landfills also have LFG energy projects\*
  - Crapo Hill Landfill, MA\* and Prince William County Landfill, VA\* [both AD]
  - Lee/Hendry County Landfill, FL [composting]

# Landfill & LFG Energy Impacts of Organic Waste Diversion

- Extent of impact varies depending on a number of factors, but includes:

- Reduction in LFG generation rates and associated energy potential
- Extension of landfill life by saving valuable space
- Reduction in the amount of leachate generated

***Knowledge of organic waste management trends is important to better understand how it may affect landfill operations and existing/future LFG energy project development***

# LMOP Resources and Tools

- LMOP Landfill and LFG Energy Project Database
- Tools: *LFGcost-Web*, benefits calculator, conversion tool
- Technical and outreach publications
- Webinars and other events
- Network of 1,100+ Partners
- Listserv – sign up to receive and view message archive

# LMOP Resources: LMOP Database

Available at [epa.gov/lmop](http://epa.gov/lmop)

## Landfill and LFG Energy Project Data

Download details about projects and landfills

**Includes data for more than 2,400 U.S. landfills**

- 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
	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	MSWLF Athens/Limestone County SLF	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						

# LMOP Resources: *LFGcost-Web*

Available at [epa.gov/lmop](http://epa.gov/lmop)

## *LFGcost-Web*, Version 3.2

### *Evaluate the initial economic feasibility of an LFG energy project*

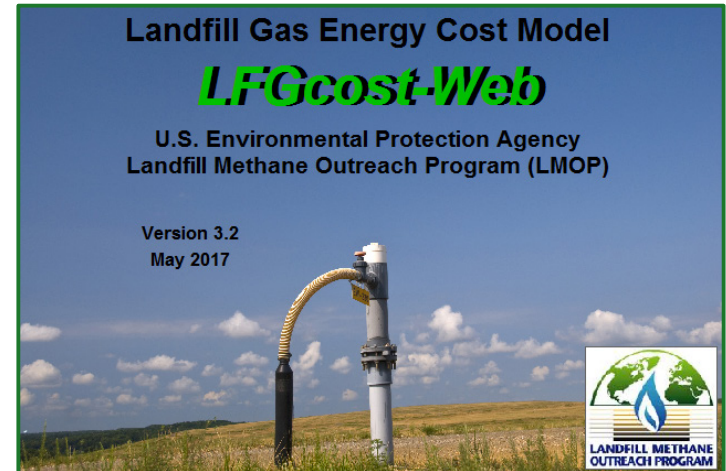
Analyze 12 LFG energy project types with or without costs for a new LFG collection and flaring system

**Released May 2017**

*User-friendly Microsoft® Excel platform*

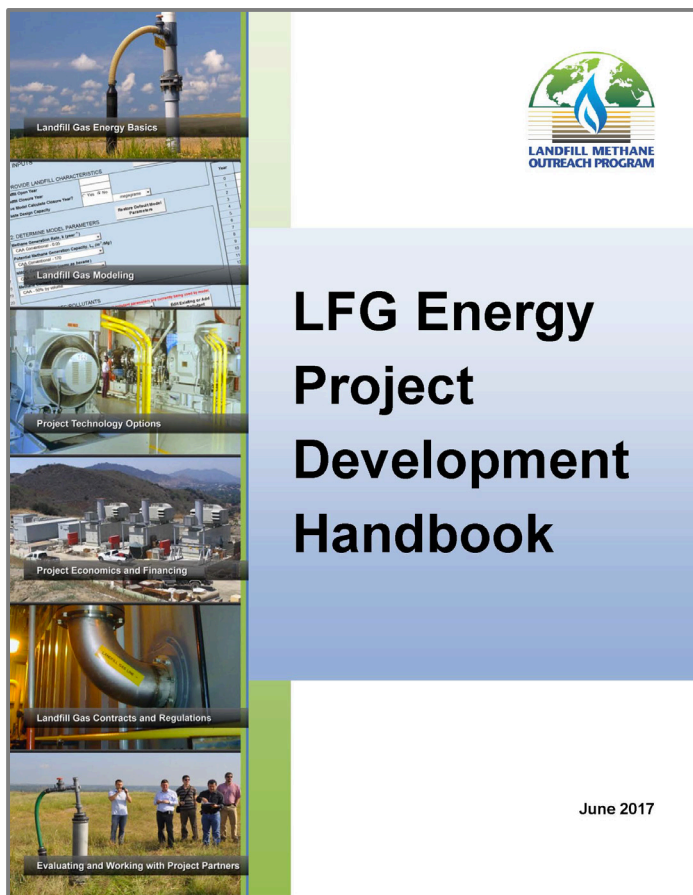
- Added ability to estimate job creation and regional economic ripple effects
- Updated reference sources for calculating electricity prices and avoided CO<sub>2</sub> grid factors
- Updated default user inputs

***LFGcost-Web* is available online to all stakeholders and transparent, allowing users to edit optional inputs**



# LMOP Resources: Handbook

Available at [epa.gov/lmop](http://epa.gov/lmop)



## LFG Energy 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



# LMOP Resources: Informational Materials

Available at [epa.gov/lmop](http://epa.gov/lmop)



## 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<sub>4</sub>) and 50 percent carbon dioxide (CO<sub>2</sub>). 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.<sup>1</sup> Methane is a potent greenhouse gas (GHG) 28 to 36 times more effective than CO<sub>2</sub> at trapping heat in the atmosphere over a 100-year period.<sup>2</sup> Learn more about landfill methane at [epa.gov/lmop/basic-information-about-landfill-gas](http://epa.gov/lmop/basic-information-about-landfill-gas).

### 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](http://epa.gov/lmop/landfill-gas-energy-project-data-and-landfill-technical-data).

### 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](http://epa.gov/lmop/about-partners-landfill-methane-outreach-program).

For more information about LMOP, program resources and LFG energy, see [epa.gov/lmop](http://epa.gov/lmop).

### 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](http://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](http://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

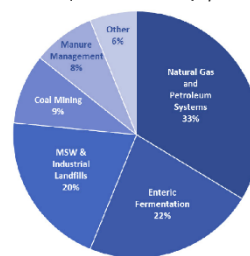
In 2014, methane accounted for about 10.6 percent of all U.S. greenhouse gases emissions from human activities.

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 <sub>4</sub>
Lifetime in Atmosphere	12 years
Global Warming Potential (100-year)	25

### U.S. 2014, Methane Emissions, By Source



[epa.gov/climatechange/ghgemissions/usinventoryreport.html](http://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.<sup>1</sup> 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.<sup>2</sup>

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

- LFG is recognized by energy certification programs as a renewable energy resource.<sup>3</sup>
- 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.



<sup>1</sup> U.S. DOE, Energy Efficiency & Renewable Energy. The Green Power Network. <https://eere.energy.gov/greenpower/markets/pricing.shtml?page=0>

<sup>2</sup> Database of State Incentives for Renewables & Efficiency (DSIRE). [www.dsireusa.org](http://www.dsireusa.org)

<sup>3</sup> Green-e certification program for green power products ([www.green-e.org](http://www.green-e.org)) and U.S. EPA Green Power Partnership ([www.epa.gov/greenpower/](http://www.epa.gov/greenpower/)).

## 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.



# Upcoming LMOP Events

## LMOP National Landfill Gas Energy Special Session

**March 2018**

(in conjunction with SWANA's LFG Symposium)

Denver, CO

visit [www.epa.gov/lmop](http://www.epa.gov/lmop) for more information



# How Can We Work Together?

- Facilitating information sharing – LMOP Database, webinars, listserv
- Providing technical information about LFG energy project development and opportunities to reduce emissions from MSW landfills more broadly
- Analyzing resource availability through LFG modeling
- Performing initial feasibility analysis using *LFGcost-Web*



**We welcome your feedback on our resources,  
website, etc.**

# Thank you!

## **Kirsten Cappel**

U.S. EPA

Landfill Methane Outreach  
Program

[cappel.kirsten@epa.gov](mailto:cappel.kirsten@epa.gov)

## **Lauren Aepli**

U.S. EPA

Landfill Methane Outreach  
Program

[aepli.lauren@epa.gov](mailto:aepli.lauren@epa.gov)

