RNG Resources and Insights from EPA Partnership Programs

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U.S. EPA Landfill Methane Outreach Program (LMOP)

THE COALITION FOR RENEWABLE NATURAL GAS

RNG WORKS Technical Workshop & Trade Expo
Produced by the RNG COALITION
to educate, demonstrate & promote best industry practices.

LANDFILL METHANE OUTREACH PROGRAM

OVERVIEW

- EPA Voluntary Partnership Programs
- Trends in RNG Project Development
- Tools and Resources for RNG Project Development

EPA Voluntary Partnership Programs

Information for the Agriculture Sector

www.epa.gov/agstar

Success Stories

- Project profiles
- Interviews with operators

Market Trends

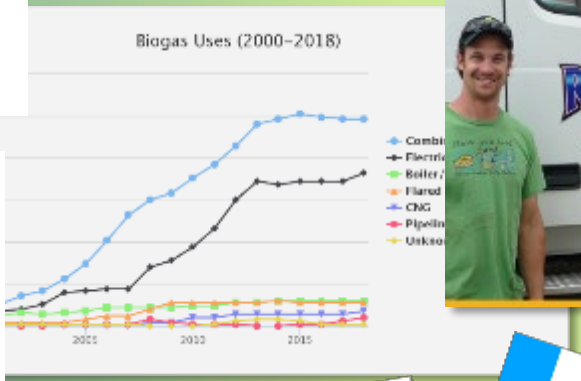
- National data for anaerobic digester projects
- Opportunities

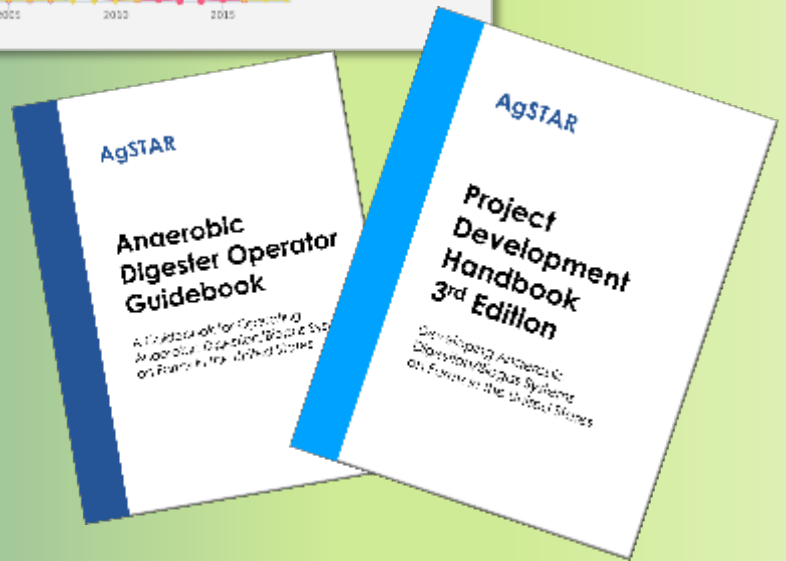
Technical Information

- Guidelines and permitting
- Updated project handbook (coming soon)
- Operators guidebook (coming soon)

Collaboration

- Webinars
- Industry events





Information for the Oil and Natural Gas Sector

www.epa.gov/gasstar

Recommended Technologies

- Lessons Learned Studies
- Technology fact sheets
- Organized by equipment type

Technical Presentations

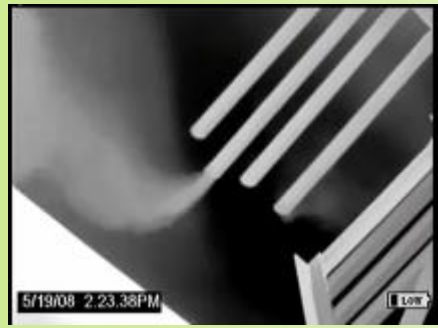
- Links to hundreds of presentations from industry experts, program partners, and stakeholders
- Searchable by title, speaker, and event

Outreach and Events

- Webinars (Program updates and Data Analytics)
- Technology Transfer Workshops
- Partnership Workshops

Methane Emissions Videos

- Remote sensing leak detection
- Infrared methane videos



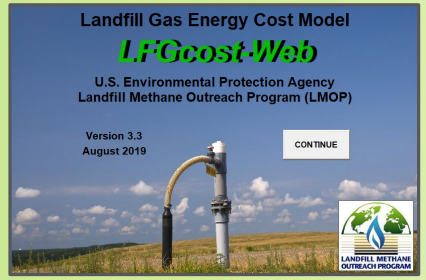
Information for the Landfill & LFG Energy Sector

www.epa.gov/lmop

LANDFILL METHANE OUTREACH PROGRAM

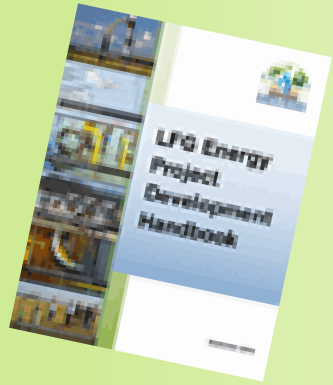
Tools

- LFGcost-Web
- RNG Flow Rate Tool
- LFG Energy Benefits Calculator
- Conversion Tool



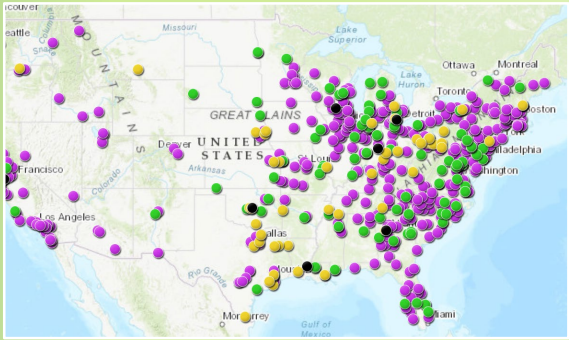
Technical Publications

- Project Development Handbook
- Fact sheets



Data

- Excel files and GIS map
- LFG energy projects
- Candidate landfills



Network

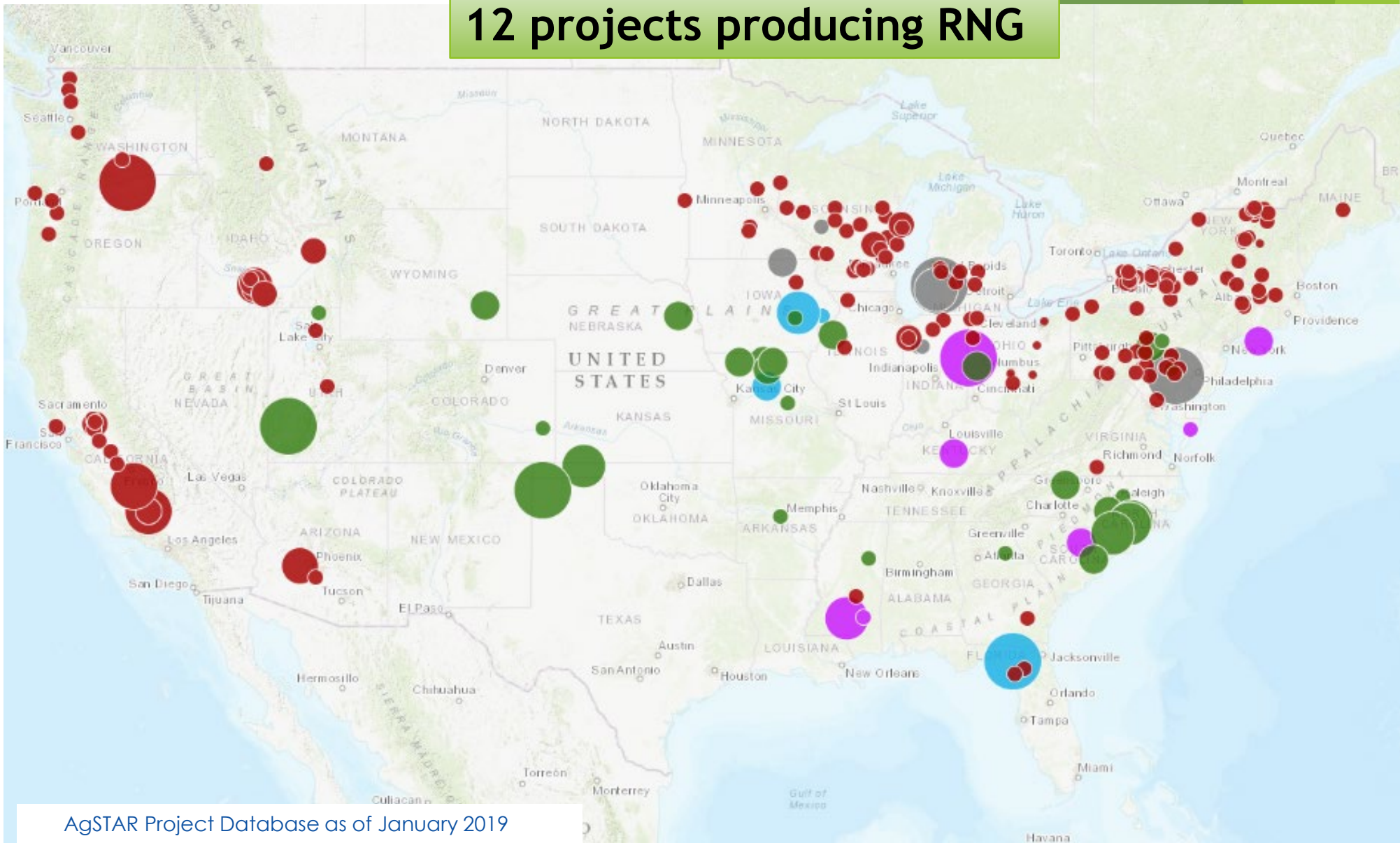
- Webinars and other events
- 1,000+ LMOP Partners
- Listserv messages

Data on RNG Projects

AgSTAR Project Map

12 projects producing RNG

- Dairy
- Hog
- Beef
- Poultry
- Mixed



AgSTAR Project Database as of January 2019

LMOP Project Map

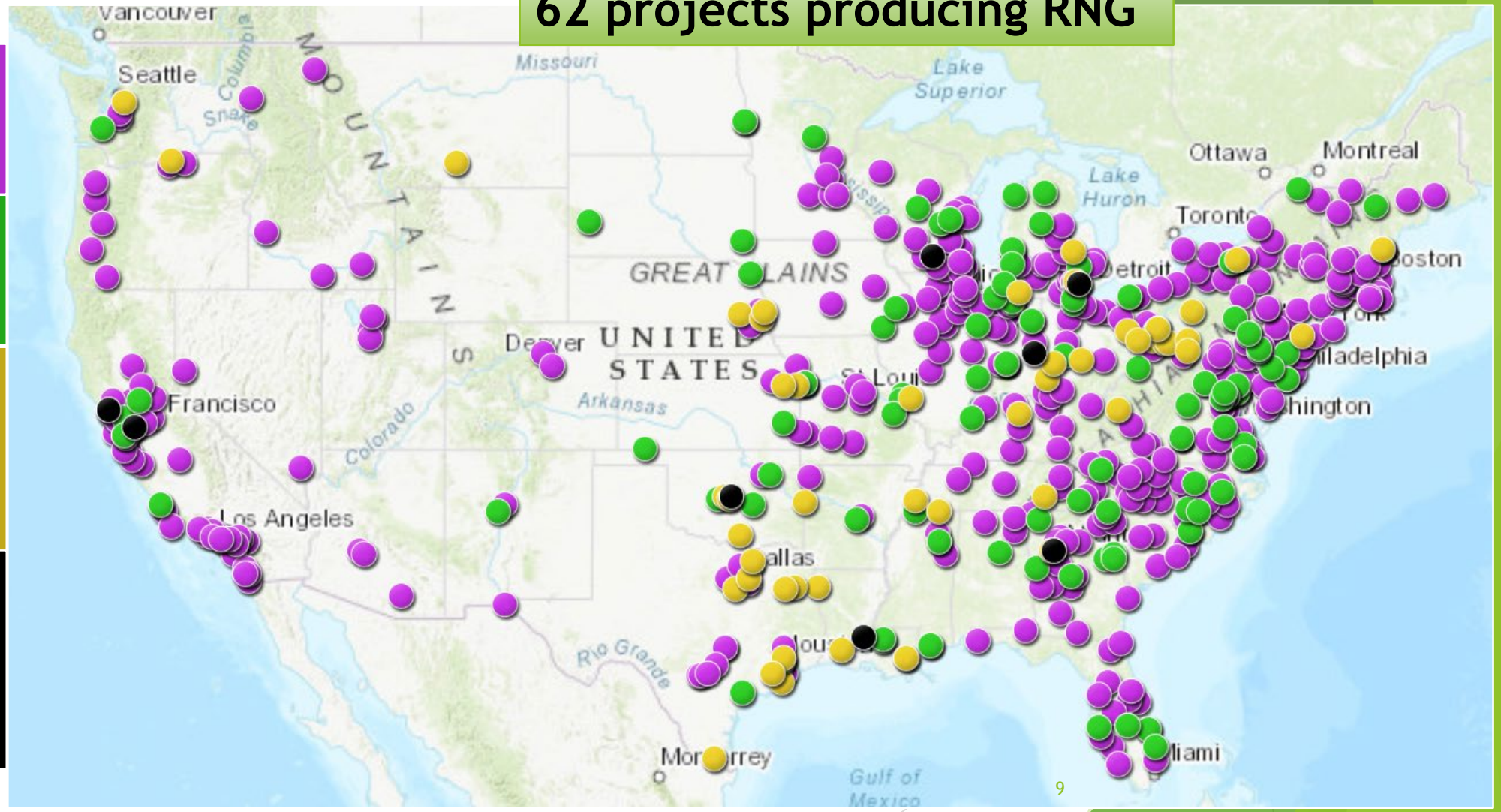
429
Electricity

104
Direct-Use

55
Renewable Natural Gas / Pipeline Injection
(49 for vehicle fuel)

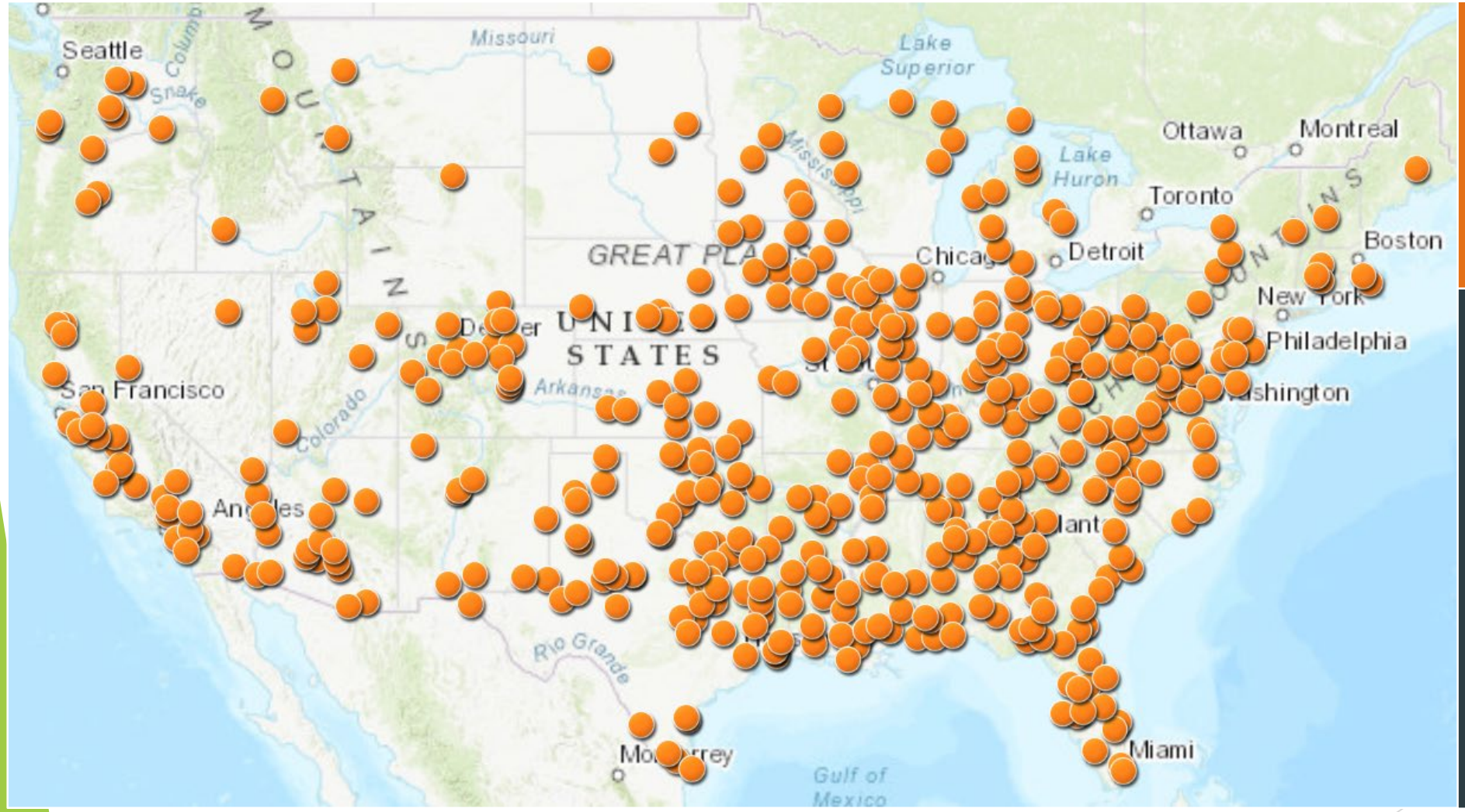
7
Renewable Natural Gas / Local Use
(7 for vehicle fuel)

62 projects producing RNG



LFG energy project counts are from LMOP's Landfill and Landfill Gas Energy Database as of July 2019

LMOP Candidate Landfills



~ 475 Candidate Landfills

(925 MW or 515 mmscfd, 47 $MMTCO_2e$/year Potential)

What is a candidate landfill?

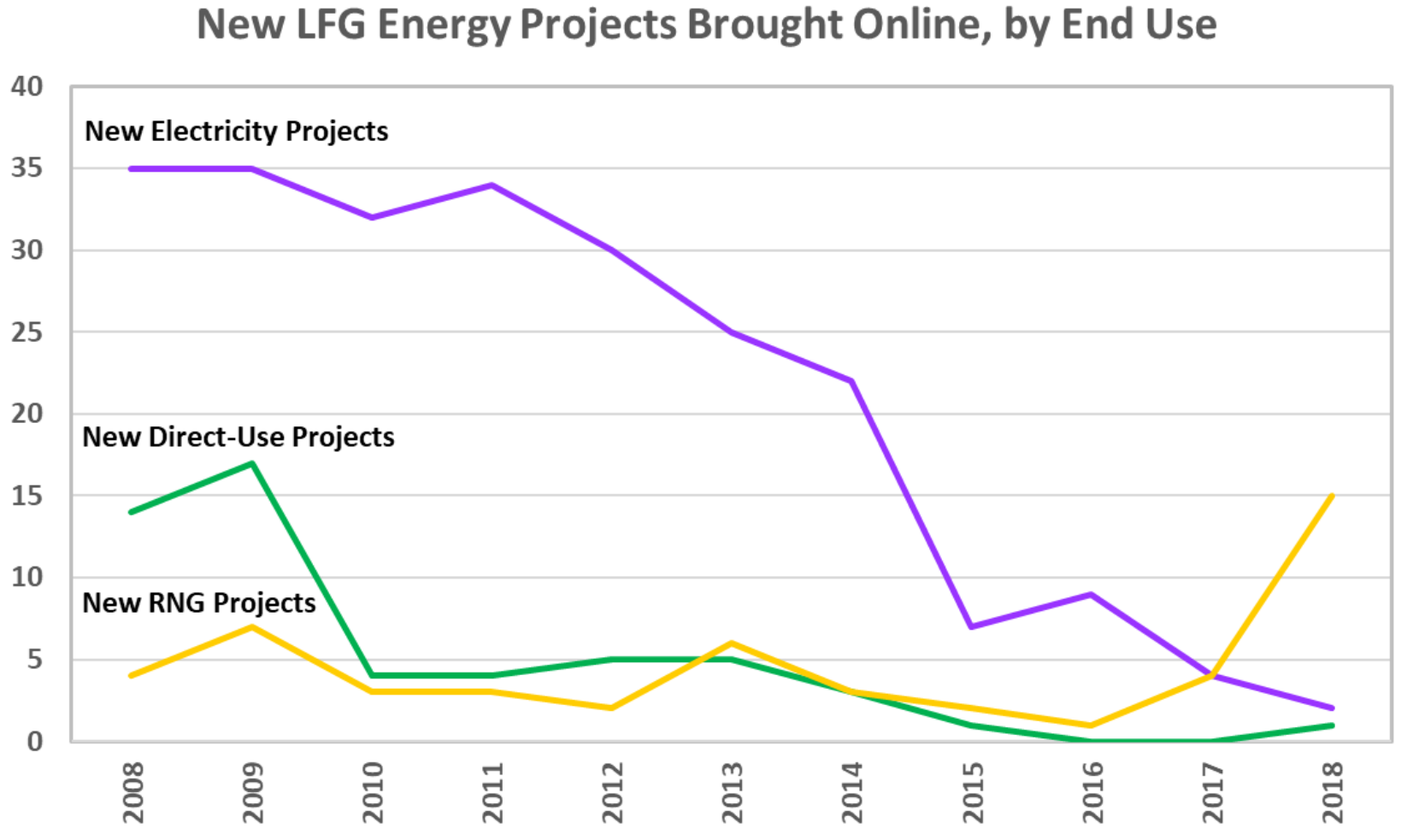
- Landfill is accepting waste or has been closed for five years or less
- Has at least one million tons of waste
- Does not have an operational, under-construction or planned project
- Can also be designated based on interest by the site

Candidate landfill counts are from LMOP's Landfill and Landfill Gas Energy Database as of July 2019

Trends in LFG-to-RNG Projects

New LFG Energy Projects Per Year

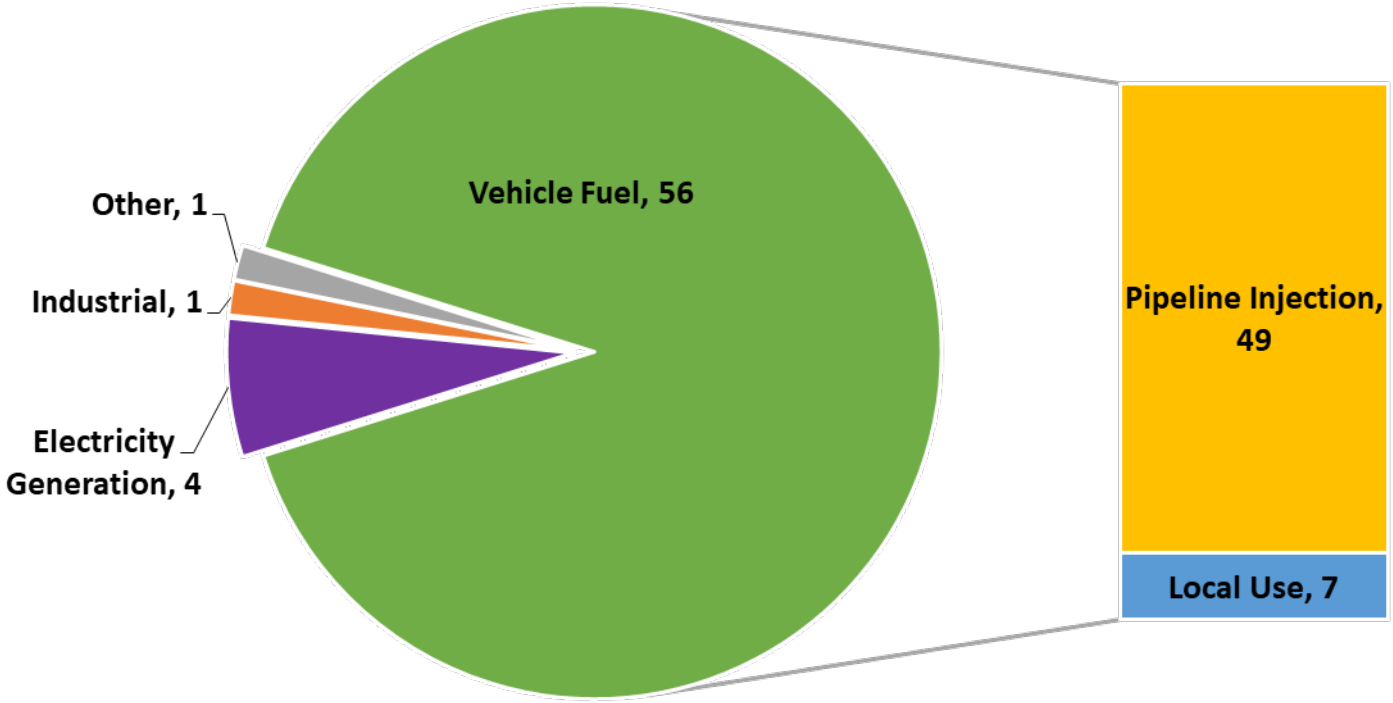
- LMOP database lists **35 under-construction or planned RNG projects**
- If all of these come online, the number of operational LFG-to-RNG projects would be **nearly 100**



Data from LMOP's Landfill and Landfill Gas Energy Database as of July 2019

LFG-RNG Project Types

- Most LFG-RNG projects provide at least some of the RNG for vehicle fuel use



Example uses of RNG as vehicle fuel:
- Waste hauling and collection trucks
- County vehicles
- City buses

Data from LMOP's Landfill and Landfill Gas Energy Database as of July 2019

LFG-RNG Project Sizes

- LFG-RNG project sizes have a wide range

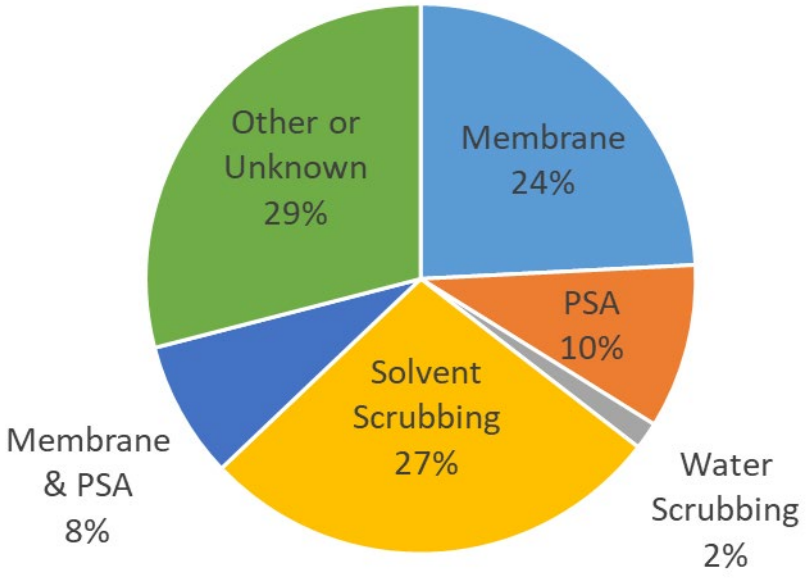
RNG Delivery Method / Project Type	Number of Projects	Project Size - LFG Flow (cfm)
Local / CNG	6	49 to 201 (average 145)
Local / LNG	1	2,500
Pipeline Injection / Vehicle Fuel	49	413 to 10,417 (average 2,975)
Pipeline Injection / Industrial, Electricity or Other	6	757 to 5,833 (average 2,775)

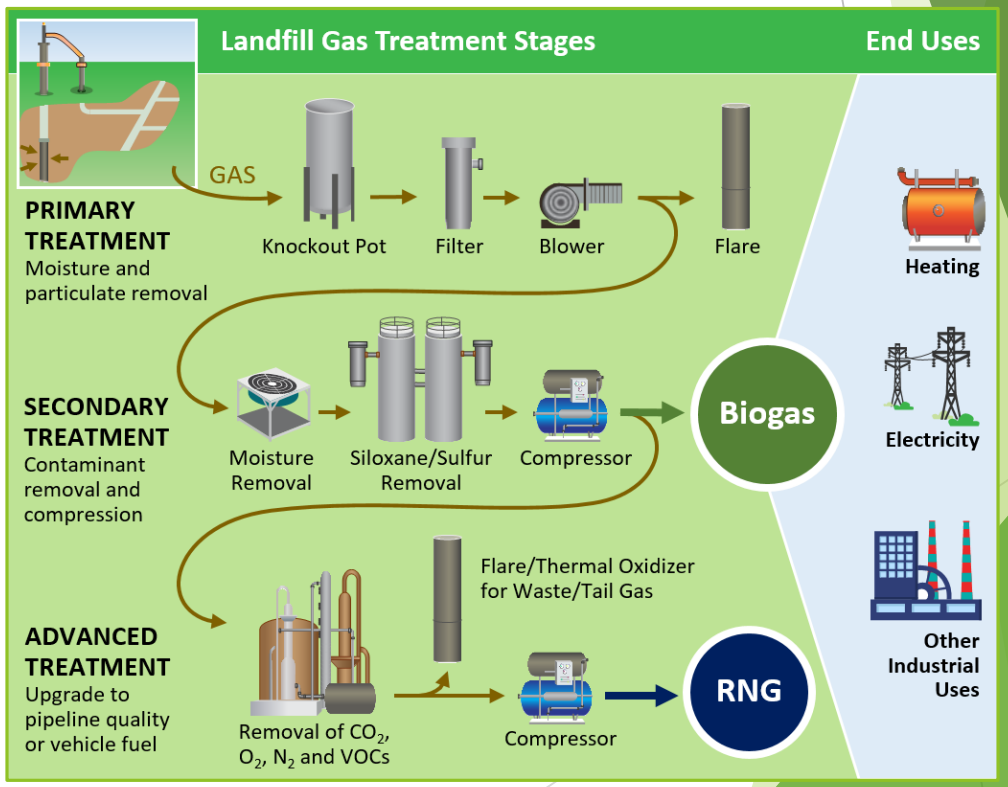
Data from LMOP's Landfill and Landfill Gas Energy Database as of July 2019

Equipment to Clean LFG-RNG

- Solvent scrubbing and membrane systems are most popular for removing CO_2 from LFG

CO_2 Removal Technologies for U.S. LFG-to-RNG Projects in 2017





Data for pie chart: Mintz, M. P. Vos, M. Tomich and A. Blumenthal. Database of Renewable Natural Gas (RNG) Projects. Argonne National Laboratory. October 2018. https://www.anl.gov/es/reference/renewable-natural-gas-database

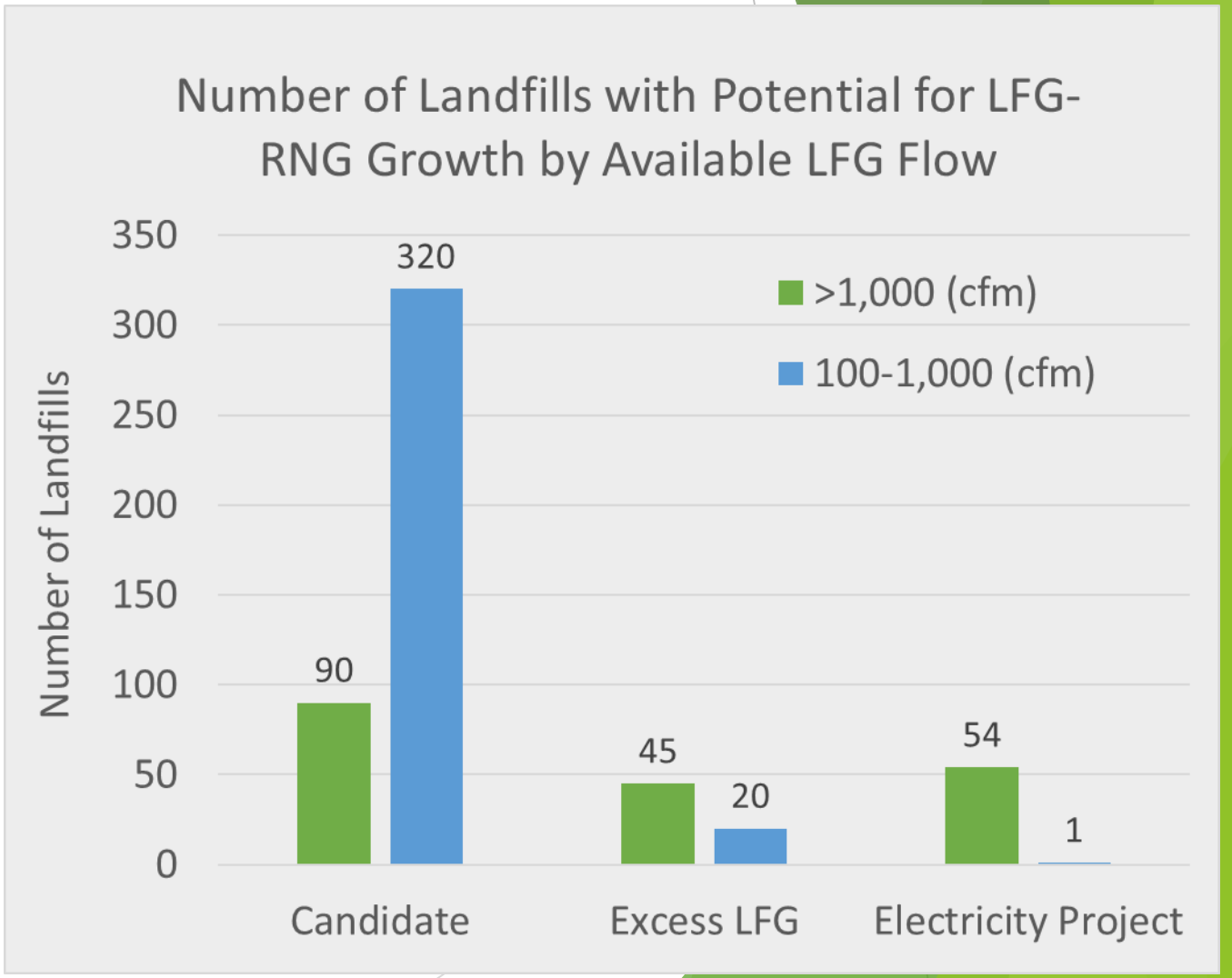
Move from Medium-Btu to RNG

- LMOP Database shows these project type changes:
  - 13 landfills: electricity project to RNG project*
  - 7 landfills: direct-use project to RNG project*
- Reasons for switch usually economic
  - Depressed prices for electricity or medium-Btu LFG
  - High maintenance costs for aging equipment
  - Renewable fuel incentives offer higher return on investment

*Landfill has an operational, under-construction or planned RNG project and information indicates the landfill or project owner made a deliberate decision to switch from a medium-Btu project type to RNG. Data are from LMOP's Landfill and Landfill Gas Energy Database as of July 2019.

Potential for LFG-RNG Growth

- Candidate landfills
- Landfills with excess LFG
- Landfills with electricity projects near end of PPA



Data from LMOP's Landfill and Landfill Gas Energy Database as of July 2019

Tools for RNG Project Development

LFGcost-Web

RNG Project Type	Tab in Model	Model's Recommended Sizes
Large-scale RNG (High-Btu)	HBTU	1,000 to 10,000 ft^3/min LFG
Onsite CNG fueling station	CNG	50 to 600 ft^3/min LFG

- Start with known LFG flow rate or have model calculate based on landfill parameters
- Option to include incentive prices, e.g., renewable fuel credits
- Outputs include installed capital cost & O&M, internal rate of return, and years to payback

RNG Flow Rate Estimation Tool

Step 1
- Enter current LFG flow rate (scfm)
- Enter gas composition (nitrogen, methane, carbon dioxide and oxygen) or use default composition

Step 2
- Review RNG processing technology matrix
- Assess upper bound nitrogen content allowable for each technology

Step 3
- Review and rate the current condition of your wellfield in the field condition ranking matrix on a scale of 1 to 5
- Most optimal "best" is 1 to least optimal "worst" is 5

Step 4
- Select the basis of the heating value to convert the adjusted flow rate into heat rates (MMBtu/hr)

LANDFILL METHANE OUTREACH PROGRAM

LMOP Renewable Natural Gas (RNG) Flow Rate Estimation Tool

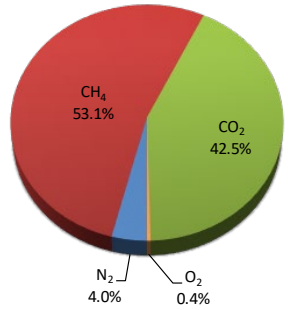
Summary Report

ABC Landfill

August 7, 2019

	Initial	Adjusted
LFG Constituents		
Nitrogen (N_2)	8.0%	4.0%
Methane (CH_4)	48.0%	53.1%
Carbon Dioxide (CO_2)	43.5%	42.5%
Oxygen (O_2)	0.5%	0.4%
Flow Rate (scfm)	2,710	2000
Heat Rate (MMBtu/hr) *(LHV basis)*	71	58

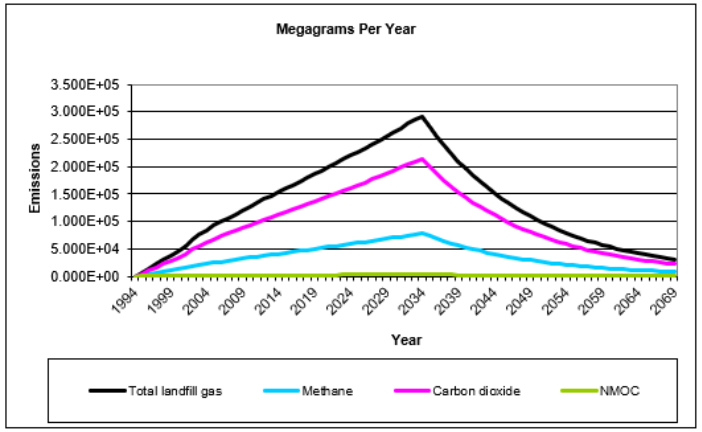
Figure 1: Adjusted Gas Quality

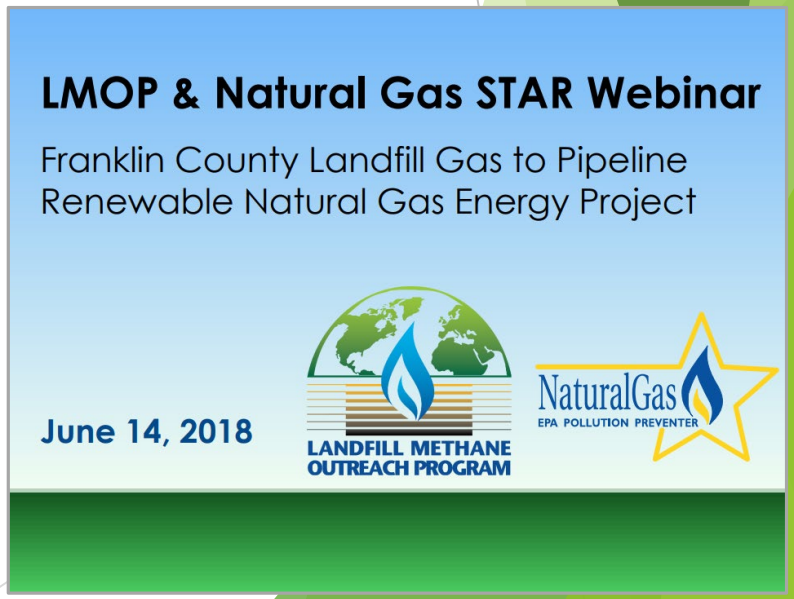


- Both tools available at epa.gov/lmop/list-publications-tools-and-resources

Franklin County SLF – LMOP Assisted Project

- RNG pipeline injection project
  - Operational in 2014
  - LFG volume increasing each year
  - Gas flow to project in 2018: 5,400 scfm
- Landfill owner and project developer are LMOP Partners
- Receiving gas distribution company is a Natural Gas STAR Partner
- LMOP involvement:
  - Assisted with LandGEM, modeled gas curve to show expected LFG generation based on waste collection
  - Provided information on RNG project development
  - Featured this project in a June 2018 webinar





How Can We Work Together

- Facilitating information sharing – project databases, webinars, listservs
- Analyzing resource availability through LFG modeling
- Performing initial feasibility analysis using *LFGcost-Web*
- Join our listserv or become a Partner
  - Sign up on www.epa.gov/lmop or www.epa.gov/agstar
  - Bring your business card to our booth (#505)

CONTACT INFO

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- RNG WORKS Exhibit Space 505