KY LANDFILL GAS TO ENERGY OVERVIEW

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Basics of Landfill Gas

- Landfill gas (LFG) contains ~50% methane, ~50% CO2, and <1% other non-methane organics.
- LFG is classified at a medium-Btu gas at 350-600 Btu/ft^3 or about half that of natural gas.
- Landfills begin producing gas in less than 1 year of waste placement and can continue to produce for 20-30 years
- 1 million tons of municipal solid waste produces:
  - ~432,000 ft^3 of LFG;
  - ~0.78 MW of power; or
  - 9MMBtu/hr of thermal energy

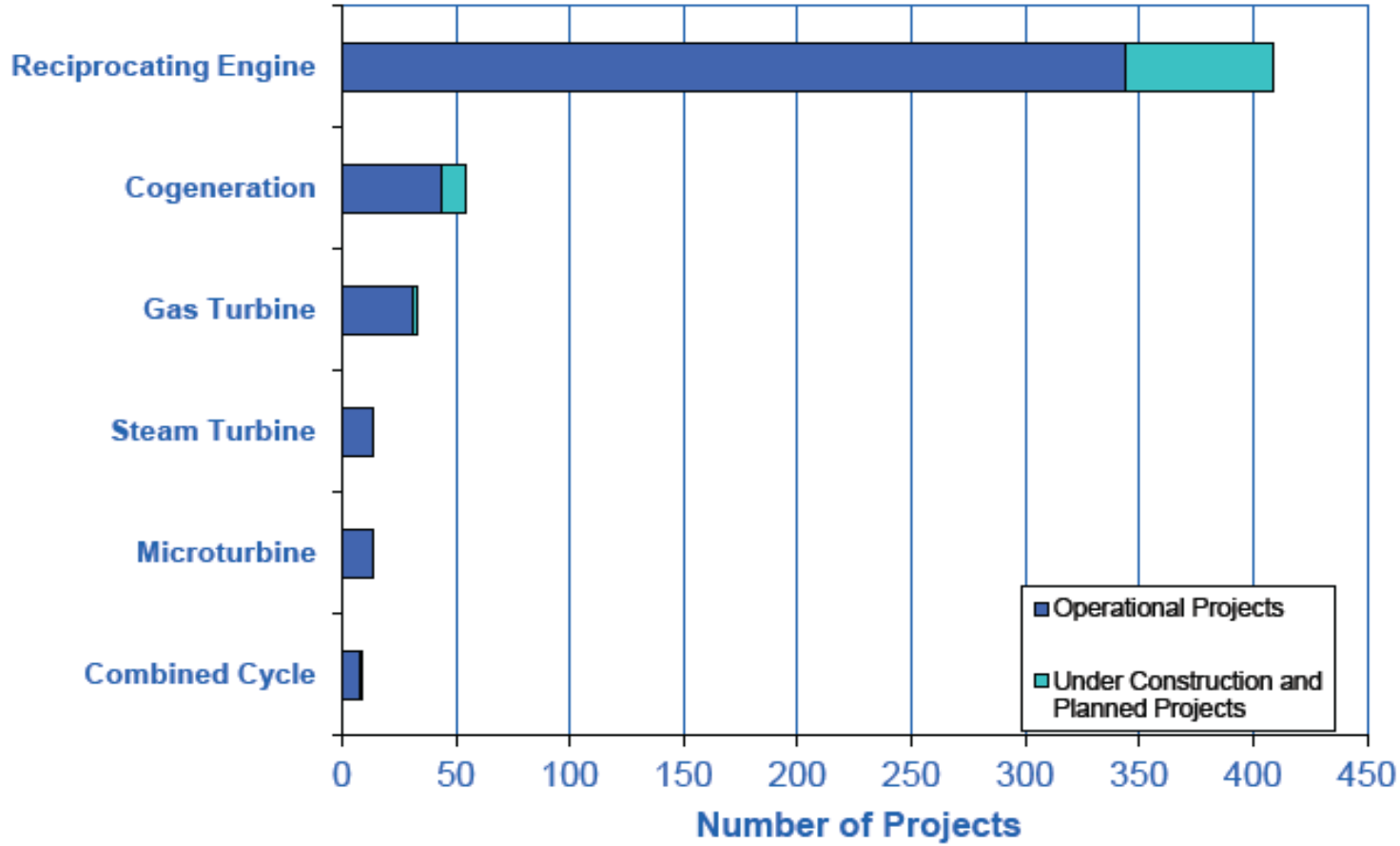
Regulatory Obligations

- Landfill New Source Performance Standard
  - Applicability
    - Maximum design capacity ≥ 2.75 million tons
    - Annual estimated uncontrolled non-methane organic compound emissions greater than 55 tons per year
  - Requirements for LFG collection and control
    - Most systems opt for flaring over LFGTE projects

Energy Use Options

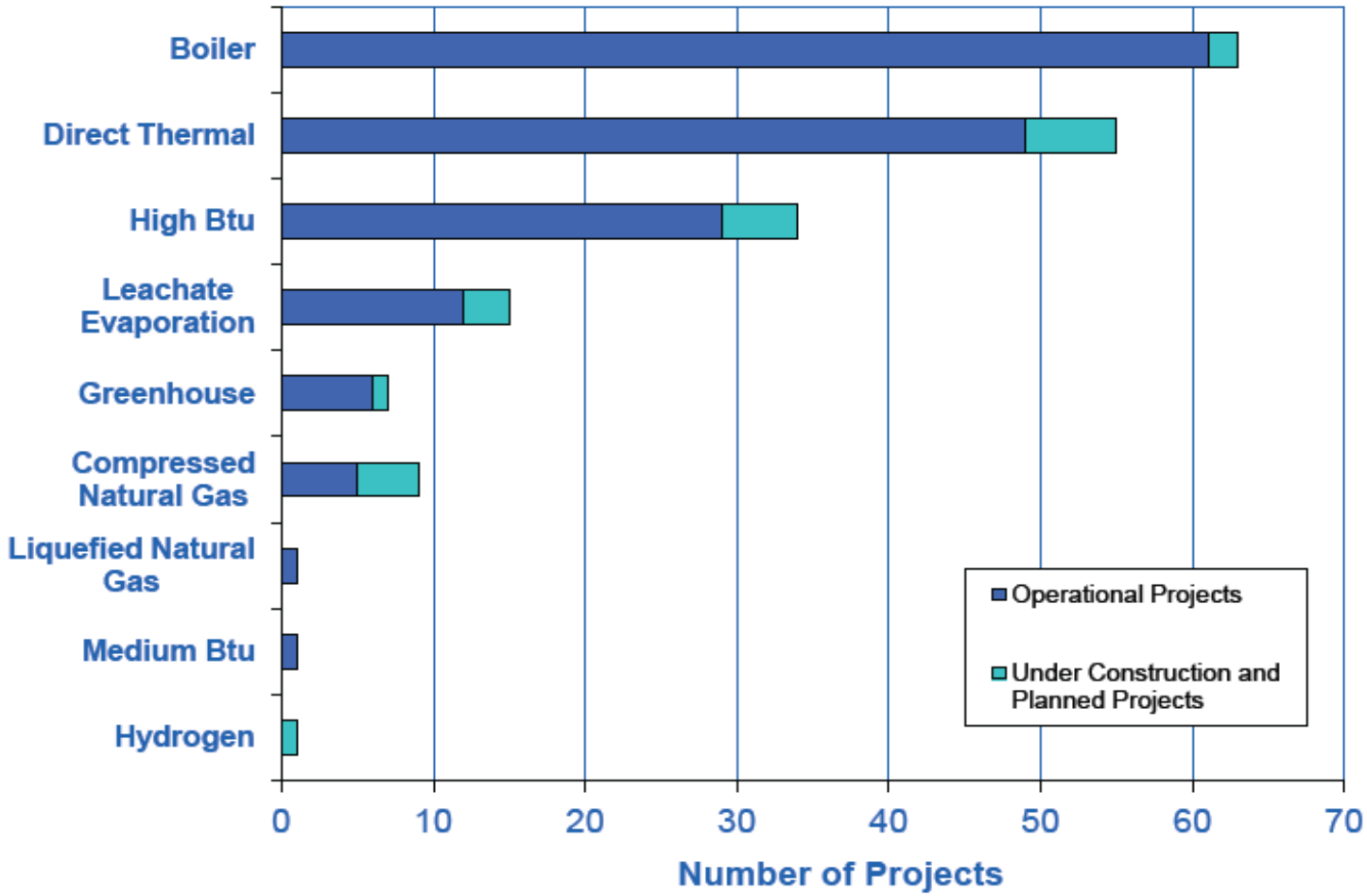
- Electricity generation
- Direct use
- Cogeneration or Combined Heat and Power
- Transportation fuel
- Nationwide over 500 projects exist in 40 states producing:
  - ~13 Billion kWh of electricity
  - ~100 Billion ft3 of LFG for direct use

Technology Trends
Electricity Projects

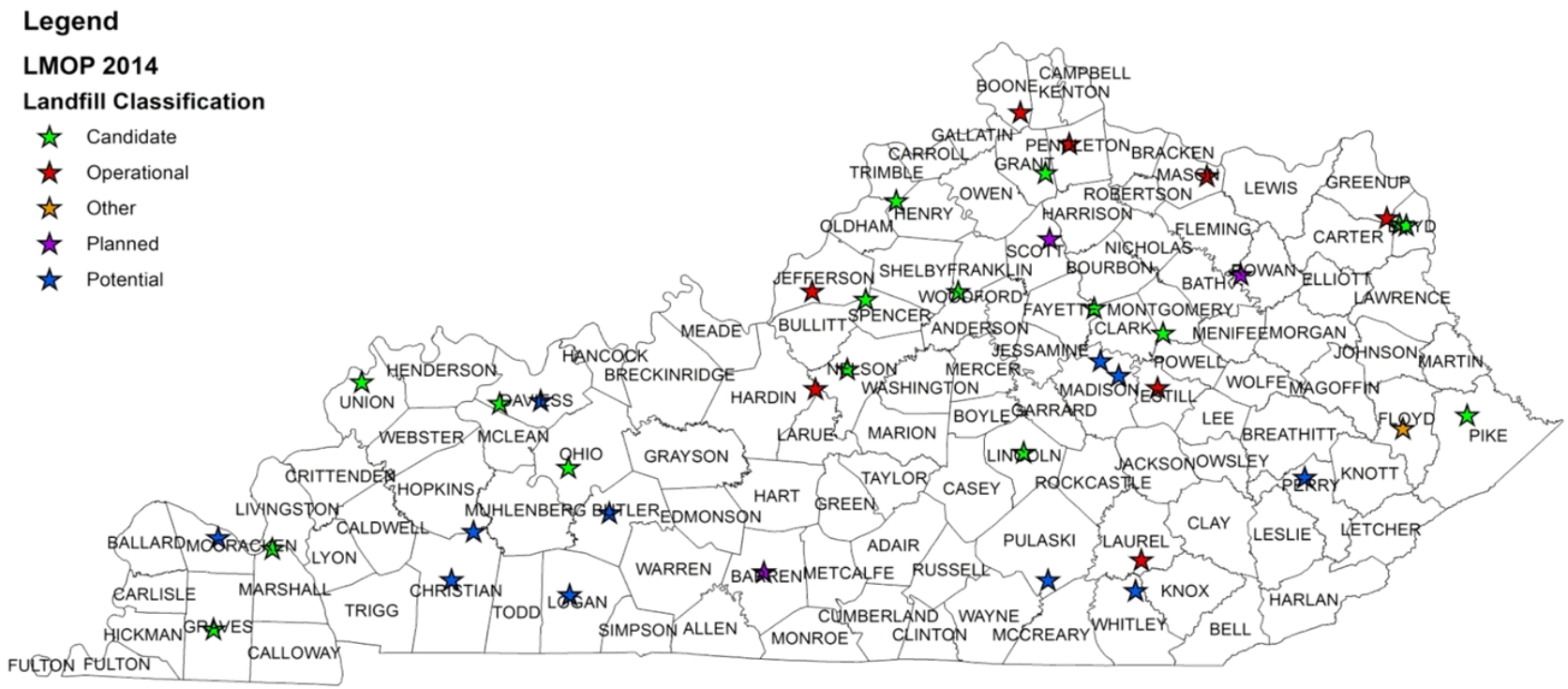


LANDFILL METHANE OUTREACH PROGRAM

Technology Trends
Direct-Use Projects



EPA Landfill Methane Outreach Project (April 2014)



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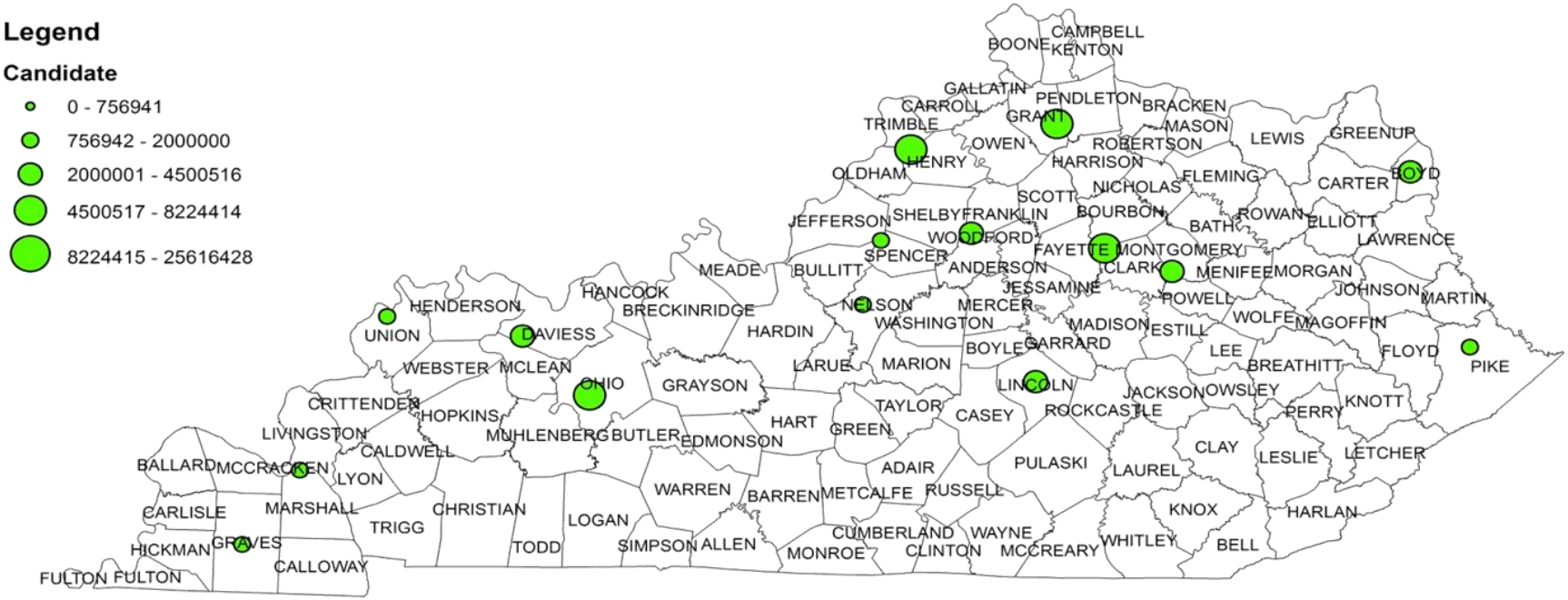

Candidate: Landfill is accepting waste or has been closed for five years or less, has at least one million tons of waste, and does not have an operational, under-construction, or planned project; can also be designated based on actual interest by the site.

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Kentucky Candidate Landfill Details

Landfill Name	County	Ownership	Status	Waste in Place (tons)	Collection System	LFG Flared (mmscfd)
Big Run Landfill	Boyd	Private	Open	756,941	Yes	0.508
Cooksey Brothers Disposal Company, Inc. LF	Boyd	Private	Closed	4,500,516	No	
West Daviess County Landfill	Daviess	Public	Open	3,500,000	Yes	0.36
Haley Pike Landfill	Fayette	Public	Closed	4,970,000	No	
Benson Valley LF	Franklin	Private	Open	3,861,778	Yes	1.76
Epperson Waste Disposal	Grant	Private	Open	6,333,360	Yes	1.89
West Kentucky Landfill	Graves	Private	Open	1,457,280	No	
Tri-K Landfill, Inc.	Lincoln	Private	Open	3,057,349	Yes	1.24
Waste Path Sanitary Landfill LLC	Marshall	Private	Open	1,321,513	No	
Rumpke/Montgomery County LF	Montgomery	Private	Open	2,519,554	No	
Nelson County SWDF	Nelson	Public	Open	1,558,900	No	
Ohio County Balefill Landfill	Ohio	Public	Open	5,881,138	Yes	1.04
Pike County Landfill	Pike	Public	Open	1,841,480	Yes	0.324
Williams LF	Spencer	Private	Open	1,295,153	No	
Valley View LF	Trimble	Private	Open	8,224,414	Yes	2.61
Dozit Company Inc. Landfill	Union	Private	Open	1,515,573	No	

Economics of LFGTE Projects

Technology	Optimal Project Size Range	Typical Capital Costs ($/kW)*	Typical Annual O&M Costs ($/kW)*
Microturbine	1 MW or less	$5,500	$380
Small internal combustion engine	1 MW or less	$2,300	$210
Large internal combustion engine	800 kW or greater	$1,700	$180
Gas turbine	3 MW or greater	$1,400	$130

* 2010 dollars.
kW: kilowatt
MW: megawatt

Component	Typical Capital Costs*	Typical Annual O&M Costs*
Gas compression and treatment	$960/scfm	$90/scfm
Gas pipeline and condensate management system	$330,000/mile	Negligible

* 2010 dollars, based on a 1,000 scfm system.
scfm: standard cubic feet per minute

Example Financials #1

Economic Performance Parameter	3 MW Engine Project (With Collection and Flaring System Costs)*		Direct-Use Project (5 Mile — With Collection and Flaring System Costs)*	
	Private**	Municipal†	Private**	Municipal†
Net present value‡	($3,508,256)	($2,898,667)	$476,674	$2,761,909
Internal rate of return	-7%	-5%	14%	24%
Net present value payback (years)	None		12	6
Capital costs‡	$7,631,513		$4,629,695	
O&M costs‡	$884,764		$408,089	

* For the internal combustion engine projects, the electricity sale price is 6¢/kWh; for direct-use projects, the LFG price is $5/MMBtu.

** 20% down payment, 8% interest rate. See case named "Electricity 2" in Appendix 4-A for the internal combustion engine project and "Direct Use 2" in Appendix 4-B for the direct-use project.

† 20% down payment, 80% municipal bond, 6% discount rate. See case named "Electricity 9" in Appendix 4-A for the internal combustion engine project and "Direct Use 8" in Appendix 4-B for the direct-use project.

‡ 2010 dollars.

Example Financials #2

Economic Performance Parameter	3 MW Engine Project (Without Collection and Flaring System Costs)*		Direct-Use Project (5 Mile – Without Collection and Flaring System Costs)*	
	Private**	Municipal†	Private**	Municipal†
Net present value‡	$587,078	$3,303,608	$3,145,698	$7,501,924
Internal rate of return	14%	24%	57%	92%
Net present value payback (years)	12	7	3	2
Capital costs‡	$5,150,800		$2,779,773	
O&M costs‡	$526,317		$128,782	

* For the internal combustion engine projects, the electricity sale price is 6¢/kWh; for direct-use projects, the LFG price is $5/MMBtu.

** 20% down payment, 8% interest rate. See case named "Electricity 1" in Appendix 4-A for the engine project and "Direct Use 1" in Appendix 4-B for the direct-use project.

† 20% down payment, 80% municipal bond, 6% discount rate. See case "Electricity 7" in Appendix 4-A for the engine project and "Direct Use 6" in Appendix 4-B for the direct-use project.

‡ 2010 dollars.

Conditions for Success in Kentucky

- Preferred approach is to sell the gas rather than electricity.
- Projects where the electricity generated is owned by the utility.
- Projects where LFG collection system is already in place.
- Direct use locations <5 mile radius from landfill.
- Private companies that have
  - a sustainability goal; and
  - resources for a LFGTE project
- Locations
  - TVA pays a premium on renewable electricity generated within their territory.
  - Municipal owned utilities may find that local generation is advantageous over purchased power.
  - Landfill projects located in a Regional Transmission Organization (RTO) could sell into Demand Response Markets.
- Staff expertise to handle increased regulatory requirements.

Barriers to LFGTE Projects

- Third-party Purchase Power Agreements (PPA) and the conflict with territory boundary laws.
- Utility avoided costs rates are low.

Benefits of Projects

- Provides a cost effective means of reducing methane emissions.
- Can serve as a compliance tool to mitigate:
  - Odor issues (improves local air quality) or
  - Methane migration from landfill into soils and groundwater
- Generates Renewable Energy Credits (RECs), creating a revenue stream.
- Can provide reliable electricity in areas that may suffer from grid instability

Looking Ahead

- Landfills are listed in the March 2014 President's Climate Action Plan: Strategy to Reduce Methane Emissions
  - Summer 2014, EPA will propose updated standards for new landfills; and
  - Take public comment on updating standards for existing landfills
  - Landfill Methane Outreach Program will continue working with states, industry, and local governments
- DEDI added a LFGTE webpage and will continue to work on candidate LFGTE project development.

Questions

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