Demonstration of LMOP Tools to Evaluate RNG Project Feasibility

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LANDFILL METHANE OUTREACH PROGRAM

SWANA's 42nd Annual Landfill Gas & Biogas Symposium

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Tools Covered Today

- LFGcost-Web (version 3.2)
  - Created in 2002 to help stakeholders estimate the costs of an LFG energy project
  - Peer reviewed in 2015-2016
  - Last updated May 2017: included addition of economic and job creation benefits for two project types
  - Download includes Excel-based tool & User's Manual
- RNG Flow Rate Estimation Tool
  - NEW: released November 2018

Renewable Natural Gas Flow Rate Estimation Tool (RNG Flow Tool)

RNG Flow Tool Overview

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)

RNG Flow Tool – Step 1 Inputs

Landfill Name:	SWANAPalooza Demo
LFG collected flow rate in standard cubic feet per minute (scfm): *Typical flow rates for different technologies are presented in the Technology Matrix worksheet.*	2,710
Nitrogen (N_2) concentration[1]: *Use default of 10% if actual concentration unknown.*	8.0%
Methane (CH_4) concentration: *Use default of 50% if actual concentration unknown.*	48.0%
Carbon Dioxide (CO_2) concentration[2]: *Use default of 39% if actual concentration unknown.*	43.5%
Oxygen (O_2) concentration[1]: *Use default of 1% if actual concentration unknown.*	0.5%

Direction related to nitrogen values and air intrusion will appear here if warranted:

See the 'Technology Matrix' worksheet for more information on LFG-to-RNG treatment technologies that may be suitable for your project. After reviewing the matrix, proceed to Step 2.

Constituent total:	100.0%	N_2 to O_2 Ratio:	16.0

RNG Flow Tool – Steps 2 & 3 Inputs

Nitrogen (N_2) concentration for LFG entering the treatment skid[1]: *Value must be less than or equal to the Nitrogen content in Step 1.*	4.0%	CH_4 concentration:	53.1%
		CO_2 concentration[2]:	42.5%
		O_2 concentration[1]:	0.4%

Go to TECHNOLOGY MATRIX for nitrogen ranges for various LFG-to-RNG treatment technologies.

Review 'Field Condition Ranking Matrix' worksheet and select a corresponding field condition compensation factor. From this step, an adjusted flow rate is calculated to represent the inlet flow rate to the RNG processing plant.

Go to FIELD CONDITION RANKING MATRIX

Select field condition compensation factor: *Ranking of field conditions range from most optimal "best" (1) to least optimal "worst" (5) conditions which could affect air infiltration/intrusion in the collection system. Ranking is subjective and varies from site to site, and can only be designated by personnel familiar with the site.*	2	Calculated inlet flow rate (scfm) to RNG processing plant:	2,000
		at estimated methane content of:	53.1%
Calculated LFG flow rate reduction factor:	1.2		

Note: If you are using LFGcost-Web to estimate the cost of an RNG or onsite CNG project, you should select Defined by User as the LFG energy project size in cell D26 of the LFGcost-Web 'INP-OUT' worksheet and enter this inlet flow rate into the project design size in cell D28 of the 'INP-OUT' worksheet. You should also enter the inlet methane content in cell D32 of the 'INP-OUT' worksheet.

Summary Report

SWANAPalooza Demo

February 6, 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

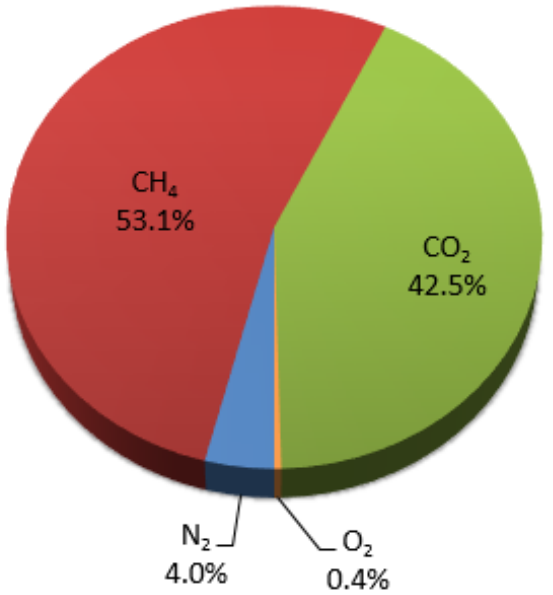


Figure 2: Comparison of Initial and Adjusted LFG Flow Rate

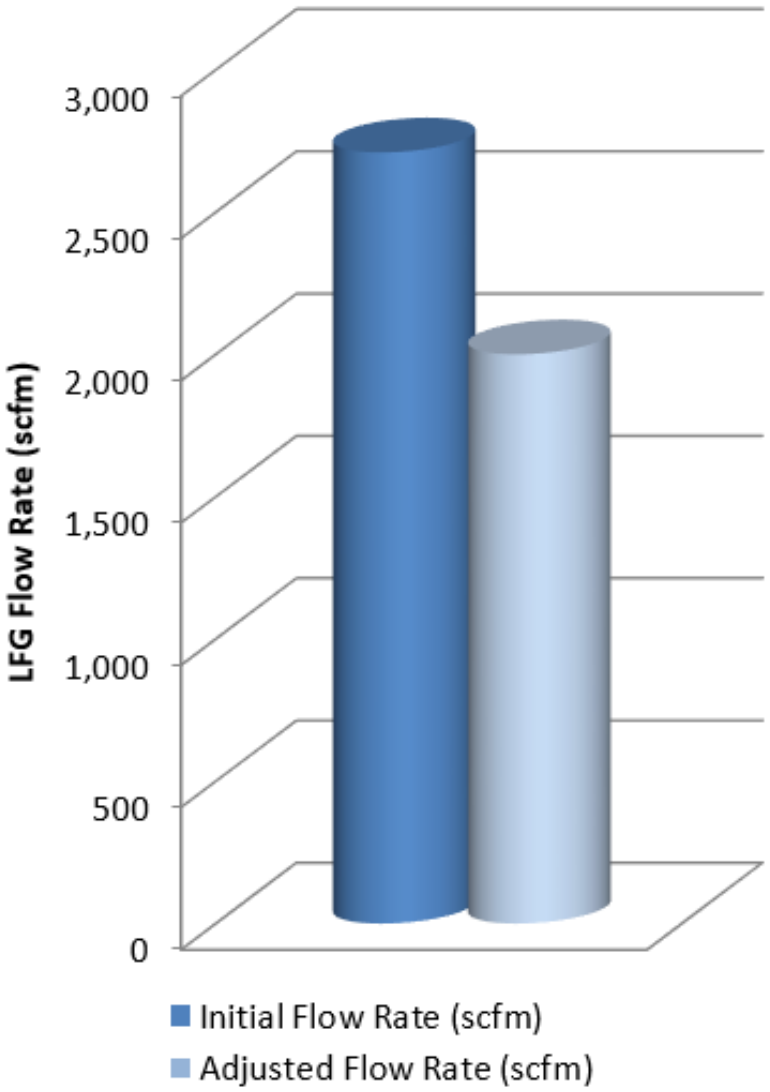
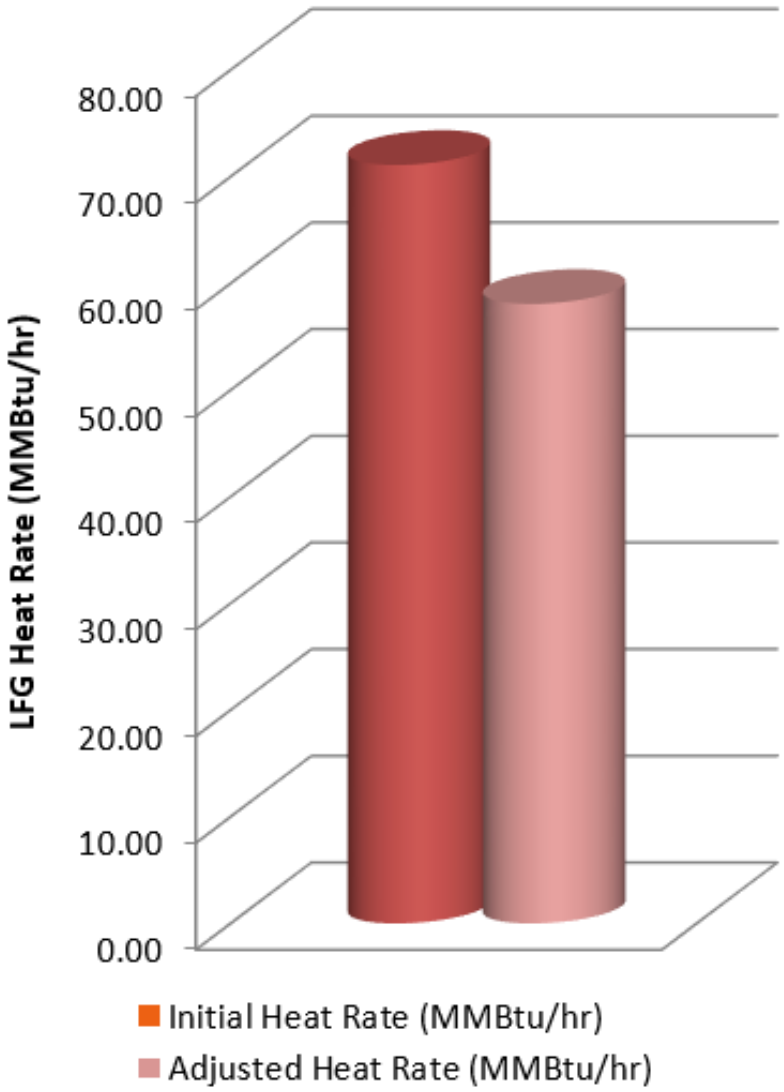


Figure 3: Comparison of Initial and Adjusted LFG Heat Rate (LHV basis)



Landfill Gas Energy Cost Model (LFGcost-Web)

Landfill Gas Energy Cost Model

LFGcost-Web

U.S. Environmental Protection Agency
Landfill Methane Outreach Program (LMOP)

Version 3.2
May 2017

CONTINUE

LANDFILL METHANE OUTREACH PROGRAM

LFGcost-Web: Available Project Types

Non-Electricity Project Types	Tab in Model	Model's Recommended Sizes
Collection and Flare – no energy recovery	C&F	10 acres or more
Large-scale RNG (High-Btu)	HBTU	1,000 to 10,000 ft^3/min LFG
Onsite CNG fueling stations	CNG	50 to 600 ft^3/min LFG
Direct LFG utilization (direct-use)	DIR	400 to 3,000 ft^3/min LFG
Boiler retrofit	BLR	3,000 ft^3/min LFG or less
Leachate Evaporators	LCH	5,000 gallons leachate per day and greater

LFGcost-Web: Available Project Types

Electricity Project Types	Tab in Model	Model's Recommended Sizes
Standard turbine-generator sets	TUR	Greater than 3 MW
Standard reciprocating engine-generator sets	ENG	800 kW and greater
Microturbine-generator sets	MTUR	30 to 750 kW
Small reciprocating engine-generator sets	SENG	100 kW to 1 MW
CHP reciprocating engine-generator sets	CHPE	800 kW and greater
CHP turbine-generator sets	CHPT	Greater than 3 MW
CHP microturbine-generator sets	CHPM	30 to 300 kW

Model Inputs: Known LFG Target Flow Rate

- Required Inputs
  - Project Start Year and Project Type
  - Include collection and flaring costs? (Yes or No)
  - Pipeline distances for Direct-use, High-Btu, and CHP projects
  - Project-specific inputs for Leachate Evaporator and Boiler Retrofit
  - Select Defined by User for LFG Energy Project Size
  - Enter Design flow rate (ft^3/min LFG)
- Optional Inputs
  - Project lifetime, operating schedule
  - Financial parameters (i.e., interest rate, incentives, commodity prices)
  - Electricity region

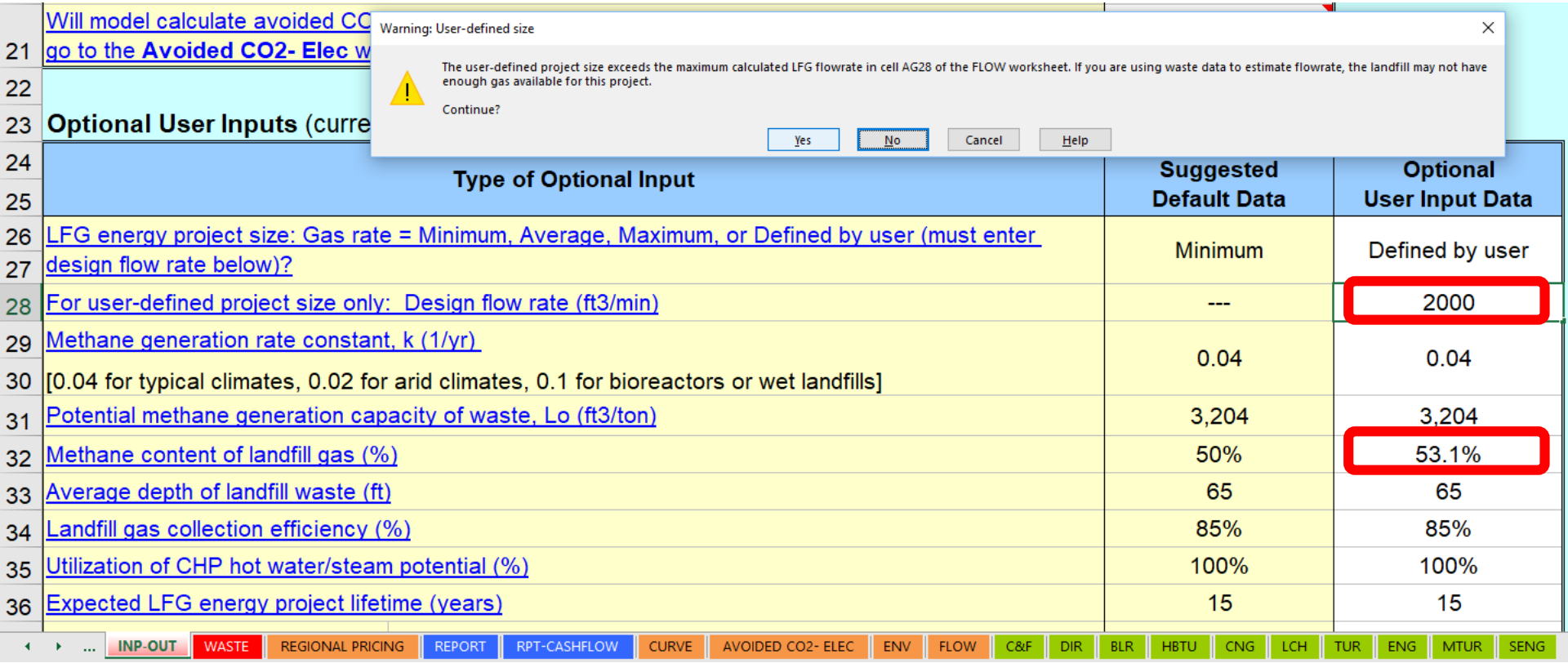
LFGcost-Web: Model Outputs

- Initial Economic Feasibility Screening for Project
  - Project size
  - Installed capital cost
  - Annual costs (O&M)
  - Internal rate of return
  - Net present value (NPV) at year of construction
  - Years to payback
- Regional Economic Impacts (Direct-use and Standard Reciprocating Engine-Generators only)
  - Jobs created within the state
  - Earnings impact within the state ($000)
  - State-wide economic output ($000)

Example Inputs: RNG Project – Large Scale High-Btu with Known Flow Rate (2,000 scfm)

	A	B	C
5	**Type of Input Required**		**Required Input Data**
6	Year landfill opened		
7	Year of landfill closure		
8	Area of LFG wellfield to supply project (acres) [assumes 1 well/acre]		
9	Method for entering waste acceptance data [CHOOSE ONLY ONE METHOD]:	Average annual waste acceptance rate (tons/yr)	
10		Waste acceptance rate calculator (in WASTE worksheet)	Go to WASTE
11		Annual waste disposal history (in WASTE worksheet)	Go to WASTE
12	LFG energy project type [refer to recommended sizes in INST worksheet when selecting]		High Btu
13	Will LFG energy project cost include collection and flaring costs? (Y)es or (N)o		N
14	***For Leachate Evaporator projects:*** Amount of leachate collected (gal/yr)		
15	***For Boiler Retrofits:*** Will boiler retrofit costs be combined with direct-use project costs? (Y)es or (N)o		
16	***For Boiler Retrofits:*** Distance between end user's property boundary and boiler (miles)		
17	***For Direct-use, High Btu, and CHP projects:***		0.5
18	Distance between landfill and end use, pipeline, or CHP unit (miles)		
19	***For CHP projects:*** Distance between CHP unit and hot water/steam user (miles)		
20	Year LFG energy project begins operation		2022
21	Will model calculate avoided CO2 from energy generation at electricity projects? (Y)es or (N)o. If (Y)es, go to the **Avoided CO2- Elec** worksheet to select the appropriate value.		N

Example Inputs: RNG Project – Large Scale High-Btu with Known Flow Rate (2,000 scfm)



Example Outputs: RNG Project – Large Scale High-Btu with Known Flow Rate (2,000 scfm)

Type of Output		Output Data
Economic Analysis:		
Design project size (ft3/min LFG)		2,000
Generating capacity for projects generating electricity (kW)		--
Average project size for projects NOT generating electricity:	(million ft^3/yr LFG)	977.62
[based on actual LFG use]	(ft^3/min LFG)	1,860.00
Average project size for projects generating electricity (kWh/yr)		--
Average project size for CHP projects producing hot water/steam (million Btu/yr)		--
Total installed capital cost for year of construction ($)		$11,079,741
Annual costs for initial year of operation ($)		$1,048,097
Internal rate of return (%)		-5%
Net present value at year of construction ($)		($6,078,541)
Years to Breakeven*		None

Example Inputs: RNG Project – Large Scale High-Btu with Known Flow Rate (2,000 scfm) & Fuel Credits

Adjusting the Optional Inputs for Fuel Credits:

51	Direct credits:	Greenhouse gas reduction credit ($/MTCO$_2$E)	$0.000	$0.000
52		Are direct methane reductions included in GHG credit?	Y	Y
53		Renewable electricity credit ($/kWh)	$0.000	$0.000
54		Renewable fuel credit ($/gal)	$0.000	$0.000
55		Avoided leachate disposal ($/gal) **	$0.000	$0.000
56		Construction grant ($)	$0	$0
57	Royalty payment for landfill gas utilization ($/million Btu)		$0.000	$0.000
58	Initial year product price: **	Landfill gas production ($/million Btu)	$2.25	$2.25
59		Electricity generation ($/kWh). Default is national avg. Go to **Regional Pricing** worksheet for more specific pricing.	$0.060	$0.060
60		CHP hot water/steam production ($/million Btu)	$4.00	$4.00
61		High Btu gas production ($/million Btu)	$2.25	$10.00
62		CNG production ($/gasoline gallon equivalent (GGE))	$2.00	$2.00

Ex. Outputs: RNG Project – Large Scale High-Btu with Known Flow Rate (2,000 scfm) & Fuel Credits

Type of Output		Output Data
Economic Analysis:		
Design project size (ft3/min LFG)		2,000
Generating capacity for projects generating electricity (kW)		--
Average project size for projects NOT generating electricity:	(million ft^3/yr LFG)	977.62
[based on actual LFG use]	(ft^3/min LFG)	1,860.00
Average project size for projects generating electricity (kWh/yr)		--
Average project size for CHP projects producing hot water/steam (million Btu/yr)		--
Total installed capital cost for year of construction ($)		$11,079,741
Annual costs for initial year of operation ($)		$1,048,097
Internal rate of return (%)		60%
Net present value at year of construction ($)		$25,297,003
Years to Breakeven*		3

Example Outputs: Onsite CNG Fueling Station with Known Flow Rate (500 scfm) and $1.50 RIN

	Type of Output		Output Data
6	**Economic Analysis:**		
7	Design project size (ft3/min LFG)		500
8	Generating capacity for projects generating electricity (kW)		--
9	Average project size for projects NOT generating electricity:	(million ft^3/yr LFG)	244.40
10	[based on actual LFG use]	(ft^3/min LFG)	465.00
11	Average project size for projects generating electricity (kWh/yr)		--
12	Average project size for CHP projects producing hot water/steam (million Btu/yr)		--
13	Total installed capital cost for year of construction ($)		$4,633,477
14	Annual costs for initial year of operation ($)		$839,586
15	Internal rate of return (%)		53%
16	Net present value at year of construction ($)		$5,365,336
17	Years to Breakeven*		3

Model Inputs: Have LFGcost-Web Estimate LFG Collection Flow Rates

- Required Inputs
  - **Landfill open and closure years and area of wellfield**
  - **Waste acceptance rates (historical or calculated average values)**
  - Project Start Year and Project Type
  - Include collection and flaring costs? (Yes or No)
  - Pipeline distances for Direct-use, High-Btu, and CHP projects
  - Project-specific inputs for Leachate Evaporator and Boiler Retrofit
- Optional Inputs
  - **Landfill modeling parameters**
  - Project lifetime, operating schedule
  - Financial parameters (i.e., interest rate, incentives, commodity prices)

LFGcost-Web: Other Model Outputs

- Environmental Impacts of Project
  - Amount of methane collected and destroyed
  - CO_2 equivalents of methane utilized in project
  - Amount of CO_2 from avoided energy generation

- Printable Outputs
  - Inputs / Outputs (INP-OUT)
  - Summary report (REPORT)
  - Economic benefits (ECON-BEN SUMMARY)
  - Detailed annual cash flow analysis (RPT-CASHFLOW)

Want to Learn More?

- Tools are available for download at:

epa.gov/lmop/list-publications-tools-and-resources

CONTACT LMOP

- Suggestions for new LMOP tools?
- Have data updates for large scale RNG project costs in LFGcost-Web?
- Need assistance running LFGcost-Web or other LMOP tools?