

LandGEM: Improved LFG Estimates from Customized Model Inputs

Brian Guzzone and Cortney Itle
ERG, Contractor for U.S. Environmental Protection Agency
Landfill Methane Outreach Program (LMOP)



16th LMOP Conference – January 31, 2013



Overview

- LandGEM Basics
- Tips for Using LandGEM as LFG Estimation Tool
- 3 Case Studies
 - Demonstrate customizing landfill-specific data into model input parameters to optimize results





LandGEM Basics

- Landfill Gas Emissions Model (LandGEM)
 - Developed by EPA's Office of Research and Development (ORD)
 - Current Version 3.02 released in 2005
 - First-order decomposition rate
 - Screening tool designed for Clean Air Act applicability and emissions inventories
 - As with all models -- better inputs = better estimates





When Using LandGEM to Estimate LFG Potential...

MODEL INPUTS

- Use **Inventory** model parameters to obtain average estimated LFG flow rates
 - **Methane generation rate, k**
 - Conventional – 0.04
 - Arid – 0.02
 - User-specified (e.g., 0.065 for >40 inches/yr precipitation)
 - **Potential methane generation capacity, L_o** – 100 m³/Mg (3,204 ft³/ton)





When Using LandGEM to Estimate LFG Potential...

MODEL INPUTS (Continued)

- Ignore **NMOC Concentration** input
- Adjust **Methane Content** from default of 50% if site-specific amount known





LandGEM Inputs Screen

USER INPUTS Landfill Name or Identifier:

Clear ALL Non-Parameter Inputs/Selections

1: PROVIDE LANDFILL CHARACTERISTICS

Landfill Open Year	<input type="text"/>	
Landfill Closure Year	<input type="text"/>	
Have Model Calculate Closure Year?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Waste Design Capacity	<input type="text"/>	<i>megagrams</i> ▼

Restore Default Model Parameters

2: DETERMINE MODEL PARAMETERS

Methane Generation Rate, k ($year^{-1}$)

Potential Methane Generation Capacity, L_0 (m^3/Mg)

NMOC Concentration (*ppmv as hexane*)

Methane Content (% by volume)

3: SELECT GASES/POLLUTANTS

Gas / Pollutant #1 Default pollutant parameters are currently being used by model.

Gas / Pollutant #2

Gas / Pollutant #3

Gas / Pollutant #4

Edit Existing or Add New Pollutant Parameters

Restore Default Pollutant Parameters

4: ENTER WASTE ACCEPTANCE RATES

Input Units:

Year	Input Units (Mg/year)	Calculated Units (short tons/year)
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		



Landfill Case Studies

1. Tennessee – site-specific k value for higher annual precipitation amounts
2. California – arid area k value for dry climate
3. Virgin Islands – landfill-specific waste data unavailable so used waste characterization study





Tennessee Landfill: Model Inputs

Landfill Parameter	Value
Open Year	1991
Expected Closure Year	2020
Waste-in-Place in 2004	1,300,000 tons
Calculated Waste Acceptance Rate for 1991 to 2003	Ranges from 51,600 to 169,400 tons/yr
Annual Increase Applied to Waste Acceptance Rates for 1991 to 2003	9.4%
Actual Waste Acceptance Rate for 2004	187,000 tons/yr
Average Waste Acceptance Rate for 2005 to 2019	187,000 tons/yr
Potential Methane Generation Capacity, L_0	100 m ³ /Mg (3,204 ft ³ /ton)
Methane Content	50%
Gas Collection Efficiency	85%

Black text = actual data

Red text = assumed or estimated data



Tennessee Landfill: Waste Acceptance Rates

Year	Waste Acceptance Rate (tons/yr)
1991	51,554
1992	56,926
1993	62,857
1994	69,406
1995	76,638
1996	84,623
1997	93,440
1998	103,175
1999	113,925
2000	125,795
2001	138,902
2002	153,374
2003	169,355
2004	187,000
2005	187,000

Year	Waste Acceptance Rate (tons/yr)
2006	187,000
2007	187,000
2008	187,000
2009	187,000
2010	187,000
2011	187,000
2012	187,000
2013	187,000
2014	187,000
2015	187,000
2016	187,000
2017	187,000
2018	187,000
2019	187,000



LandGEM Inputs for TN Landfill

USER INPUTS

Landfill Name or Identifier: Tennessee Landfill

Clear ALL Non-Parameter
Inputs/Selections

1: PROVIDE LANDFILL CHARACTERISTICS

Landfill Open Year	1991	
Landfill Closure Year	2020	
Have Model Calculate Closure Year?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Waste Design Capacity		megagrams

Restore Default Model
Parameters

2: DETERMINE MODEL PARAMETERS

Methane Generation Rate, k (year^{-1}) **User-specified k value should be based on site-specific data and determined by EPA Method 2E.**

User-specified: User-specified value:

Potential Methane Generation Capacity, L_0 (m^3/Mg)

Inventory Conventional - 100

NMOC Concentration (*ppmv as hexane*)

CAA - 4,000

Methane Content (% by volume)

CAA - 50% by volume

3: SELECT GASES/POLLUTANTS

Gas / Pollutant #1 **Default pollutant parameters are currently being used by model.**

Total landfill gas

Gas / Pollutant #2

Methane

Gas / Pollutant #3

Carbon dioxide

Gas / Pollutant #4

NMOC

Edit Existing or Add
New Pollutant
Parameters

Restore Default
Pollutant
Parameters

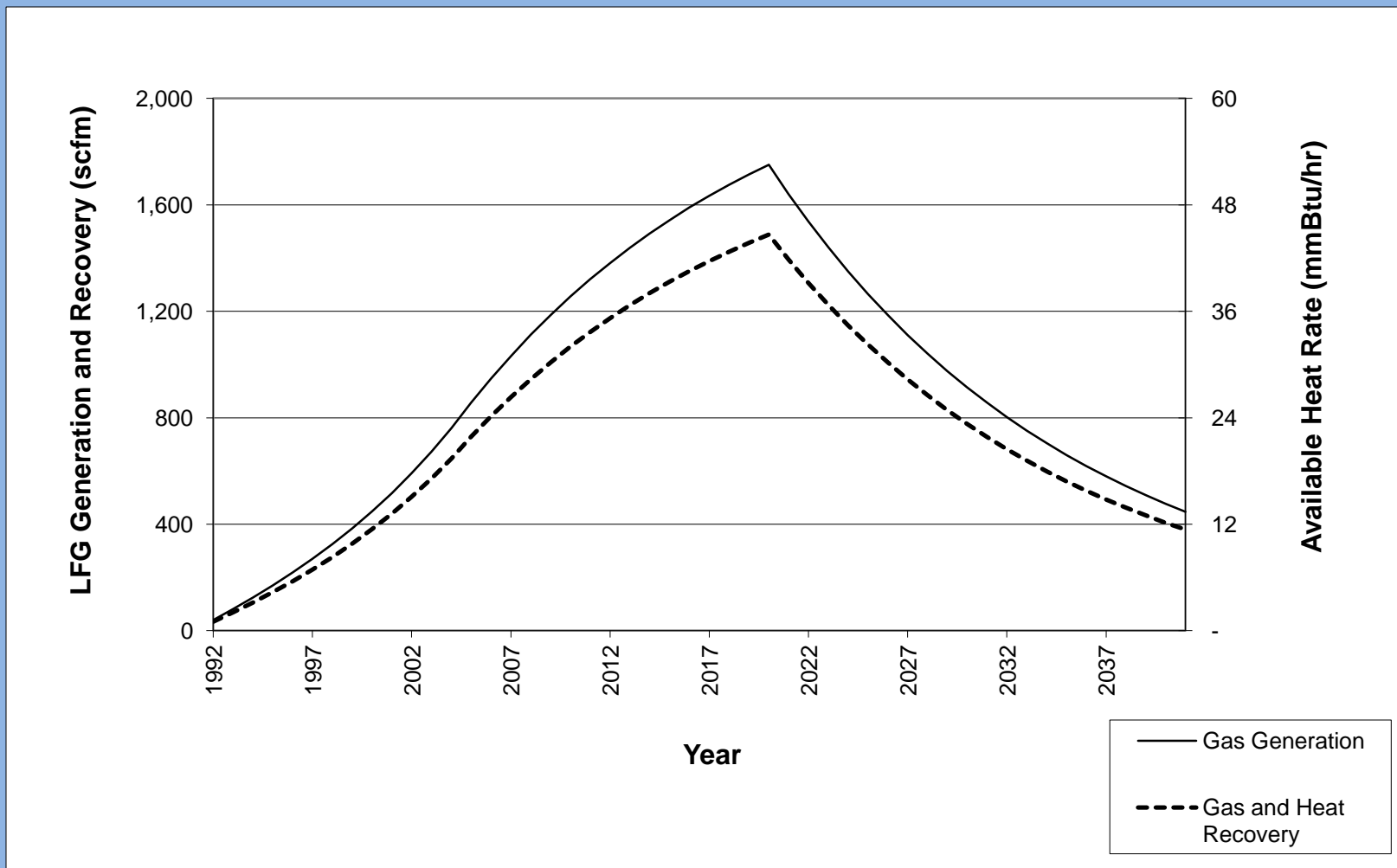
4: ENTER WASTE ACCEPTANCE RATES

Input Units:

Year	Input Units (short tons/year)	Calculated Units (Mg/year)
1991	51,554	46,867
1992	56,926	51,751
1993	62,857	57,143
1994	69,406	63,096
1995	76,638	69,671
1996	84,623	76,930
1997	93,440	84,945
1998	103,175	93,796
1999	113,925	103,568
2000	125,795	114,359
2001	138,902	126,275
2002	153,374	139,431
2003	169,355	153,959
2004	187,000	170,000
2005	187,000	170,000
2006	187,000	170,000
2007	187,000	170,000
2008	187,000	170,000
2009	187,000	170,000
2010	187,000	170,000
2011	187,000	170,000
2012	187,000	170,000
2013	187,000	170,000
2014	187,000	170,000

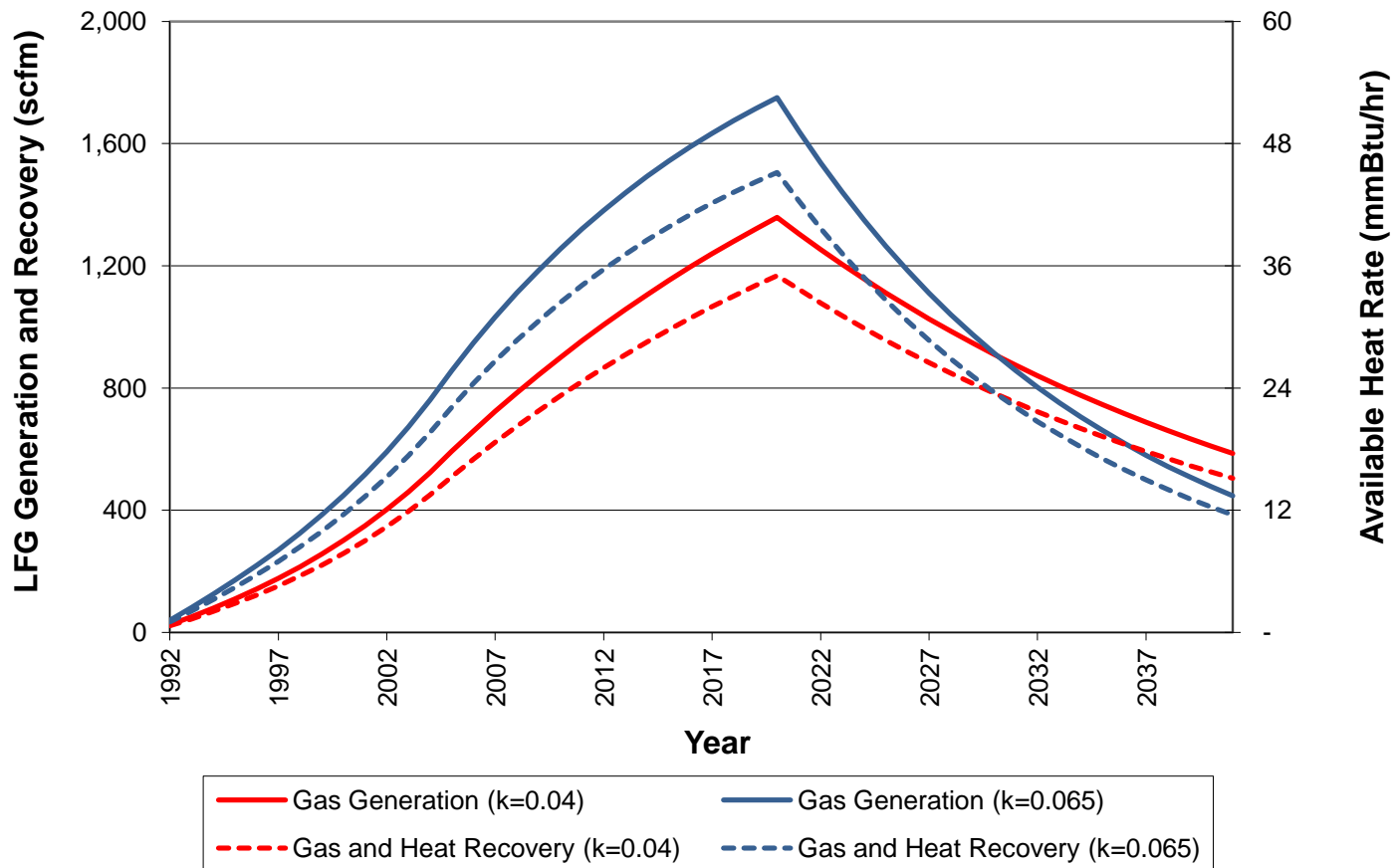


Tennessee Landfill: Gas Curve ($k = 0.065$)





Tennessee Landfill: Gas Curve (k = 0.065 and 0.04)





California Landfill: Model Inputs

Landfill Parameter	Value
Open Year	1970
Expected Closure Year	2008
Waste-in-Place in 2000	1,614,000 tons
Calculated Waste Acceptance Rate for 1970 to 1999	53,800 tons/yr
Actual Waste Acceptance Rate for 2004	63,700 tons/yr
Average Waste Acceptance Rate for 2000 to 2007	63,700 tons/yr
Potential Methane Generation Capacity, L_0	100 m ³ /Mg (3,204 ft ³ /ton)
Methane Content	50%
Gas Collection Efficiency	85%

Black text = actual data

Red text = assumed or estimated data



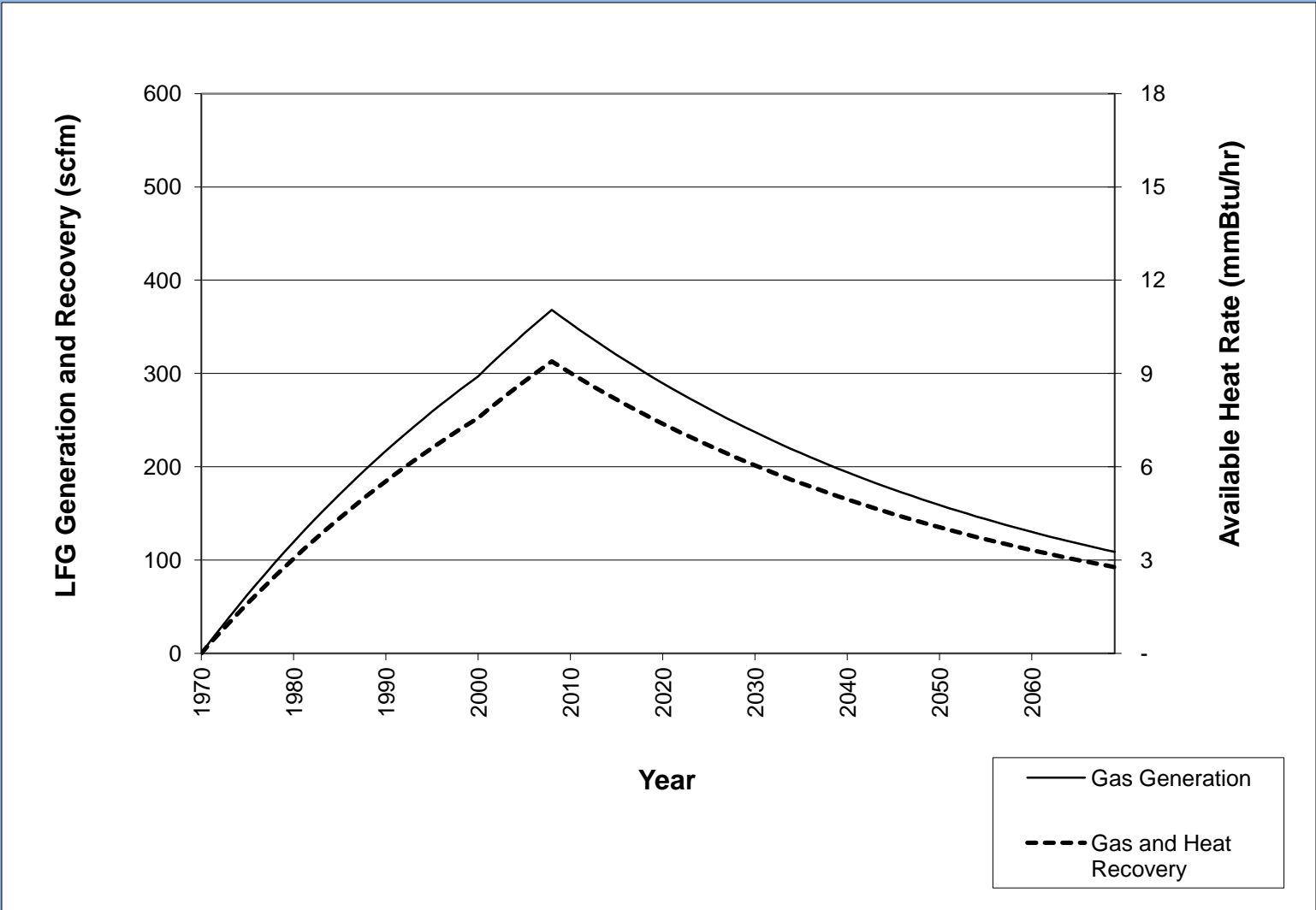
California Landfill: Waste Acceptance Rates

Year	Waste Acceptance Rate (tons/yr)
1970	53,800
1971	53,800
1972	53,800
1973	53,800
1974	53,800
1975	53,800
1976	53,800
1977	53,800
1978	53,800
1979	53,800
1980	53,800
1981	53,800
1982	53,800
1983	53,800
1984	53,800
1985	53,800
1986	53,800
1987	53,800
1988	53,800

Year	Waste Acceptance Rate (tons/yr)
1989	53,800
1990	53,800
1991	53,800
1992	53,800
1993	53,800
1994	53,800
1995	53,800
1996	53,800
1997	53,800
1998	53,800
1999	53,800
2000	63,700
2001	63,700
2002	63,700
2003	63,700
2004	63,700
2005	63,700
2006	63,700
2007	63,700

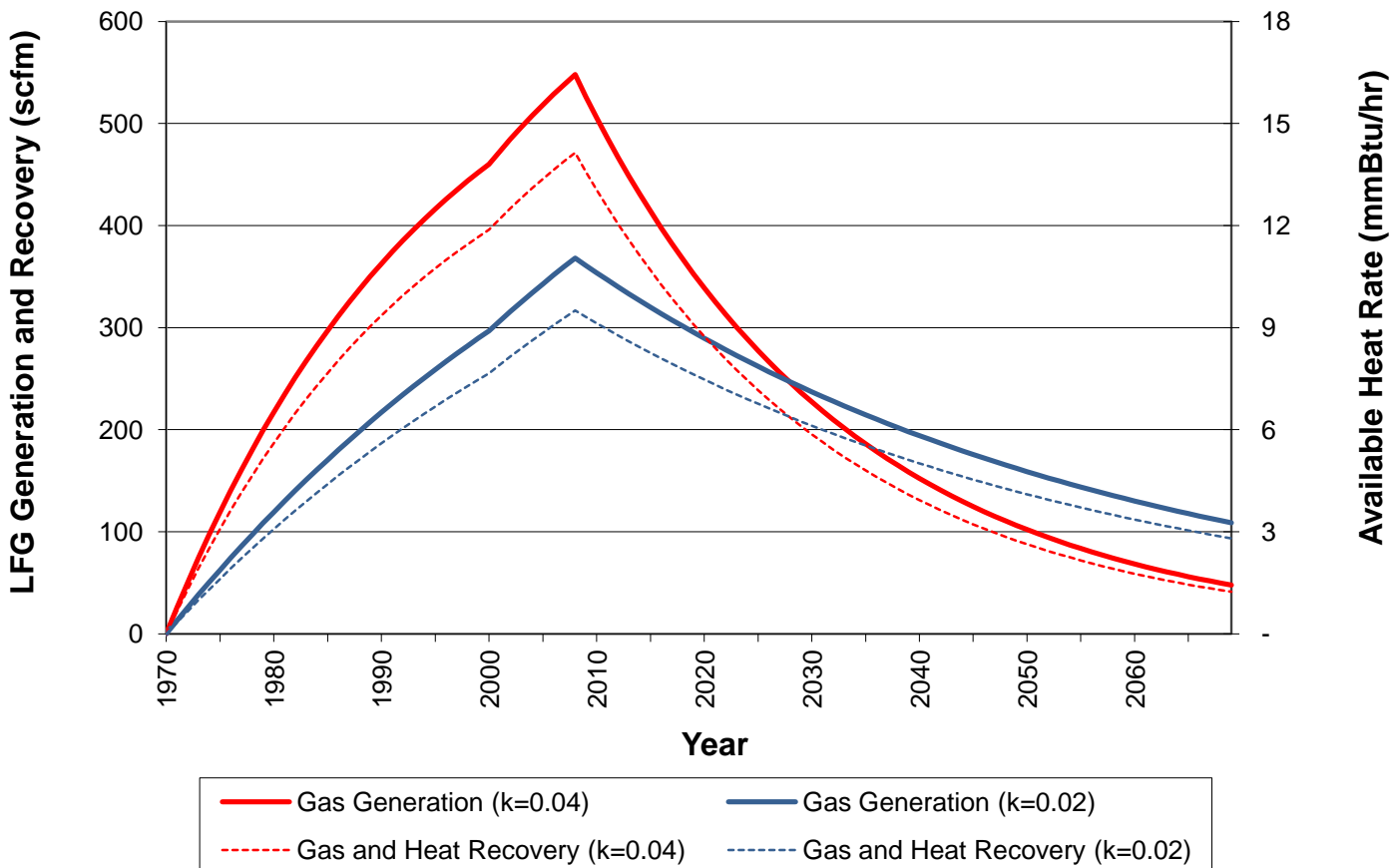


California Landfill: Gas Curve (k = 0.02)





California Landfill: Gas Curve (k = 0.02 and 0.04)





Virgin Islands Landfill: Model Inputs

Landfill Parameter	Value
Open Year	1980
Expected Closure Year	2012
Actual Waste Acceptance Rate for 1980	51,100 tons/yr
Annual Increase Applied to Waste Acceptance Rates for 1981 to 2008	3.2%
Annual Decrease Applied to Waste Acceptance Rates for 2009 to 2011	5%
Putrescible Portion of Waste Stream	77.5%
Potential Methane Generation Capacity, L_0	100 m ³ /Mg (3,204 ft ³ /ton)
Methane Content	50%
Gas Collection Efficiency	65%

Black text = actual data

Red text = assumed or estimated data



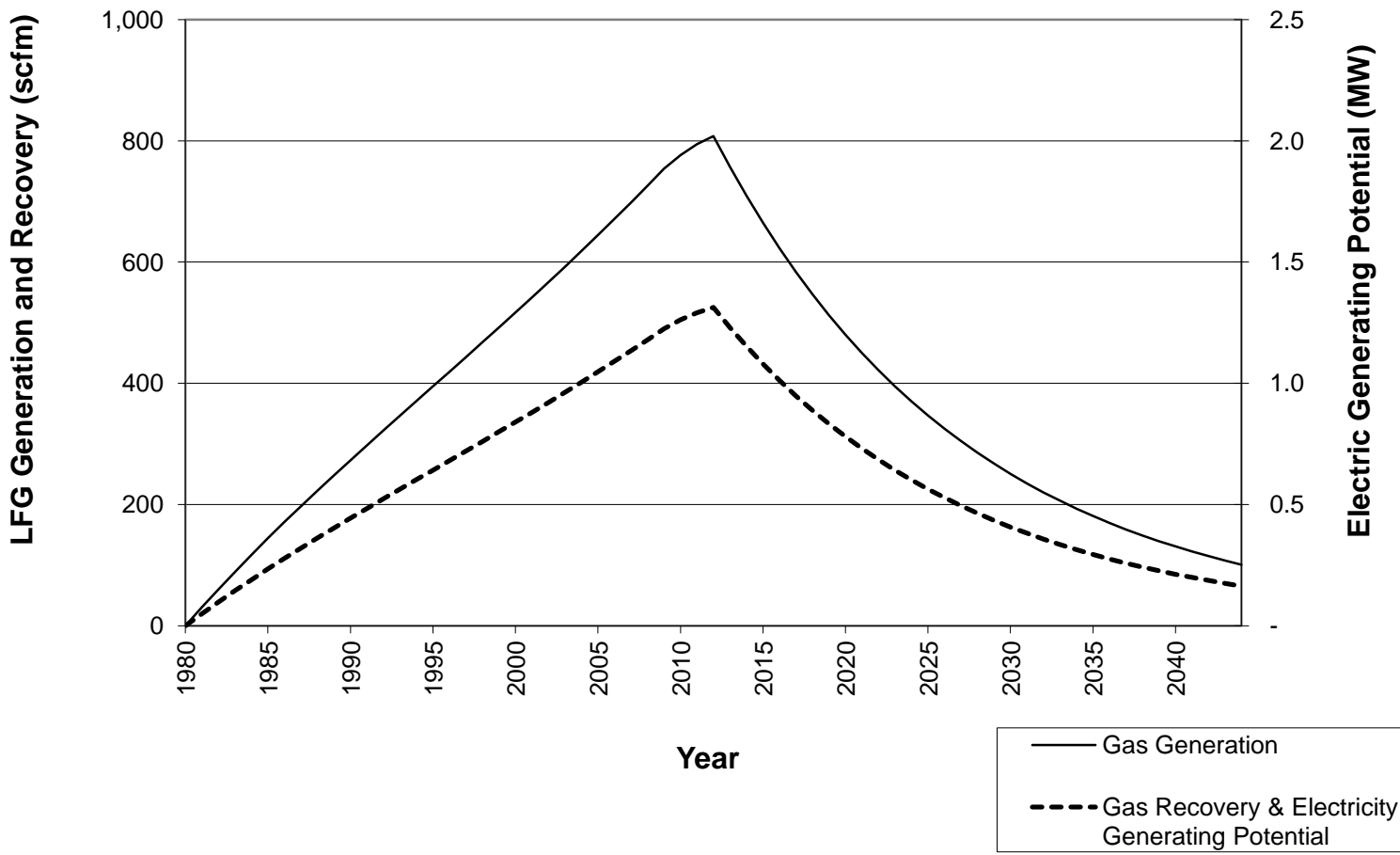
Virgin Islands Landfill: Waste Acceptance Rates

Year	Waste Acceptance Rate (tons/yr)
1980	39,600
1981	40,900
1982	42,200
1983	43,600
1984	45,000
1985	46,400
1986	47,900
1987	49,400
1988	51,000
1989	52,600
1990	54,300
1991	56,000
1992	57,800
1993	59,700
1994	61,600
1995	63,600

Year	Waste Acceptance Rate (tons/yr)
1996	65,600
1997	67,700
1998	69,900
1999	72,100
2000	74,400
2001	76,800
2002	79,300
2003	81,800
2004	84,400
2005	87,100
2006	89,900
2007	92,800
2008	95,700
2009	91,000
2010	86,400
2011	82,100

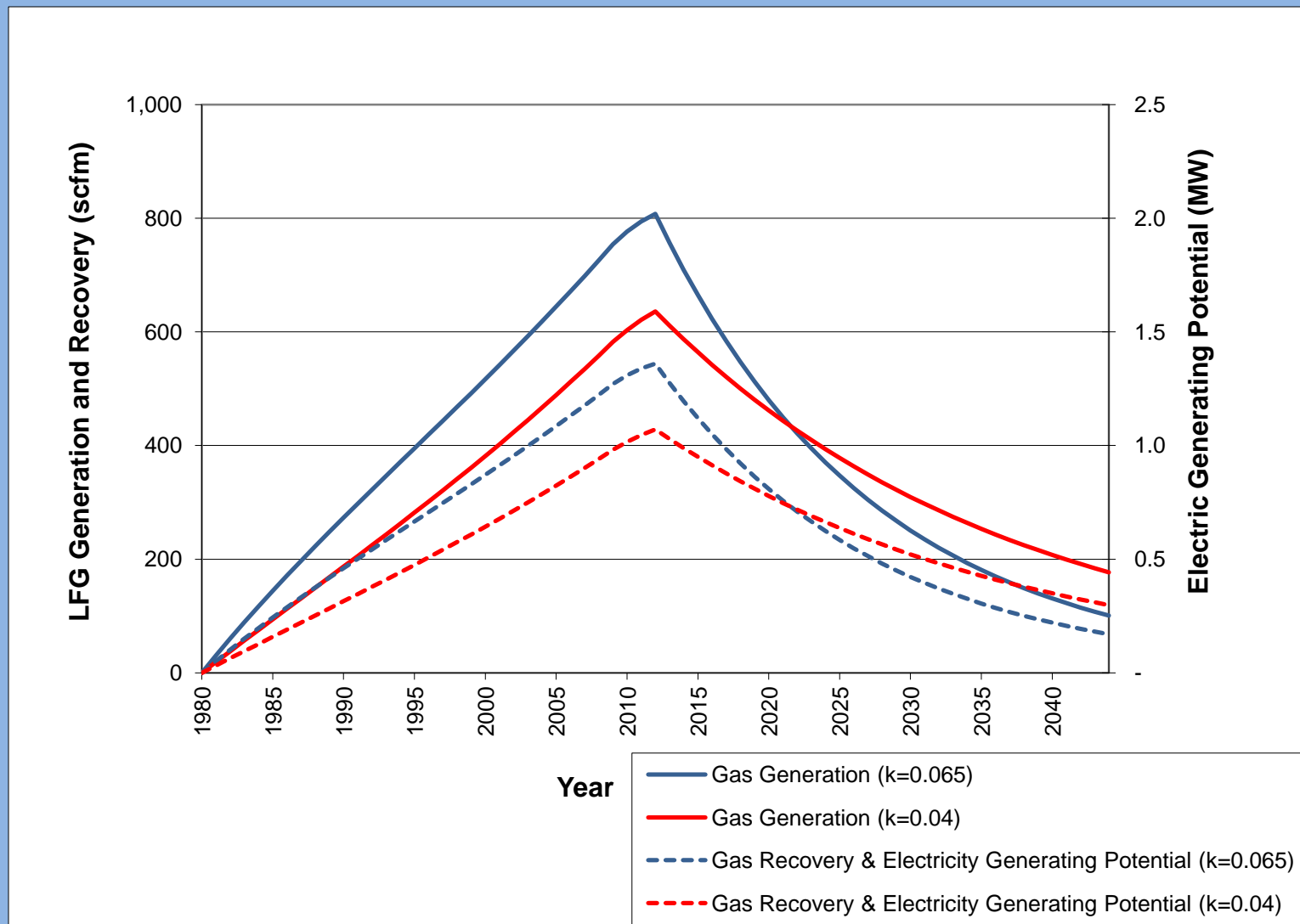


Virgin Islands Landfill: Gas Curve (k = 0.065)





Virgin Islands Landfill: Gas Curve (k = 0.065 and 0.04)





For More Information

Submit a request to LMOP at:

<http://www.epa.gov/lmop/contact.html>

