

Renewable Energy From Landfill Gas

Landfill Gas Energy: A Sustainable Energy
Source from Small Landfills in New England
Portland, Maine
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Waste Management's 2007 Sustainable Growth Initiatives

- ❑ Double our waste based energy production
 - *Power 2 million homes by 2020 – currently 1 million.*
 - ***Short-term initiative to build 60 new renewable energy facilities over the next five years***
- ❑ Triple the tons of recyclable materials processed
 - *Process 20 million tons by 2020 – currently 8 million.*
- ❑ Preserve and restore more wildlife habitats across North America
 - *Increase the number of facilities to 100 – currently 49 across 19,000 acres.*
- ❑ Invest in cleaner technologies
 - *Direct capital expenditures of up to \$500 million (over 10 years) to reduce emissions by 15% and increase fuel efficiency by 15%.*



Environmental Protection Is The First Priority For Any Project!

Renewable Energy projects cannot work if you do not first commit resources to the landfill gas collection system and priority to safety and compliance

- Long-term planning
- Appropriate operations staffing
- Training
- Capital

A properly designed and well-run collection system will provide more consistent and higher quality gas for a renewable energy project



Types of Landfill Gas Projects

❑ Electricity Generation

Onsite plants, generation at LFG Buyer's facility, or blended with fossil fuel at utility plant

❑ Commercial/Industrial Heating Fuel

Steam boilers, kilns, heating, greenhouses, liquid disposal, etc.

❑ Process to Natural Gas

Separate methane from carbon dioxide and other constituents



Inventory of Landfill Gas Projects

Type of Project	U.S.	WM	Owned by WM
Electricity Generation	300+	80	43
Com/Ind Heating Fuel	110+	22	8
Natural Gas Production	<20	8	0
Totals	425+	110	51



WMRE Activities in New England

Power Generation

- New Milford (CT) 2 MW
- Fitchburg (MA) 3.2 MW (undergoing expansion)
- Turnkey (NH) 9.4 MW

Gas Sales

- 5 sites in MA

Under Construction

- Turnkey – gas sale to UNH
- Crossroads – targeted completion early 2009.



Project Comparisons

Subjective rating with “1” most favorable and “3” least favorable

Project Type	Med. BTU	Power	High BTU
Air Permitting	1	3	2
LFG Quality Specifications	1	2	3
Technology Risk	1	2	3
Product Specification Risk	2	1	3
Renewable Energy Incentives	3	1	2
Access to Markets	3	1	2



Alternative and Emerging Technologies

□ Process landfill gas to vehicle fuel

- Landfill gas to LNG or CNG
 - LNG: Prometheus Energy, Bowerman Landfill, Orange Co., CA
 - CNG: SWACO, Columbus, OH
 - LNG: WM, Altamont Landfill, Livermore, CA
- Landfill gas to diesel: WM R&D effort

□ Waste Heat applications

- Radiator water used for heating (e.g. greenhouses)
- Exhaust heat used for sludge drying, industrial liquid waste evaporation, etc.



Fossil Fuel Value - \$/MMBTU

Commodity	Coal	Natural Gas	Oil	LNG	Diesel	Wholesale Electricity
Product Units	Ton	MMBTU	Barrel	Gallon	Gallon	MWH
Value per Product Unit	\$40-\$60	\$6-\$10	\$80-\$105	\$1.00-\$1.40	\$2.80-\$3.60	\$35-\$60
Product Units per MMBTU	.043	1	0.17	12.0	7.7	0.293
Value per MMBTU	\$1.70 - \$2.60	\$6 - \$10	\$13 - \$18	\$12 - \$17	\$22 - \$28	\$10 - \$18



LFG Value per MMBTU

Project Type	Med BTU – Coal	Med BTU - Nat Gas	High BTU	Electricity
Fossil Fuel Value	\$1.70 - \$2.60	\$6 - \$10	\$6 - \$10	\$10 - \$18
Discount for LFG	0 – 30%	40% - 70%	0%	0%
Conversion Efficiency	95%	95%	80%	28%
LFG Value	\$1 - \$2	\$2 - \$5	\$5 - \$8	\$3 - \$5
Sec 45 Tax Credits	0	0	?	\$1.30
RECs at \$3 - \$55	0	0	?	\$0.1 - \$4+
Final LFG Value	\$1 - \$2	\$2 - \$5	\$5 - \$8	\$4 - \$10
Price Volatility	Site-specific	Site-specific	Seasonal Weather	Fossil Fuel



Identification of Potential Projects

- ❑ High-level screening of LFG availability
- ❑ Assessment of Medium BTU Buyers
- ❑ Power plant screening from available information about energy market
- ❑ Identify supplemental revenue streams – Sect. 45 tax credits, GHG offsets, project subsidies, etc.
- ❑ Assessment of Landfill issues – Community relations, landfill operations, permitting efforts, royalties, host fees
- ❑ Compare options: IRR, EBIT, risk, and landfill benefit



Landfill Gas Quality

- ❑ Methane: Ideally > 48%
- ❑ Oxygen:
 - Engines: Ideally < 1%, tolerance up to 2.5%
 - Natural Gas Processing: <0.2%
 - Heating Fuel: varies, but generally flexible
- ❑ Nitrogen: Most critical for natural gas processing, <2%
- ❑ Contaminants: moisture, H₂S, siloxane

Allowable levels vary with project type and vendor specifications

Requires coordination and cooperation between landfill owner and power plant owner to balance compliance with gas quality.

Sometimes a trade-off between gas cleanup and facility maintenance



Prime Mover Selection

□ Reciprocating Engines

- High efficiency + low parasitic load = more net output per btu
- Range of sizes (500 kw to >2 mw) = match gas flow curve

□ Gas Turbines

- Low efficiency + high parasitic load = less net output per btu
- Large capacity (3 mw to 5 mw) = High gas flow needed

□ Microturbines

- Medium efficiency + high parasitic load = less net output per btu
- Small capacity (60 kw to 250 kw) = Applicable to low gas flows
- Lower emissions = more amenable to air permit constraints
- Highly adaptable to waste heat utilization = higher total efficiency



Renewable Energy Engine Room



Renewable Energy Plant



WM Approach to 3rd Party Projects

- ❑ Keep the number of parties to a minimum
- ❑ Choose an ownership structure that maximizes incentives to the project, then select a gas pricing schedule that shares these values
- ❑ Define gas quality specifications with priority to compliance
- ❑ Share any potential market upside, once the return on capital by the investing party is achieved

Goal is to achieve both parties' interests in promoting green energy and meeting compliance, while sharing in financial returns



What's it going to take for your small LFGTE project to succeed?

(Besides luck, persistence, celestial alignment)

- A champion
- Multiple revenue streams
- Outside funding
- Thinking outside the box
- Willingness to take on risk



Curbside to Power

