

Role of Landfill Gas to Energy in Landfill Remediation

Landfill Gas Generation

- **Anaerobic Decomposition of Organic Waste**
- **About half METHANE and half CARBON DIOXIDE**
- **450 to 550 BTU per cubic foot of landfill gas**
(Natural gas is 1000 BTU per cubic foot)

LFG Collection and Control

Gas Collection and Control System (GCCS) is installed for environmental protection:

- **Off-Site Underground Migration (RCRA Subtitle D)**
- **Groundwater Contamination (RCRA Subtitle D)**
- **Odor**
- **Landfill Cap Stability**
- **NMOC Emissions through cap (NSPS & GHG)**

GCCS is rarely installed for the primary purpose of supporting a LFG to Energy project



Components of GCCS

Installed incrementally during active life of landfill and completed at closure of landfill.

- Vertical wells or horizontal collectors
- Header pipe connecting wells to blower
- Blower places vacuum on wells
- Condensate and leachate collection system
- LFG is delivered to flare or gas utilization project
- Typical Cost of \$9,000 to \$20,000 per acre

GCCS Well Head



GCCS Header Pipe



Basic Types of LFGtE Projects

- **Electric Energy:** Wholesale to electric utilities
 - *With or without heat recovery*
- **Alternative Energy:**
 - *Gas conditioned, compressed and shipped via pipeline to user as fuel in boilers, power plants, asphalt plants, cement kilns, industrial dryers, greenhouses, etc.*
 - *Hot water recovered through exchangers shipped via pipeline to user boilers*
- **Processed Gas:** Gas purified and converted to Liquefied Natural Gas (LNG) for vehicle fuel.

Active LFG Utilization Projects

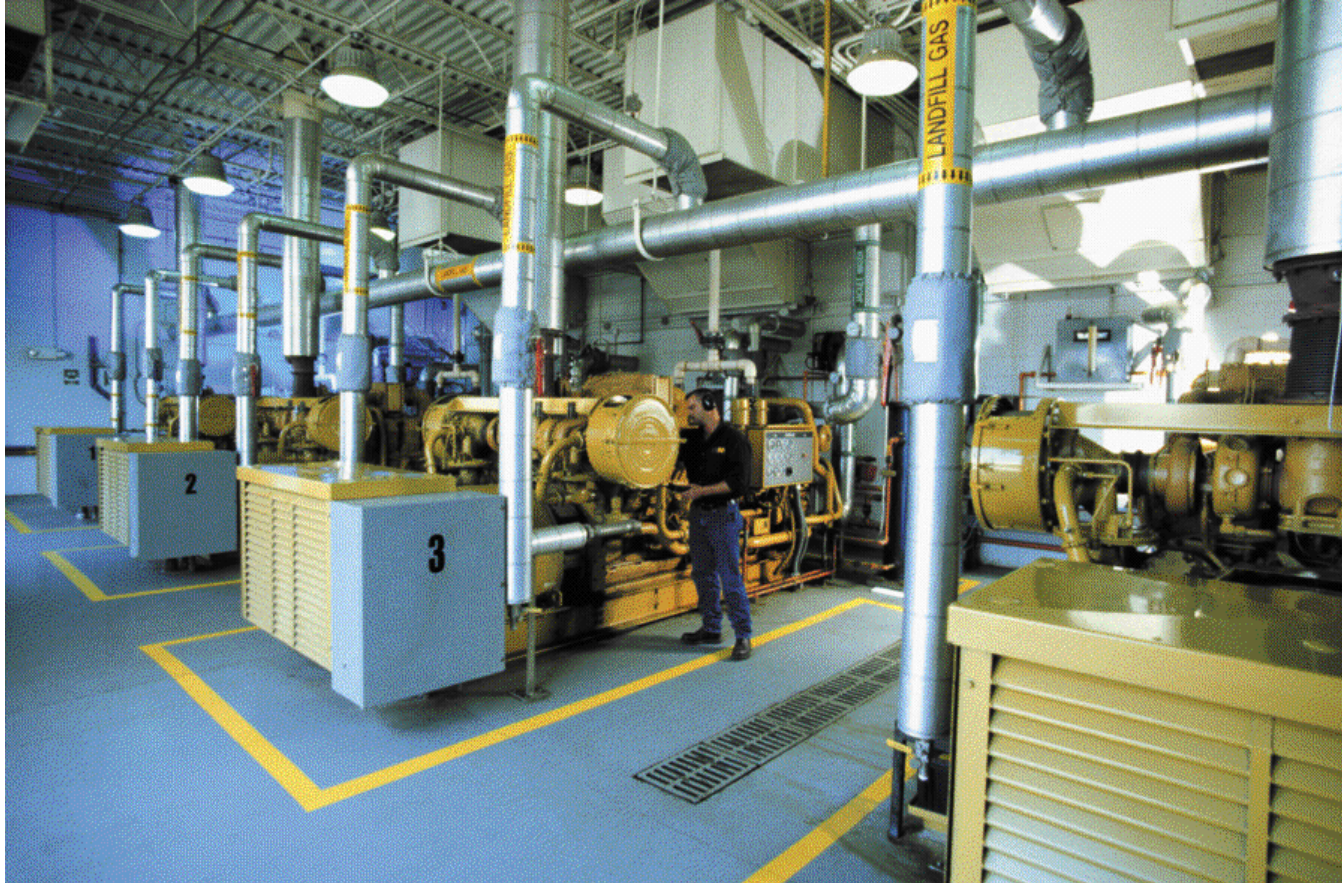
<u>WM</u>	<u>Project Type</u>
90	Electric Energy: On-site power plants
	Alternative Energy:
19	- Pipeline projects
14	- Evaporators: disposal of waste liquids
<u>5</u>	Processed Gas: processing to LNG
128	Totals

Average LFGTE Project

For discussion purposes, average size project is:

- 1,600 cubic feet per minute of landfill gas
- 400,000 million BTU (MMBTU) per year
- 4000 kilowatts of electricity
- About 32,000,000 kwh per year

3.2 MW Engine Plant



Electric Energy Capital Cost

Capital cost of 4 MW plant: \$4 -6 million.

- **Land Acquisition**
- **Site Work**
- **Building**
- **Gas conditioning**
- **Equipment pricing**
- **Interconnect**
- **Instrumentation & controls**

Electric Energy Operating Cost

**Total Cost to generate power: 2.5 to 3.5
c/kwh**

- **Capital Cost**
- **Financing costs**
- **Depreciation period**
- **O&M Contract**
- **Taxes, Administration, Permitting**

Does not include LFG purchase Price



Energy Pricing

- **Energy:**
 - PURPA avoided costs to Qualifying Facilities are typically 3 to 4 c/kwh in current market.
 - May be higher or lower in deregulated markets.
- **Green Attributes:**
 - Renewable portfolio standards (RPS)
 - Green Pricing (Renewable Energy Credits)

Keys to Successful LFGTE Projects

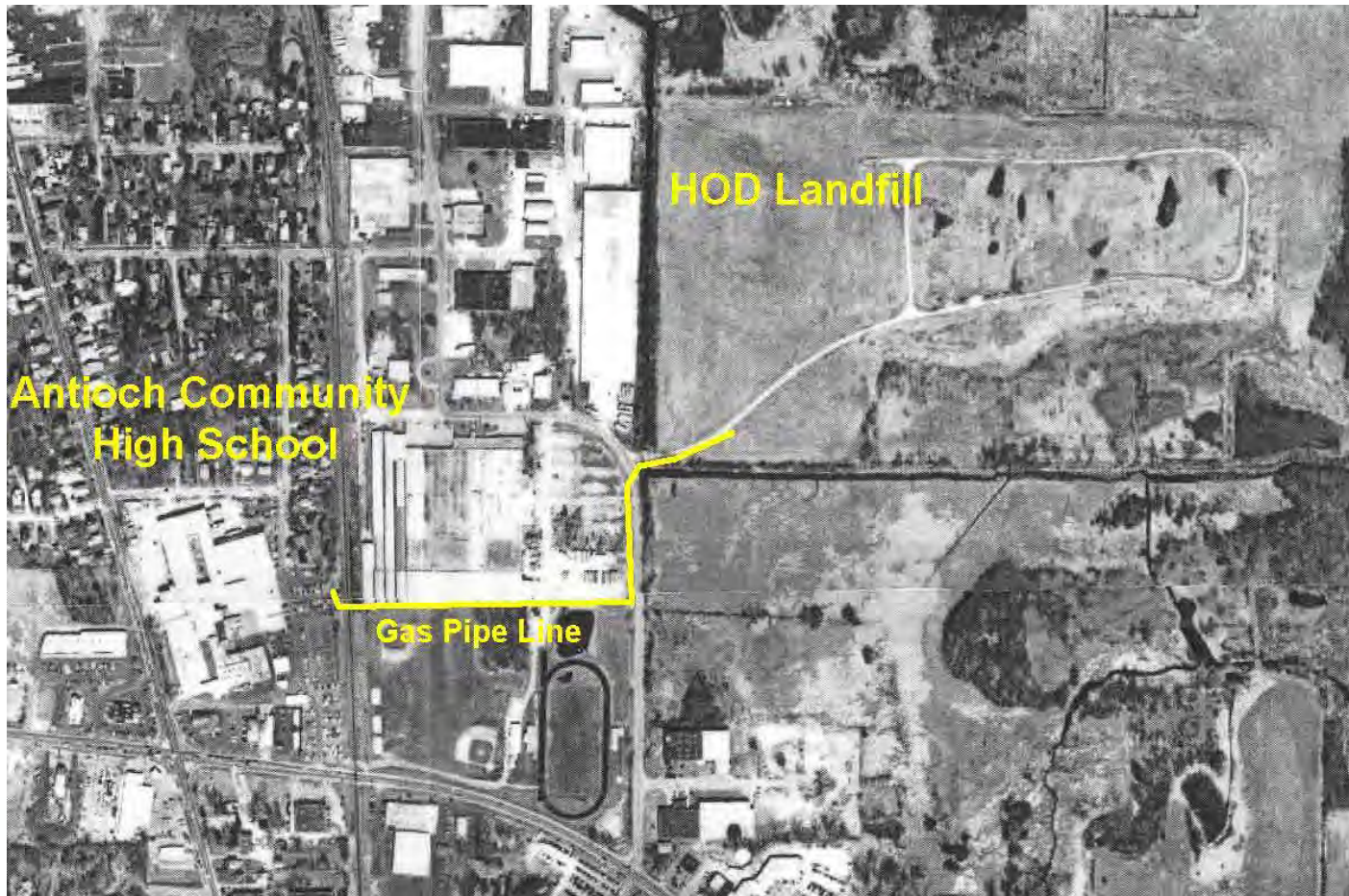
- **Access to ‘free’, consistent, long-term supply of quality fuel**
 - *12-15 years minimum*
- **User demand matches gas supply**
 - *GCCS are 7/24/365 operations*
- **Proximity to energy user/purchaser**
 - *High voltage electric transmission lines*
 - *Higher energy demand user(s)*
- **Energy pricing competitive with fossil fuels**
- **Ability to limit capital costs**



**Antioch Community High
School, District 117
Landfill Gas-to-Energy Project**

2003 LMOP Project of the Year

Antioch Community High School Gas-to-Energy Project



Antioch Community High School Gas-to-Energy Project

HOD Landfill

- **51-acre municipal and industrial solid waste landfill, active from 1963 to 1984**
- **35 gas extraction wells**
- **Initial gas production was 325- 350 cubic feet per minute**
- **Design calcs estimated >200 cfm for the next 15-20 years**
- **ROD required thermal destruction of gas**



Antioch Community High School Gas-to-Energy Project



Antioch Community High School Gas-to-Energy Project

Renewable Energy Project

- **Illinois Department of Commerce and Community Affairs (DECCA) administers the renewable energy resource program in order to foster investments in and the development and use of renewable energy resources within the state of Illinois**
- **Antioch Community High School District 117 submitted a grant application under the organic waste biomass (electrical production) category in April 2002**
- **A grant of \$550,000 was approved for the gas-to-energy project**



30-kW Capstone MicroTurbines



Antioch Community High School Gas-to-Energy Project

Project Schedule

- **“Fast track” project**
- **Design began September 2002**
- **Construction began December 2002**
- **System startup Fall 2003**



Antioch Community High School Gas-to-Energy Project

System Design

- **Tie-in to existing gas system at the landfill**
- **Collect, condition, and compress the landfill gas at the landfill– removes unwanted moisture and corrosive compounds**
- **Install 12 Capstone MicroTurbines which will produce up to 360 kW of 3-phase electricity at 480 volts. This is enough electricity to power approximately 300 homes.**
- **The exhaust from the MicroTurbines routed through a heat recovery system. This system is used to preheat water in the gas-fired boilers at the Antioch Community High School.**



Construction at Antioch High School



Construction at Antioch High School



30-kW Capstone, Lunar Enclosure Rolled Out for Maintenance



Antioch Community High School Gas-to-Energy Project

Benefits of the Project

- **Cost savings to tax payers by using recovered gas to produce energy and heat**
- **Beneficially reusing landfill gas to produce environmentally friendly “green energy”**
- **Reduction in greenhouse gas emissions to environment**
- **Public relations and marketing of a waste-to-energy project for the community and the state of Illinois**
- **Educational possibilities (physics, chemistry, economics)**



KEYS TO PROJECT SUCCESS

Positive Factors

- **No land acquisition cost**
- **\$550K DECCA grant from State of IL**
- **Discount on microturbines**
- **LFG provided at no charge**

Negative Factor

- **Waning gas production – currently 125-150 scfm**



FUTURE METHANE UTILIZATION

- **Objective: Closing Pricing Disparity**
 - *Coal: \$0.80 - \$1.30 MMBTu*
 - *Natural Gas: \$3.75 - \$4.50 MMBTu*
 - *Propane: \$4.50 - \$5.25 MMBTu*
 - *Landfill Methane: \$0.10 - \$1.50 MMBTu*

FUTURE METHANE UTILIZATION

- **Vehicle Fuel**
 - *LNG*
 - *Bio-Diesel*
- **Commerical/Industrial Utilization**
 - *Pipeline*
 - *Co-Locating Factories, Big Box Retail*
- **Heat Recovery**
 - *Heat exchanger on combustion devices*
 - *Geo Loops in landfills*

Potential LFGTE at Remedial Landfills

- **Most successful LFGTE projects are on large regional disposal facilities (RDFs)**
- **Most RDFs managed under RCRA Subtitle D**
- **Landfills on NPL tend to be older, smaller**
 - *Lower Btu value, lower gas generation, low prospects for long-term production*

