



Methane to Markets

Landfill Biogas Technology Applications at Small Landfills

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Why Use Landfill Biogas (LFG)?

- Locally available fuel source
- Easy to capture and use
- Source of renewable energy
- Constant supply - 24 hours a day, 7 days a week
- Reliable technologies exist for using landfill gas
- >90% up time
- Uses a source of energy that otherwise would have been wasted
- Reduces greenhouse gas emissions.

Minimum Size Landfill

- Typical large scale project
 - Minimum depth
 - 8 meters for managed sites
 - 15 meters for unmanaged sites
 - Minimum waste in place (tonnes)

Closing Date	Wet Climate	Dry Climate
1996-2000	3,000,000	2,500,000
2001-2005	1,800,000	1,500,000
2006-2010	850,000	1,000,000
2011-2013	550,000	700,000
After 2013	480,000	650,000

Minimum Size Landfill

- Small scale project
 - Landfill that does not meet previous criteria
 - Successful projects with 85 m³/hr for some technologies
 - Landfill that has been closed 10 years but still producing gas
 - Open landfill with a closed area with biogas recovery

Possible Uses for Small Applications

- Direct Use
- Electricity Production
- Microturbine Combined Heat and Power

Direct Gas Utilization

- Boilers
- Process heaters
- Greenhouses
- Infrared heaters
- Ceramics and glass
- Biodiesel production
- Autoclave/medical waste incineration

Greenhouses

- Direct heat or use waste heat from electrical generation
- Generate electricity to power lights
- 6 operational and under construction greenhouse projects in the U.S.



Infrared Heaters

- Used to heat storage and maintenance facilities
- Requires very little LFG to heat large spaces
- Easy to install
- 4 operational projects in the U.S.

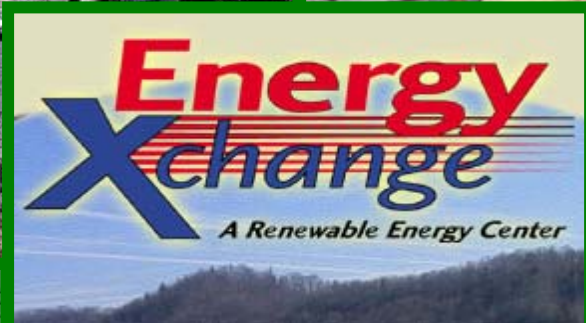


Ceramic and Glass Production

- Used to fuel ceramic kilns or glass furnaces
- Provides large cost savings to industries and artists
- 2 operational projects in the U.S.
- 2 projects in development in the U.S.



Energy Center



Biodiesel Production

- Biodiesel production facility
 - Biogas is used to fuel Biodiesel production
 - Project in Denton Texas, U.S.
 - Project in Jackson Co., NC



Small Electrical Generation

- Small Internal Combustion Engine
 - 55-800 kW
- Local electric generation opportunities



Combined Heat and Power

- **Microturbine Application**
 - 70-230 kW
 - Greater overall energy recovery efficiency from waste heat recovery - up to 80%
 - Specialized CHP systems available
 - Flexible - hot water or steam generation from recovered heat
 - Thermal energy available for other uses (sanitation, greenhouses, biodiesel production)

Combined Heat and Power Illinois, USA

- First school co-generation (CHP) project on LFG
- 12 microturbines with 360 kW capacity
- Exhaust energy produces 290,000 BTUs/hour at 550°
- School expects to save \$100,000/year



Summary

- Many ways to beneficially utilize LFG at smaller landfills
- Available niche technologies range from research and development stage units to commercially available systems