Commercializing Landfill Gas to Energy Opportunities in (South) Eastern Europe

GE's Jenbacher integrated LFG to Energy solution

Gerhard Pirker
Program Manager
GE Energy Jenbacher gas engines

Novi Sad, 2010
LFG to Energy - Future regions

30 countries with >10 MW short term potential

Western Europe
FRA, ITA, ESP, GBR ...
450

USA, CAN
1,150

Latin America
600

Near/Middle East
300

China + Southeast Asia
650

South Korea
20

Australia
40

South Africa
40

Rest of World
200

Total technical potential in MWel = ~4,000

(South)/Eastern Europe/ RUS 550

GE proprietary information for internal use only

GE Energy Jenbacher gas engines
LFG to Energy solution
Drivers & Barriers in new countries

Drivers

- Some professionally managed landfills (mostly in the capital/ bigger cities)
- High share of biodegradables in the MSW
- First reference plant in the country
- Incentives
  - Government electricity buying guarantee
  - Attractive/ supported feed in tariff
- Kyoto Protocol, Carbon Trading (CDM/JI)
- Technology co-operations and financing schemes available

Barriers

- Landfill design and waste management not suitable for LFGTE
- Low feed-in tariffs (in case of coal-based energy supply)
- Changing political situation, municipalities own gas rights
- No regulations on environmental protection imposed
- Lengthy process of project preparation
  - Gas suction system not optimized
  - CDM/JI Bureaucracy
- Pilot projects relatively risky in terms of economics
The amount and chemical composition of the produced gas depends on a variety of factors:

- **Landfill size**
  - total size of the landfill

- **Waste composition**
  - organic portion in MSW, VOSCs

- **Time**
  - opening and closure of landfill

- **Water level**
  - amount of leachate in the landfill body

- **Climate**
  - temperature, wind, air pressure etc.

- **Emplacement**
  - landfill structure, design, compression
# Landfill Questionnaire

Landfill name and location: 

Landfill Owner/Operator: 

Address, City, State: 

Contact Details (Phone, Email): 

Project Developer: 

Address, City, State: 

Contact Details (Phone, Email): 

**Drop-Case Criteria** (if any or none drop out criteria apply) 

> Landfill is inappropriate for LFG to Energy

- [ ] Landfill has been closed for 10 years or greater?
- [ ] There are points on the landfill that are catching on fire?
- [ ] The landfill accepts less than 80% of the waste from organic sources (e.g., food waste, paper, yard trimmings, wood, sewage sludge)?
- [ ] The landfill is deeply inclined and/or is the waste density loose?
- [ ] The landfill waste collection is organized (wasted deposit height is less than 0.3m high and was never compacted)

**Landfill status** 

- [ ] Landfill opened
- [ ] Landfill active unit
- [ ] Landfill was closed

Current and future landfill dimensions, please indicate measuring units: 

- [ ] Millimeters
- [ ] Feet
- [ ] Acres
- [ ] Meters

<table>
<thead>
<tr>
<th>Current number of inhabitants in the collection area of the landfill:</th>
<th>Current body of waste length and width:</th>
</tr>
</thead>
<tbody>
<tr>
<td>min. 200,000</td>
<td>min. 2 ft x 5 acres</td>
</tr>
</tbody>
</table>

Average (minimum, maximum) waste deposit height today: min. 6 in

Landfill was: 

- [ ] Constructed as a quarry (gravel pit)
- [ ] Filled into a natural area
- [ ] Constructed along with a slope

Current body of waste volume: min. 500,000 m³

Landfill is divided up into: 

- [ ] One body
- [ ] Different cells/areas

Minimum total site capacity in this stage: 

<table>
<thead>
<tr>
<th>Length x width x height or volume</th>
<th>min. 500,000 m³</th>
</tr>
</thead>
</table>

### Waste Analysis and Composition

<table>
<thead>
<tr>
<th>Waste Category</th>
<th>Composition %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood/wood refuse</td>
<td>50%</td>
</tr>
<tr>
<td>Medical/hospital waste/waste</td>
<td>15%</td>
</tr>
<tr>
<td>Other industrial refuse</td>
<td>20%</td>
</tr>
</tbody>
</table>

### Landfill Design and Operation

- [ ] No biosealing made at
- [ ] No biosealing
- [ ] Over a ramp piled up at one spot
- [ ] Spread all over the surface

- [ ] A cover will be composted with:
- [ ] A cover will be placed over
- [ ] A cover is not compacted
- [ ] A cover is not covered

- [ ] Soil
- [ ] Other materials
- [ ] At a layer thickness of

- [ ] Landfill consists of sectors
- [ ] With different waste ages
- [ ] With different waste facies
- [ ] Inhomogeneous

- [ ] The landfill is equipped with
- [ ] Leachate outlet
- [ ] Leachate recirculation
- [ ] None of those

If covered, please indicate material and method

- [ ] Temporarily with: V
- [ ] Permanently with: V
- [ ] No cover

---

**GE Energy Jenbacher gas engines**

**LFG to Energy solution**

**GE imagination at work**

**GE proprietary information**

**for internal use only**
Project margin LFGTE - Case 1: Gas collection & flaring/utilization mandatory

Feed-in tariff

CDM/ JI revenue

1 MW

Feed-in tariff

CDM/ JI revenue

5 MW

PROFIT

PROFIT

CAPEX genset

CAPEX BoP

O&M genset

O&M Plant

*all figures stated in US$ cent per kWhel and calculated for 60,000 operating hours (=7.5 years) of J320
Project margin LFGTE - Case 2: Gas collection & flaring/utilization **NOT** mandatory

*all figures stated in US$ cent per kWh el and calculated for 60,000 operating hours (=7.5 years) of J320*
Success factors for profitable LFGTE projects

- Long-term planning of entire project
- Try to reach project size >> 1MWel
- Strive for long-term Power Purchase Agreement
- Try to obtain further revenues with heating (CHP) or other
- Select robust, light-weight engines with high power density in containerized configurations
- Install professional and flexible gas capturing system
- Thorough assessment of landfill condition and gas quality (gas curve, VOSCs, other impurities, leachate ...)
- Gas engine availability is key for economics electrical efficiency also important
- Apply engine, which can deal with low LHV and varying gas qualities
- Ensure long-term service structure and contracts to maximize plant availability
CH$_4$ concentrations in combustion chamber*

*Simplified gas mixture: only methane and air!

Max. 14.5% CH$_4$ = 100% CH$_4$

Upper ignition limit

Min. 4.76% CH$_4$ = lower ignition limit

Lean combustion range

5.2 – 5.5%

Combustion limit LHV:

LFG example

CH$_4$:CO$_2$

min. 1:1 < 33/27

CH$_4$/N$_2$

min. 28/72 < 33/39

Jenbacher type 3 and type 4 engines can run full load with each possible composition of landfill gas due to special...

- ignition system
- spark plugs
- piston heads
- combustion chamber geometry
LFGTE challenges

- Low LHV, high inert portions (CO2/N2)
- Leachate, Sulfur
- Siloxanes = VOSCs
- LHV fluctuations, Oxygen Content
- Emission compliance
- Capacity adaption, shift
- Less experienced O&M staff

GE Jenbacher solution

- Special design and ignition system
- Gas conditioning & special design
- Temperature Swing Adsorber (TSA)
- LEANOX®, DIA.NE®, gas mixer, TCB
- LEANOX®, CL.AIR®, TSA
- Modular, compact, broad range
- Remote services, flexible CSA

GE Energy Jenbacher gas engines
LFG to Energy solution
# Landfill gas project Ana Lioissia/ GRE

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of units and engine type</td>
<td>4 x JMS 620 GS-L.L</td>
</tr>
<tr>
<td>Fuel</td>
<td>Landfill gas</td>
</tr>
<tr>
<td>Electrical output</td>
<td>9,700 kW (extension)</td>
</tr>
<tr>
<td>Thermal output</td>
<td>5,500 kW</td>
</tr>
<tr>
<td>Commissioning</td>
<td>September 2006</td>
</tr>
</tbody>
</table>
Landfill gas project Maribor/ SLO

No. of units and engine type: 1 x JGC 312 GS-L.L
Fuel: Landfill gas
Electrical output: 625 kW
Commissioning: 1998
Landfill gas plant Pohang, Korea

No. of units and engine type: 2 x JGC 320 GS-L.L
Fuel: Landfill gas
Electrical output: 2,116 kW
Commissioning: May 2002
Landfill gas plant Pinto, Spain

- No. of units and engine type: 11 x JMS 420 GS-L.L
- Fuel: Landfill gas
- Electrical output: 15,543 kW
- Thermal output: 8,327 kW
- Commissioning: June 2000
Where do you find information?

>> GE Jenbacher intranet - Webportal

https://information.jenbacher.com