

# Appropriate business conditions to utilize gas from landfills for power generation



Gerhard Pirker, Marketing Program Manager  
GE Energy Jenbacher gas engines  
Methane to Markets Partnership Exposition

Landfill Sector  
Session 3: Transitioning LFG to Beneficial Use, 9:20 AM

October 30-31, 2007  
China World Center, Beijing



GE imagination at work

# The Landfill Gas (LFG) business for GE-Jenbacher

# GE Energy is a worldwide leading supplier of reliable and efficient products/services for the energy industry

Turbines, gas engines, control equipment, generators, software and other for

Coal

Wind/ Solar energy

Oil

Natural Gas

Nuclear energy

Renewables

>> GE Energy  
Jenbacher gas



WORLDWIDE PARTNER



**John Krenicki, Jr.**  
President and  
Chief Executive Officer,  
Energy

- Financial Results 2006:  
Revenues 19.1 billion US\$,  
Net Earnings: 3.0 billion  
US\$

# Overview GE-Jenbacher gas engines



World wide 1,500 employees (1,200 in HQ Jenbach, Austria)

0.25-3MW Gas Engines, Generator Sets, Co-/Trigeneration, Container Solutions

Total installed base : 7,350 engines, 8,260 MWe

Total LFG base installed: 1,190 units, output 1,140 MWe all over the world

# GE-Jenbacher worldwide presence

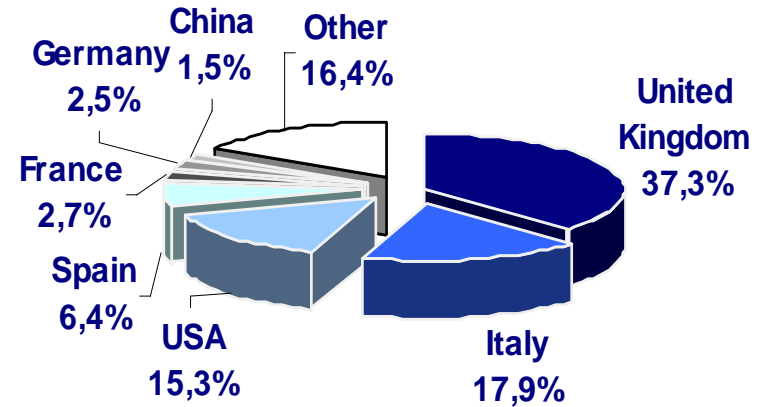


**Arpley/UK**  
18 x JGC 320 GS-L.L  
18,612 kWel

**Cavenago/Italy**  
3 x JMC 312 GS-L.L  
1,803 kWel



**Total = 1,140 MWel**





# GE-Jenbacher worldwide presence



**Pohang/Korea**  
2 x JGC 320 GS-L.L  
2,116 kWel

**Pinto/Spain**  
11 x JMS 420 GS-L.L  
15,543 kWel/ 8,327 kWth

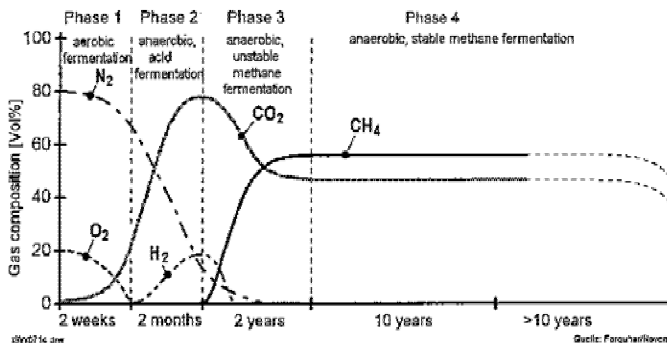


# Evaluation of business conditions and profitability

# Parameters to influence LFG PG output

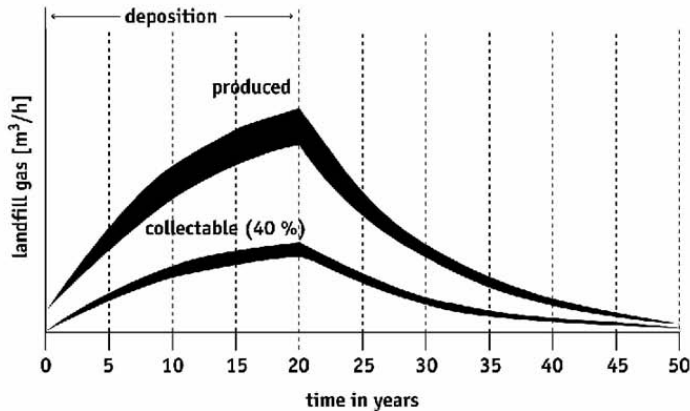


- Landfill size and existence in years
- Future additional waste to be deposited
- Tightness of landfill (surface/ sides/ bottom)
- Share of organic/ inorganic waste
- Composition of LFG: % CH<sub>4</sub>-CO<sub>2</sub>-O<sub>2</sub>-N<sub>2</sub>
- Gas contaminations: halides, sulphur ...
- Amount of leachate inside the liner
- Clime: temperature, wind, air pressure
- LHV- fluctuation, gas pressure fluctuation
- Humidity of landfill gas
- Electrical efficiency





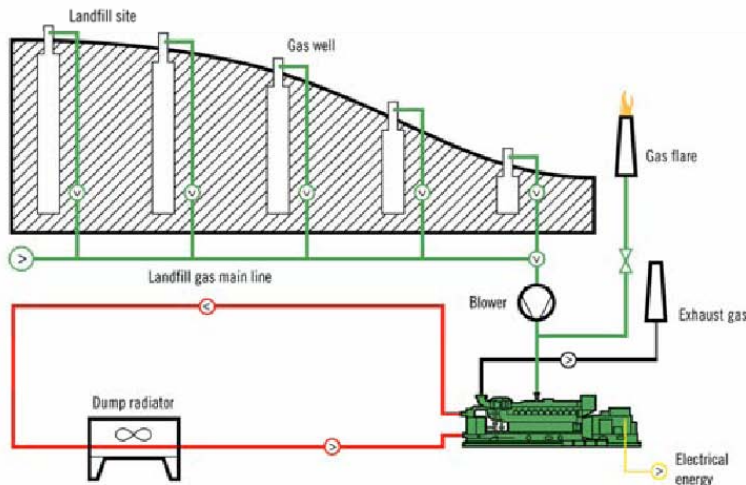
# >> Output per ton of waste may vary a lot



- Depending on all these parameters the electrical output from 1 million tons of waste may vary between

**5,000 - 8,700 MWhel**

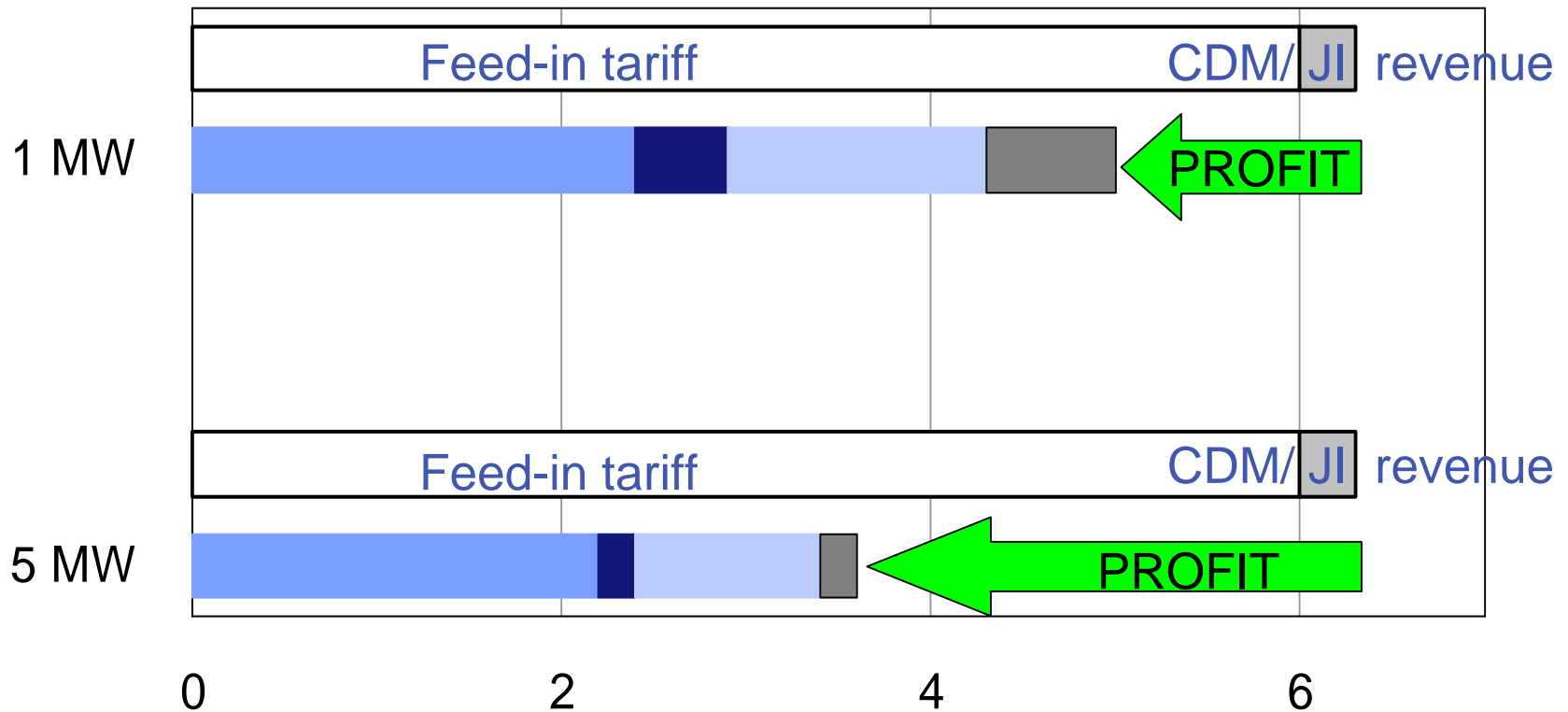
for 15 - 25 years



- Intensive planning is mandatory to establish a sustainable project

- The electrical efficiency of the gas engine is a core success factor for a profitable LFG project

# Project margin LFG PG - Case 1: Gas collection & flaring/utilization mandatory

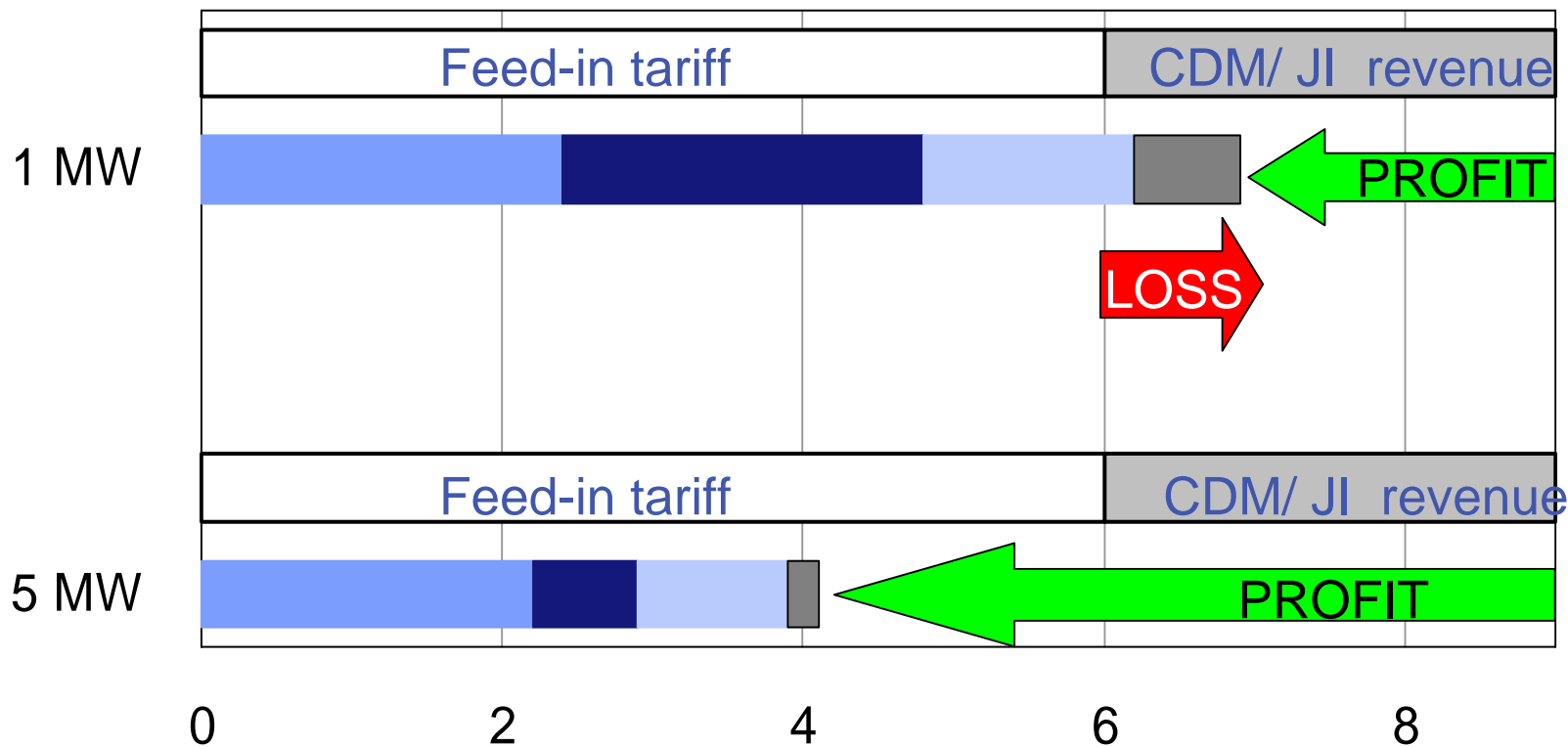


■ CAPEX genset ■ CAPEX BoP ■ O&M genset ■ O&M Plant

\*all figures stated in US\$ cent per kWh<sub>el</sub> and calculated for 60,000 OH/ good gas quality, J320

# Project margin LFG PG - Case 2:

## Gas collection & flaring/utilization **NOT** mandatory



■ CAPEX genset ■ CAPEX BoP ■ O&M genset ■ O&M Plant

\*all figures stated in US\$ cent per kWh<sub>el</sub> and calculated for 60,000 OH/ good gas quality, J320

# The UK LFG PG utilization model

- In the UK GE-Jenbacher since 1990 installed 452 engines at landfill sites all over the country
- Totally around 700MWeI installed
- Mainly responsible for this boom was the introduction of NFFO (Non-Fossil Fuel Obligation) & ROCs (Renewables Obligation Certificates):



# Outlook Asia/China



GE imagination at work



# Success factors for profitable LFG projects

- Extensive and long-term project planning
- Information about general landfill condition (e.g.: leachate!)
- Project size  $\gg$  1MWeI
- High-tech gas capturing system
- Flexible and mobile fleet of modular container units
- Gas engine electrical efficiency is crucial
- Try to obtain further revenues with heating
- Long-term energy purchase agreement
- Take advantage of CDM/JI



# Recommendations to improve business conditions in Asia

- Legal framework for LFG PG utilization to establish a mechanism like NFFO, ROCs/UK or EEG/Germany >> build up confidence among the project owners:
  - Supported feed-in tariffs, fixed/ guaranteed over a certain period of time
  - Utilities must give LFG PG project owners a sustainable access to the public grid
- Especially small projects need competent support to lower their administrative CDM/JI costs
- Given these subsidies a mandatory gas capture/ recovery can then be imposed

**In order to increase LFG PG utilization in Asia/China the legal framework should be adapted to EU models**

# Some Chinese GE-Jenbacher LFG plants



**Nent LF/HongKong**  
2 x JGS 320 GS-S.L  
2,130 kWel



**Xing Feng LF/China**  
2 x JGS 320 GS-S.L  
2,130 kWel



**Bei Shen Shu LF/China**  
1 x JGS 212 GS-S.L  
526 kWel

**Went LF/China**  
2 x JGS 320 GS-S.L  
2,130 kWel



# Backup

# General factors influencing LFG projects

## FAVORABLY

- In times of energy shortage Landfill gas presents an alternative to conventional fuels
- CDM/JI projects are important drivers for LFG utilization
- Asian mega cities need new concepts to manage their waste

## NEGATIVELY

- Landfill consistently became more contaminated
- Gas pretreatment overhead costs also for small projects
- Considerable administrative costs and emphasis of CDM also for small projects
- Asian governments did not yet establish business conditions like given in EU/WH

**Due to these facts after a boom in the 90ties the worldwide LFG-utilization business stagnated in recent years**



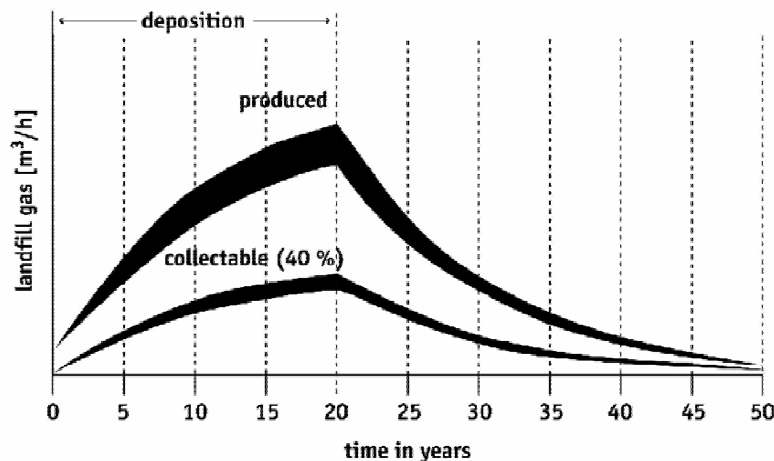
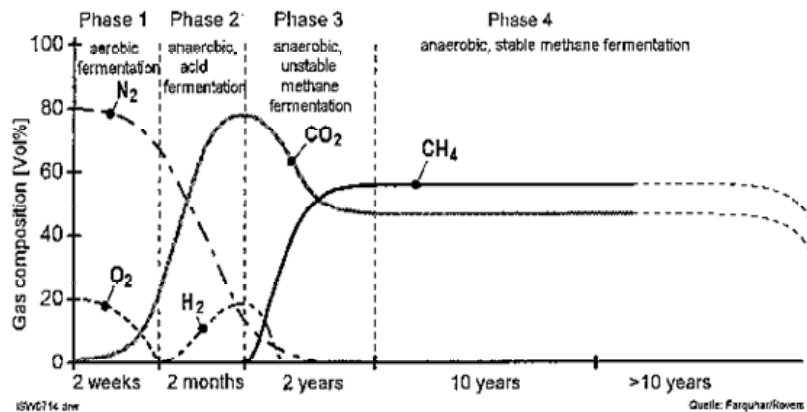
# Jenbacher landfill gas engines are **ecomagination** certified

Due to their cost-effectiveness, high output and measurable benefits to the environment, Jenbacher landfill gas engines have been certified as GE “ecomagination” product by an independent agency.

**Ecomagination is a GE commitment to use and develop new technologies to help customers around the world meet escalating environmental challenges.**



# Utilizable LFG varies in amount and sustainability



Depending on these parameters:

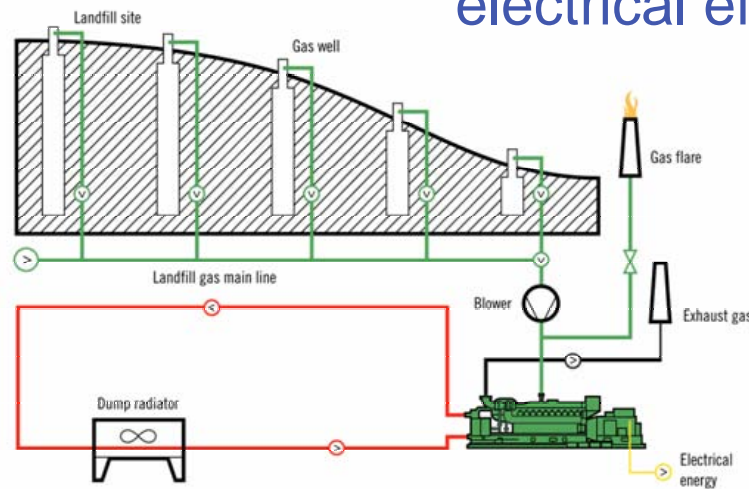
- 1 ton of municipal waste is converted to average 10 m<sup>3</sup><sub>N</sub> landfill gas per year
- A landfill generates gas over a period of 15-25 years with different intensity
- LHV = approx. 4.5 - 5 kWh/m<sup>3</sup><sub>N</sub>
- 40-50% of gas collectable from a covered landfill

**>> 1 million tons waste => 18,000-25,000 MWh/year input over a period of 15-25 years**

# Adjust and maximize annual energy output

- To adapt to fluctuation of emitted gas modular container genset solutions are superior

- e.g.: 21.300 MWh = 8,200 J320 operating hours >> 8,700 MWh<sub>el</sub> output (41% electrical efficiency)



- Electrical efficiency, LHV-fluctuation, gas pressure fluctuation and humidity of gas determine output

**>> 1 million tons waste => annual 8,700 MWh<sub>el</sub> output for 15-25 years**



# ***Power Generation with Landfill Gas in the UK***

*M2M Conference, Beijing, 31 October 2007*







- In the UK landfill gas is seen as a valuable fuel source
- The UK has more landfill gas power generation projects than any other country
- 1.1% of the UK's electricity is generated from landfill gas





- Given that landfill gas is environmentally damaging and needs to be extracted and destroyed, it makes good sense to generate electricity from it.



Authorised Distributor  
Jenbacher gas engines



- Landfill sites need to be engineered for gas collection to be successful.
- This is starting to happen in China.





## Rule of thumb estimate of landfill gas generation

- It takes 1 million tons of domestic waste to generate 1MW
- Yields vary greatly



## Government assistance (1)



### The Non Fossil Fuel Obligation (NFFO), 1989 -1999



- Electricity suppliers had to purchase a certain amount of electricity generated from non-fossil fuels
- There were five NFFO orders between 1990 and 1998
- Prices were determined by competitive tendering
- The price per kWh started at £0.065 (first order) and fell to £0.029 (fifth order)
- Prices were guaranteed for 7 years in the first two orders, 15 years in the later orders





## Government assistance (2)



### The Renewables Obligation (2002 – present)

- Requires electricity suppliers to source a percentage of electricity from renewable sources
- The percentage increases each year from 3% in 2002 to 15.4% in 2015
- Has resulted in increased prices compared with NFFO
- But prices are not guaranteed
- A Renewable Obligation Certificate (ROC) is obtained for each MWh
- ROCs are traded
- The combined value of electricity and ROC is presently £0.08 - £0.09 per kWh





## Costs in the UK (approximate);

- To establish 1MW including electrical connection, gas wells, gas blowers, £1m
- For each additional MW, £0.5m





- Power is generated by the landfill operator or by a contractor who pays the landfill operator a royalty.
- The royalty is generally 5% - 20% of revenue



- Usually 1MW units in containers are used.
- They are easy to install and can be moved between sites.



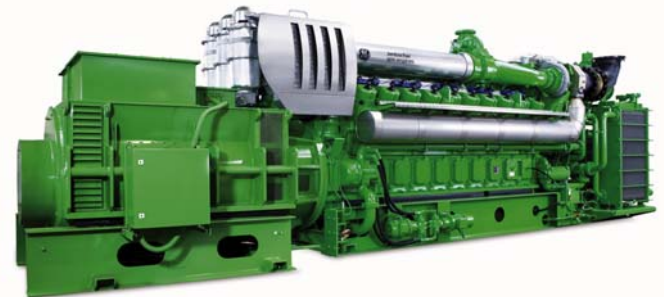


- Sometimes a building is used. This is a 12MW site.

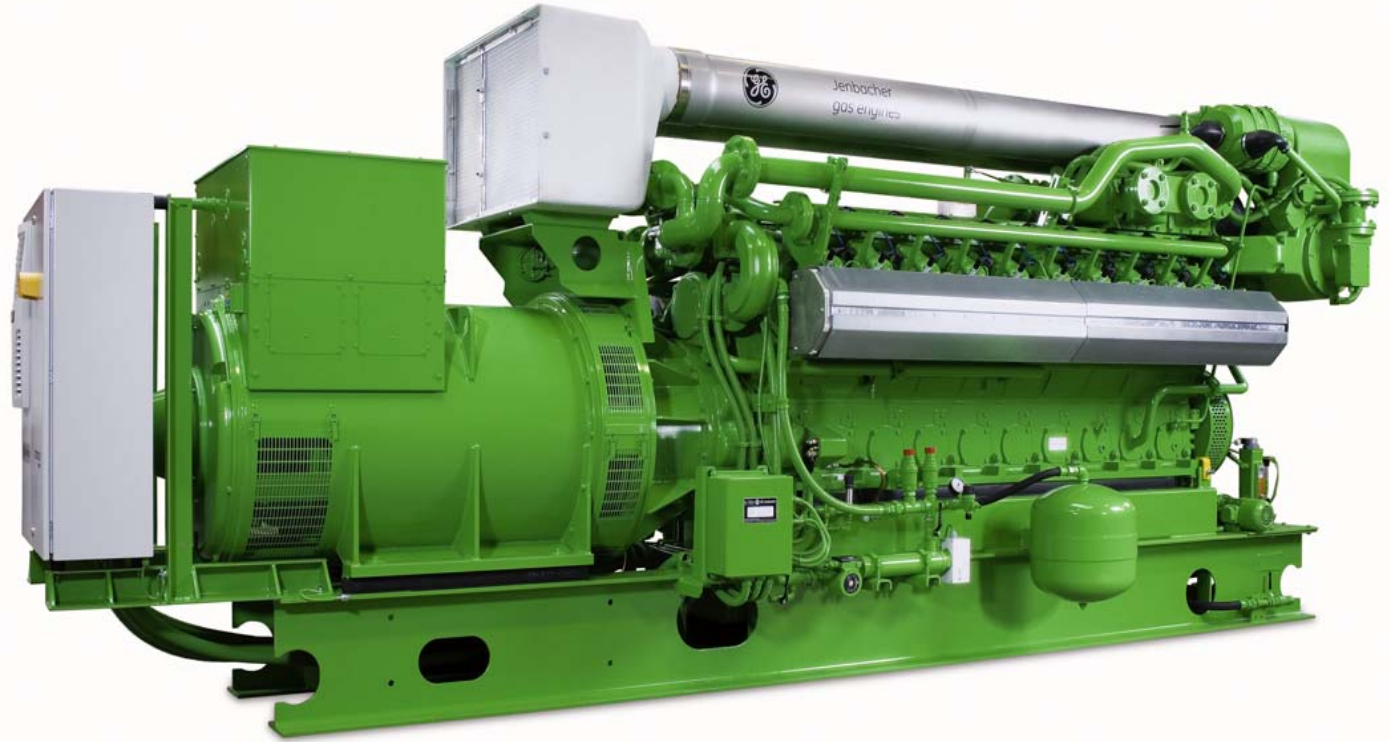


## Engines need to;

- Handle changing methane levels
- Generate full power at low methane levels – down to around 30% methane
- GE Energy Jenbacher engines are ideal
- Turbines are not suitable
- Clarke Energy has 15 years landfill gas experience and 80%+ market share in the UK







- The GE Energy Jenbacher J320 1MW engine
- The most popular engine in the UK for landfill gas applications
- 41% electrical efficiency



***Thank you!***

