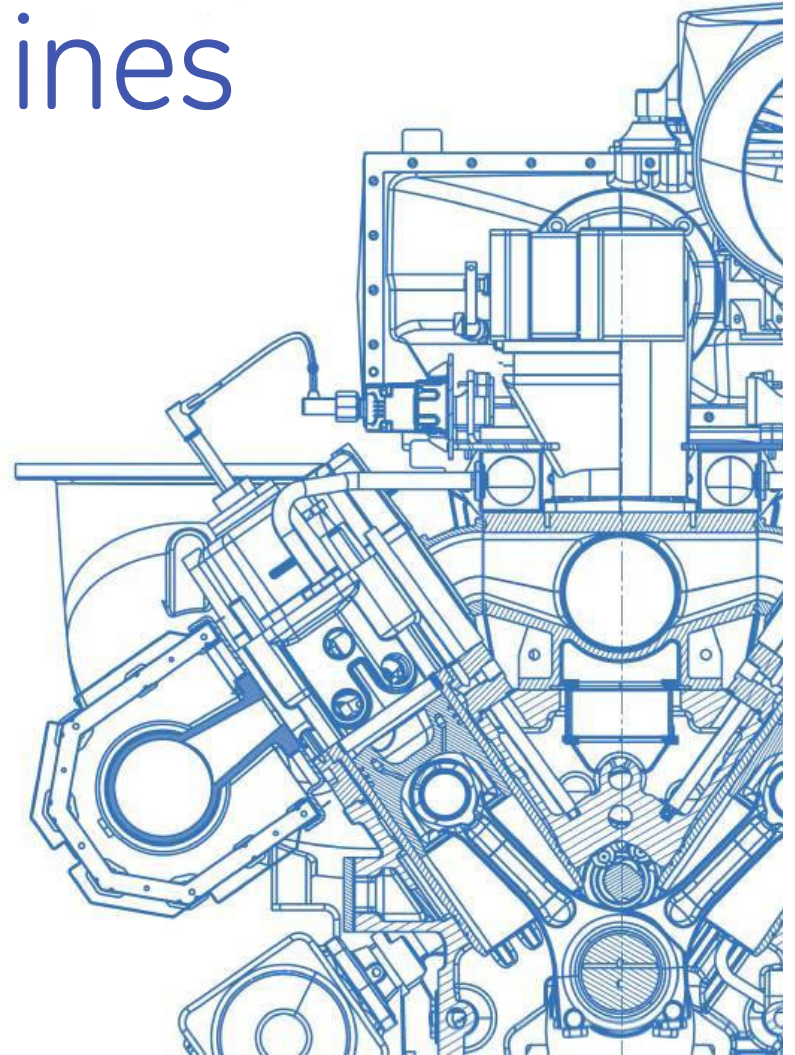


Jenbacher gas engines



imagination at work

Jenbacher gas engines – Overview 1

A leading manufacturer of gas-fueled reciprocating engines for power generation.

- Power range from 0.25MW to 4MW, 4 platforms / 11 products
- Fuel flexibility: Natural gas or a variety of renewable or alternative gases (e.g., landfill gas, biogas, coal mine gas)
- Plant configurations: Generator sets, cogeneration systems, container solutions
- Delivered engines: about 8,500 units / 9,800 MW



Headquarters



Jenbach, assembly hall 2

GE's Jenbacher product team has 1,300 of its about 1,700 worldwide employees located at Jenbach, Austria.

GE also operates two regional gas engine assembly facilities in Hangzhou, China, and in Vereasegyház, Hungary.

Jenbacher manufacturing facilities



Jenbach, Austria
Main manufacturing site
and business HQ



Hangzhou, China
Packaging for Asian units



Veresegyház, Hungary
Container manufacturing

GE's Jenbacher ecomagination solutions

Due to their cost-effectiveness, high output and measurable benefits to the environment, the following Jenbacher applications have already been certified as GE “ecomagination” products by an independent agency:

- **Biogas**
- **Landfill gas**
- **Coal mine gas**



Advantages of on-site energy supply

Energy supply directly at the load source allows to reduce or avoid transport and distribution losses.

Key features of Jenbacher plants

- High electrical efficiencies of up to 44%
- Overall efficiencies (electrical and thermal) of over 90%
- Minimum NO_x-emissions through the patented LEANOX® lean mixture combustion
- Specially designed engines for use of alternative, renewable energy sources and special gases
- Maximum operational safety and availability
- High power density

Type 2



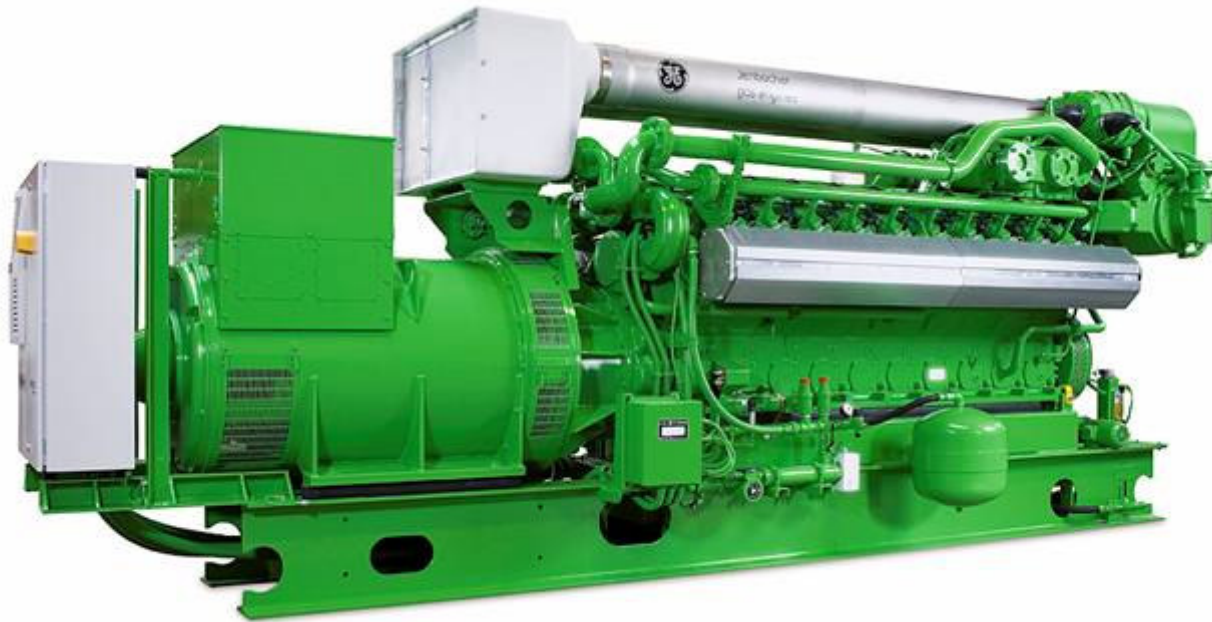
- Since 1976 in the product program
- Up to 2007: More than 850 engines delivered

Type 2

- Electrical output from 250 to 350 kW
- Packaged in a 20- or 40-foot ISO-container



Type 3



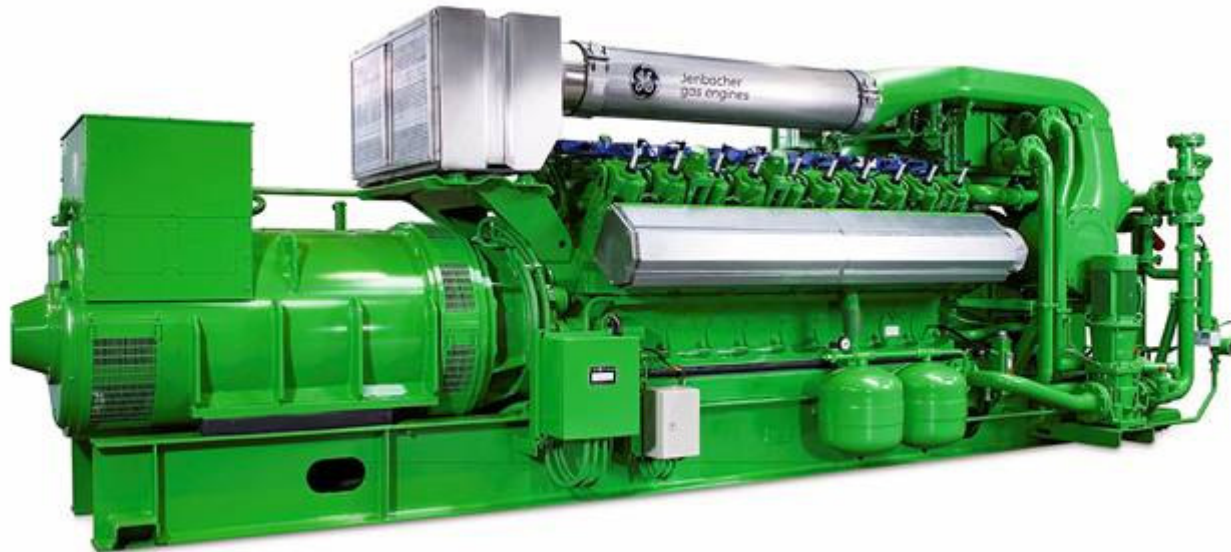
- Since 1988 in the product program
- Up to 2007: More than 4,550 engines delivered

Type 3

- Electrical output from 500 to 1,100 kW
- Available as V12, V16 and V20 cylinder engine
- Packaged in a 40-foot ISO-container



Type 4



- Since 2002 in the product program
- Up to 2007: More than 550 engines delivered

Type 4

- Electrical output from 800 to 1,500 kW
- Available as V12, V16 and V20 cylinder engine
- Containerized version available



Type 6



- Since 1989 in the product program
- Up to 2007: More than 1,850 engines delivered

Type 6

- Electrical output from 1.8 to 3 MW
- Available as V12, V16 and V20 cylinder engine



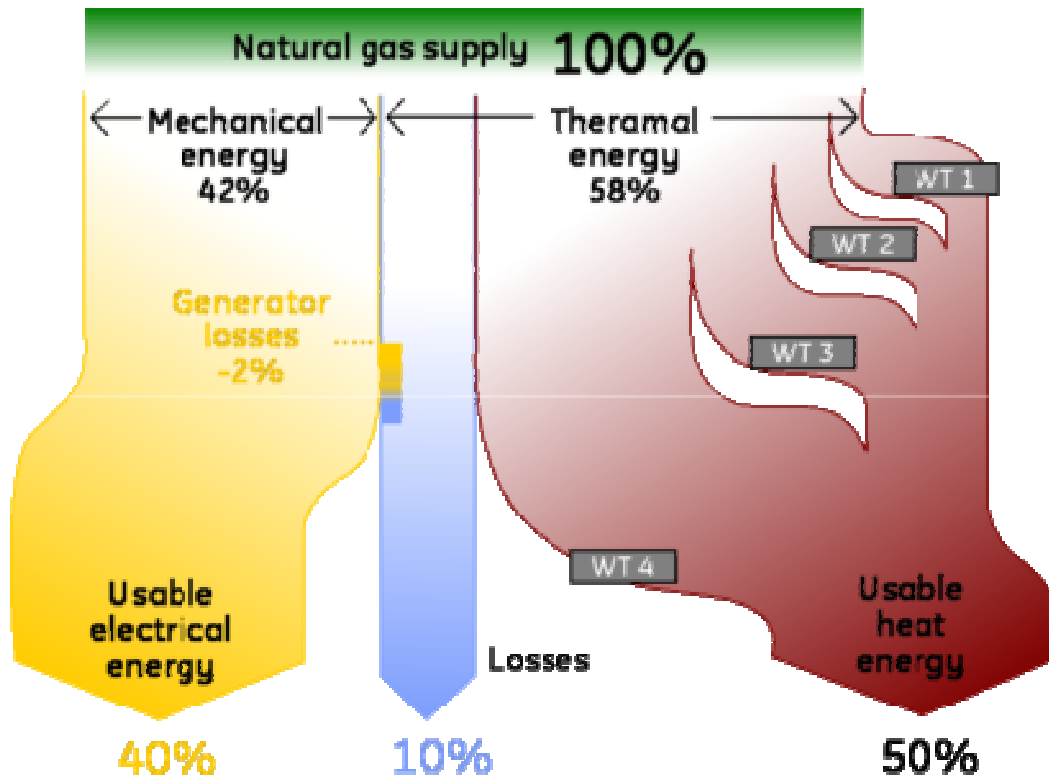
J 624 GS

The world's first 24-cylinder gas engine

Engine Output:	4 MW
Engine Speed:	1,500 rpm
Displacement:	145 l
Bore x Stroke:	190 mm x 220 mm



Energy Balance of a Gas Engine



[HE 1](#)
Mixture intercooler

[HE 2](#)
Oil heat exchanger

[HE 3](#)
Engine jacket
water heat exchanger

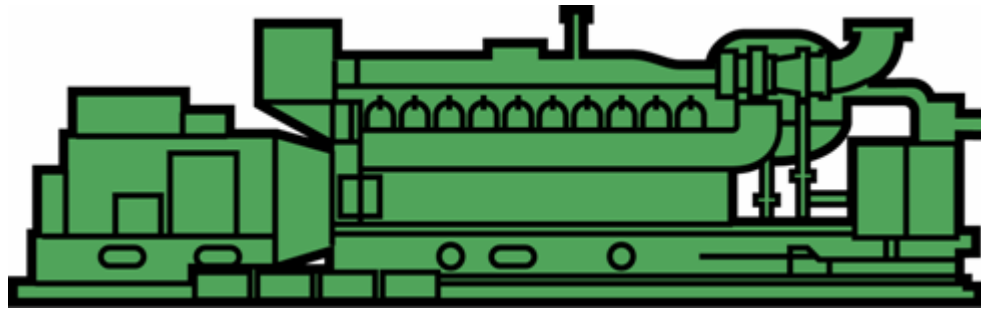
[HE 4](#)
Exhaust gas
heat exchanger

Jenbacher cogeneration systems offer numerous advantages

- High electrical efficiencies of up to 44%
- Overall efficiencies of over 90%
- High flexibility in adaptation to customers' heat and power demands
- Minimum emissions through LEANOX® combustion
- Small footprint
- Fuel flexibility through special engine design
- Maximum operational safety and availability
- Low investment costs



Fuel Gases for JENBACHER Gas Engines



Natural
Gas,
Propane,
LNG, ...

Biogas
(Landfill Gas,
Gas from
Biomass
Sewage Gas)

Synthetic Gases
(Wood gas,
Pyrolysis Gas,
Coke Gas,...)

Natural gas

Jenbacher plants for on-site energy supply based on natural gas as fuel.

Advantages of natural gas

- Well developed natural gas supply systems
- Lowest emissions of all fossil fuels
- Most important fossil energy source

Biogas and special gases

Jenbacher plants generate energy using gases from landfills, agriculture, coal mining, chemical plants, and other industries.

Advantages

- Substitute for conventional fuels
- Alternative disposal of problem gases
- Highly efficient for cogeneration of power and heat
- Avoids venting methane into the atmosphere
- High potential for reduction of greenhouse effects

Biogas – a renewable energy source



Cows Give Both – Milk and Power:
Using Biogas in Gas Engines



imagination at work

Biogas – renewable fuel able to substitute fossil fuels

For a wide range of organic substances from agriculture, food waste or food industry anaerobic fermentation is a superior alternative to composting.

Biogas ...

- results from anaerobic digestion of organic materials
- is a mixture of methane and carbon dioxide
- serves as a high-energy, CO₂-neutral fuel

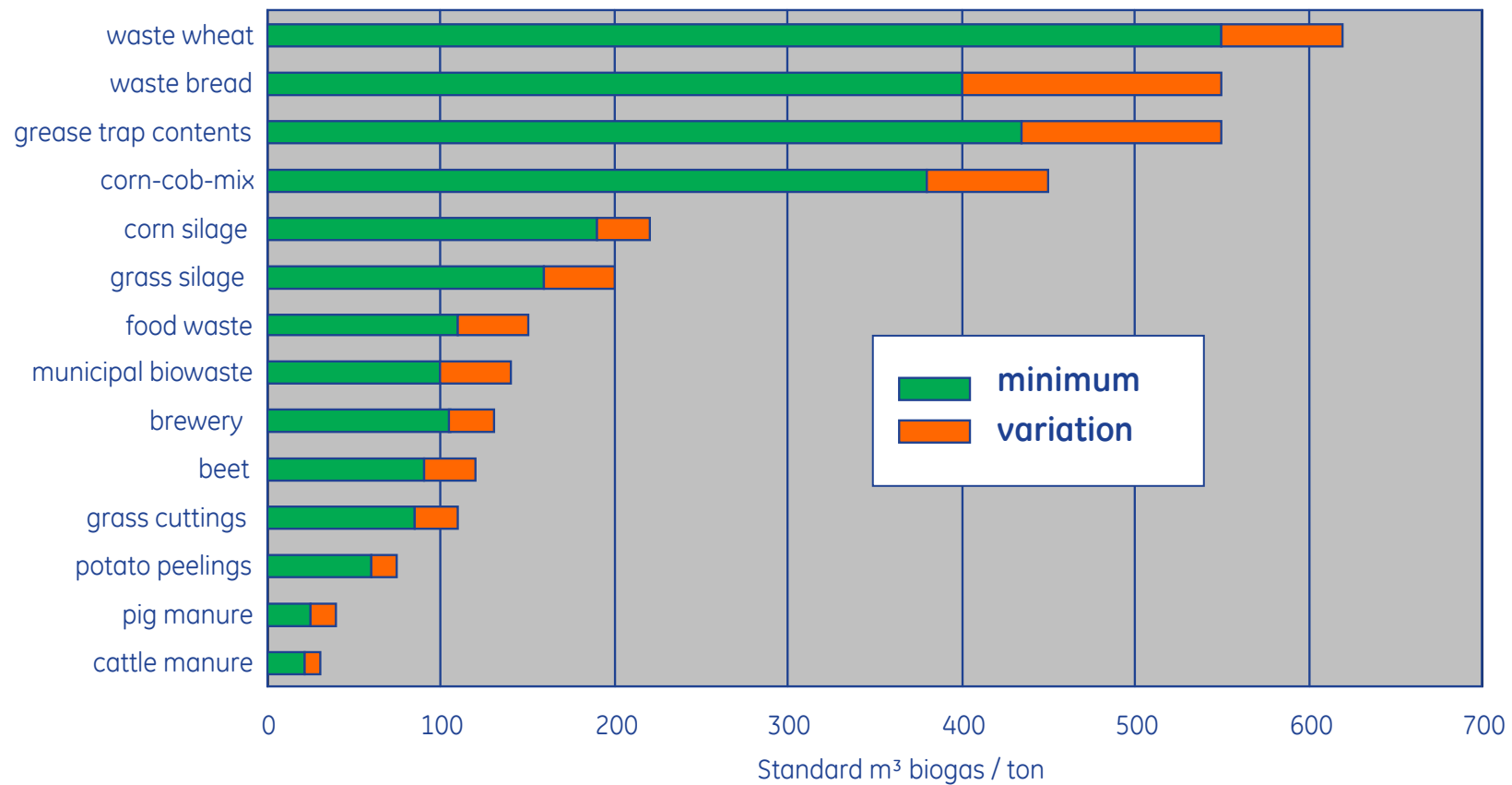


Operational conditions of the fermentation process

- **Temperature**
 - mesophile process: 35 - 40°C
 - thermophile process: 50 - 55°C
- **Dry matter concentration**
 - dry fermentation: 20 - 30%
 - wet fermentation: 10 - 15%
- **Retention time**
 - minimum 15 days
 - range: 20 - 50 days
 - common: 25 - 30 days
- **Absence of oxygen**
- **pH value from 6.5 to 7.5**



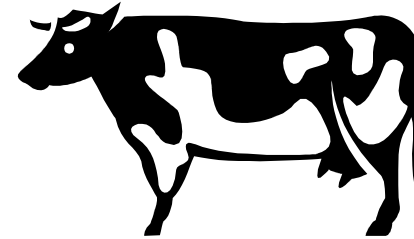
Biogas yields of suitable organic materials



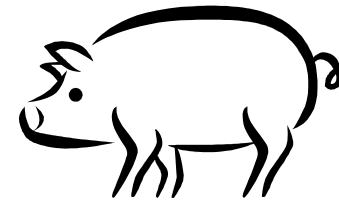
Energy potential of biomass

1 Live Stock Unit (LSU) = 500 kg live weight

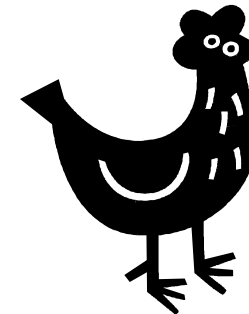
1 LSU = 0.6 - 1.2 milking cow
approx. 1.3 m³ biogas/LSU, day
LHV = approx. 6.0 kWh/m³_N



1 LSU = 2 - 6 pigs
approx. 1.5 m³ biogas/LSU, day
LHV = approx. 6.0 kWh/m³_N



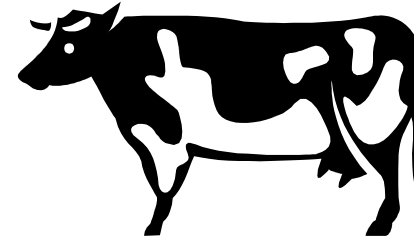
1 LSU = 250 - 320 layers
approx. 2 m³ biogas/LSU, day
LHV = approx. 6.5 kWh/m³_N



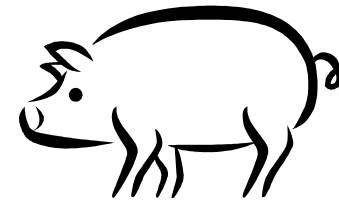
Energy potential of biomass

1 JMS 312 GS-B.L with 500 kWel can be fueled by manure of:

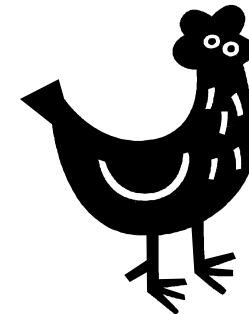
3,600 dairy cows



14,000 feeding pigs



700,000 laying hens or chickens



Biogas is well suited for combustion in gas engines

Gas mixture composition:

- 50 – 70% methane (CH_4)
- 30 – 50% carbon dioxide (CO_2)

The generated power is used ...

- to feed electricity into the public power grid
- to meet the own electricity requirements

Thermal energy can be used ...

- to feed the district heating network
- for heating purposes on site



Advantages of Anaerobic Digestion

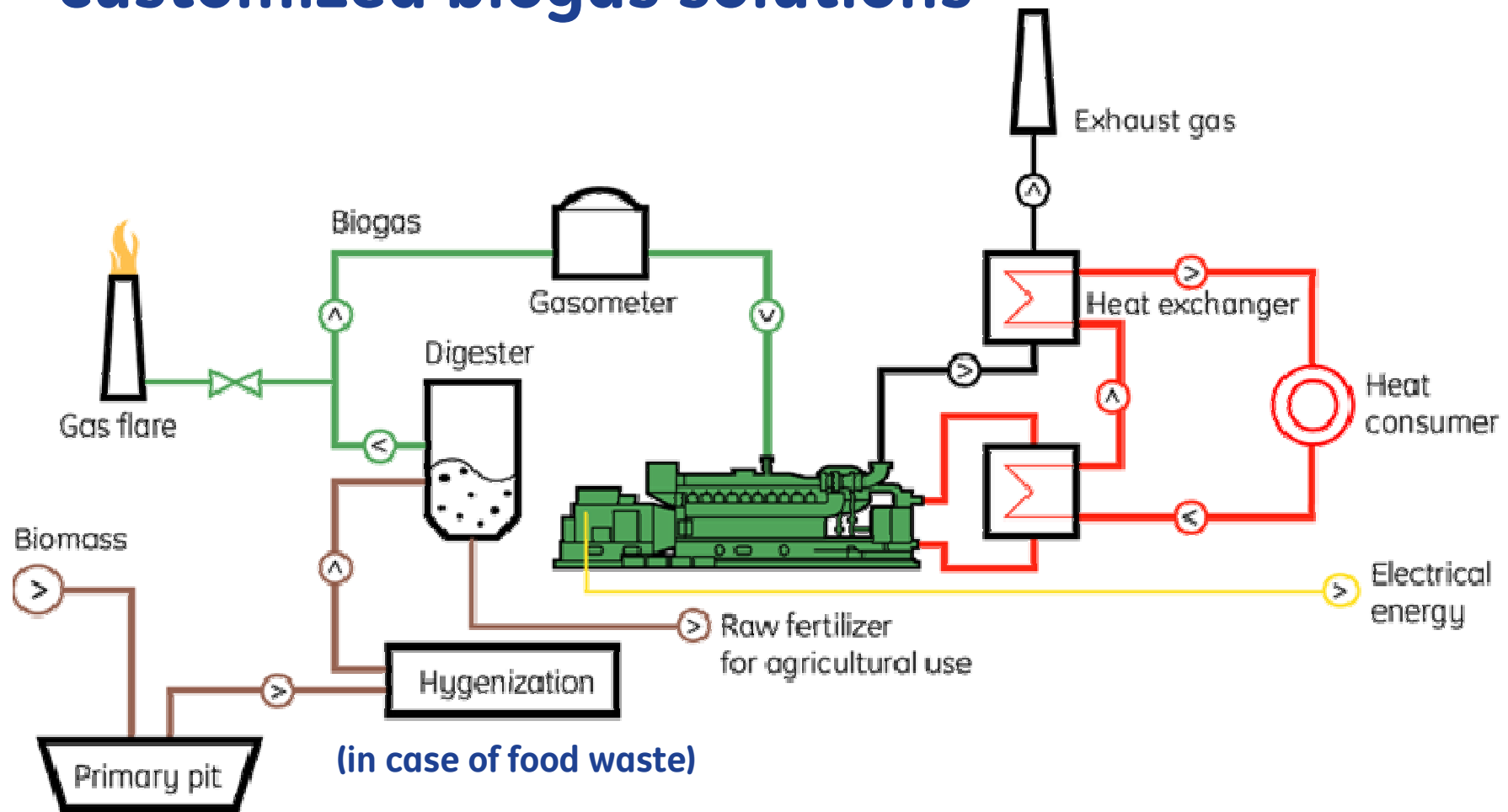
For the Customer:

- **improvement of manure properties**: odor reduction, elimination of acid components, viscosity decrease, mineralization of organic nitrogen, reduction of pathogenic germs and weed seeds
- **additional** income from **heat and power production**
- **waste water treatment** without costly sewer connection

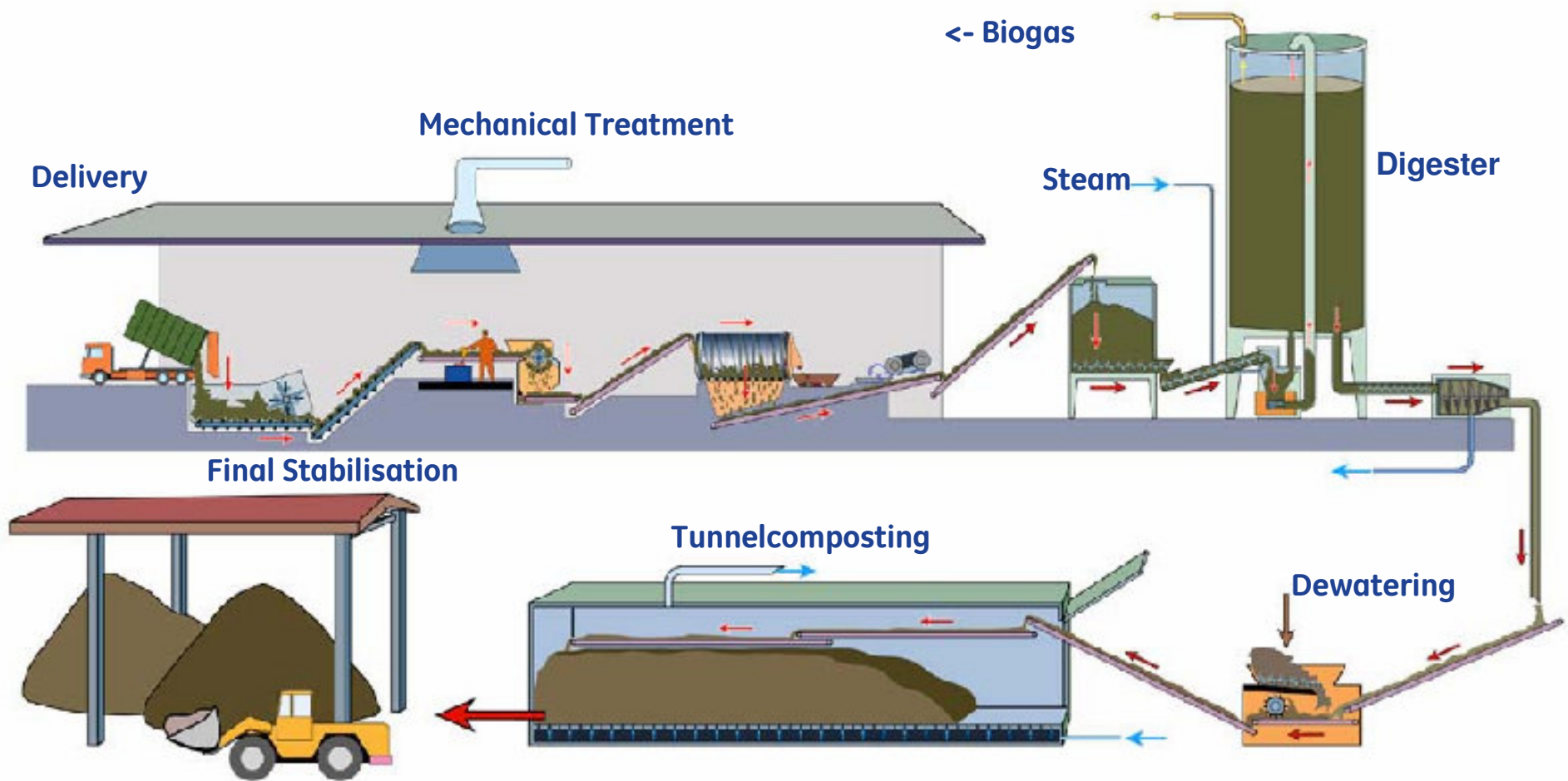
For the Environment:

- **reduction** of **methane and ammonia emissions** from manure
- **reduction** of **nitrate wash-out** into groundwater
- **recycling** of **fertilizer compounds** from organic wastes
- **reduction** of **carbon dioxide emissions** by substitution of fossil resources

GE's Jenbacher gas engine business offers customized biogas solutions



Biomass Digestion of bio-waste

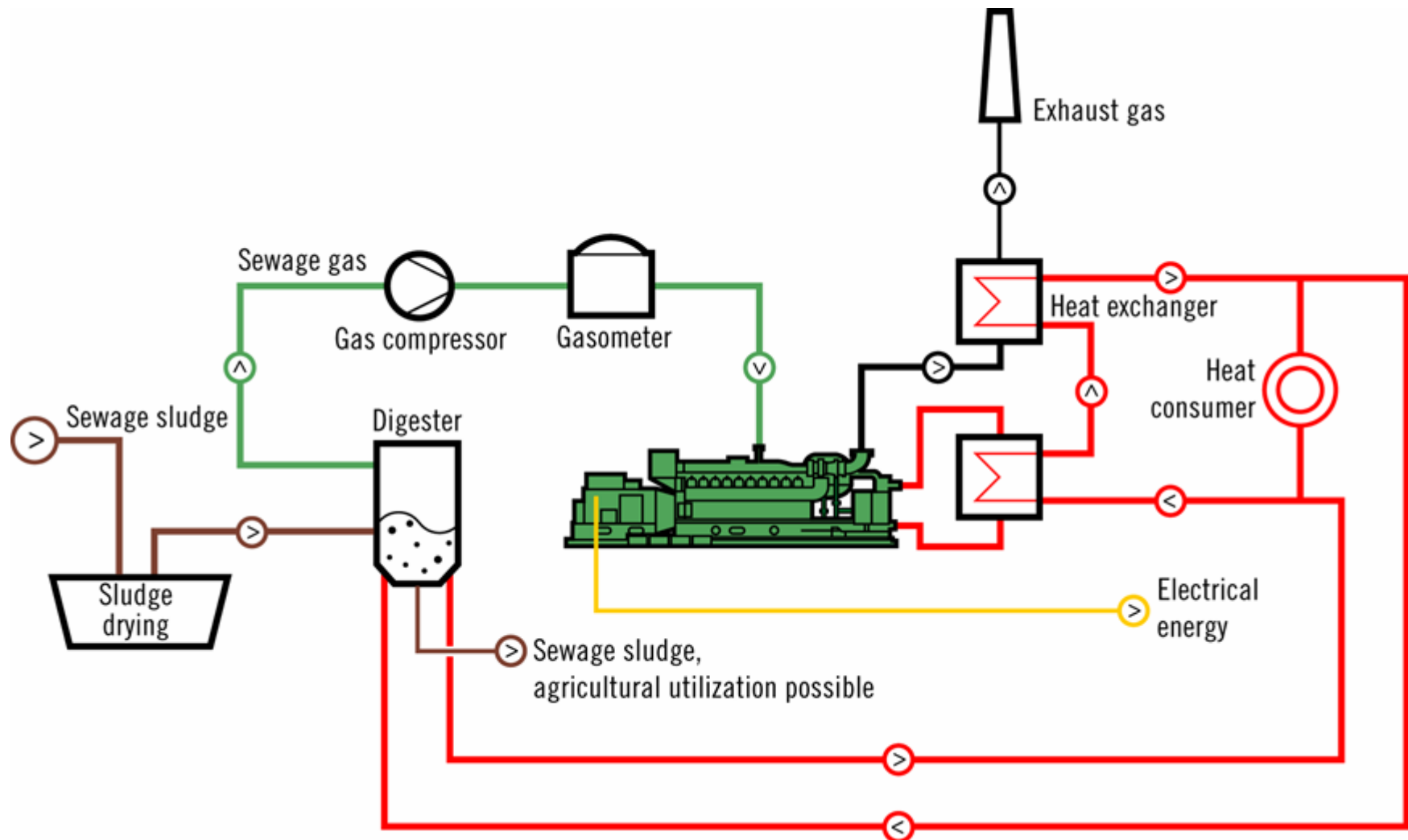


Biogas plant Highmark, Canada



No. of units and engine type:	1 x JMC 320 GS-B/N.LC
Fuel:	Biogas/Natural gas
Electrical output:	1,060 kW
Thermal output:	1,240 kW
Commissioning:	March 2004

Utilization of Sewage Gas



Sewage Treatment Plant



Strass Zillertal/Austria

1 x JMS 208 GS-B.LC

Utilization of Landfill gas

background and experience



imagination at work

Landfill (LFG) gas background

- LFG is a by-product of the decomposition of municipal solid waste (MSW)
- Composition of LFG:
 - ~ 50% methane (CH_4)
 - ~ 50% carbon dioxide (CO_2)
 - <1% non-methane organic compounds (NMOCs)
- For every 1 million tons of MSW:
 - ~ 0.8 MW of electricity
 - ~ 12.000 m^3 per day of landfill gas
- If uncontrolled, LFG contributes to smog and global warming, and may cause health and safety concerns

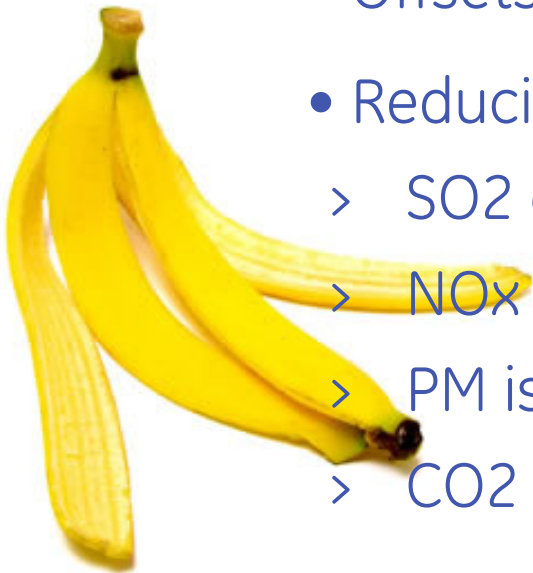
Why is it important to care about landfill gas?

- Methane is a potent heat-trapping gas
- Landfills are the largest human-made source of methane
- There are many cost effective options for reducing methane emissions while generating energy
- Projects reduce local air pollution
- Projects create jobs, revenues, and cost savings

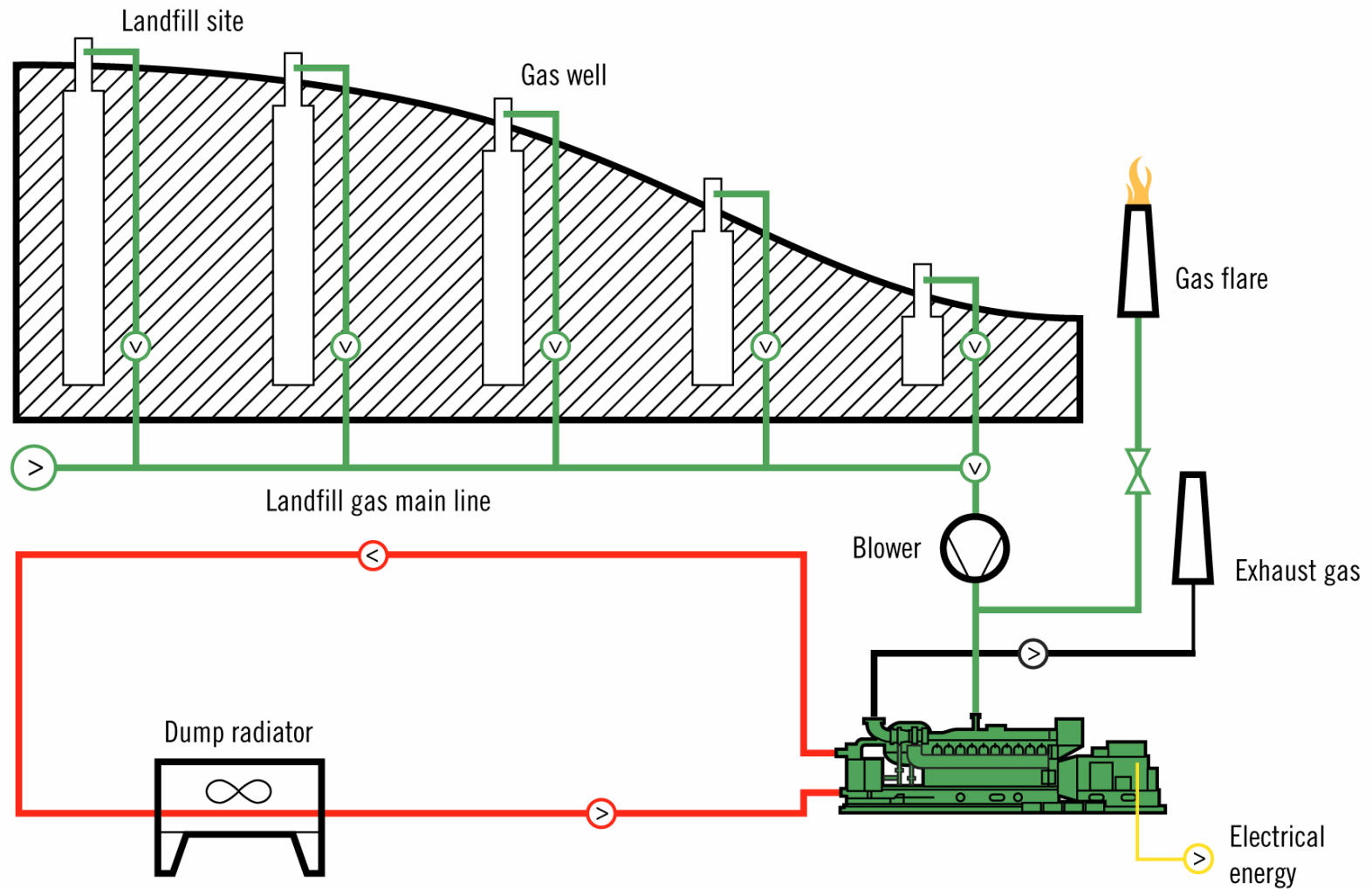


Benefits of LFG utilization

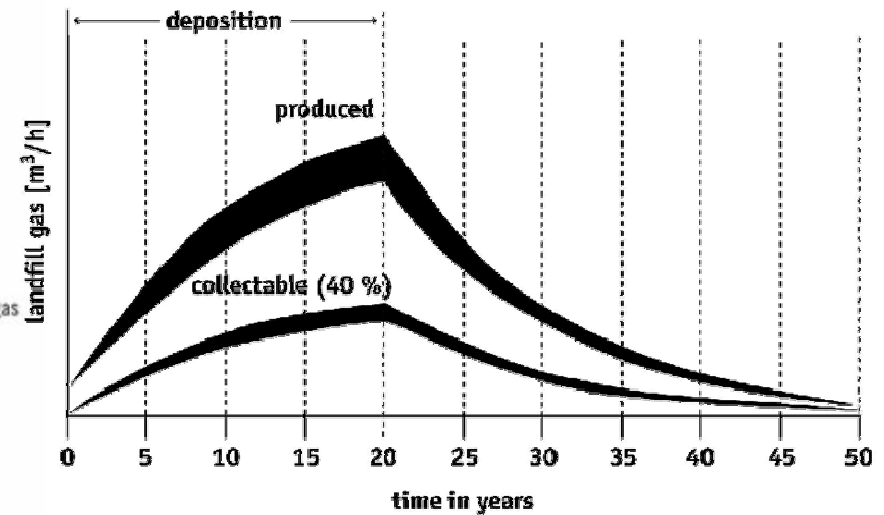
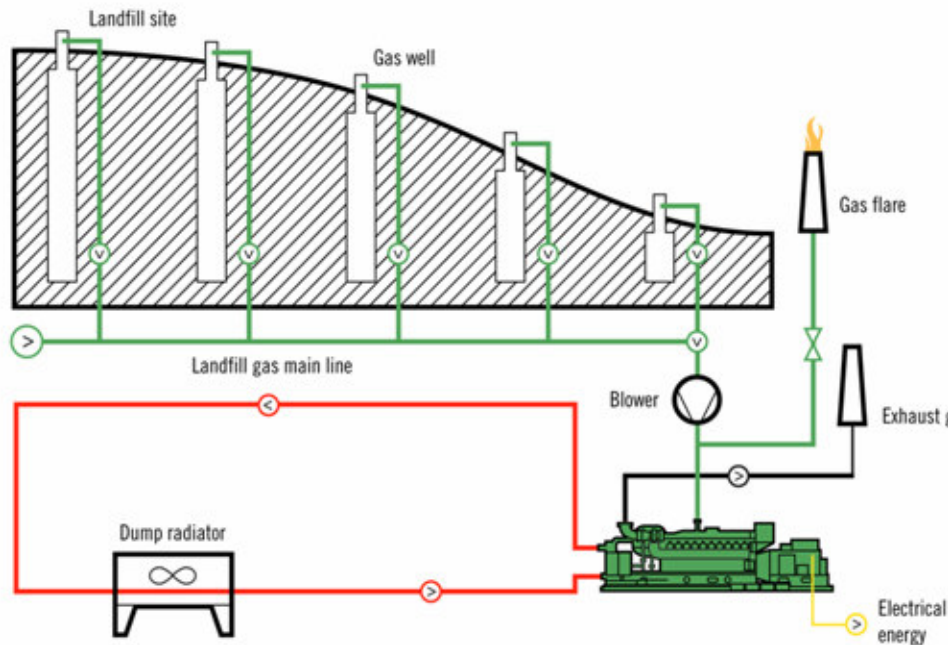
- Destroys methane and other organic compounds in LFG
- Each 1 MW of generation =
 - > planting ~ 37 km² of trees per year,
 - > removing the emissions of ~20.000 European cars per year
- Offsets use of nonrenewable resources (coal, oil, gas)
- Reducing emissions of:
 - > SO₂ contributes to acid rain
 - > NO_x contributes to ozone formation and smog
 - > PM is a respiratory health concern
 - > CO₂ is a global warming gas



Utilization of Landfill Gas



Landfill Gas production



- > 1 ton domestic waste => 150 - 250 Nm³ Landfill gas over a period of 15 - 25 years
- > LHV = approx. 4.5 - 5 kWh/Nm³
- > 40 - 50% collectable from a covered landfill

Utilization of Landfill Gas



Murcia/Spain

2 x JGC 320 GS-L.L

Electrical Output:
2 x 1,006 kW



Utilization of Landfill Gas



NENT/Hong Kong

2 x JGC 320 GS-L.L

Electrical Output:
2 x 922 kW



Utilization of Landfill Gas



Arpley/UK

18 x JGC 320 GS-L.L

Electrical Output:
18,612 kWel

Thank you...