AHK-Conference & Trade Mission

17.11.2009 Vilnius

Heat and Power Generation from Renewable Energy Resources

MWM

Energy. Efficiency. Environment.

Agenda

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References

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Brand Mission

MWM has a leading market position for high efficient and ecologically innovative energy solutions granting optimal fit and is the reliable partner for an continues and durable added value in the worldwide and decentralized power generation.

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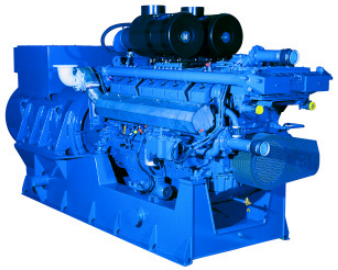
Profile

Development from an genset producer into a solution provider



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Profile

Market segments

Cogeneration

- Important market segment for MWM where we offer Co- and Trigeneration plants for natural gas

Special Gas

- This rapidly growing segment comprises various biogases, as well as gaseous by-products from the oil and gas industry, mining and cokery

Greenhouse

- Installation and Service for special CHP-applications for Greenhouse

Diesel

- Diesel generating sets represent an important complementation to our gas generating sets portfolio

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Profile

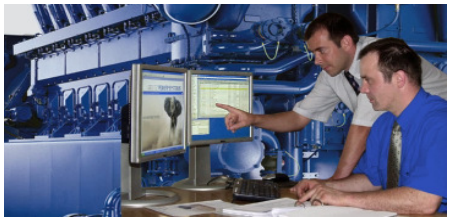
Market segments: Service

Maintenance

Our concepts((e.g. Servicecontracts), our experts and our response time make sure that we meet your demands to our products at anytime.

Service

Worldwide 24-hour support
Professional consultancy, product supervision, quick guarantee processing



Documentation

Modern software enables us to identify spare parts for all MWM engines in use worldwide, quickly and precisely

Training Center

Permanent training allows us to monitor and improve the qualification of our service personnel
Training provided locally

Logisticcenter

Optimised processes allow extremly short leadtime of the parts.the high effciency and flexibilityt enables to deliver our customers worldwide directly: just in time.

X-Change Center

Cost & time savings, we use basic engines and recycled parts

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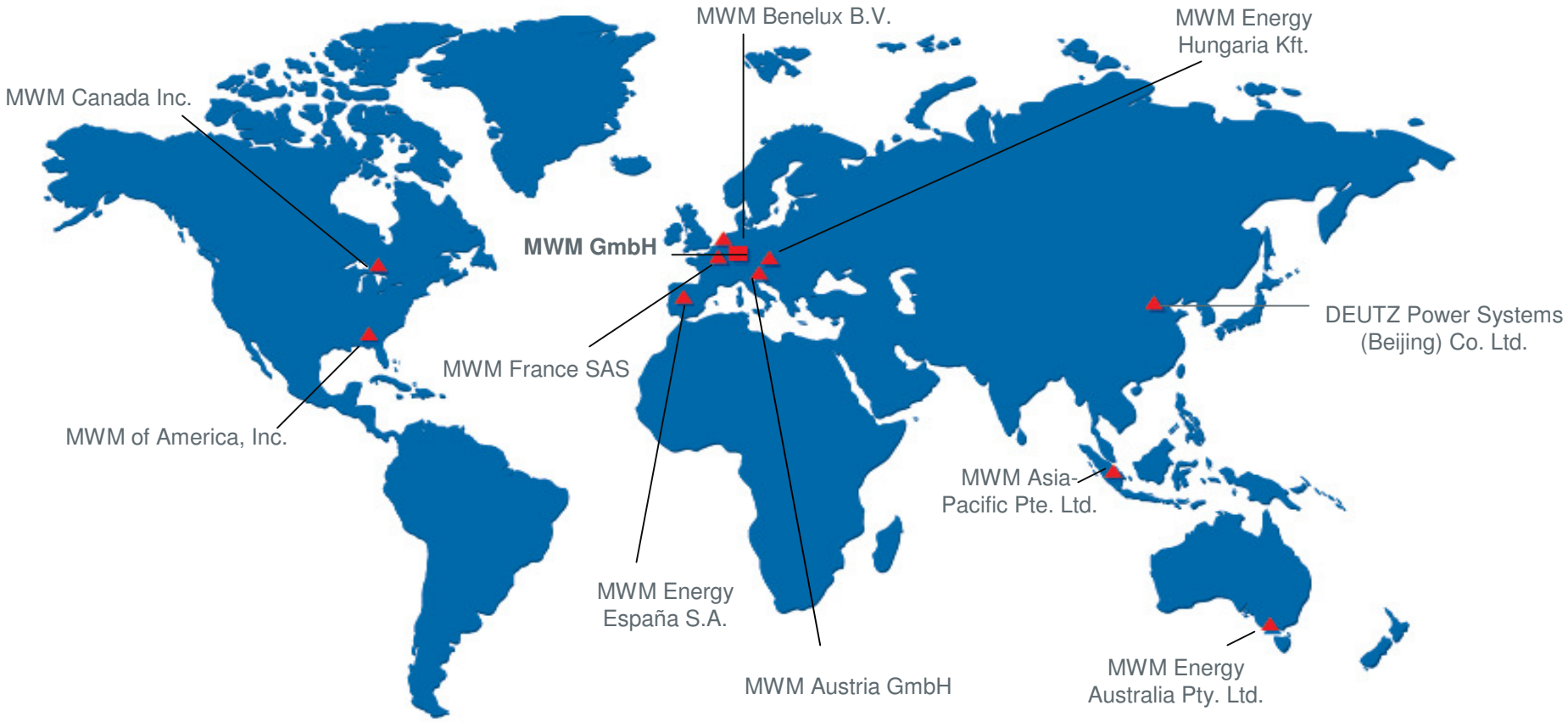
MWM group worldwide

MWM built up a network of 10 subsidiaries in all main markets



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History

The long-established company MWM

The MWM can look back at a tradition lasting over 135 years which has always been accompanied by innovations.

1871 Car inventor Carl Benz set the basis with the foundation of his "Mechanical Workshop" in Mannheim.

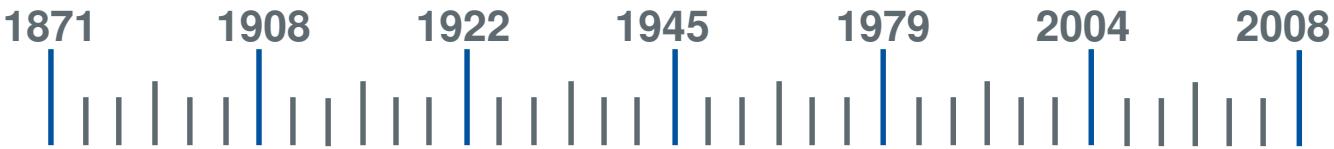
1922 The company split up. The Motoren-Werke Mannheim AG, formerly Benz, "Stationary Engine Construction" evolved.

1985 Klöckner-Humboldt-Deutz AG took over MWM.

2005 Deutz AG spun off a division known as DEUTZ Power Systems

2007 Deutz sold it to the investment firm of 3i in the fall of 2007.

2008 Re-Branding to MWM



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Key Figures

Figures, Data, Facts

- approx. 1,150 employees worldwide
- Revenue 2008/09: approx. 350 million Euro
- Total installed output in 2008/09:
  approx. 800 MW_{el}

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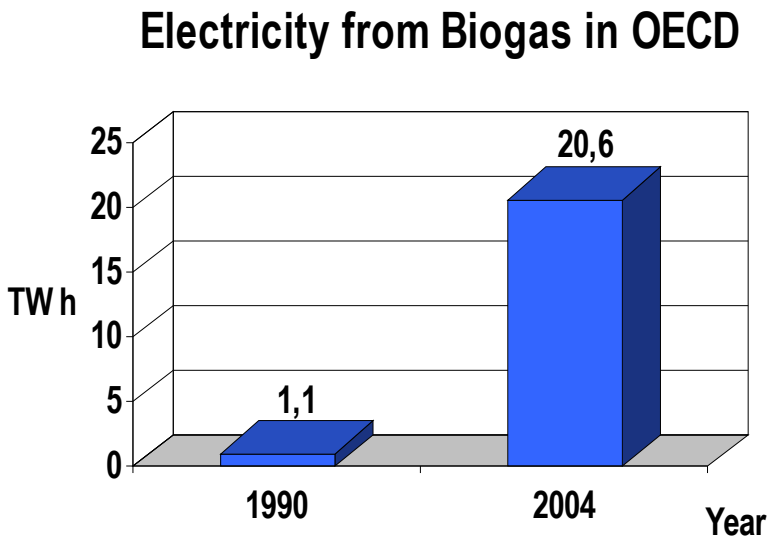
Historical background

Biogas as renewable fuel

- The limited availability of fossil fuels as well as increase sensitivity for environmental protection has resulted in considering renewable fuels as a solution for present and future
- Biogas is a renewable energy used in decentralized CHP power plants with gas engines allowing the use of locally available fuels for producing electricity and heat on a CO2 neutral basis
- The use of biogas in the OECD has increased by approx. 20 times in the time period 1990 to 2004
- The EU declared target in 2020 is to reach up to 30 % of power generation with renewable fuels, i.e. further significant growth for biogas is expected



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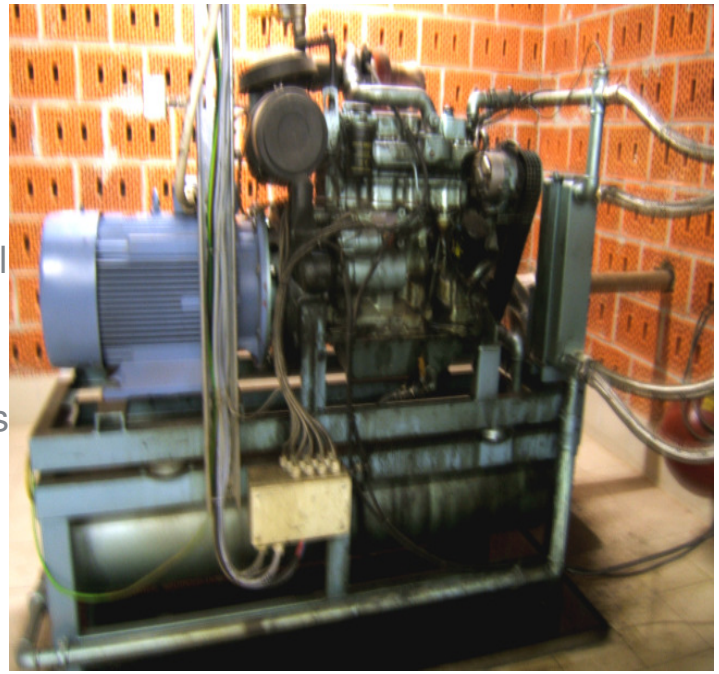
Historical background

Gas Engine Technology

- In order to meet the market growth requirements, many engine manufacturers used adapted diesel engines for biogas applications by:
  - Using uncontrolled Dual Fuel engines or
  - Exchanging the fuel pump system by an external ignition system
- These open loop controlled engines in many cases could not meet reliability requirements due to:
  - Original products not designed for continuous operation (automotive derivates)
  - Non considering of the continuously changing biogas qualities / compositions
- Only some manufacturers addressed characteristics of biogas within design of gas engines



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Biogas Definition and characteristics

Definition

Biogas typically defines a gas resulting from the anaerobic (in the absence of oxygen) decomposition or fermentation of organic material like:

- Sewage waste →sewage gas

- Municipal waste or leftovers →landfill gas

- Liquid manure or dung

- Energy crops (corn, wheat, grass)

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Biogas Definition and characteristics

Typical chemical composition of Biogas

Composition of the biogas mainly depends on:

- Quality and composition of the input biomass material (vegetal, animal, a.s.o.)
- Operation of the plant, specially temperature and pressure in the fermenter

Component	min	typical	max
methane (CH_4) [%]	45	55	70
carbon dioxide (CO_2)[%]	20	40	55
oxygen (O_2)[%]	0.01	0.3	2
nitrogen (N_2)[%]	0.01	4.7	10
Methane number	125	130	150
Lower heating value	4.5	5.5	7.0

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Biogas Definition and characteristics

Main contaminants in the Biogas

- Contaminants are substances which due to its nature are harmful to the use in reciprocating engines

  Either directly due to its corrosive effects

  Or

  Indirectly due to its further reaction to building corrosive products during or after the combustion

- Although water vapour in the fuel is not considered to be harmful, it can combine with organic compounds during the combustion process to form mineral acids like sulphuric acid.

contaminant	empirical values
Ammonia (NH3)	**10 – 1550 mg/Nm³**
Hydrogen sulphide (H_2S)	**5 – 3000 mg/Nm³**

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Products

Product portfolio

Gen Sets

- Electric power range 400 – 4,300 kW_{el} per unit
- Gas and diesel sets

Cogeneration/Trigeneration

- Project-specific layout of plant components
- Modular concepts for easy installation

Turn-Key-Solutions

- Consultancy, Engineering, Design
- Complete delivery and assembly of power plants

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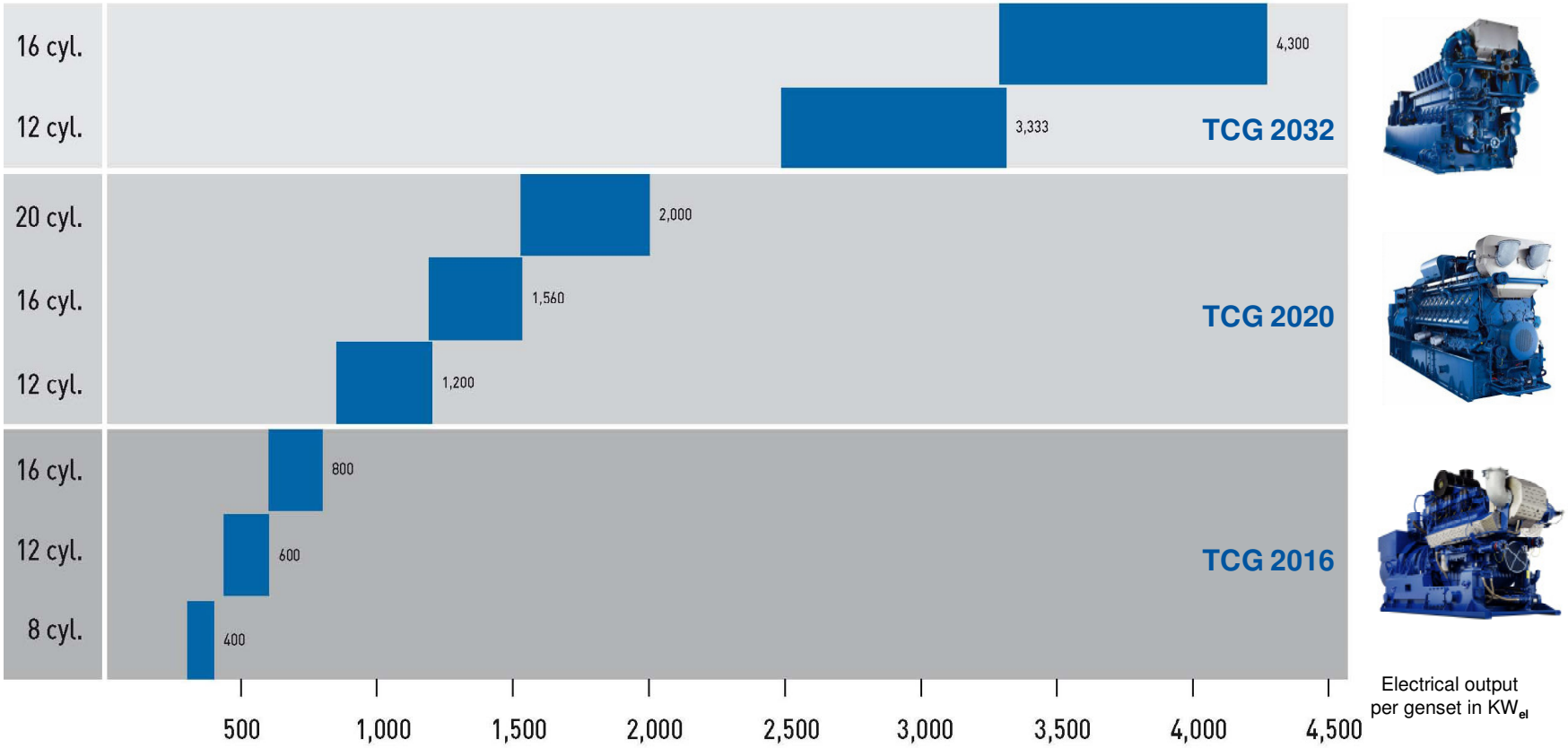
Products

50 Hz Product Range Gas



With our gensets we can cover a power range from 300kW_{el} up to 50 Mw_{el} for decentralized power production

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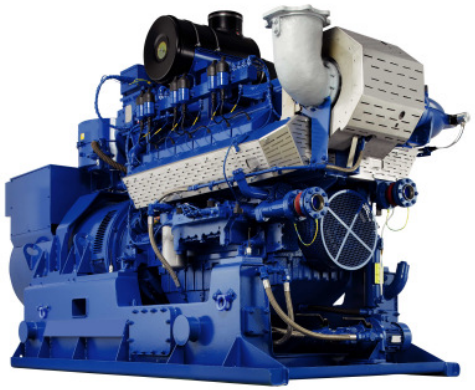
Products

Product overview

TCG 2016 C

- Engine power: 400 - 800 kW_{el} at 1,500 min^{-1} (50 Hz) and at 1,800 min^{-1} (60Hz)
- State-of-the-art 8-, 12 and 16 cylinder V-engines
- Turbocharging and intercooling
- Single cylinder heads with four-valve technology
- Centrally arranged industrial spark plug with intensive plug seat cooling
- Microprocessor-controlled high-voltage ignition system
- Electronic control and monitoring of genset operation through TEM
- Exhaust emissions controlled according to combustion chamber temperature



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Products

Product overview

TCG 2020

- Engine power: **1.200 – 2.000 kW$_{el}$** at 1,500 min^{-1} (50 Hz, 60 Hz with gearbox)
- State-of-the-art 12, 16 and 20 cylinder V-engines
- Turbocharging and two-stage intercooling
- Single cylinder heads with four-valve technology
- Microprocessor-controlled high-voltage ignition system
- One ignition coil per cylinder
- Electronic control and monitoring of genset operation through TEM
- Exhaust emissions controlled according to combustion chamber temperature

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Products

Product overview

Total Electronic Management (TEM)

- Wide range of control and monitoring options
- Easily adjustable to local conditions
- Simple and secure operational concept
- Convenient remote diagnosis and remote control
- Functions allowing optimized economical efficiency
- Available for the engine series TCG 2016 to TCG 2032
- A modular system to govern all auxilliary functions
- Multiple language documentation and handling

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Engine Optimization

- **During this presentation we want to concentrate on those motorical measures we developed and implemented based on our experience with this type of applications**
- **The issues to be presented cover:**
  - Gas supply pressure
  - Mixing of biogas and air
  - Mixture intake into combustion chambers
  - Combustion (compression ratio and spark plug design)
  - Bearing design and metallurgy
  - Lube oil management

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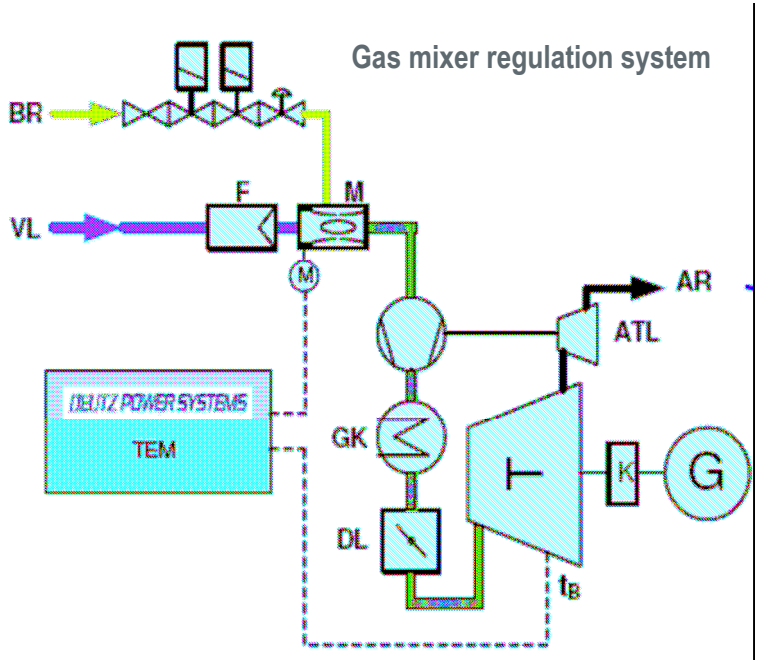
Engine Optimization

- Gas supply pressure
  Using turbocharged lean burn combustion system with open combustion chamber means mixing gas and air at engine inlet and compressing the mixture afterwards in the turbocharger and also allowing to use zero biogas pressure at engine inlet, resulting in
  - Reduction of investment costs (no compressors required)
  - Increase overall plant efficiency (no energizing of compressors required)
- Biogas – Air mixing
  When using an electronic multi-gas mixer, the system can be set to have a pre-programmed starting position depending also on the gas composition, this allows
  - Easy and reliable engine start
  - Run with alternative fuel (propane) until the biogas process is running on a stable basis and switching over to biogas operation



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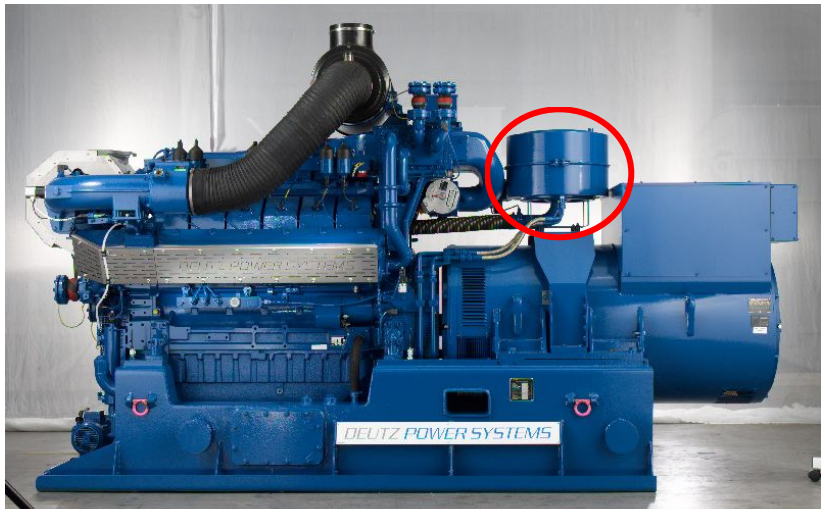
Engine Optimization

Mixture intake

- It is essential for proper engine operation to avoid condensations (= corrosion danger) on the way to the cylinders.
  Measures adopted include

  - Mixture cooler temperature has to be kept as high as possible (> 65° C)
  - Mixture cooler resistance shall be increased by using tin coated fins
  - Crankcase breather has to have a very high water separation capability by adequate size



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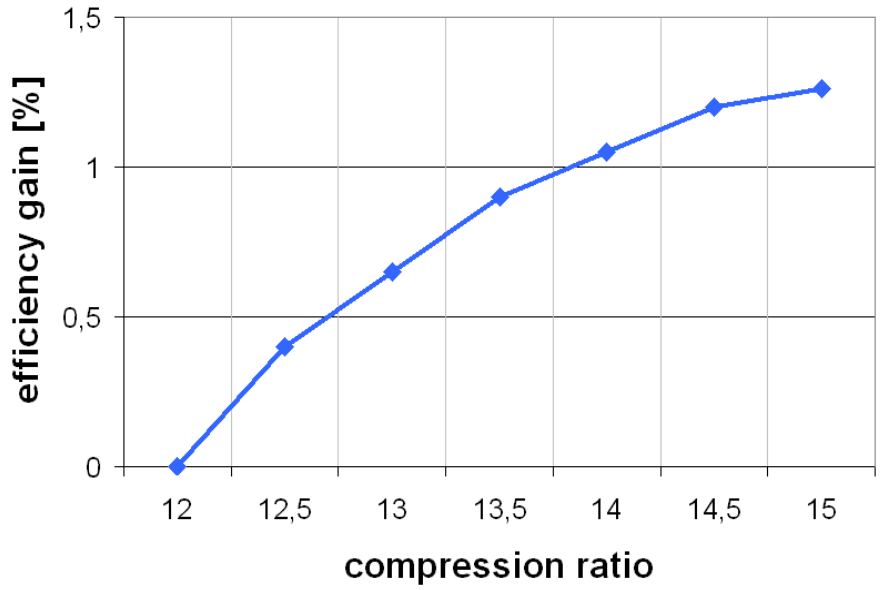
Engine Optimization

Combustion process – Compression ratio

- From a thermodynamic point of view, efficiency of combustion is proportional to the compressio ratio of the engine.

  On the other side higher compression ratio means higher risk of knocking and consequently higher operational risk.

  Since the MN of biogas is approx. 30% higher than natural gas, biogas has a significantly higher margin against knocking. This can be used accordingly.



Efficiency gain vs. Compression ratio Epsilon (calculated)

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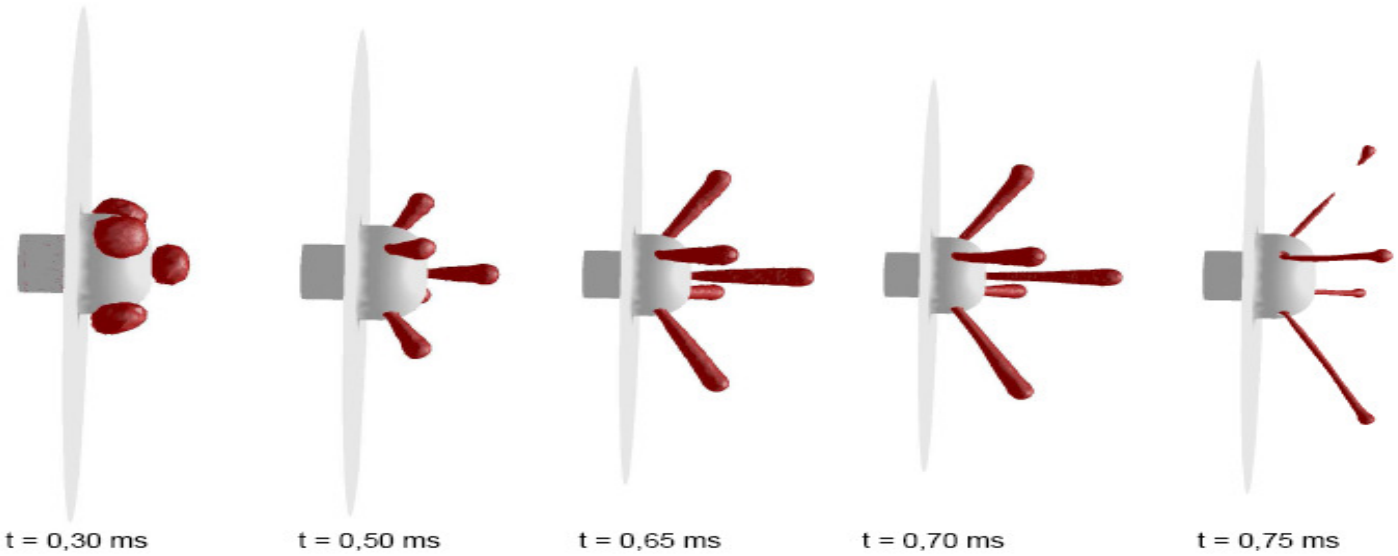
Engine Optimization

Combustion process –spark plug design

Combustion process- Spark plug design
Prechamber volume and bore shape energizes the mixture to increase flame propagation

Flame propagation



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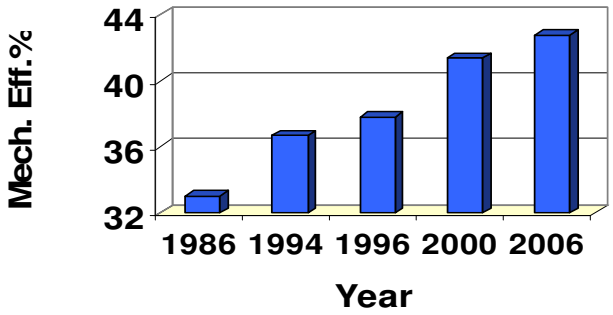
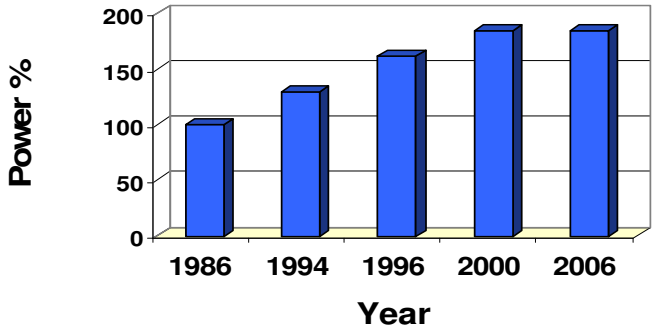
Conclusion

- Biogas is a renewable fuel with a special composition which demands proper addressing in both, plant layout as well as in engine / genset design
- Biogas has advantages when used in reciprocating engines resulting in improvements on efficiency and power output (and not onlyx for this gas type)
- State of the art technology is already making use of this advantages
- This is a solid support from the industry to the efforts of producing more and more heat and electricity with renewable fuels in order to achieve the levels of CO2 reduction expected by the both producers and customers





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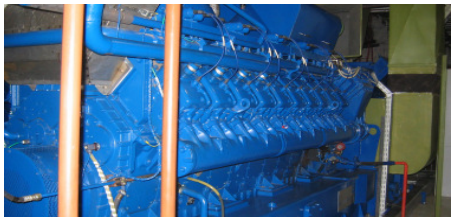
References

Segment: Natural Gas

Chowchilla, California, USA
16 x TBG 632 V16, Natural Gas, 52 MW

Munich International Airport, Germany
2 x TBG 632 V16, 7 MW

AMD, Dresden, Germany
9 x TCG 2032 V16, Natural Gas, 34 MW



Mangga Dua Square, Indonesia
8 x TCG 2020 V20, Natural Gas, 14.7 MW

Meirama, Spain
6 x TBG 632 V16, Natural Gas, 22 MW

Pattonville, Ludwigsburg, Germany
1 x TCG 2020 V20, Natural Gas, 2 MW

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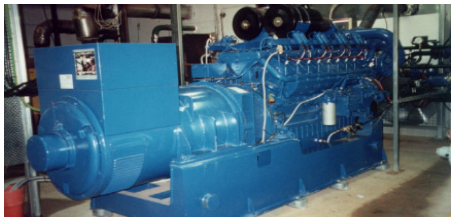
Segment: Special Gas

Coking Plant, Italiana Coke, Liguria, Italy
9 x TBG 632 V16, Coke Oven Gas, 25 MW

Budenheim Landfill, Germany
3 x TCG 2016 V12 K, Landfill Gas, 1.4 MW

Coal-Mine, Pniowek, Poland
2 x TBG 632 V16 + 1 x TCG 2032 V16,
Mine Gas, 11 MW



Bramberge, Germany
2 x TBG 616 V16 K, Flare Gas, 1.2 MW

Emschermündung Sewage Plant, Germany
4 x TBG 620 V16 K, Sewage Gas, 5 MW

Biogas Plant, Gaarestrup, Jütland, Denmark
1 x TBG 616 V16 K, Biogas, 647 kW

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References

Segment: Greenhouse

Delta Nutsbedrijven B.V., Holland
12 x TBG 620 V16 K + 4 x TCG 2020 V20, Natural Gas, 25 MW

G&G Flowers - Gameren, Holland
2 x TCG 2020 V12

Van Rijn Rozen en Paprikaaweker – De Kwakel, Holland
3 x TCG 2020 V20

Wordragen - Bruchem, Holland
1 x TCG 2020 V16

Seesun - Kapelle, Holland
12 x TBG 620 V16K, 4 x TCG 2020 V20

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Thank you.

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