

# Coal Mine Gas Utilization with Gas Engines - Case Study Sasyadko Mine, Ukraine

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**GE Energy**  
**Jenbacher gas engines**



**Methane to Markets**

**Methane to Markets Partnership Exposition**  
**Coal Sector, Session 2, 10:30**

October 30-31, 2007  
China World Center, Beijing



GE imagination at work



# The Coal Mine Gas business for GE Energy



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# 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\$



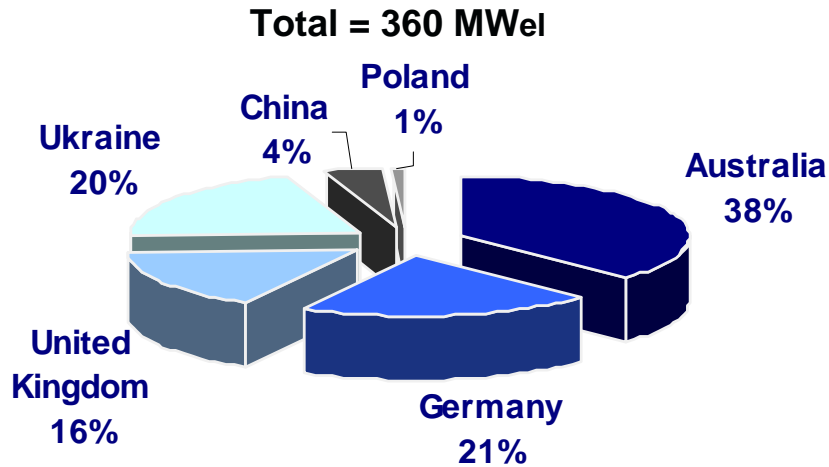
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# Overview GE Energy Jenbacher gas engines



- 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 : > **8,000 engines**, >**7,000 MWeI**
- Total **CMG base** installed up to know: **169** units, output **360MWeI**

# GE-Jenbacher is a leading supplier for PG and CHP plants fueled by CMG



Thoresby Colliery,  
United Kingdom  
2 x JGC 420 GS S.L  
3 MWeI

## Split of installed CMG gas engines by country in % MWeI



Teralba, Australia: 8 x JGS 320, 8 MWeI, 5 MWth

Fenne, Germany:  
14 x JMS 620 GS S.LC,  
40 MWeI  
41 MWth



# Project overview Sasyadko



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# Sasyadko - A milestone in CMG utilization



- Large scale Coal Mine Methane CHP plant nearby Donezk, Ukraine
- Awarded "World's best Power Plant" and "Project-of-the-Year"\*
- Total capacity 73MWe<sub>el</sub> delivered with 12/24 engines in operation since May 2006 ("phase I")
- Mitigating emissions at an amount equivalent to 2.6 to 2.9 million tons of CO<sub>2</sub> annually
- Considerable contribution to Ukraine's CH<sub>4</sub> emission reduction/ approved one of Ukraine's first projects in international emissions trading in accordance with the Kyoto Protocol



**ecomagination**

\* see announcements in Diesel & Gas magazine Jan/Feb issue 2006 respectively PEI magazine, renewable category 2006

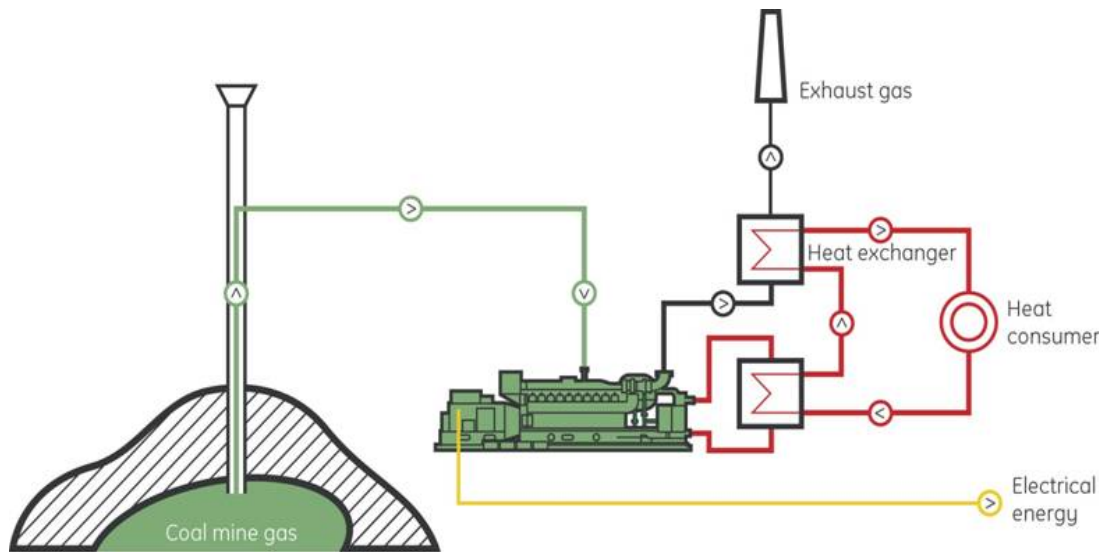
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Coal Mine Gas Utilization with Gas Engines -  
Case Study Sasyadko Mine, Ukraine  
Beijing, October 2007



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# Technical project data Sasyadko



Gas consisting of 25% methane (fluctuations)  
LEANOX<sup>®</sup> system rapidly reacting to unpredictable changes in methane concentration and gas quality

System handles extremely low pressure of 100 mbar >> gas does not have to be compressed

## Thermal output >>

- heating the mine
- replacing existing boilers
- surplus heat supplied to Donezk district heating system

## Electrical energy >>

- used on-site
- including pumps &
- ventilation system
- critical for mine safety

## Special features >>

- cooling system
- silencer
- heat recovery unit
- compact V-shaped engine design lowers foundation size requirements



# Some more pictures and plant location



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# Lessons learned from Sasyadko - The CMG power generation business today



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# The coal mine gas business has changed



- Mine operations equipped with a modern degasification system
- Projects have been initiated by supported feed-in tariffs or other public subsidies
- Mine safety and emission reduction only co-drivers

>> main task = optimizing electrical and thermal efficiency from good quality CMG

- focusing at the engine supply



- Degasification system less powerful >> lower and more fluctuating methane concentration
- Mine operations in remote areas
- Projects are initiated by emission reduction credit trading following the Kyoto protocol mechanisms (CDM & JI)
- Mine safety and emission reduction are the main drivers

>> main task = ensuring availability and durability of engines despite more critical gas

- service coverage
- plant engineering know-how

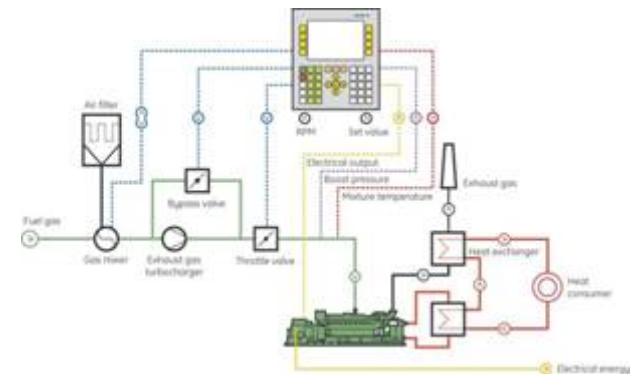
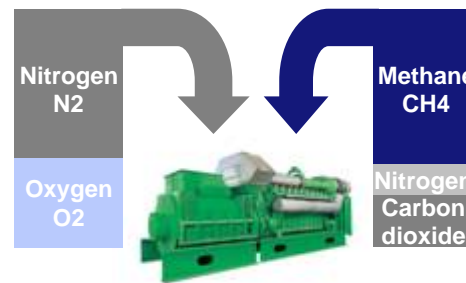
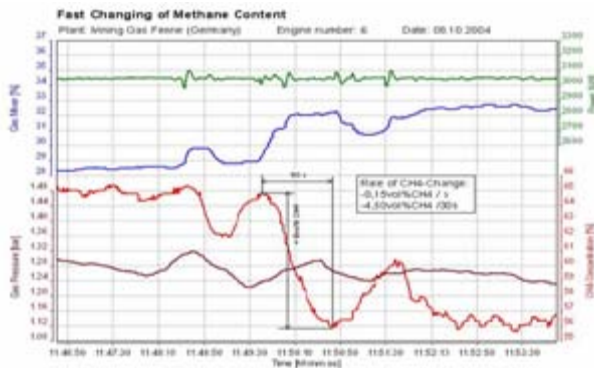


# Typical challenges using CMG with gas engines

- low CH<sub>4</sub>-range
- air content (O<sub>2</sub>)
- quick CH<sub>4</sub>-fluctuations
- gas contaminations
- **gas humidity**
- gas pressure fluctuations

>> all depending on mine type and degasification system

- extensive gas analysis
- gas pretreatment know-how
- efficient engine layout for large LHV range
- appropriate engine control system to ensure stable energy output (DIA.NE<sup>®</sup> + LEANOX<sup>®</sup>)



# The GE-Jenbacher Solution

**GE Jenbacher's aim is to contribute to safety and ensure profitability and emission reduction to mine operations**

- GE-Jenbacher know-how from 20 years experience ensure reliability, efficiency and flexibility in CMG utilization for PG
- GE-Jenbacher's selected subcontractors care for an appropriate gas supply and pretreatment and thus contribute to work safety
- GE-Jenbacher sales & service team and distributors support project owners along the project lifetime
- GE-Jenbacher gas engines allow
  - Availability/ durability down to low calorific values + high gas humidity
  - Low life cycle costs through specific Customer Service Agreementand are permanently further tuned to this specific application



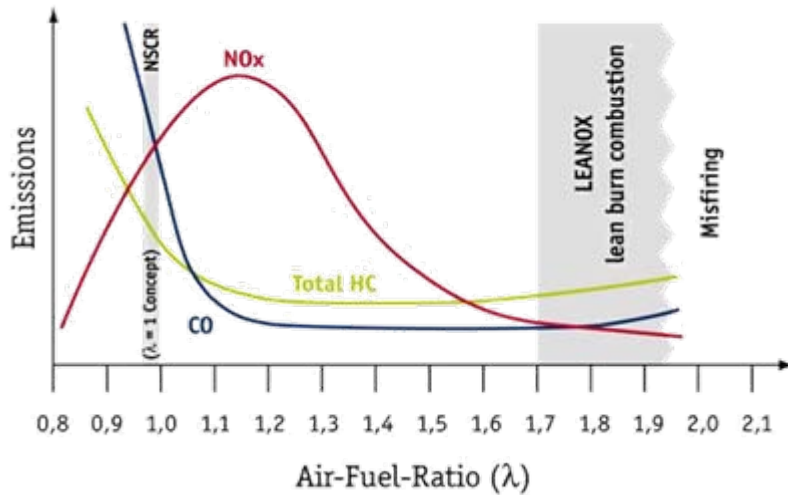
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**Thank you very much  
for your attention!**

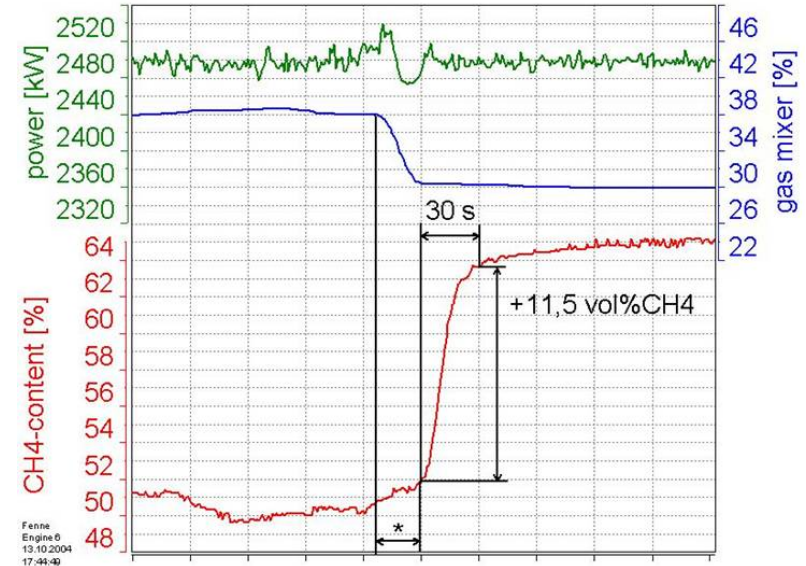


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# GE-Jenbacher *LEANOX*<sup>®</sup> + *DIA.NE*<sup>®</sup>



*LEANOX*<sup>®</sup> system levels out fluctuations in methane content and keeps NOx emissions below the critical values



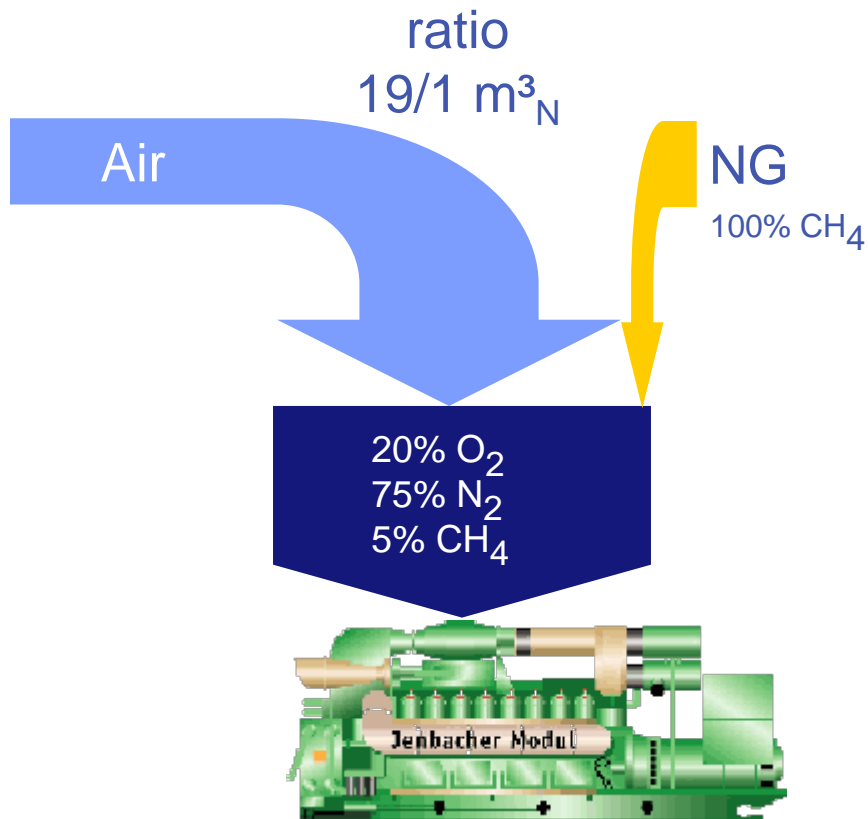
*DIA.NE*<sup>®</sup> enables smooth and automatic engine start and operation despite gas fluctuations and other issues



**>> Chinese version soon available**

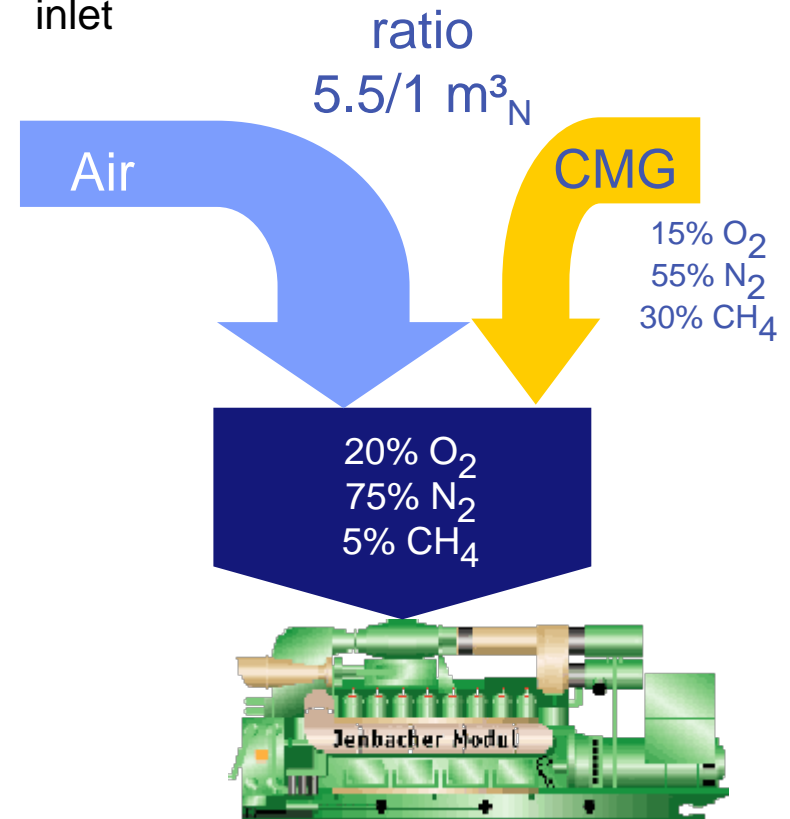
# NG versus CMG air/fuel ratio

## Natural Gas Operation



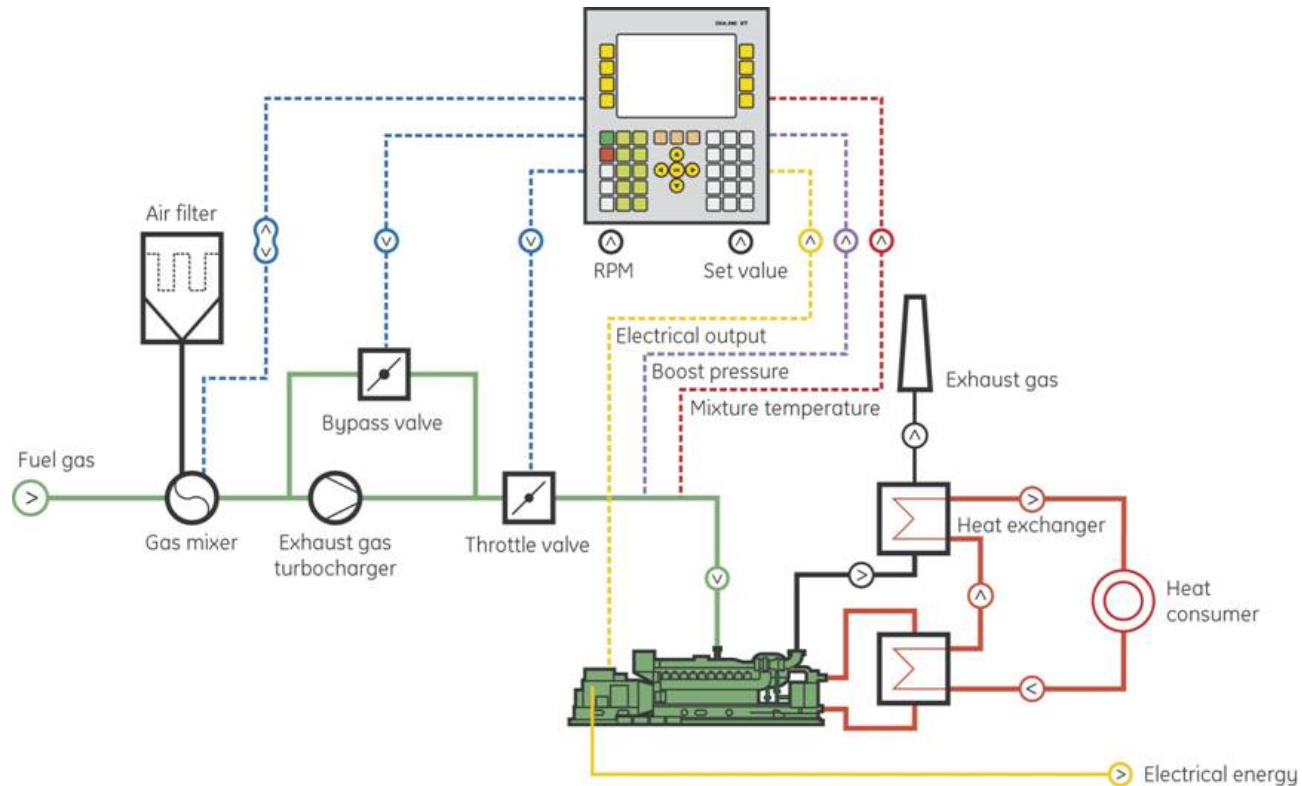
## CMG Operation

With CMG the engine has to take in much higher volumes through the fuel inlet





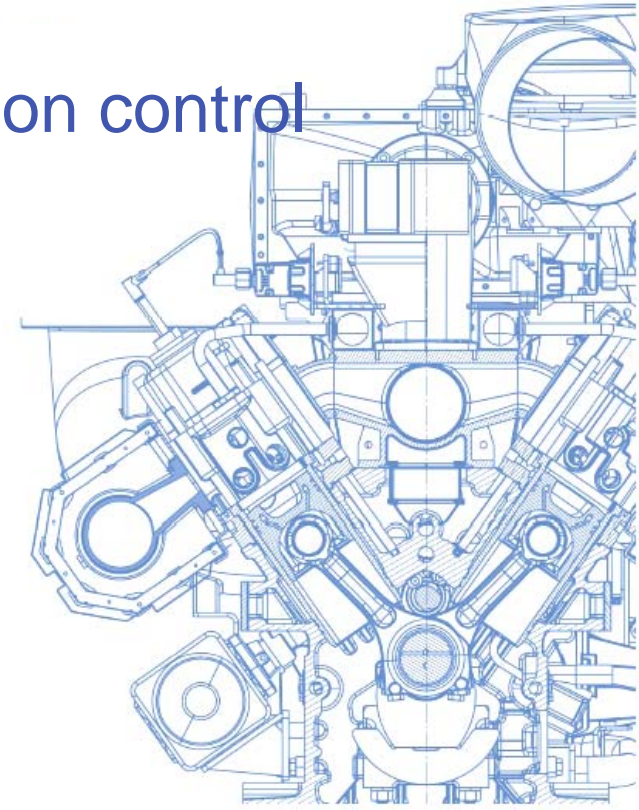
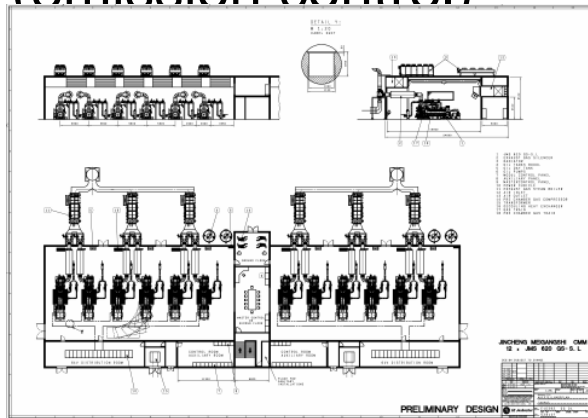
# DIA.NE<sup>®</sup> + LEANOX<sup>®</sup> optimum solution



The GE-Jenbacher DIA.NE<sup>®</sup> + LEANOX<sup>®</sup> engine control system is an optimum solution to handle the CMG-specific air/fuel ratio as well as methane fluctuations and provides a stable energy output

# Specially adapted engines for CMG power generation

- gas pretreatment  
(filter, condensate drainage, preheating, drying...)
- layout for large LHV range  
(turbo charger tuning, gas train, gas mixer, peripheral system...)
- high dynamic of power- and combustion control  
(emission control)



# CMG Applications with Type 6 engines

- 3MW >> lowest specific investment
- Longtime experience with CMG plants in Germany, UK, Australia and Ukraine
- Efficiency, reliability and durability proofed by >1.650 installed engines
- Not just a converted diesel unit but a designed gas engine



# Customer requirement I - Increase Work Safety



## Gas explosions in coal mines cause severe accidents

**>> Increased pressure on production output targets and lower coal prices resulted in critical safety conditions in many mining operation**

- Additional gas drainages decreases the danger of gas explosions
- A CMG utilization project demands an appropriate degasification system, what consequently increases work security
- Increase in safety leads to increase in productivity - the initial investment is not too high and can be shared with project partners
- Controlled gas utilization gives a clear picture of future methane quality and resources and thus enables professional project planning
- All these measures have a positive impact on workers working attitude and improve the image of the mining sector in general



# Customer requirement II - Increase Profitability

## Mining sector faces tough business conditions

### COST REDUCTION OPPORTUNITIES

- autonomous on-site power supply for pumps, ventilation and other
- replacing boilers and other local heating facilities
- committing to security standards, that had to be established anyway



### ADDITIONAL REVENUES THROUGH ...

- selling emission reduction credits at a current rate of around US\$ 55,- /MWhel
- feed- in tariffs, that are possibly further supported by government
- receiving tax credits for safety measures
- selling thermal energy to local heating system



# Customer requirement III - Emission Reduction

## Coal Mine Gas is dominantly contributing to the GHG effect

- CH<sub>4</sub> is 21 times more harming to the environment than CO<sub>2</sub>, thus reduction has a high leverage on mitigating the GHG effect
- That's why governments and international stakeholders are paying much attention to this issue and CER credits will probably increase further
- Several professional Carbon Credit Advisors and Carbon Developers came into existence, that support project owners
- Despite those favorable facts relatively few CMG reduction projects have been announced and some are conducted at a poor level
- Achieving emission reductions not only provides additional revenues (see profitability) but improves the image of the mine and strengthens the mining sector position within a country's energy portfolio





# ***Coal Gas to Energy Solutions***

*M2M Conference, Beijing 31<sup>st</sup> October 2007*

*“Concept to Creation”*





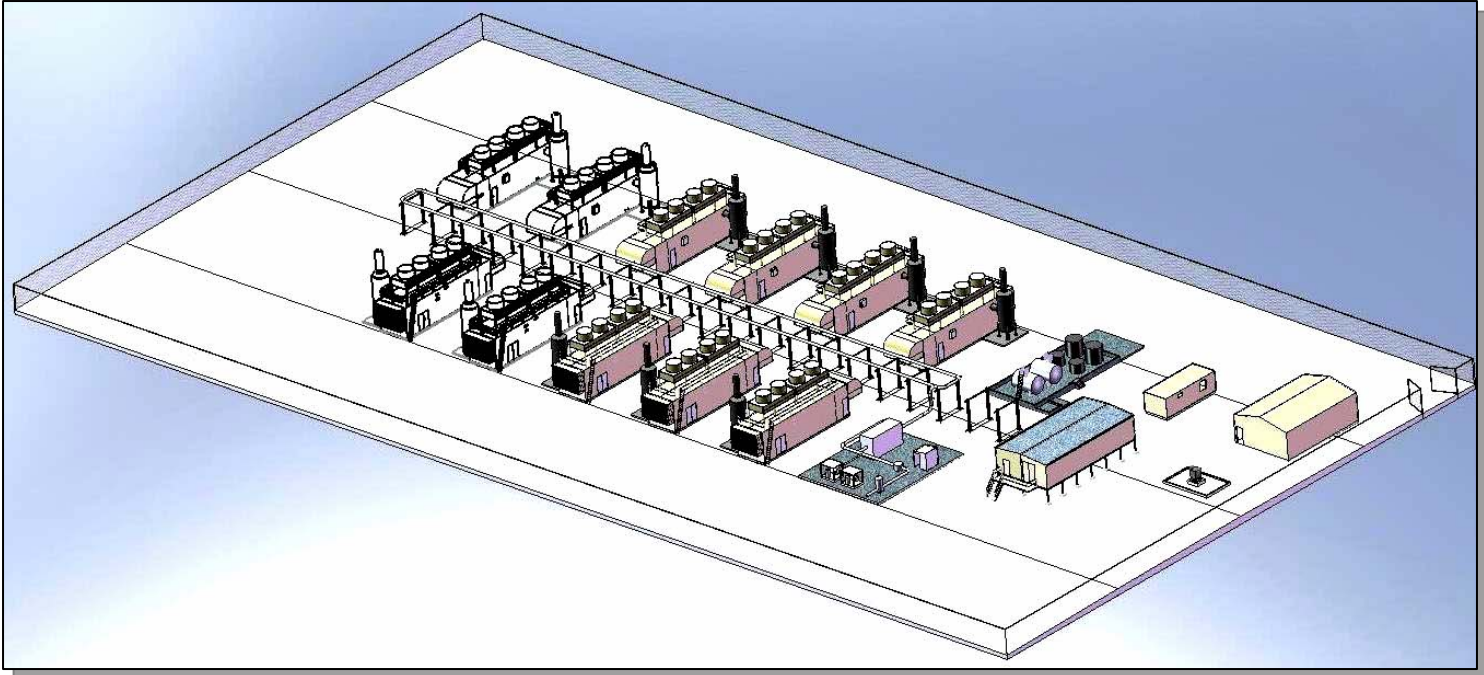
# Overview of Presentation



- Introduction
- Clarke Energy & GE Jenbacher Background
- Technical and Commercial Challenges
- Design and Delivery Approach
- Operation and Maintenance – Life Cycle
- Case Examples



# Introduction - Concept



# Introduction - Creation



Authorised Distributor  
Jenbacher gas engines





## Clarke Energy background



- Established in the UK as a specialised engine service company in 1989, operating now in 7 countries
- GE Energy Jenbacher's largest independent distributor
- Clarke Energy has installed capacity of over 1,500MW of GE Energy Jenbacher products worldwide, equating to 6% of the worldwide power generation market share.
- Total service solutions provider in Supply, Design, Install and Operate
- Over 900MW under Operation and Maintenance contracts



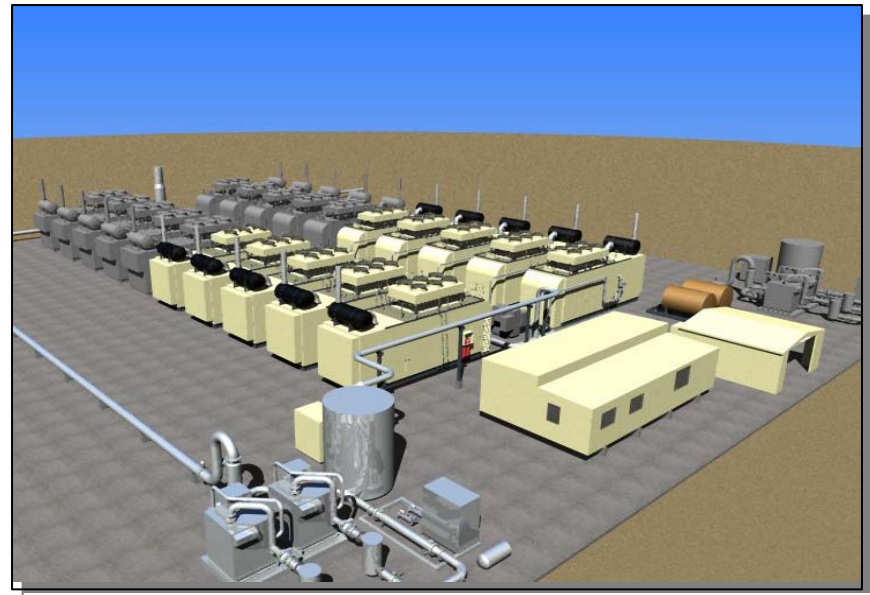
## Clarke Energy highlights



- Sole distributor for GE Energy Jenbacher engines
- Designs and builds complete power stations
- Extensive design and project team experience
- The major product and service provider in Coal Seam / Coal Mine applications in Australia, UK and regions where CE operate
- Most experienced suppliers and operators in CSM/CMM generation
- In Coal Gas - Over 235 MW on 17 sites in Australia and the UK.

# Technical and Commercial Challenges

- Fuel Gas supply and availability
- Quality of gas - conditioning
- Connection and Export availability - NSP
- Economics – PPA, CapX / OpeX, Timeline, GSA
- Regulatory consents – AGA, NEEMCO etc
- Approvals – Timeline and Development consent



# Key Technical Challenges

- Gas pretreatment (filter, condensate drainage, preheating, drying...)
- Layout for large LHV range (turbo charger tuning, gas train, gas mixer, peripheral system...)
- High dynamic of power - and combustion control (emission control)
- Modular design for augmentation or reduction in gas reserves

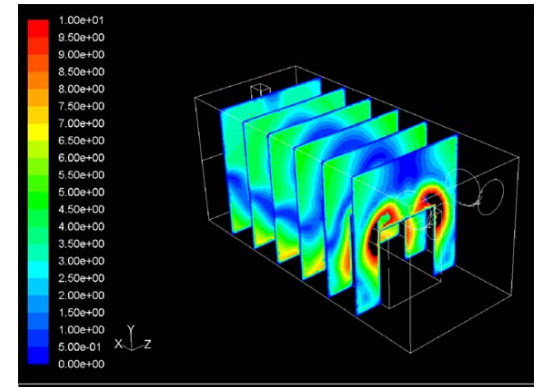
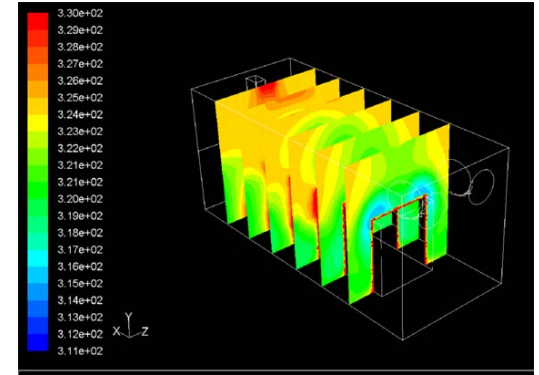


# Gas Conditioning / Cooling CSM/ CMM

Examples

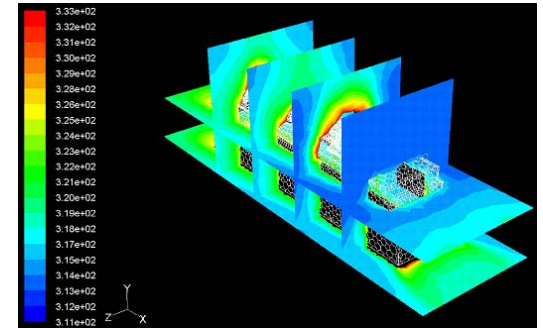
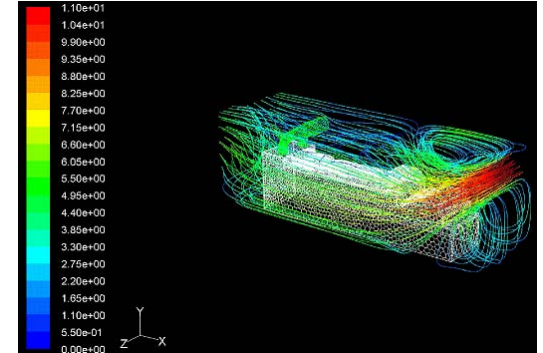


# Design & Delivery - 'Fast Track' approach and performance

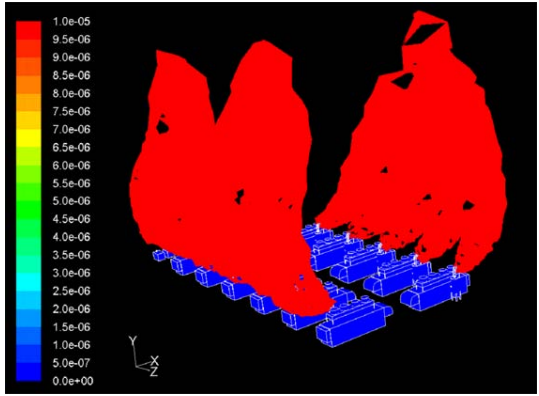
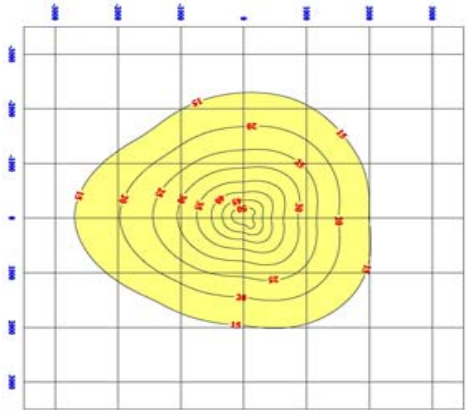




# Design & Delivery - 'Fast Track' approach and performance



# Design & Delivery - 'Fast Track' approach and modular design



# Clarke Energy Australia – Coal Mine Installations – Oaky Creek

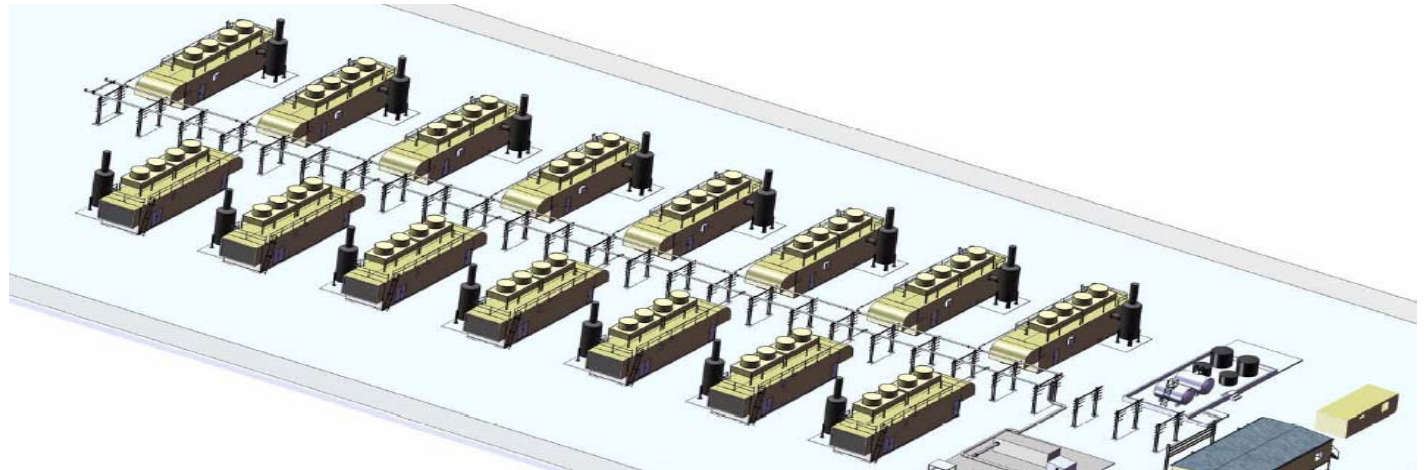


- Full turnkey installation
- 13MWe power output
- 12 x JGS 320 engines [expanding to 20)
- Coal Mine & Coal Seam Methane
- Long term O & M contract
- Commissioned June 2006



# Clarke Energy Australia – Coal Mine Installations – Moranbah North

- Full turnkey installation
- 45 MWe installed capacity
- 15 x JGS 620 engines
- Coal mine / seam methane
- Commissioning Aug / Sept 2008



# Clarke Energy Australia – Coal Mine Installations – Glennies Creek



- Full turnkey installation
- 11MWe installed capacity
- 10 x JGS 320 engines
- Coal mine / seam methane
- Commissioning Sept / Oct 2007



# Clarke Energy Australia – Coal Mine Installations - Teralba

- Full turnkey installation
- 8MWe power output
- 8 x JGC320 engines
- Closed / Abandoned Mine
- Commissioned June 2004
- Long term O & M contract



# Clarke Energy Australia – Coal Seam Installations – Daandine, Qld



- Full turnkey installation
- 33MWe installed power
- 11 x JGS 620 engines
- Coal seam methane
- Long term O & M contract
- Commissioned Feb 2007







# Advantages of Proven Experience and Product



- Certainty of Cost and Time
  - Administration and Tender call period
  - Proven Specification and Design completed
  
- Certainty of Delivery
  - Proven build model
  - Proven approvals
  - Continuous improvement gains
  
- Certainty of Early Generation
  - Shortest engine delivery in the market today
  
- Competitive Design and Delivery

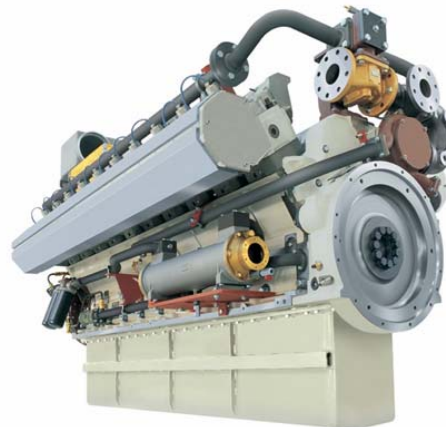
# The Benefits of the Clarke Energy / GE Jenbacher Partnership

## GE ENERGY JENBACHER

Equipment design  
Equipment development  
Equipment manufacture  
Parts manufacture  
“Product Quality Focused”

## CLARKE ENERGY

Proven Design and integration of BoP  
Project & Construction Management  
Commissioning  
Service & Maintenance  
Parts Stockholding  
“Customer / Project Quality Focused”





# ***Clarke Energy*** **&** ***GE Energy Jenbacher***

***“The Perfect Partnership” for coal mine applications***

**Contact [www.clarke-energy.com](http://www.clarke-energy.com)**