Heat to Power

Safely, Economically and Efficiently

Global Methane Initiative
Krakow, Poland
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Coal Methane Challenges

• Quality and composition of the methane gas

• Understanding of the quantity of gases

• Variable flow rates and composition over the life of the project

• Availability of end use options

• Economics of mitigation
Methane Sources

• CBM – Coal Bed Methane
• CMM – Coal Mine Methane
• AMM – Abandoned Mine Methane
• VAM – Ventilated Air Methane

VAM gas typically has a low methane content (< 1%)
Greenhouse Gas Emissions

- The Global Warming Potential (GWP) of methane is 21 times higher than that of CO₂ and therefore inefficient combustion increases the greenhouse gases emitted.

- For example: 19 mscf/d of waste methane gas generates the following daily CO₂ emissions:

<table>
<thead>
<tr>
<th></th>
<th>T/d</th>
<th>T/yr</th>
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</thead>
<tbody>
<tr>
<td>Vented</td>
<td>7.6</td>
<td>2,775</td>
</tr>
<tr>
<td>65% combustion</td>
<td>3.3</td>
<td>1,205</td>
</tr>
<tr>
<td>80% combustion</td>
<td>2.3</td>
<td>840</td>
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<tr>
<td>100% combustion</td>
<td>1.0</td>
<td>365</td>
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99.99% Efficient combustion converts the methane to CO₂ and H₂O
Combustion of Methane

\[ \text{CH}_4 + 2\text{O}_2 = \text{heat} + \text{CO}_2 + 2\text{H}_2\text{O} \]

Methane + Oxygen = heat + Carbon Dioxide + Water

Poor combustion results in the creation of:

- CH\(_4\), CO, particulates
- Black carbon
- Over 250 compounds
- Volatile organic hydrocarbons or VOC’s – benzene
- Sulfur compounds - H\(_2\)S, carbon disulfides, mercaptans

99.99% efficiency requires the right mixture of fuel and air

Negative impact on air quality, human health and climate
Flaring Concerns

- Difficult to measure efficiency and it varies significantly
- Crosswinds allow gases to escape unburned
- Difficulty burning rich gases often producing soot deposits and black smoke (BTEX, VOC, PAH)
- Entrained liquid droplets decrease combustion efficiency
- Poor performance for low heat content gases
- Visible flame and poor air quality

Based on ARC and U of A Research
Efficient Combustion

Welltesting/Workover

Gas processing

Acid gas

Italy

Crossfield gas plant

Clayhurst, Alberta
Coal Mine

• Venting 5 MMscf/d of methane
• 640,000 tonnes of CO$_2$e eliminated yearly by incinerating at 99.99%
• Carbon credits valued at $15/tonne of CO$_2$e
• Annual gross revenue = $ 9.6 million
• Opportunity to utilize the heat
Wasted Energy 9,000 Trillion Btu/yr

Drying cassava paste by a gas flare, a market woman risks her life to earn a living in Agessere, Nigeria. If a sudden flame surge doesn't harm her, airborne toxics eventually might—risks that prompted activists to demand an end to gas flaring, promised by 2008.
Options for the Energy

- Electricity generation
- Pipeline distribution
- On site heating
- Heating of mine ventilation air
- Town gas
- Coal drying
- Produced water vaporization
HeatQuest – Heat to Power

Waste Gas Incinerator

QTI-HX-PG

HeatQuest Exchanger

Waste gases from various sources

TURBINE

GENERATOR

EVAPORATOR

CONDENSER

PUMP

Optional: Excess heat from other sources

ORC Power Plant
ORC Power Skid
Technical Advantages

• Gas does not have to be cleaned or have H₂S removed
• No moving parts - Reduced downtime and maintenance
• Easily accommodates changing flow rates and composition
• Portable skid mounted
• Economic
Portable Trailerized Units
Oil Sands

In-situ Combustion and SAGD Projects

- <1% H₂S and CH₄
- 99% CO₂, and N₂
- Safe and efficient combustion of low heat content produced gas
- Improved air quality
- Reduce noise levels
- Significant fuel gas reduction over flaring
- Reduced CO₂ eq. emissions

Kerrobert, Saskatchewan
Q3000 Incinerator Unit
Waste gas = 4.7 MJ/m³  Fuel Gas Price $3.86  Fuel Gas = 37 MJ/m³
Conclusions

• Improved coal mine safety and productivity
• Methane emissions reduced - air quality improved
• Replacement of Fossil fuel energy sources with green energy
• Additional revenue generated from the sale of heat, power and carbon credits
• Measurable and cost effective improvement over existing flaring and venting practices
Clients

ExxonMobil
Baytex Energy Trust
Husky Energy
Spectra Energy
ConocoPhillips
bp
Petro-Canada
Suncor Energy
Devon Energy
NATCO
Petrobank
Altagasi
Talisman Energy
Enerchem International Inc.
Dominion
Calspan
Nexen
Schlumberger
Bonavista Energy Trust
Murphy Oil Corporation
Geogresources
Encana
Apache Corporation
NuVista Energy Ltd.
