MEGTEC Systems

VAM Processing –
September 9-10, 2011
KEY CONTENT OF PRESENTATION

✓ MEGTEC MARKET LEADING ACTOR SERVING GLOBAL INDUSTRIES
✓ CLIMATE CHANGE AND METHANE

GLOBAL VAM MILE STONES
✓ UN APPROVED VAM CER’s
✓ WORLDS LARGEST VAM PROCESSING PLANT
✓ OVER 100,000 MWh FROM VAM POWER PLANT
MEGTEC Locations Worldwide

2010: $190 MM Turnover

MEGTEC Worldwide Headquarters

MEGTEC Regional Offices

Americas
- 490 employees

Europe
- 250 employees

Asia
- 90 employees
Industry Applications

Advanced Materials Processing
- Lithium-ion Batteries
- Solar Films
- Membranes
- Composites

Environment, Climate & Energy
- Air Abatement Systems
- Carbon Management
- Energy Recovery
- Biofuels & Renewable Energy

Printing & Packaging Applications
- Digital Printing
- Commercial Printing
- Newspaper Printing
- Packaging

✓ Battery Separators
✓ Extrusion Laminates
✓ Flexible Packaging
✓ Foil Laminates
✓ LCD Screens
✓ Medical Products
✓ Membrane Manufacturing
✓ Metal Coil Coating
✓ Photovoltaic Cells
✓ PSA Label Stock
✓ Rechargeable Battery Foils
✓ Solar Films

✓ Bakery & Food
✓ Biofuels Production
✓ Biogas Generation
✓ Chemical Processes
✓ Coal Mines
✓ Electronics
✓ Fiberglass Processes
✓ Flexible Packaging
✓ Gas & Diesel Engines
✓ Landfills
✓ Odour Market
✓ Pharmaceutical
✓ Wood Products
✓ Commercial Printing
✓ Semi-commercial Printing
✓ Newspaper Printing
✓ Digital Printing
✓ Insert Printing
✓ Direct Mail
✓ Book Printing
✓ Label Printing
✓ Flexible Packaging
✓ Carton Packaging
Environment, Climate & Energy
Regenerative Thermal Oxidizers (RTO)
Catalytic Oxidizers
Solvent Recovery Systems
Distillation Systems
Heat Recovery Systems
Bioscrubbers / Bioreactors
Ventilation Air Methane (VAM) to Energy
Greenhouse Gas Abatement (GHG)
Regenerative Thermal Oxidizers, RTO

Sizes ranging from 500 to 90,000 scfm capacity, single & multiple can designs

CleanSwitch® RTO

Epsilon® RTO

Vocsidizer® RTO

RTO’s: In total over 4,000 installed - whereof ..

.. over 800 Vocsidizers
MEGTEC’s proven VAM processing technologies destroy methane while generating high quality carbon credits and electricity for coal mines.

Since 2007, VAM Power Plant WestVAMP at BHP Billiton in Australia is oxidizing Ventilation Air Methane, using the energy released to generate high grade steam, driving a conventional steam turbine.
MEGTEC was awarded the prestigious EPA Climate Protection Award for 2008.

MEGTEC is the only manufacturing company in the world to receive this award in 2008.
GLOBAL WARMING AND CLIMATE CHANGE

-Why is VAM of interest?
One thin bubble of atmosphere
Some heat radiation is reflected back to Earth by the atmosphere, making the planet a livable place.
We are moving enormous amounts of atoms from Earth to atmosphere, changing the composition and characteristics of the atmosphere.
Gases accumulate and reflect more heat back to Earth.
One thin bubble of atmosphere

Green House Effect resulting in Global Warming
CO2 can retain some heat in atmosphere
Methane can retain MUCH more heat
Green House Gas  METHANE

GREENHOUSE GASES CONTRIBUTIONS

- **CO₂**
- **CH₄**
- CFC’s 12%
- N₂O 5%
- Trop Ozone 13%
- **CH₄** 17%
- CO₂ 53%

<table>
<thead>
<tr>
<th></th>
<th>CO₂</th>
<th>CH₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Power</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>(21 in the first Kyoto Period)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life time in atmosphere (years)</td>
<td>20 000 – 50 000</td>
<td>12</td>
</tr>
</tbody>
</table>

- Second most important greenhouse gas
- Much more powerful greenhouse gas than CO₂
- Short life time in atmosphere, so emission reductions will have a quick, positive impact
- **Generates energy when abated (oxidized)**
Global Methane Emissions - by source

BIGGEST TOTAL SOURCE: Cows, sheep etc
50-100 kg CH4 per cow and year = 1-2 t CO2e

PROBLEM: Each source is very small
ANNUAL GREENHOUSE EFFECT on Global Warming

½ million cars = 1 million t CO₂e

Coal mine VAM
1,000,000 m³/h, 0.8% (50,000 t CH₄/yr)
- All emissions are going into the same thin bubble of atmosphere.

- Trading with Carbon Credits is an efficient instrument to guide investments to where they most cost efficiently reduce GHG emissions.

- VAM processing is such a type of investment. It is totally dependent on allocation of Carbon Credits, which at sufficient value make it a profitable investment and likely to happen. It is therefore an excellent example of the Rule of Additionality!
Calculations of VAM based CERs

Examples:
250 000 Nm³/h @ 0.9 % VAM comes to 240 000 tonnes of CO₂e
125 000 Nm³/h @ 0.9 % VAM comes to 120 000 t CO₂e
125 000 Nm³/h @ 0.3 % VAM comes to 40 000 t CO₂e

<table>
<thead>
<tr>
<th>VAM conc’n Nm³/h vent air</th>
<th>0.3 %</th>
<th>0.6 %</th>
<th>0.9 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 000</td>
<td>40</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>250 000</td>
<td>80</td>
<td>160</td>
<td>240</td>
</tr>
<tr>
<td>500 000</td>
<td>160</td>
<td>320</td>
<td>480</td>
</tr>
<tr>
<td>1 000 000</td>
<td>320</td>
<td>640</td>
<td>960</td>
</tr>
</tbody>
</table>

Annual emission reductions in thousand tons of CO₂e
CONCLUSIONS for short pay back:
• VAM concentrations should be min ½ percent
• Carbon Credits should be minimum USD 10/t
• Failure in international climate talks create uncertainty about post 2012 credits
• Present values of most carbon credits do not support VAM project economics
MEGTEC VAM installations Worldwide

• Demos

- British Coal Demo 1994
- CONSOL Energy Demo 2007 - 2008
- Demo 2001 2002 BHP
MEGTEC VAM installations Worldwide

- Demos
- Commercial

MEGTEC Worldwide Headquarters

MEGTEC Regional Offices

British Coal
Demo 1994

CONSOL Energy
Demo 2007 - 2008

AES-SONGZAO
6 units 2011

BHP Billiton
4 units since 2007

ZHENGZHOU
since 2008
Waste to Energy – Ventilation Air Methane (VAM) Processing

By 2010 over 100,000 MWh of electricity and 625,000 carbon credits generated.
Host/Customer is ZhengZhou Coal Mining Group, Henan Province

PDD administrator is EcoCarbone, France

System capacity: 62 500 Nm3/h  VAM concentration: 0.3% to 0.7%
The complete installation includes VAM abatement and energy recovery in the form of hot water for local use.

The MEGTEC delivery was fully commissioned and taken over by customer October 2008.

**The globally first project to be awarded VAM-based CER’s** (Kyoto related Carbon Credits).
**Hot water from VAM**

### Heat straight from bed.

- **Water at 70 - 150°C**
  - 0.3%: 1.5 MW
  - 0.5%: 3.8 MW
  - 0.7%: 6.1 MW

- **- - - For each 125 000 Nm3/h of ventilation air - - -**

### Secondary heat-exchanger.

- **Water at 70°C**
  - 0.5 MW
  - 2.7 MW
  - 5 MW

- **Water at 150°C**
  - -
  - -
  - 1.5 MW
Electricity from VAM Power Plant

For each 125 000 Nm3/h of ventilation air:

<table>
<thead>
<tr>
<th></th>
<th>0.3%</th>
<th>0.5%</th>
<th>0.7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat straight from bed.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Water at 70 - 150°C</td>
<td>1.5 MW</td>
<td>3.8 MW</td>
<td>6.1 MW</td>
</tr>
<tr>
<td>Steam at chosen T</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- - - For each 125 000 Nm3/h of ventilation air - - -

For large size plant, conversion from thermal to electrical energy can be expected to be around 30%.
0.2 % methane needed to maintain oxidation. Energy of concentrations above 0.2 % can be recovered. Interesting combinations of electricity and thermal generation can be achieved.

**Example:** 800 000 m³/h

1 % CH₄ → 72 MW(th) → 21 MW(el) (at 30% efficiency)

**Example:** 800 000 m³/h

0.6 % CH₄ → 36 MW(th) → 10 MW(el) (at 30% efficiency)
Hot water from electricity generation can drive an absorption chiller generating cooling for deep level coal mining.

**Example:**

\[
\begin{align*}
800,000 \text{ m}^3/\text{h} & \rightarrow 72 \text{ MW(th)} \\
1\% \text{ methane} & \rightarrow 21 \text{ MW(el)} \\
& \rightarrow 19 \text{ MW(el)} + 38 \text{ MW(cool)}
\end{align*}
\]
Installed at the DaTong coal mine, ChongQing Province
Supplied by MEGTEC
Investor is a joint venture owned by:

- Shenzhen Dongjiang Environmental Renewable Energy Co Ltd
- SongZao Coal & Electricity Co Ltd
- AES Corp (US-based global power generation company)
VAM PROCESSING at the Da Tong mine, ChonQing Province, China

- The 6 Vocsidizer units were produced in China
- Processing capacity is 375,000 Nm3/h of ventilation air
- Includes hot water generation for local use
VAM MARKET ISSUE

- Failing Climate Talks and low value of carbon credits are holding VAM investment projects back.

VAM MARKET HIGH LIGHTS

- Globally first VAM based CERs approved by the UN.
- Major VAM processing plant in operation in China.
- VAM Power Plant has generated more than 625,000 carbon credits and over 100,000 MWh of electricity.

Thank you!