Global VAM Project Opportunities

UNECE

GMI Partnership-Wide Meeting

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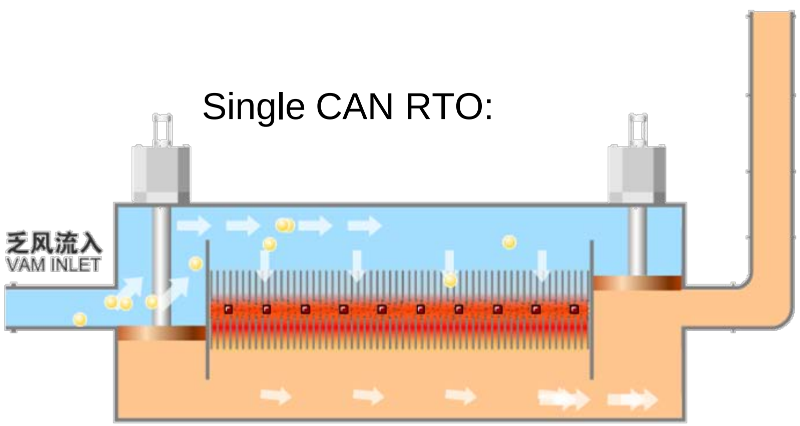
VAM Market Information

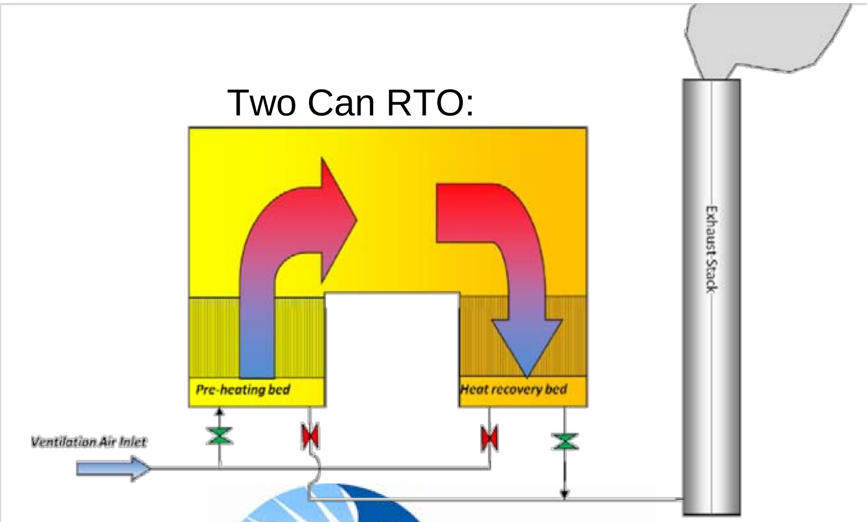
The total worldwide VAM emission in 2009 was calculated at 28.7 Billion cubic metres, the table below shows the top 5 world VAM emitters:

Country	2009 UG coal production (MMT)	2009 VAM emission (Bm3)	2009 VAM emission (MMtCO2e)
China	2,663	18.2	259.1
United States	378	2.8	40.3
Ukraine	97	2.6	36.9
Australia	117	1.3	17.6
Russia	100	1.0	14.6
Total	**3,355**	**25.9**	**369**

VAM Abatement Technologies

- The Regenerative Thermal (or Catalytic) Oxidiser (RTO or RCO) is currently the most suitable technology available to safely, effectively and economically process large quantities of ventilation air and oxidise the VAM.
- RTO's can be in two configurations:- Single can, or two can:
- Single can RTO's have one large media bed which heats, oxidises and recovers heat in a single bed, whereas a Two can RTO has two individual media beds:- (one for heating, the other for recovery), they are separated by an oxidation chamber.





VAM Technology/Project Development Timeline

1994 Thoresby – Megtec, UK

2001 Appin – Megtec, Aus

2006 WestVAMP – Megtec, Aus

2007 Windsor – Megtec , USA

2008 Zhengzhou, Megtec, China

2009 JWR – Biothermica, USA

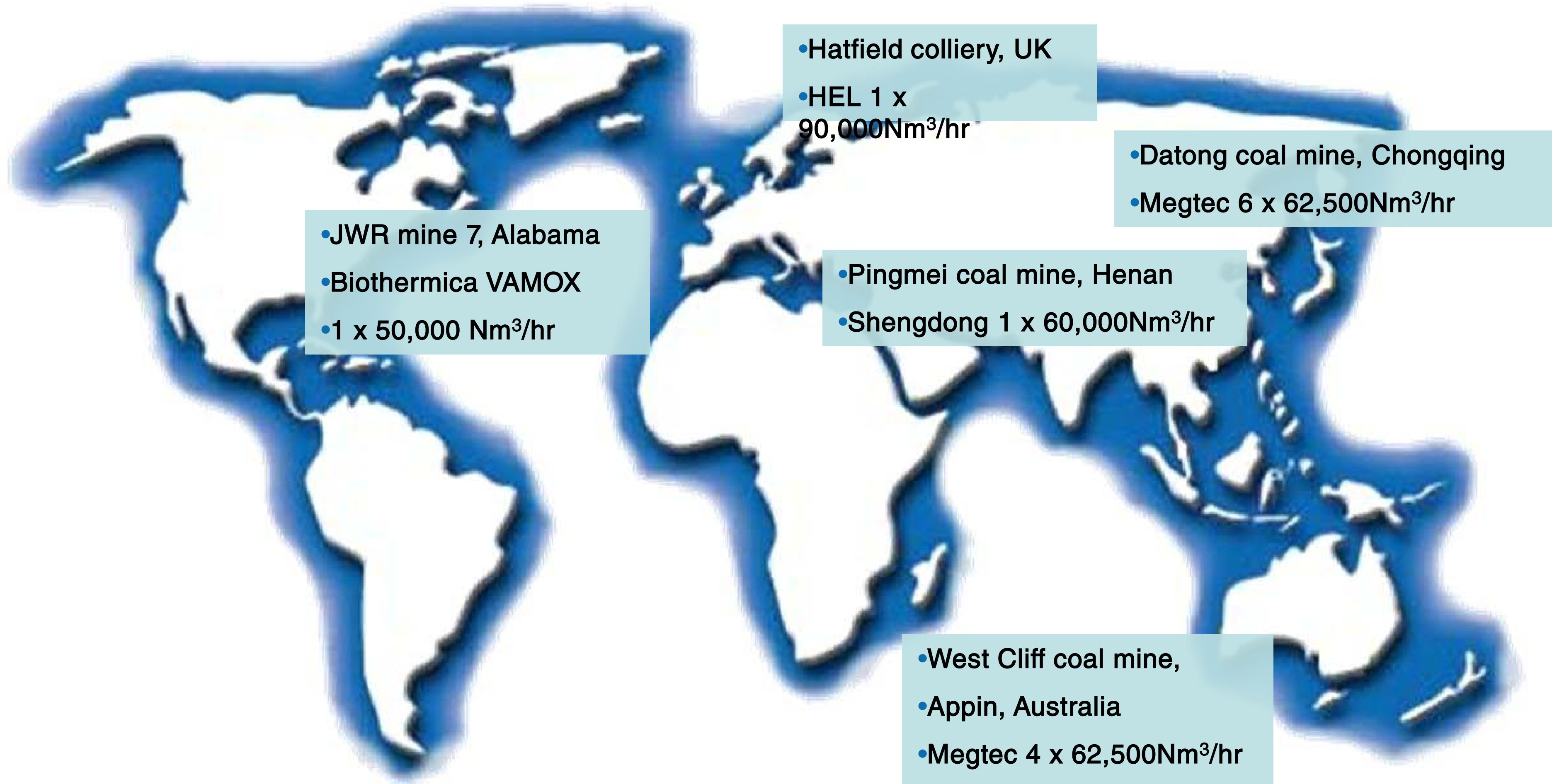
2010 Pingmei – Shengdong, China

2011 Hatfield – GMT , UK

Global Methane Initiative

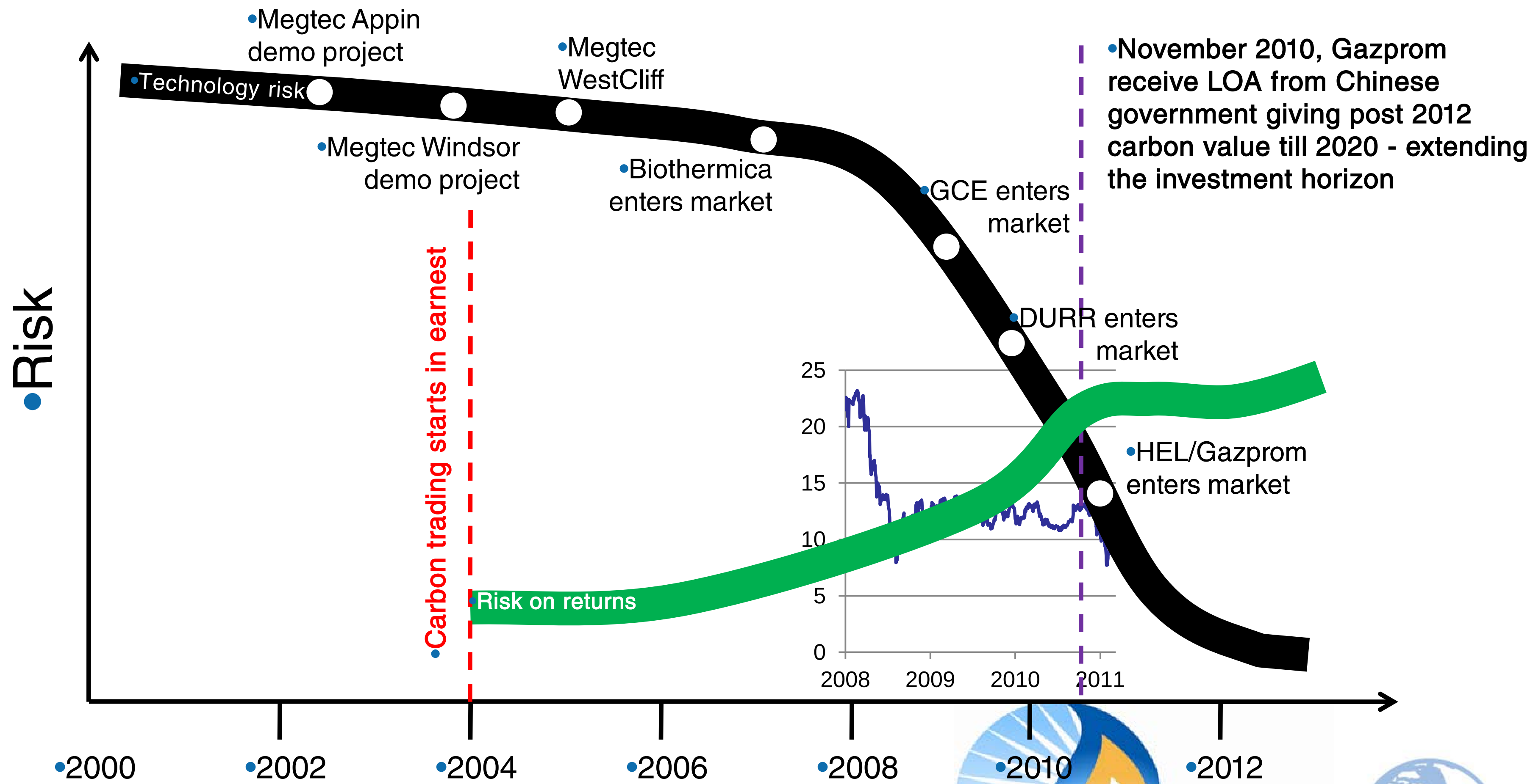
U.S. EPA Coalbed Methane Outreach Program

Current Worldwide VAM Projects



VAM Risk Profile

The recent introduction of commercial VAM oxidiser equipment into the market has reduced the technical risk, however uncertainty in the carbon market with reducing CER value has increased risk on returns:



Global Methane Initiative

U.S. EPA Coalbed Methane OUTREACH PROGRAM

Potential for VAM Abatement

Global Methane Initiative

U.S. EPA Coalbed Methane Outreach Program

VAM Market Information

China

- Worlds largest underground coal producer, (2,660 M tonnes in 2009), calculated 18.3Bm^3 of VAM emitted in 2009.
- CDM mechanism in place with carbon value till 2020 to enable return on investment.

Australia

- Produced 117 M tonnes from underground mining in 2009, calculated 1.3Bm^3 of VAM emitted in 2009.
- Recent proposal of carbon tax may provide a mechanism for return on investment

Mexico

- Only produced 11.5 M tonnes, however the majority of coal mines use modern longwall mining techniques and exhibit favourable VAM abatement characteristics such as large volumes and high VAM concentrations.
- CDM and VER mechanisms in place

VAM Market Information

Russian federation, Ukraine & Kazakhstan

- Totally produced 300 M tonnes in 2009, calculated 6.2Bm3 of VAM emitted in 2009. Wide range of mining techniques, mining conditions and levels of mechanisation. Significant potential for VAM abatement projects.
- JI mechanism provides a difficult path to achieve financial return and issue of ERU's.

India

- Produced 529 M tonnes in 2009, however majority from surface mining, most underground mines are small scale and not gassy, offering poor conditions for VAM abatement.
- Future prospect due to rate of development and CDM mechanism in place.

United States

- Produced 378 M tonnes from underground mines in 2009, calculated VAM emission of 2.8Bm3. Large gassy coal mines give favourable conditions for VAM abatement projects, however VER market gives high risk of financial return.

South Africa

- Produced 250 M tonnes in 2009, coal mines tend to be shallow, thus not gassy – however good future potential as coal mines access deeper reserves.
- CDM mechanism in place for financial return.

VAM Market Information

Western Europe

- EU ETS does not recognise Mine Methane as a greenhouse gas, thus no commercial mechanism exists to enable return on investment
- JI projects have shrinking investment horizon
- Unusual situation as much investment is in China where all carbon revenues from VAM mitigation will enter the EU ETS

Poland

- Significant appetite for energy recovery at coal mines (early adoption of CMM to power, first tri generation facility)
- Significant opportunity for VAM destruction
- VAM concentrations typically enable mitigation projects at many mines, small percentage have capacity for power generation
- Legislative barriers need removing (safety laws prevent VAM destruction at Evase exit)
- Carbon market or other commercial incentive required to ensure commercial viability

VAM Abatement Technologies

Technology	Single can RTO with ceramic media	Two can RTO with ceramic media	Two can RTO with catalytic media	Combustion air for power generation
Advantages	Most significant experience in this application. Proven solution. Compact design, small footprint. Embedded steam pipes enable high grade heat recovery if VAM concentration permits.	Mature, proven technology. Longer residence time, lower oxidation temperature & parasitic load. A range of suppliers to choose from .	Further reduced oxidation temperature and parasitic load. Longer residence time and higher thermal efficiency. Mechanical design is mature and proven	Additional energy content of VAM reduces overall fuel consumption
Disadvantages	Low residence time, higher oxidation temperatures & parasitic load. High equipment cost	Larger footprint than single can design	Catalytic media can be poisoned by other contaminants in the VAM, new/unproven technology. High equipment cost, high technical risk	Dirt/water in VAM causes significant operational difficulties with power plant. Only consumes small volumes of VAM

Heat Recovery and Utilization Options

Reducing CAPEX

- Power generation – waste heat recovery boiler to steam turbo generator, c.30% net electrical efficiency
- Power generation – waste heat recovery to Organic Rankine Cycle, c.13% net electrical efficiency
- Heat generation – waste heat recovery boiler to produce steam or hot water, up to 90% heat recovery efficiency
- Direct exhaust heat use – exhaust air used for downcast shaft heating

Conclusions

Reducing CAPEX

- VAM mitigation technologies mature and proven
- New technology providers emerging
- CAPEX and OPEX costs reducing
- Revenue risks increasing as carbon market investment horizons shrink and prices fluctuate generally lower
- High profit potential for future projects when/if a future international carbon mechanism materialises
- High potential for catalytic oxidizers if technology barriers can be worked out in field proving
- High mitigation potential and mature technology should lead Governments toward commercially supporting this technology

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