

The Power of VAM

- technology application update

*For Methane to Markets
in Cagliari 29 April 2008*



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- technology application update



UPDATE HEAD LINES

- Update on **VAM to Electricity** at WestVAMP, Australia
- Update on **VAM Abatement** at CONSOL, USA
- Update on **VAM to Thermal Energy**
- Next steps
- VAM reduction potentials

WestVAMP by April 2008

- in full operation since over 1 year



Fuel contains ~ 99% air



- **250 000 Nm³/h** (150 000 scfm) of ventilation air with
- **0.9% CH₄** concentration (VAM + drainage gas) generating
- **High pressure, superheated steam** (60 bar, 460°C) driving a
- **Conventional 6 MWe power plant steam turbine**

WestVAMP by April 2008

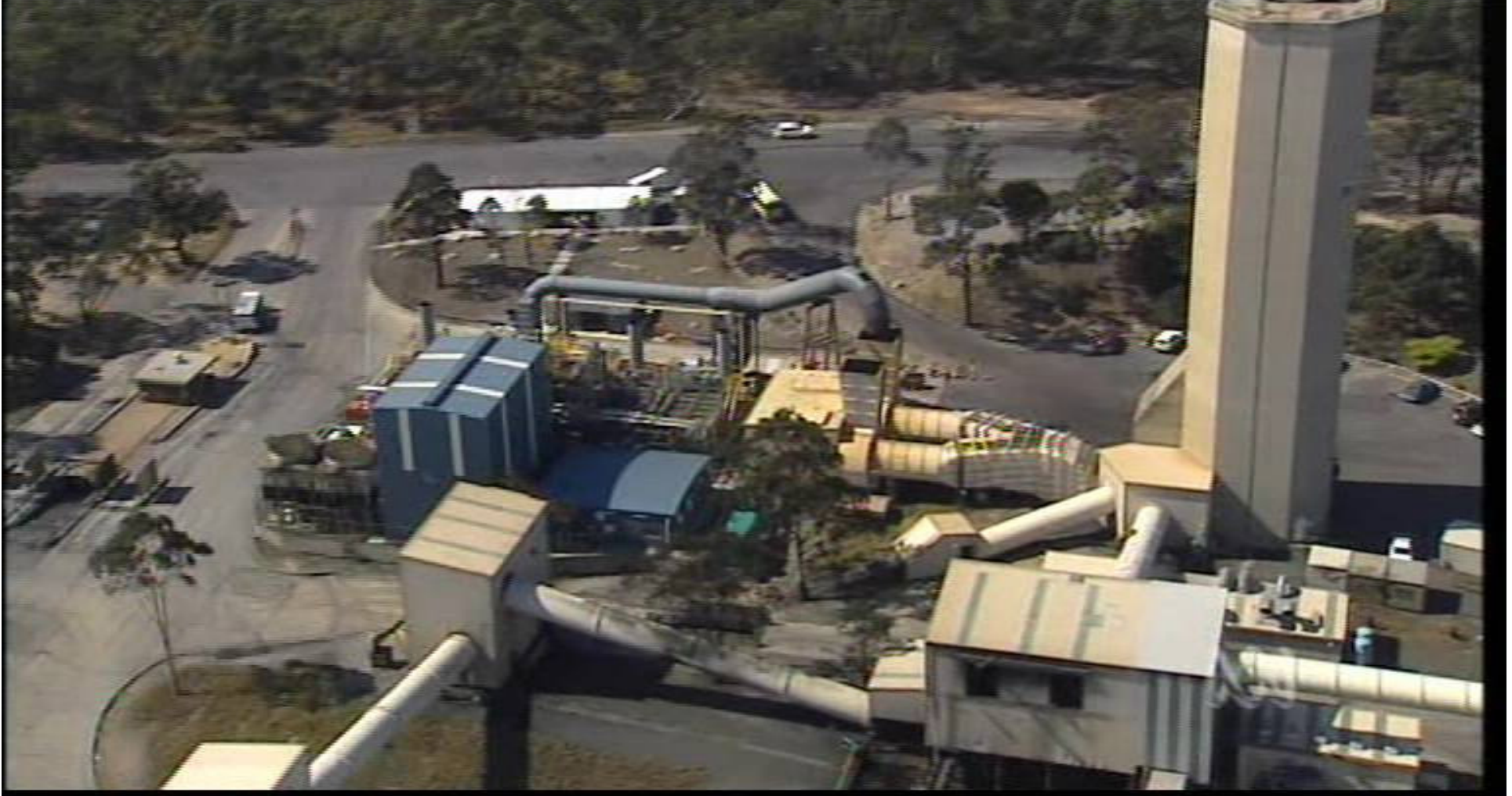
- in full operation since over 1 year



Reported to in first year of operation have generated **220 000 t CO₂e from reducing VAM** emissions and an **additional 30 000 t CO₂e from replacing energy** (with more CO₂ efficient energy source)

WestVAMP by April 2008

- in full operation since over 1 year



Officially opened on 14 September 2007 by the Premier of NSW.

The Project is partly Government funded by the AGO (Australian Greenhouse Office)

Honorable awards

- for WestVAMP

- Aug 2007; Highly Commended in Excellence Awards 2007 of NSW Minerals Council
- Sept 2007; WestVAMP received the Excellence in Energy Award 2007 by the Australian Institute of Energy

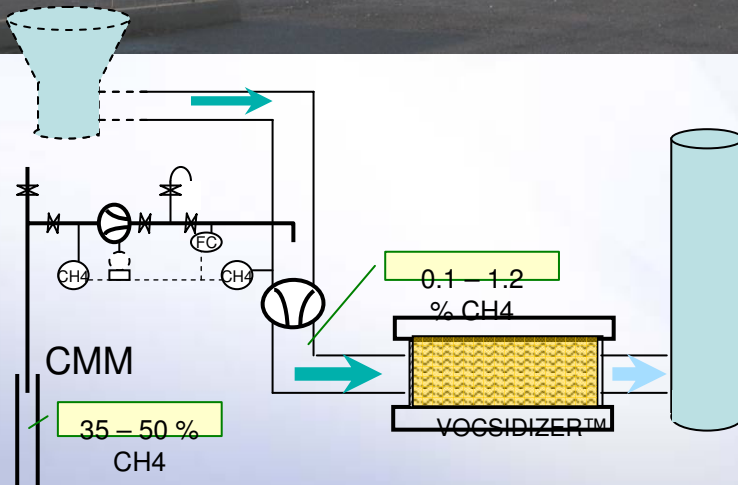


US VAM Project at CONSOL Energy, USA



Windsor mine, West Liberty site, West Virginia CONSOL Energy, USA

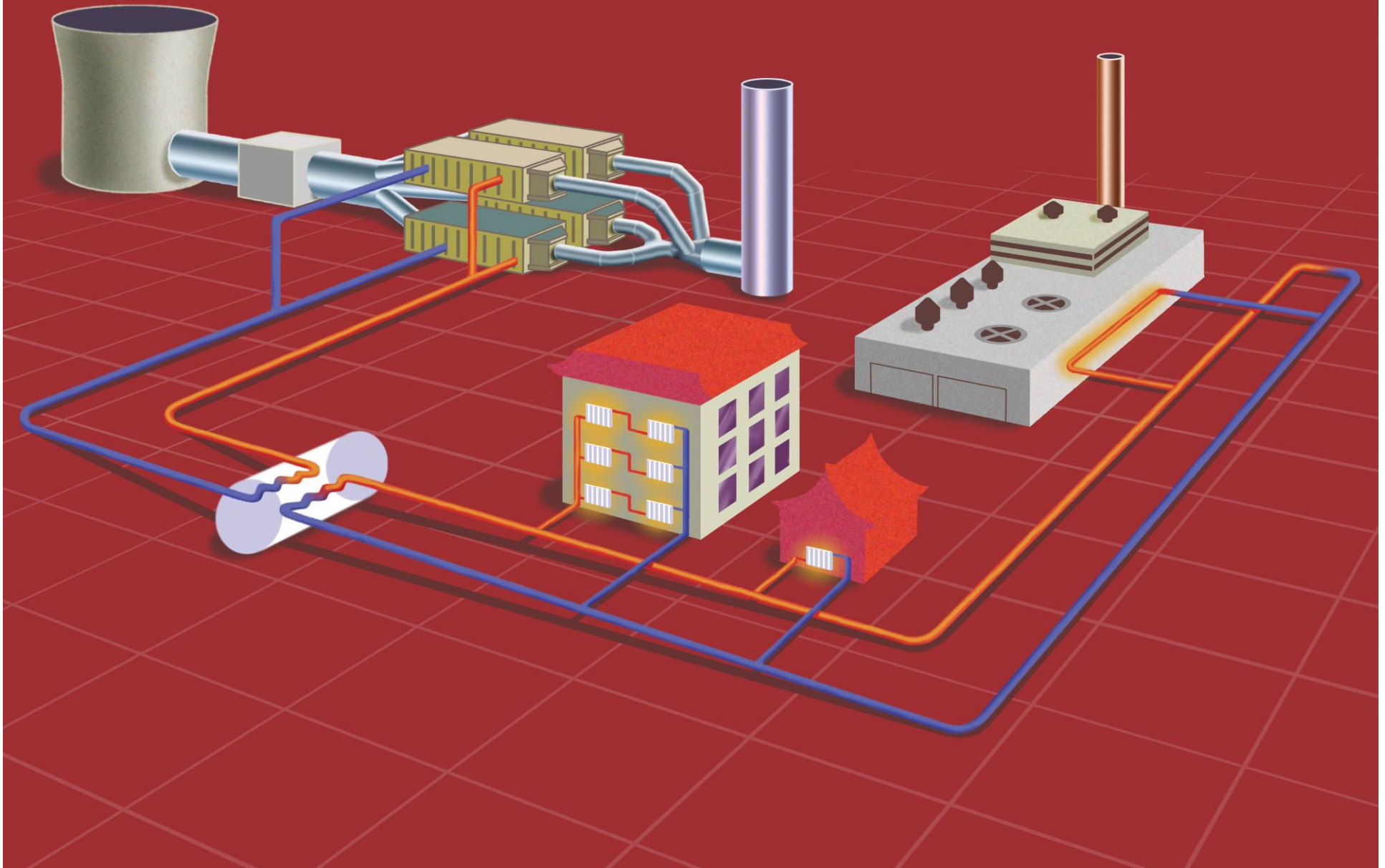
- Simulating various concentrations of VAM by injecting high concentration (35-50%) Abandoned Mine Gas into ...
- 50 000 m³/h (30 000 scfm) of fresh air
- Unmanned operation since May 2007
- Rebuilt in April 2008 for improved availability, presently being re-started



The Project is partly Government funded by the US EPA and the US DOE

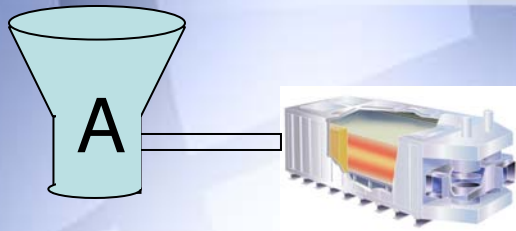
VAM to Thermal Energy

- for District Heating / cooling

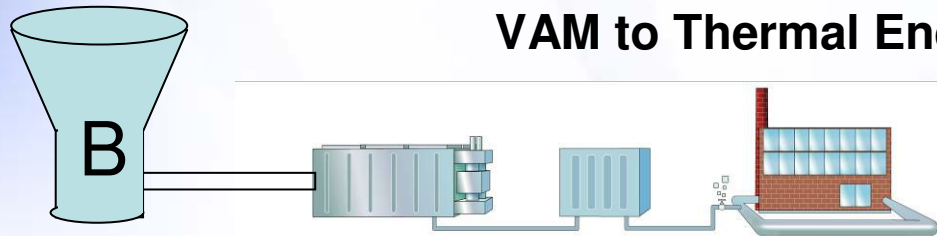




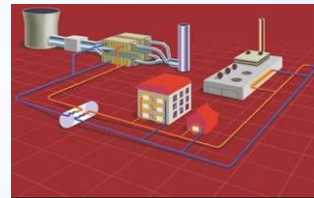
THREE OPTIONAL VAM VOCSIDIZER CONCEPTS



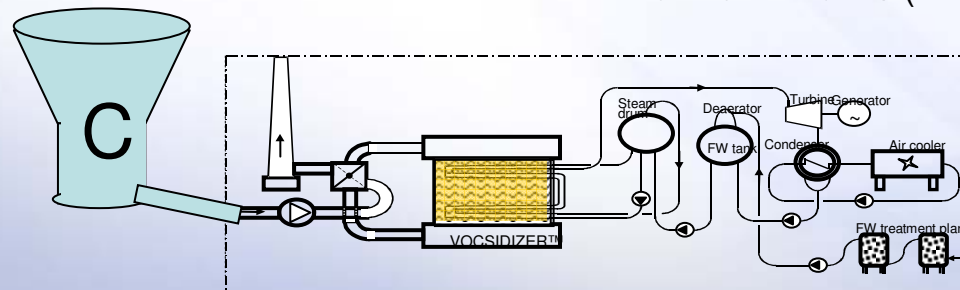
VAM Abatement Only



VAM to Thermal Energy



VAM to Energy



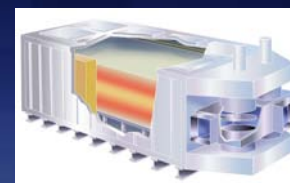
VAM Power Plant (VAM to Electrical Energy)

Next steps



- Based on experience in VAM application now prepared to roll out installations on broad basis
- Mostly Abatement or VAM to Thermal Energy
- Large number of prospects mainly in China, but also in Australia, Europe and in the Americas
- Plan to start production in China within a year
- When ready to release info on progress, will do so via M2M.

Calculations of CERs



For calculation of amount to CERs, consider:

- VOC oxidizer cleaning efficiency and availability
- conversion rate of CH₄ into CO₂e.

The formula will be:

[Cleaning Efficiency] x [Hours of availability] x [Volume flow of ventilation air] x [VAM concentration] x [(CH₄ weight) x Global Warming factor – (CO₂ weight)]

which comes to:

$$0.97 \times [8760 \times 0.97] \times [\text{Flow of ventilation air}] \times [\text{VAM concentration}] \times [0.71 \times (21 - 2.75)]$$

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

| | 0.3 | 0.6 | 0.9 |
|-----------|------------|------------|------------|
| 125 000 | 40 | 80 | 120 |
| 250 000 | 80 | 160 | 240 |
| 500 000 | 160 | 320 | 480 |
| 1 000 000 | 320 | 640 | 960 |

Thousand tons of CO₂e per year

IN ADDITION at energy recovery :

If carbon based energy is replaced, the effect on Global Warming is ~20% better.



The aim of all efforts
to reduce GHG emissions

is now to **break the trend
of increasing global warming,**

which is melting the ice of the Arctic.

