

Ventilation Air Methane Abatement System Review

Pennsylvania Climate Change Advisory Committee

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Outline

- Coal Mine Methane Emissions
- Project Rational
- CONSOL field trial at Windsor Mine
- Plan to implement technology at Enlow Fork Mine
- Questions

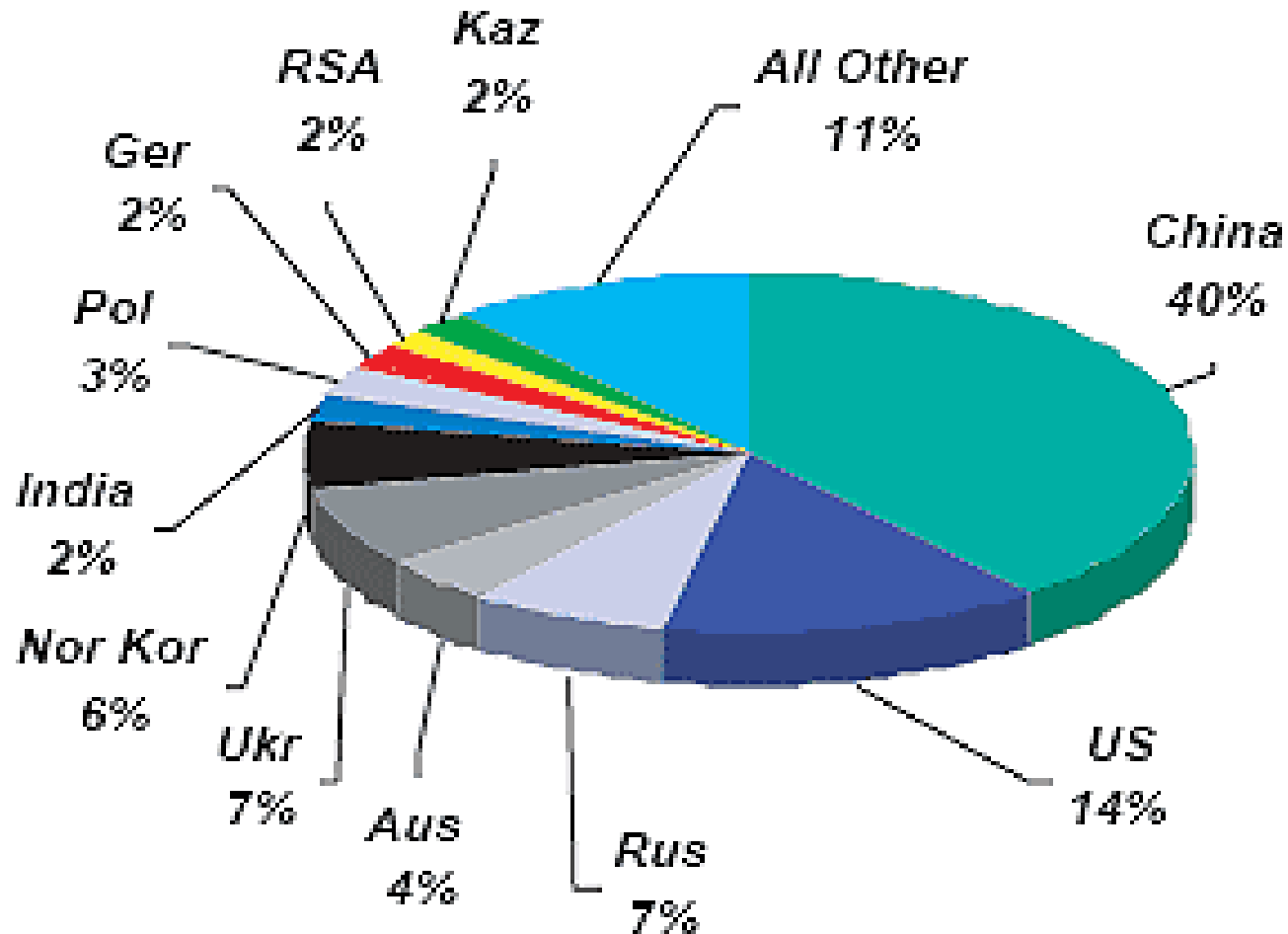


Coal Mine Methane Emissions

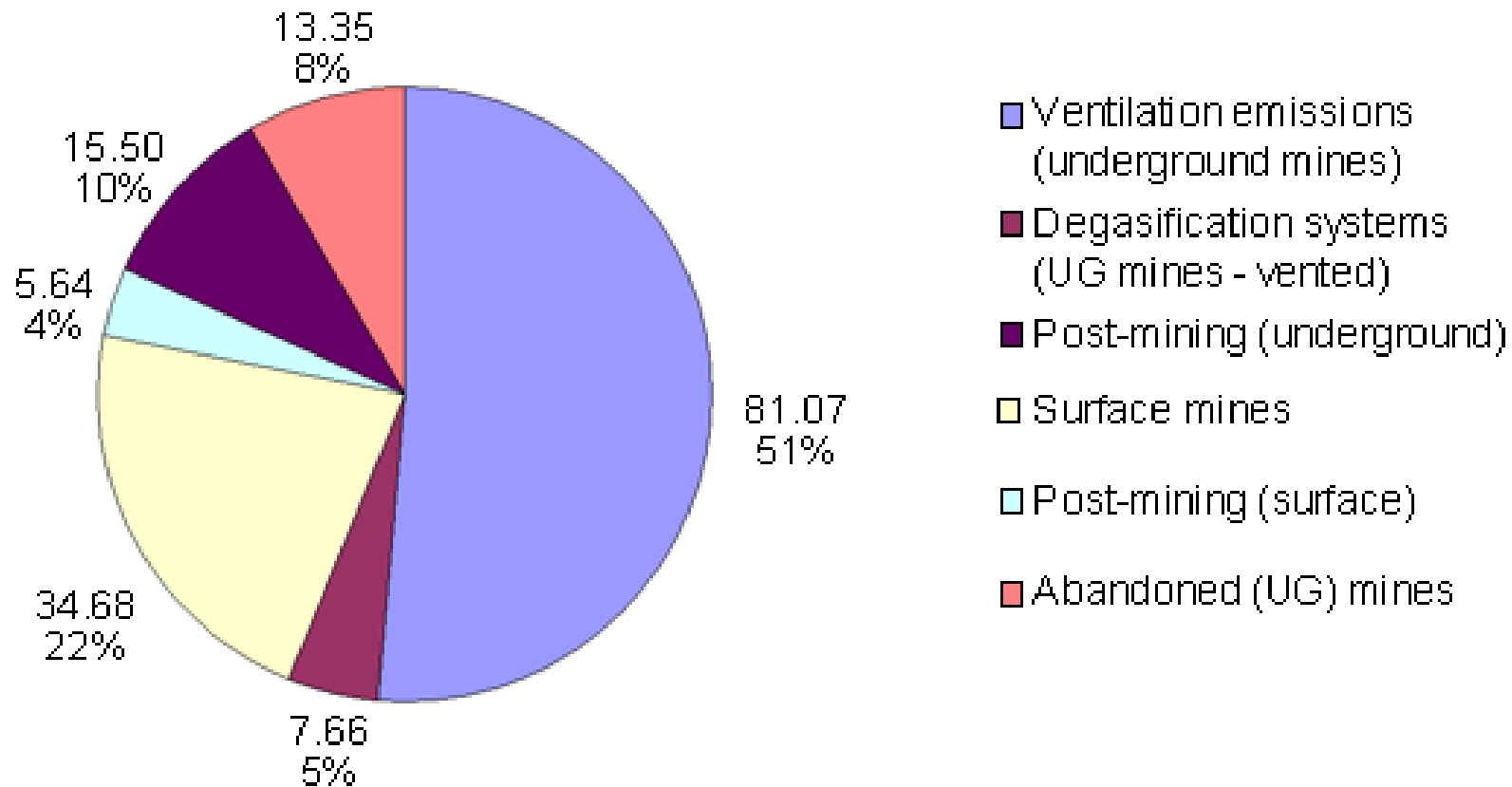


Global CMM (2000)

377 million metric tonne CO₂e
(938.5 bcf methane)



2006 US CMM Emissions (Billion Cubic Feet)



2006 US CMM Emissions

	Methane (bcf)	MM tonne CO2 equivalent
Total	157.9	63.4
Underground Emissions	117.58	47.2
Surface Emissions	40.32	16.2

12.3%

2006 Pennsylvania CMM Emissions

	Methane (bcf)	MM tonne CO2 equivalent
Accounts for 6 underground longwall mines in PA or 42.8 tons out of 64.5 tons of bituminous coal production in PA	19.38	7.78



Project Rational



CONSOL Methane Emissions

- CONSOL's greenhouse gas footprint is mostly methane.
- Ventilation air methane (VAM) represented 23.1 bcf of the 25.5 bcf (91%) of methane emitted by CONSOL in 2006.
- It appears likely that under future U.S. law, coal mine methane will be eligible as an Offset
- The low concentration of methane in ventilation air (0.3% to 1.5%) means that specialized equipment is required to capture or use it - regenerative thermal oxidizer (RTO)



CONSOL Field Trial at Windsor Mine



First U.S. Field Trial of VAM Oxidation – CONSOL's Windsor Test

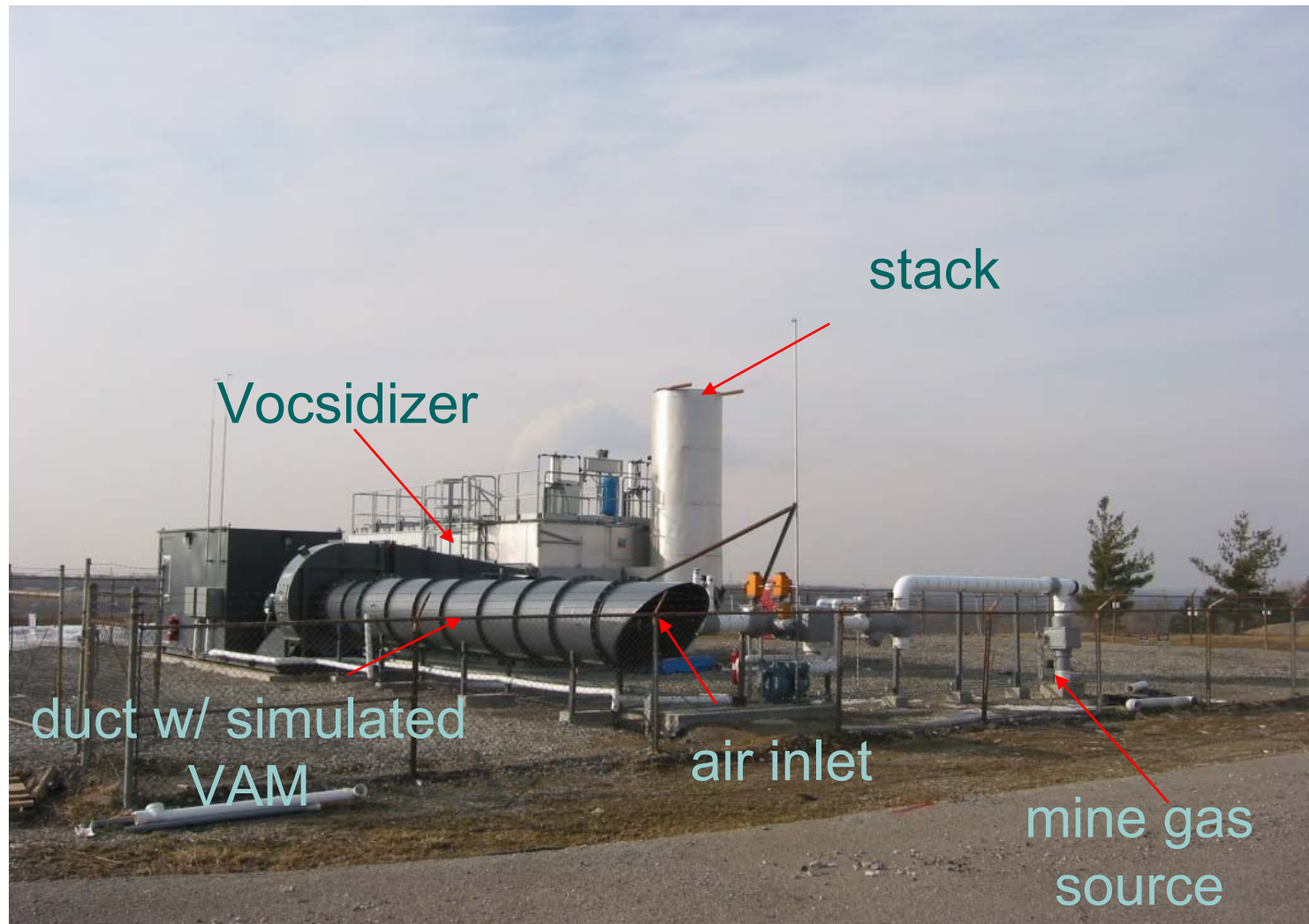
- Test commercial-size VOCSIDIZER reactor on an inactive coal mine
- Simulate VAM by diluting coal mine methane with air
 - Test with no impact on an active mine
 - Verify safety systems
 - Evaluate O&M requirements and costs
 - Gain hands-on experience
 - Observation by MSHA and state agencies
 - First step for future installation on a mine ventilation fan
- Objective to evaluate the technical/economic feasibility of applying a full-scale system at an underground coal mine



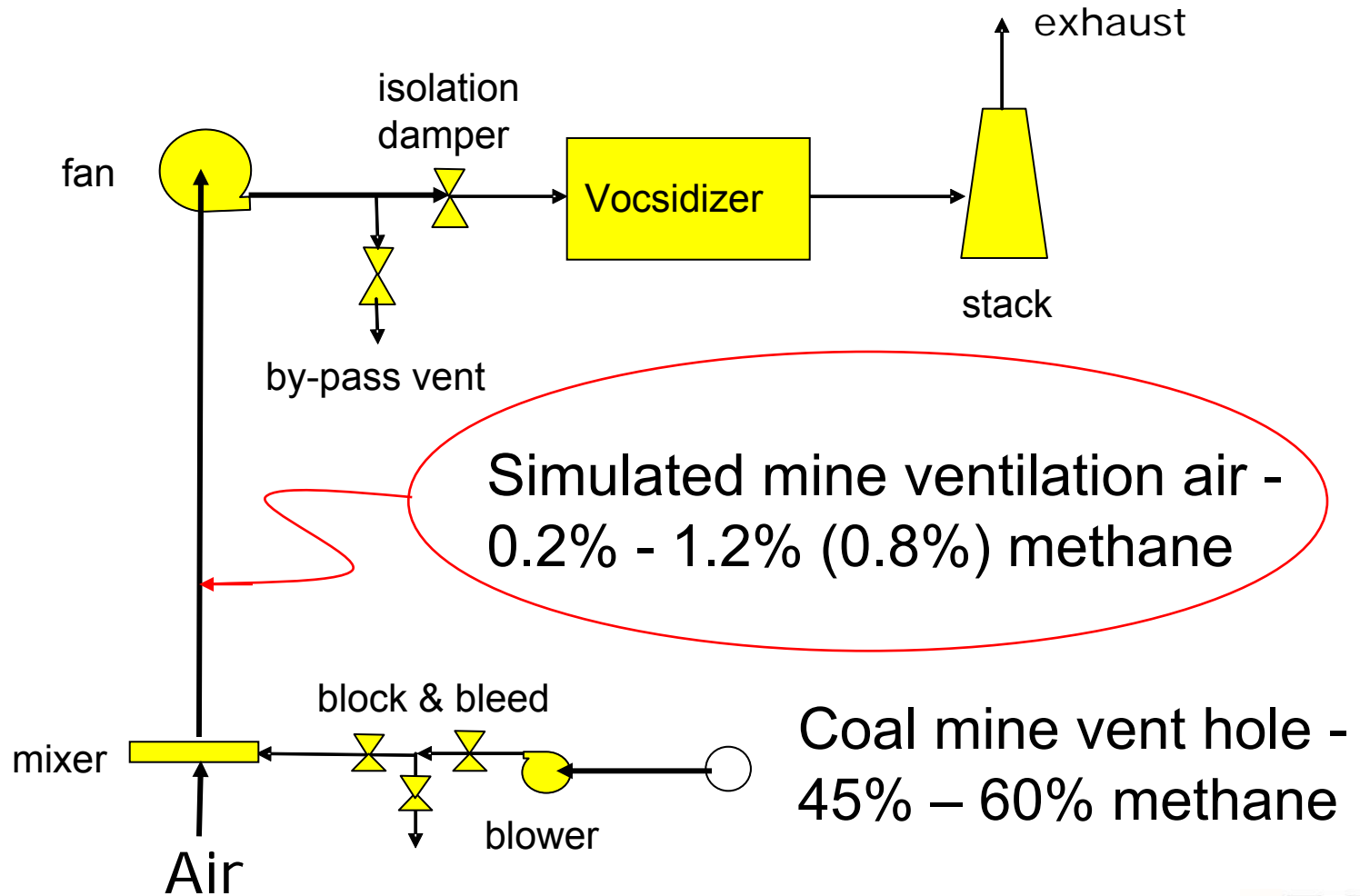
Field Trial Site: Closed Windsor Mine



Field Trial Installation at Windsor Mine



Field Trial Schematic Diagram



Regenerative Thermal Oxidizer

- RTO's are designed for oxidative destruction of VOCs
- Self-sustained operation on very dilute ($\geq 0.2\%$) methane
- Convert methane to CO_2 and water, reducing global warming potential by 87%
- Produces essentially no SO_x , NO_x , CO, or particulate matter



VOCSIDIZER

- Large bed of ceramic material in an airtight steel container
- Air plenum chambers above and below the bed
- Startup electrical heating element in the center of the bed
- Pneumatically actuated valves control flow
- Single module sized to process 30,000 CFM of ventilation air

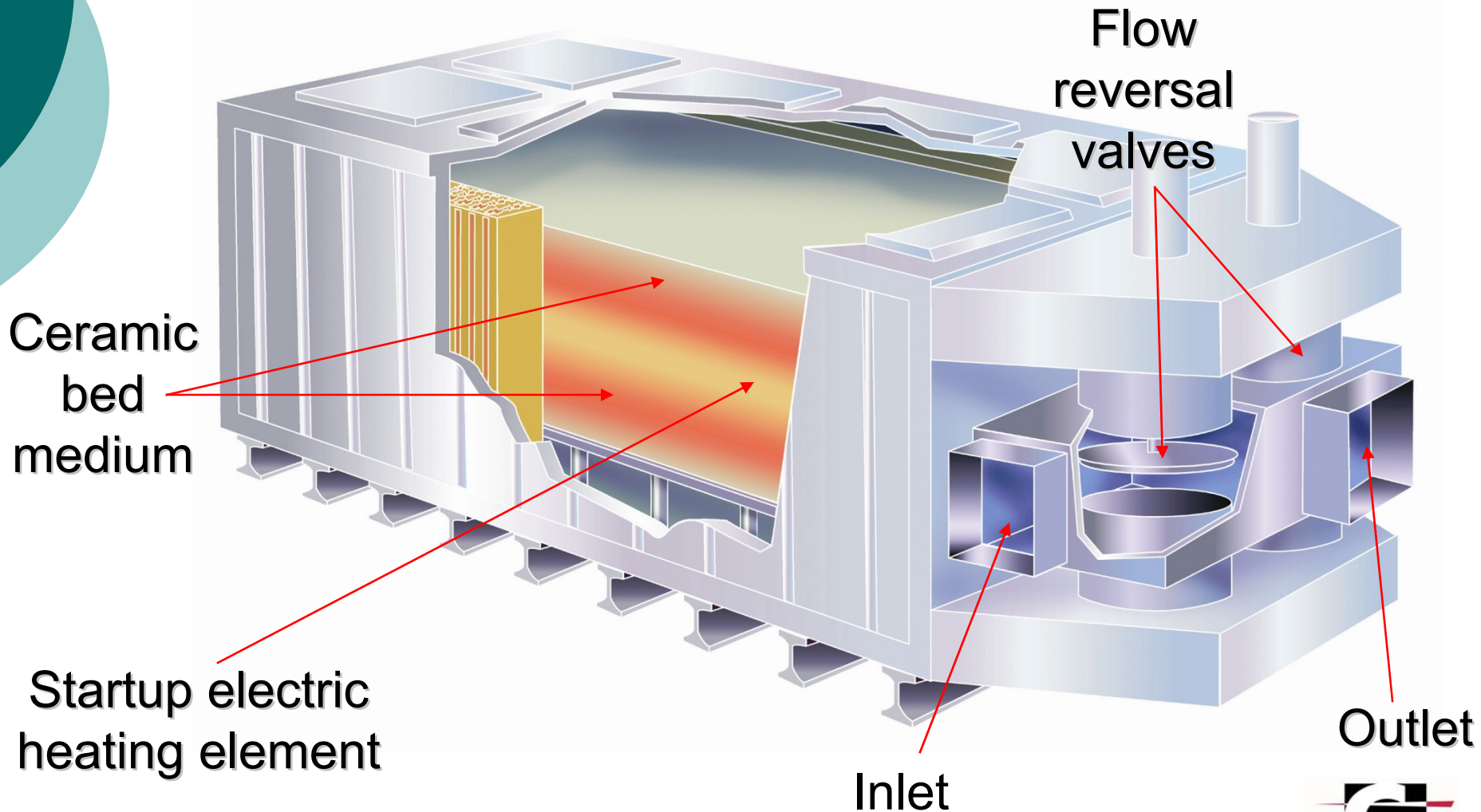


Principle of Operation

- At start up, bed electrically heated to 1000 °C (1832 °F)
- Ventilation air forced through the bed, methane is oxidized, and the released heat is recovered by the bed medium
- Air flow is reversed, and heat recovered in the first cycle heats the incoming ventilation air to oxidation temperature
- Process repeats



VOCSIDIZER Cut-Away View



Performance Evaluation

- Emissions and methane conversion performance tests at “typical” conditions
- Parametric performance tests - methane conversion at variable conditions
- Long-term testing to evaluate O&M issues
 - Continuous operation at full flow and at 0.6% methane concentration to evaluate O&M issues
 - 2007 and 2008 campaigns
 - 4133 hours of unmanned operation



Field Trial Conclusions

- Methane conversion meets spec ($\geq 95\%$) at all conditions tested
- Pollutant emissions meet spec - de minimis
- Self-sustained operation demonstrated at methane concentrations ranging from 0.3% at half flow to 1.0% at full flow – a six-fold range of methane feed rate.
- Long-term testing led to improved components and media



Plan to Implement Technology at Enlow Fork Mine



Implementation of Technology

- CONSOL and Green Holdings Corp. plan to install a 150,000 cfm VAM abatement system at Enlow Fork mine
- Will use an RTO from a commercial supplier
- Location options:
 - E15 bleeder fan, currently operating
 - E22 bleeder fan, now under construction
- Planned start up late 2010



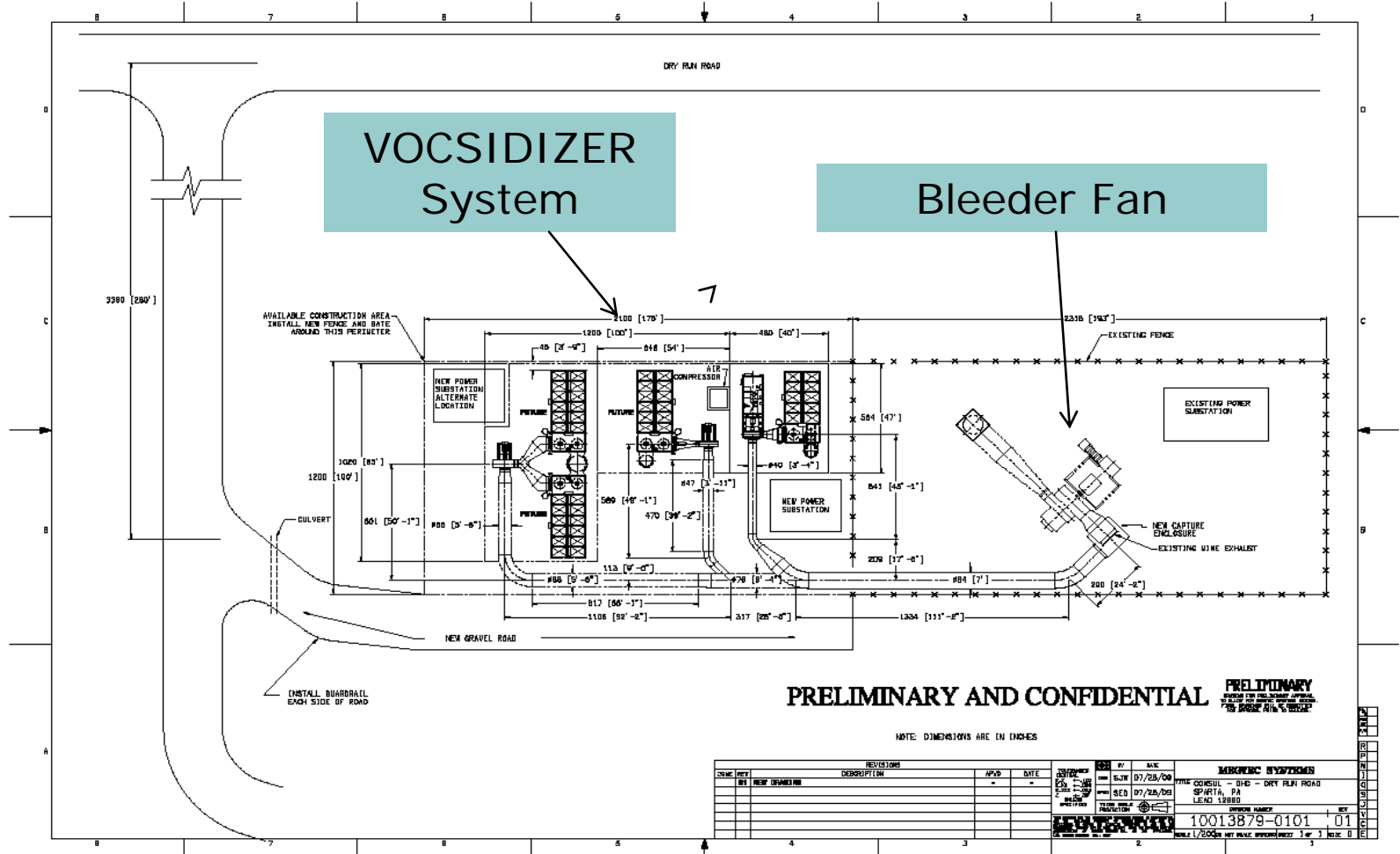
- A turnkey developer of greenhouse gas emission abatement and energy efficiency projects within the Kyoto Protocol and Voluntary Market mechanisms
- Access to capital and engineering support
- VAM abatement projects in China
- Headquarters in Cayman Islands; offices in Houston and London
- www.greenholdings.com

Commercially Available RTO's for Coal Mines

- MEGTEC Systems
 - VOCSIDIZER single-bed model
 - Two-can models
- Biothermica VAMOX system
- Dürr Systems, Ecopure RL
- Gulf Coast Environmental Systems



Preliminary Equipment Layout



Stay Tuned, more to follow....

Questions?



Back up slides....



Biothermica



VAMOX[®] Demo Project



**Visit of MSHA
District Managers
March 2009**



MEGTEC Systems, Inc.



- International company; annual revenue of ~\$260MM
- One of the largest manufacturers of RTOs in the world; one system called “VOCSIDIZER”
- Evaluating and testing technologies for abating VAM emissions and conversion into energy for over 10 years



Dürr Systems

- 4000 systems for air purification worldwide
- Rotary regenerator



Dürr Systems Ecopure Model



Gulf Coast Environmental Systems

- Over 350 integrated regenerative thermal and catalytic oxidizer systems worldwide



Commercial VOCSIDIZER - Australia



WestVAMP



GCE Regenerative Thermal Oxidizer

