METHANE ABATEMENT PROJECTS IN DEVELOPMENT AT CONSOL ENERGY

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Meeting “Carbon Offset Opportunities for Coal Mine Methane Projects in the Climate Action Reserve”, Morgantown, WV, November 9, 2010
CONSOL Energy Inc.

- Began mining coal in 1864
- 16 mine complexes in WV, PA, VA, KY, OH, UT
  - Largest producer of U.S. bituminous coal
  - Largest U.S. producer of underground mined coal
- CNX Gas unit
  - CBM, shale, and conventional gas in VA, PA, WV, and TN
  - Largest producer in the Appalachian Basin
- Production: 59 MM ton coal, 127 Bcf gas in 2010
- Reserves: 4.5 B ton coal, 3 Tcf gas
- Annual revenue: $4.6 billion
- Number of employees: ~8,200
- Safety record ~2x better than industry average
- River Operations: 24 towboats, 650 barges
- Baltimore Terminal: 12 MM ton/y capacity
- Only U.S. coal company with an R&D department
CONSOL’s Methane Emissions

- CONSOL’s greenhouse gas footprint is mostly methane.
- Ventilation air methane (VAM) represented 91% of the 25.5 bcf of methane emitted by CONSOL in 2006.
- It appears likely that under future U.S. law, coal mine methane will be either:
  - an allowable “offset”, or
  - subject to a performance standard.
- Voluntary carbon credit market exists now.
Three Methane Abatement Projects Underway

**Project 1:** Ventilation air methane (VAM) abatement at Enlow Fork Mine

**Project 2:** VAM abatement at McElroy Mine

**Project 3:** Conversion of waste methane to electricity at Fallowfield gas plant
1.) Ventilation Air Methane (VAM) Abatement at Enlow Fork Mine

- The low concentration of methane in ventilation air, 0.3% to 1.5%, means that specialized equipment is required to capture or use it. The technology choice is a regenerative thermal oxidizer (RTO)
- CONSOL joined with Green Holdings Corp. to install an RTO methane abatement system.
- Amortized with carbon credit sales
Green Holdings Corp.

- 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
- Ventilation air methane abatement projects in China
- Headquarters in Cayman Islands; offices in New York and Beijing
- www.greenholdings.com
Regenerative Thermal Oxidizer

- RTO’s are designed for oxidative destruction of volatile organic compounds. Methane destruction efficiency is typically \( \sim 98\% \)
- Self-sustained operation on very dilute (0.2 – 1.4\%) methane streams
- Convert methane to \( \text{CO}_2 \) and water, reducing global warming potential by 87\%
- Produces essentially no \( \text{SO}_x, \text{NO}_x, \text{CO}, \) or particulate matter
RTO Principle of Operation

- At start up, ceramic medium bed heated to 1832 °F (1000 °C), either with propane burner or electrical heaters.
- Ventilation air forced through the bed, methane is oxidized, and the released heat is recovered by the ceramic bed medium.
- Air flow is reversed, and heat recovered in the first cycle heats the incoming ventilation air to oxidation temperature.
- Process repeats.
1. Fan carries VAM from mine shaft to RTO

2. VAM enters RTO through medium bed (A) to pre-heated oxidation chamber

3. Oxidation of CH$_4$ is exothermic and maintains the oxidation chamber at 1832 °F (1000 °C)

4. VAM exits the oxidation chamber via media bed (B) where the air is cooled as heat is transferred to the ceramic bed

5. Directional flow of VAM alternates every two minutes to maintain the temperature of the oxidation chamber within operational limits
Implementation at Enlow Fork Mine

- CONSOL and Green Holdings Corp. will install a 150,000 cfm VAM abatement system
- Enlow Fork Mine; E15 bleeder fan
- Will use an RTO from a commercial supplier
- Ultimately financed by sale of carbon credits
- Planned start up Q2 2011
CONSOL Energy’s Enlow Fork Mine

- Location: Washington and Greene Counties, near Enon, PA
- Largest deep mine in the U.S.
- Production: 11.1 MM tons in 2009
- Recoverable reserves: 346 MM tons
- Coal mined from the Pittsburgh Seam, Northern Appalachia Basin
- Established in 1990
- 2 longwalls and 6 continuous miners
- Ships by rail and barge
Enlow Fork Mine E15 Bleeder Fan

- Morris Twp., Washington Co., near Sparta, PA

- Recent operating data:
  - 181,000 cfm
  - 0.8% methane

- Design Concept
  - Place system on cuttings pit
  - Obtain or modify all applicable permits

- Design system to meet all permitting requirements
Location of Project

Washington County, Pennsylvania
Description of Enlow Fork RTO System

- The plant will be composed of three individual RTO units, each capable of processing 50,000 scfm of VAM with methane concentration between 0.5% and 1.2%.

- Each RTO unit is equipped with:
  - two heat-exchange ceramic medium beds
  - an oxidation chamber (with propane burners)
  - an inlet/exhaust valve housing
  - direct-drive supply fan
  - exhaust stack
  - temperature and methane sensors

- The RTO units are arranged in an array connected to the mine evasé by a ≥100-foot-long duct, which captures no more than 80% of the mine fan’s output.
Enlow Fork Mine E15 Bleeder Fan
Enlow Fork Mine E15 Bleeder Fan
Reclaimed Cuttings Pit
Preliminary Equipment Layout at E15 Bleeder Fan
RTO Plant Safety Systems

- Plant is situated at least 100 ft from evasé
- Collection box designed not to restrict the exhaust of the ventilation air from the mine
- Isolation dampers activated by LEL sensors located in the inlet duct
- Daily visual inspection of the site
RTO Plant Monitoring Systems

- Sensors constantly measure flow rate, temperature and pressure of VAM in the inlet duct.
- Data from methane sensors located at the inlet of the RTO and in the exhaust stack used to determine quantity of methane destroyed.
- Methane destruction data are stored and used to claim carbon credits.
- Constant remote monitoring of data via modem, and broadcast of any upset condition.
Permitting Status

- Federal, state, and local permits required; 5 approving organizations
- Process can take 6-10 months
- Started in February 2010
  - Meetings with agencies
  - Formal submittals
  - Public review period
  - Final permit approval
U. S. Mine Safety and Health Administration (MSHA)

- Addendum to Mine Ventilation Plan
- Submitted to District 2 on August 9, 2010
Pennsylvania Department of Environmental Protection

- Bureau of Mine Safety
  - Inspect equipment before operation
  - Submitted August 9, 2010

- Bureau of Mining and Reclamation
  - Modification to mining activities permit
  - Approved July 14, 2010

- Bureau of Air Quality
  - Plan approval to construct and operate an air contamination source and/or install an air cleaning device
  - Submitted June 23, 2010
Morris Township

- Conditional Use Permit
- Approved July 6, 2010
Planned Schedule

- Complete permitting
- Engage equipment supplier
- Construction
- Planned start up Q2 2011
- Verify and sell carbon credits
2.) VAM Abatement at McElroy Mine

- CONSOL joined with Verdeo Group to install a 160,000 cfm RTO VAM abatement system
- McElroy Mine; 5 North 11A bleeder fan
- Will use an RTO from Dürr USA
- Planned start up Q2 2011
- Ultimately financed by sale of carbon credits
Verdeo Group is a methane gas emissions management firm focused largely on the mining and oil and gas sectors in North America.

Verdeo works with companies to identify, develop and finance projects that maximize the value from waste methane gas and process emissions.

Numerous projects in Appalachia and the western and southwestern U.S.

Headquartered in Washington, DC; offices in Texas and Colorado

www.verdeogroup.com
CONSOL Energy’s McElroy Mine

- Location: Marshall County, near Glen Easton, WV
- One of the largest deep mines in the U.S.
- Production: 9.9 MM tons in 2009
- Recoverable reserves: 348 MM tons
- Coal mined from the Pittsburgh Seam, Northern Appalachia Basin
- Established in 1968
- 2 longwalls and 6 continuous miners
- Ships by barge
McElroy Mine
5 North 11A Bleeder Fan

- Cameron District, Marshall County, near Glen Easton, WV

- Recent operating data from a similar fan at McElroy Mine (Reid Ridge Bleeder Fan):
  - 209,000 cfm
  - 1.2% methane

- Design Concept
  - Place system on cuttings pit
  - Obtain or modify all applicable permits

- Design system to meet all permitting requirements
Location of Project

Marshall County, WV

Glen Easton, Cameron District, Marshall County
Shaft Under Construction Now

Summer 2010

Bleeder Shaft to be online Q1, 2011

Typical Evasé
When fully operational the McElroy VAM project could generate up to 380,000 credits annually.
Some Safety Considerations

- Each RTO is equipped with a suction fan; therefore, the ducting is at a slight negative pressure during normal operation.
- The air gap between the evasé and the VAM capture scoop is sufficient to not impede the VAM flow during RTO shutdown.
- The RTO plant will be greater than 100 feet from the evasé.
- Fast-acting methane sensors at the VAM capture hood will detect concentrations higher than the set limit and trigger a slam valve at the RTO inlet before the VAM can travel the duct length.

Safety is Highest Priority
Ventilation Air Quality Testing

Testing conducted at a comparable bleeder shaft at McElroy:
- Particulate analysis
- Metals and Metalloids
- Acidic gases and compounds
- Methane concentration time lapse
- Sulfur Dioxide
## Permitting Requirements

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<thead>
<tr>
<th>Stakeholder</th>
<th>Permit / Regulation</th>
<th>Current Status</th>
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<td>Air Quality</td>
<td>o Project was issued an air permit waiver on the basis that the emissions post-abatement were below thresholds required for an air permit</td>
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|             | Land use            | o Construction of the VAM oxidation plant required an amendment to the existing land use permit for the bleeder shaft  
|             |                     | o Official approval of the amendment has been received |
|             | Mine Ventilation and Safety | o Construction and operation of the VAM oxidation plant requires MSHA approval of an addendum to the existing Mine Ventilation plan  
|             |                     | o CONSOL is currently in the process of submitting a formal addendum to the mine ventilation plan.  
|             |                     | o Discussions have been held with MSHA on the plant design and function |
Schedule

- Bleeder shaft online: Q1 2011
- Plant fabrication: Q4 2010 to Q1 2011
- Plant construction: Q2 2011
- Oxidation plant fully commissioned and online: Q2 2011
- Offset generation: Q3 2011 to Q3 2021 (up to 380,000 offsets per year)
3.) Conversion of Waste Methane to Electricity at Fallowfield Gas Plant

- Fallowfield plant (Fallowfield Twp., Washington County, PA) uses a membrane system to purify coal bed methane to meet pipeline specifications
- Dehydration, CO\textsubscript{2} removal, compression
- CO\textsubscript{2} vent stream contains 35% to 50% methane
- Will use this otherwise wasted vent gas to generate electricity and carbon credits via an ultra-low emission 200 kWe (140 kWe net) microturbine
- Pennsylvania Energy Development Authority Grant providing 50% of cost
Fallowfield Gas Plant Microturbine

Turbine site

Vent
Project Benefits

- Maximize the resource recovery and beneficial use of coal mine methane by recovering 18,521,000 cubic feet per year of otherwise vented methane
- Reduce greenhouse gas emissions by reducing waste methane gas venting
- Reduce purchased electricity requirements by 1,168 MWh per year, thus further reducing greenhouse gas emissions
- Total reduction in greenhouse gases is 6744 metric tons of CO\(_2\) equivalent per year (6486 metric tons from reducing waste methane and 288 metric tons from avoided purchased electricity)
- Anticipated equipment life is 20 years; will provide recovery of 370,420,000 cubic feet of methane and greenhouse gas reduction of 134,880 metric tons of CO\(_2\)e
- Donation to Charleroi Area school district of the value of the electricity generated during the first two months of operation
Thank You