

# *OVERVIEW OF CMM RECOVERY AND UTILIZATION TECHNOLOGY*

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**Methane to Markets**

Advanced Resources International, Inc. 

# Presentation Outline

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1. Terminology
2. CMM Recovery Technologies
  - Pre-Drainage via Vertical Wells
  - Gob Wells
  - In-Seam/In-Mine Horizontal Boreholes
  - Cross-Measure Boreholes
3. CMM Utilization Technologies
  - Power Generation
  - On-Site Applications (boiler fuel, coal drying)
  - Pipeline Injection
  - LNG

# 1. Terminology

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# Terminology

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- **Coalbed Methane (CBM)**
  - Methane contained in coal seams. Often referred to as virgin coalbed methane, or coal seam gas.
- **Coalmine Methane (CMM)**
  - The subset of CBM that is released from the coal seams during the process of coal mining.
- **Abandoned Mine Methane (AMM)**
  - Methane that continues to be released from the coal bearing strata once a mine is closed and sealed. May also be referred to as coal mine methane because the liberated methane is associated with past coal mining activity.

# Terminology (Cont'd)

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- **Vertical Pre-Drainage Well**
  - Well drilled through a coal seam or seams and cased to pre-drain the methane prior to mining
  - Similar to conventional oil and gas wells, hydraulic fracturing or open-hole cavity completions generally used
  - Gas quality typically high and pipeline quality
- **Horizontal Pre-Drainage Well**
  - Vertical wells that are turned with directional drilling techniques to be completed horizontal in the coal seam
  - Use in mining applications becoming more widespread
- **Gob Well**
  - Well drilled from the surface to a point 10 to 50 feet above the working coal seam prior to mining
  - As mining advances under the well, the methane-charged strata around the well subside and create a fractured zone known as the "gob" area, which releases gas and is a significant source of methane
  - Gas quality starts high initially but will deteriorate over time due to contamination with the mine ventilation system

# Terminology (Cont'd)

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- **In-Seam/In-Mine Horizontal Boreholes**
  - Well drilled into the working coal seam from underground workings
  - Drains methane from the virgin and unmined areas of the coal seam shortly before mining
  - Drilled in both relatively short and long lengths. Gas quality is high and typically pipeline quality
- **Cross-Measure Boreholes**
  - Common international methane drainage technique used outside the US and Australia to drain methane from gob areas in conjunction with longwall mining
  - High angle boreholes are drilled from underground sites typically on the tail gate (return) side of the longwall panel into overlying and underlying rock strata
  - Typically tens to a few hundred meters in length and are installed just prior to and generally close to the working face
  - Gas quality is typically low (e.g. 25-50%) due to contamination of the gas with the mine ventilation system

## 2. CMM Recovery Technologies

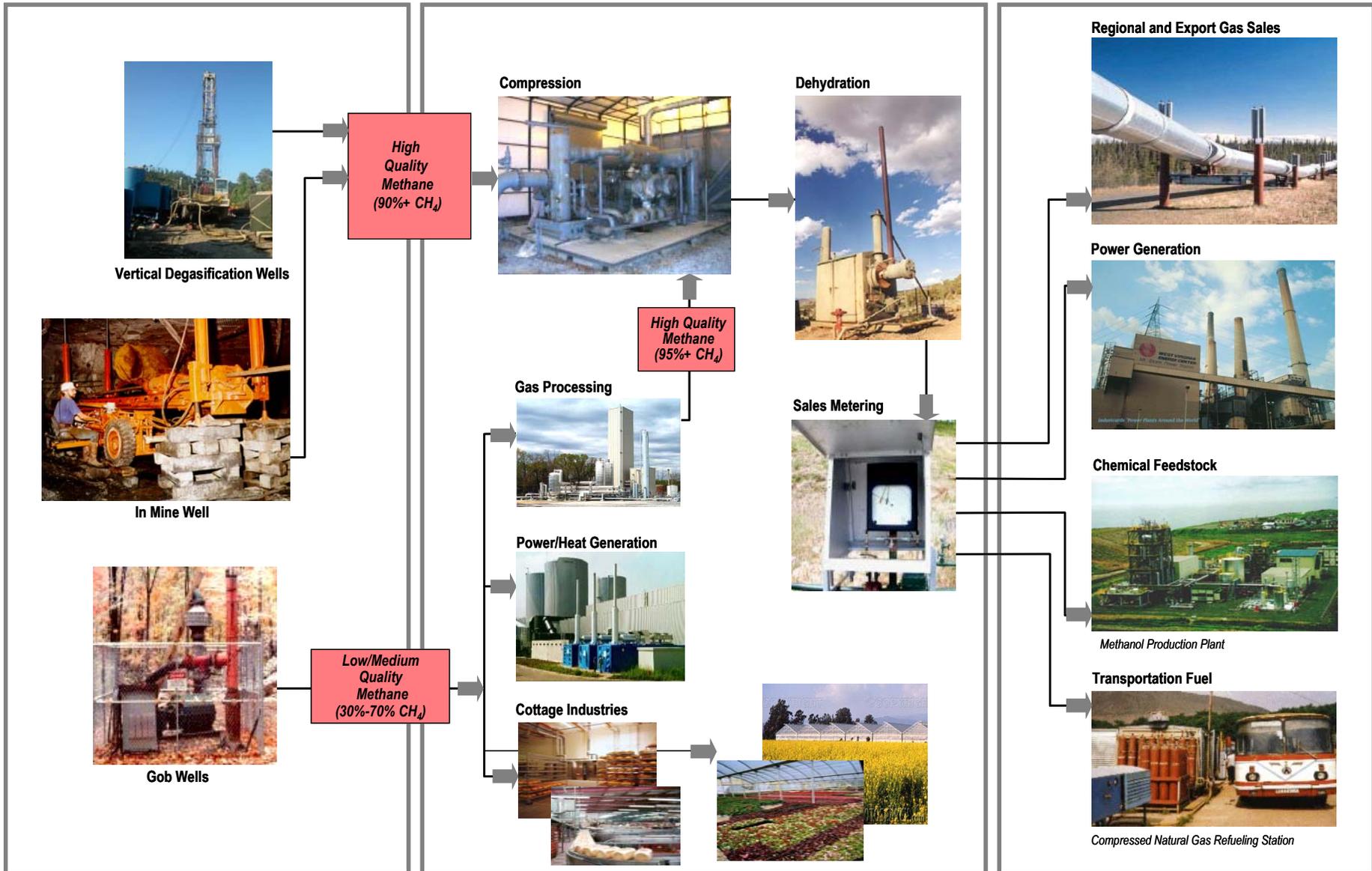
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# CMM/CBM: Production Through Utilization

## METHANE EXTRACTION AND RECOVERY

## GATHERING, COMPRESSION, AND PROCESSING

## METHANE TO MARKETS



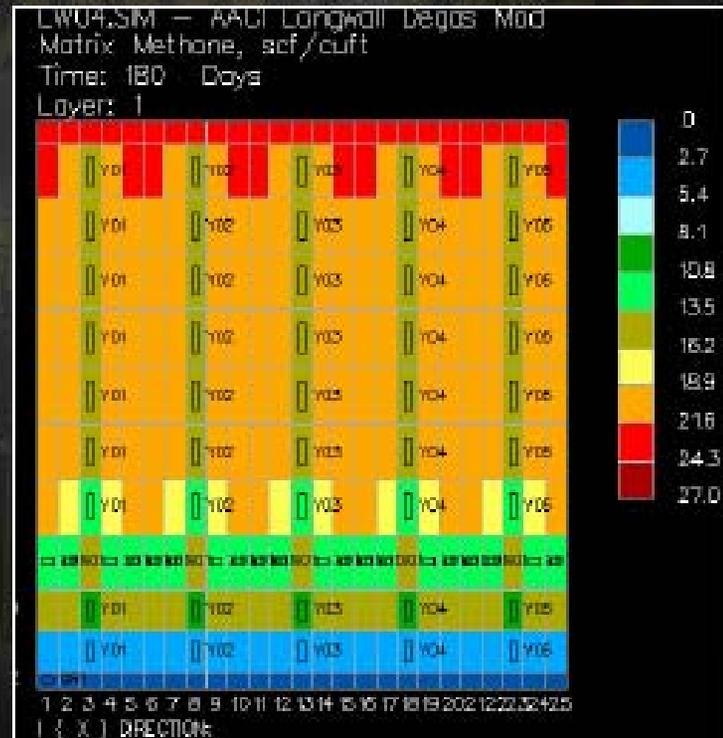
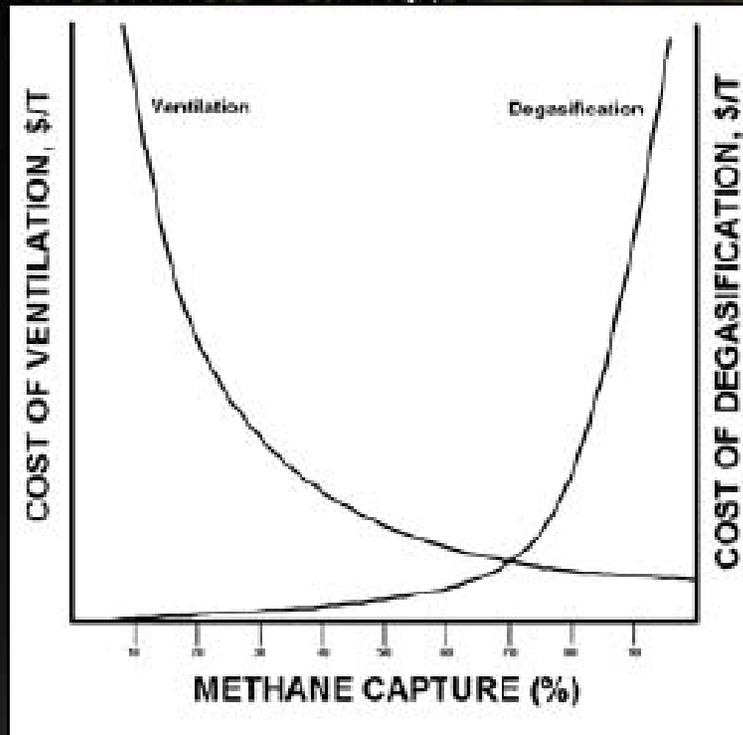
## 2. CMM Recovery Technologies

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The production and recovery of methane prior to and during coal mining can greatly improve mine safety as well as lower production costs by decreasing ventilation requirements and improving productivity.

# Ventilation vs. Methane Drainage

- Relative Cost Comparison & Gas Content Reduction From Methane Drainage

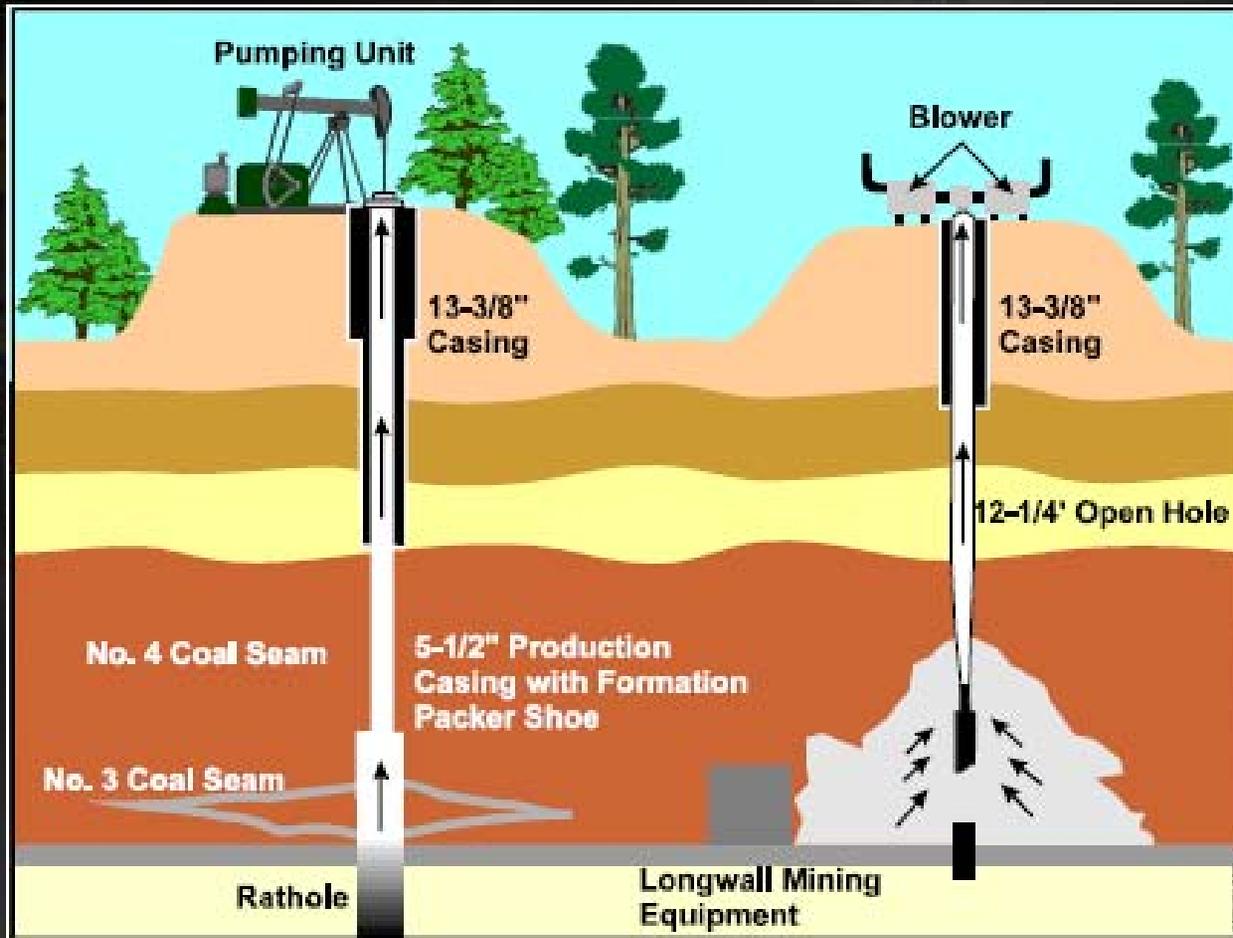


# Surface-Based Degasification Methods

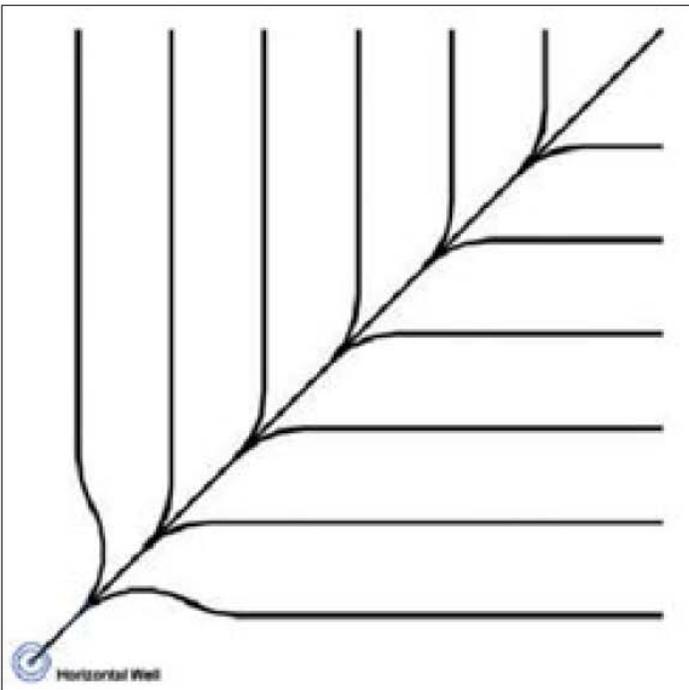
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- **Vertical, Stimulated Wells.** Wells drilled from the surface that are generally cased, cemented, and hydraulically stimulated. Studies by the U.S. Bureau of Mines show that up to 73% of the original gas in-place can be produced via vertical wells. These type of wells are ideally suited for multiple, thin seam situations.
- **Horizontal Wells.** These types of well are gaining in popularity and can produce 70 to 80% of the gas in-place. Good application for settings where there is one or two principal seams.

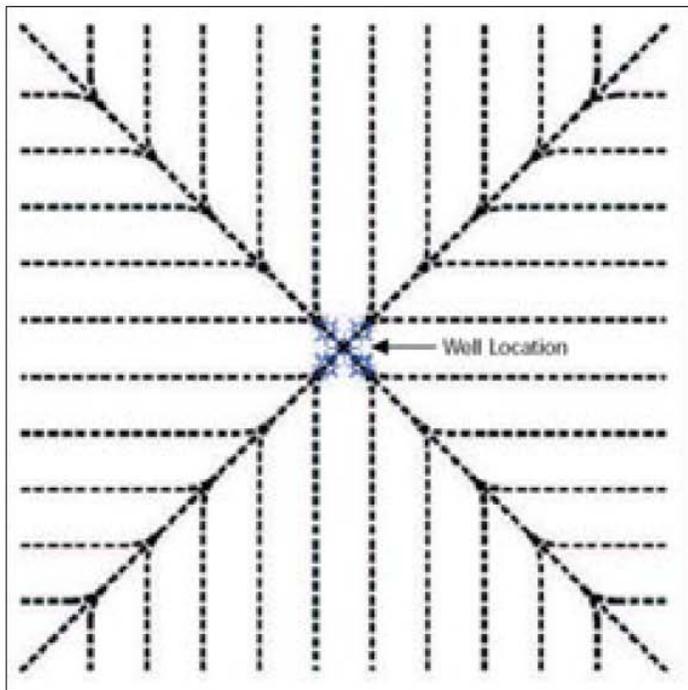
# Design of Vertical CBM & CMM Wells



# Pinnate Drilling - CDX



CDX's proprietary Z-pinnate Horizontal Drilling and Completion System configured in the shape of a leaf (single pinnate pattern)



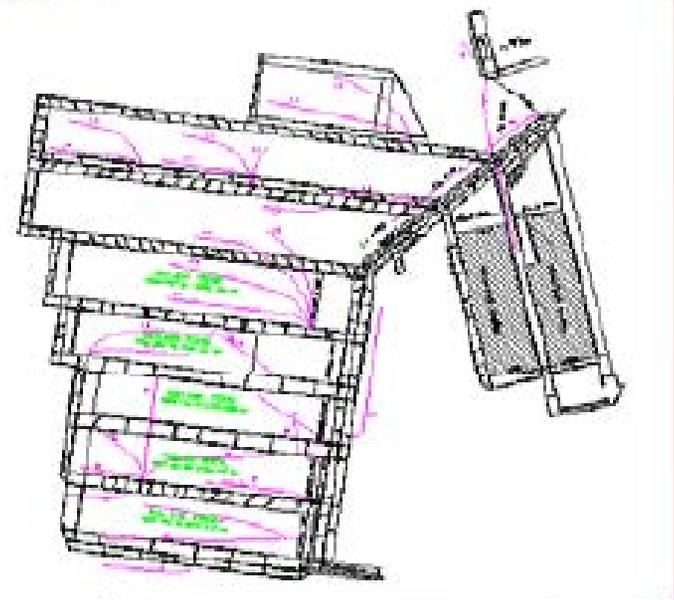
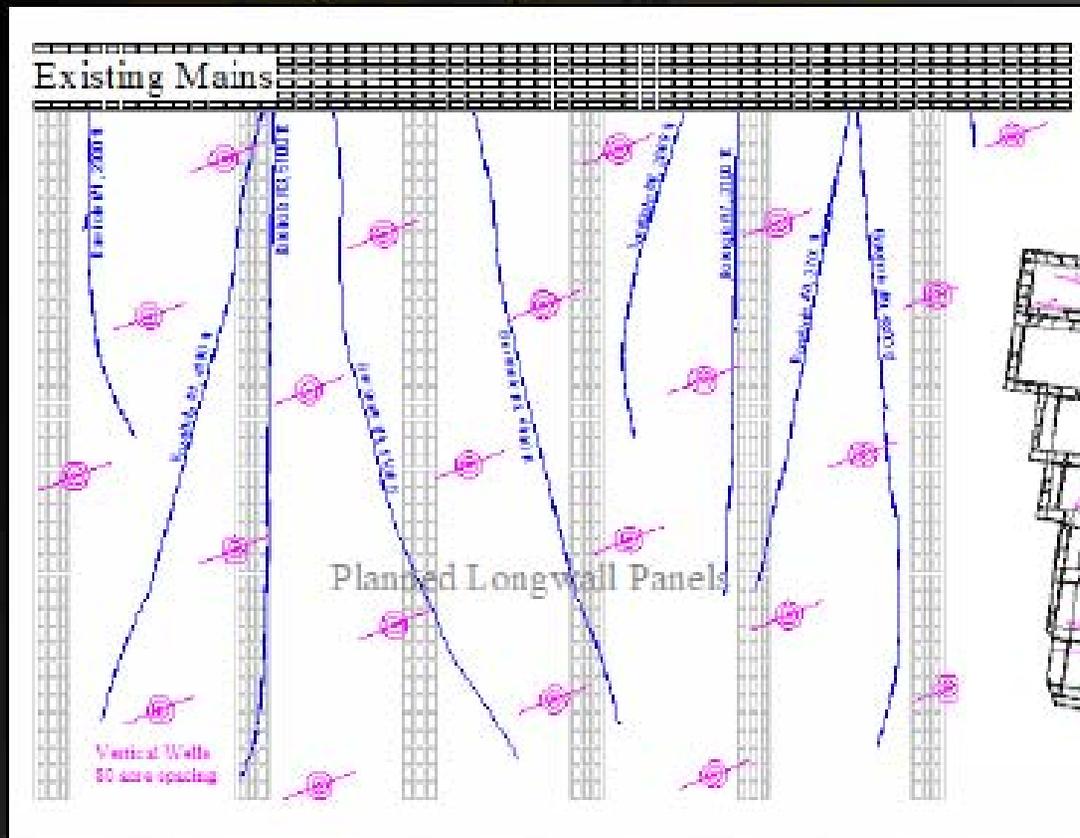
Multiple Pinnate patterns can be nested and drilled from one well site



# Gardes Energy Services Radial Multi-lateral Technology

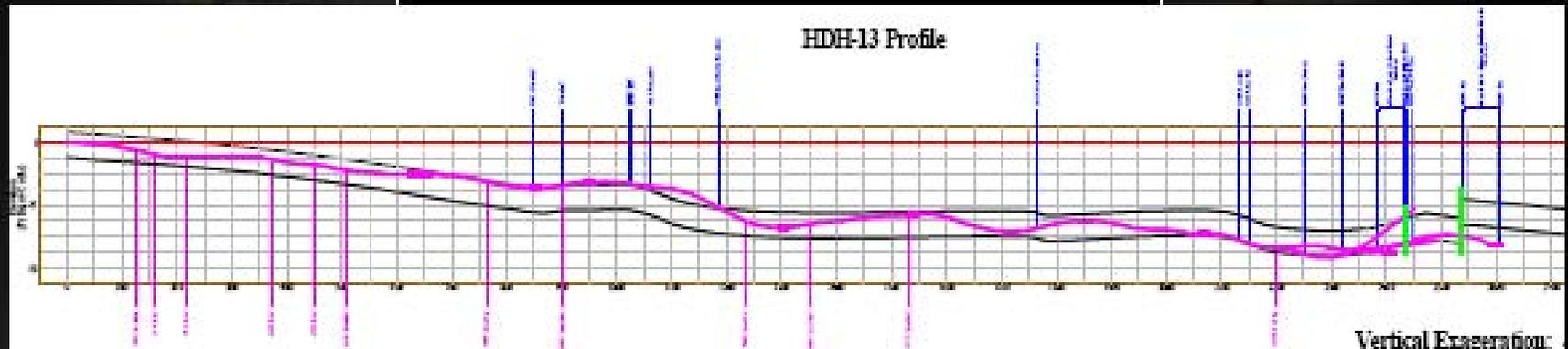
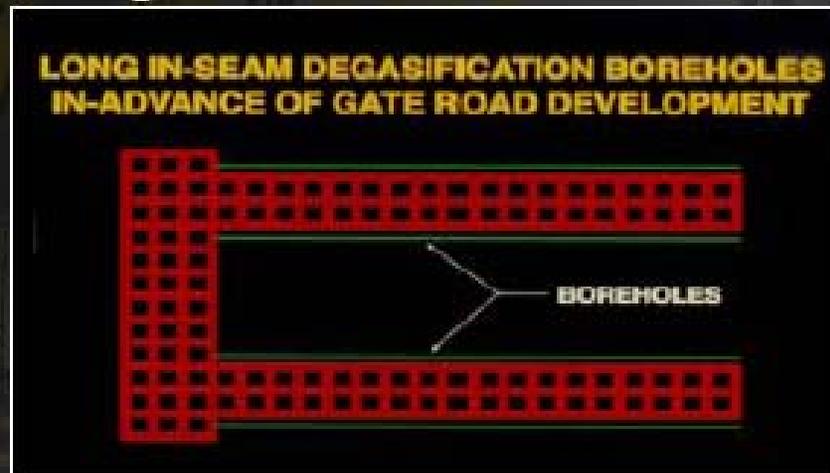
# Methane Drainage Techniques

- Pre Mining – Long, In Seam Boreholes



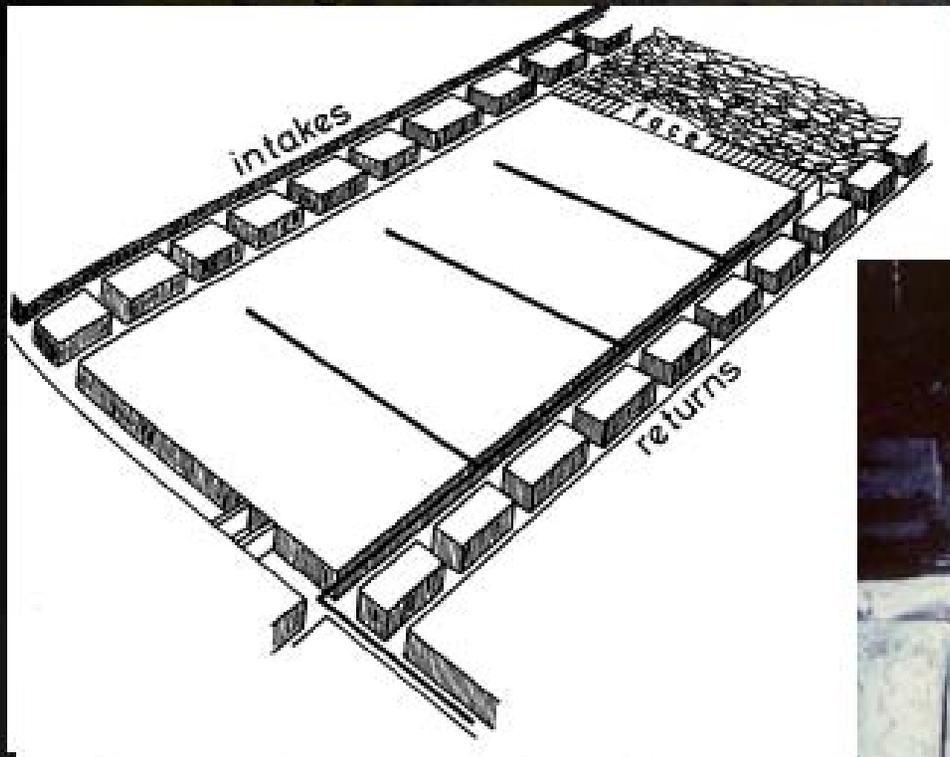
# Methane Drainage Techniques

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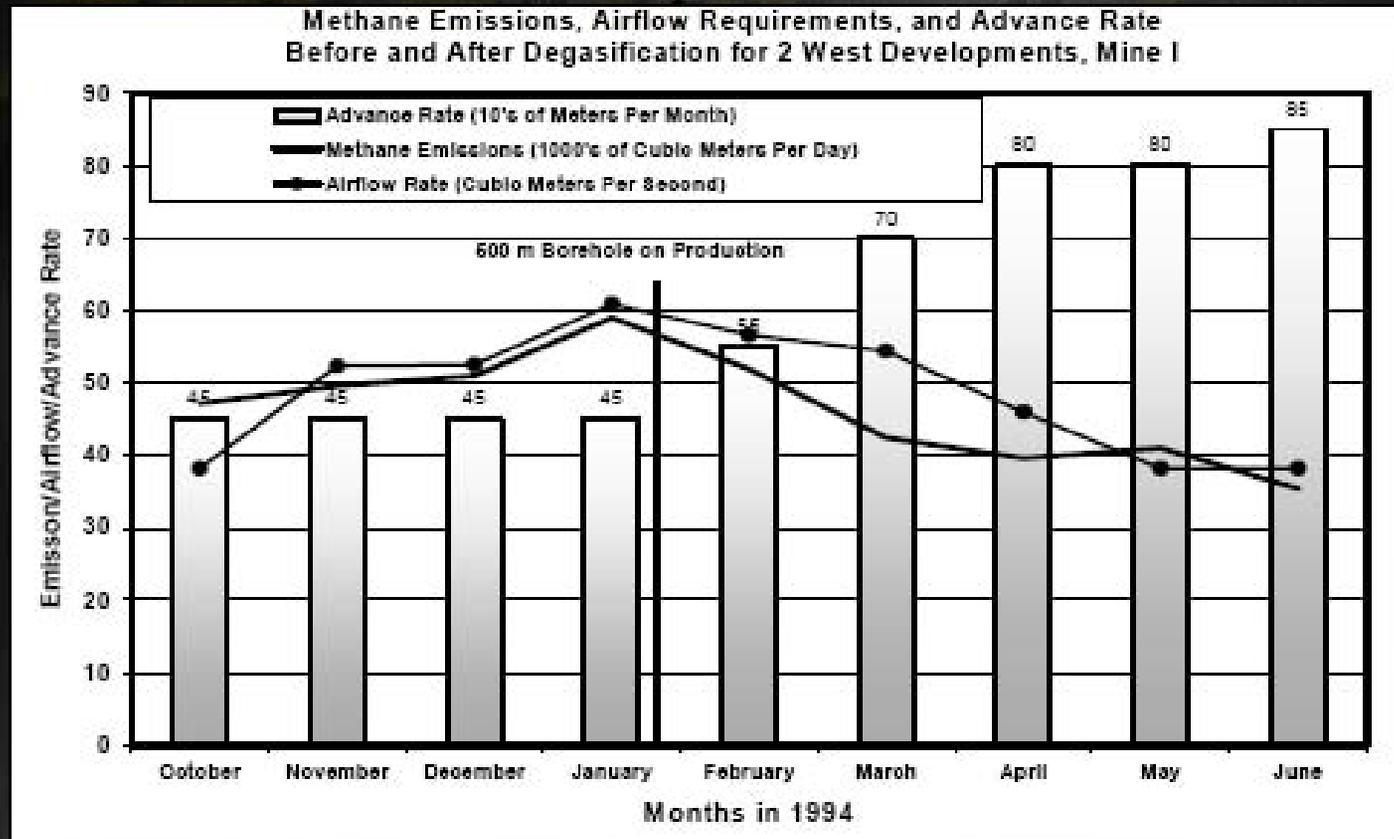
# Methane Drainage Techniques

- Pre Mining - Cross-Panel Boreholes



# Methane Drainage Techniques

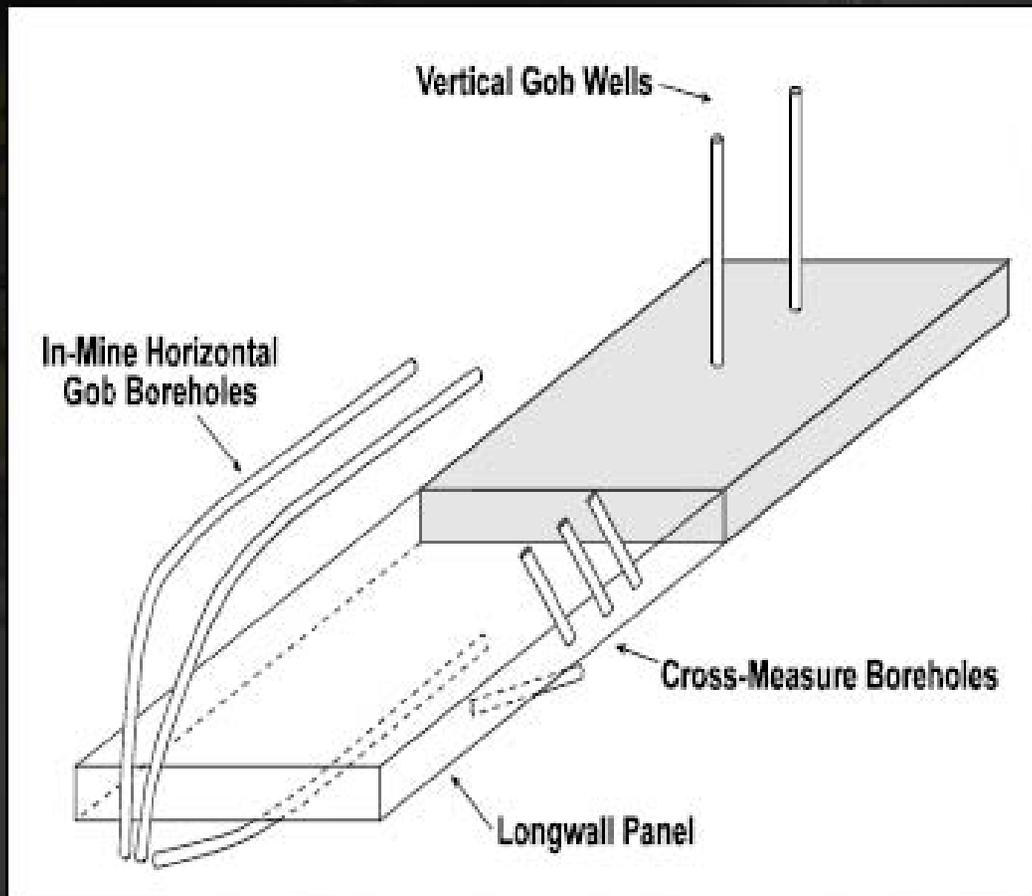
- Effect on Gate Road Development MIMOSA # 1 Mine



# *Long Hole Directional Drills*

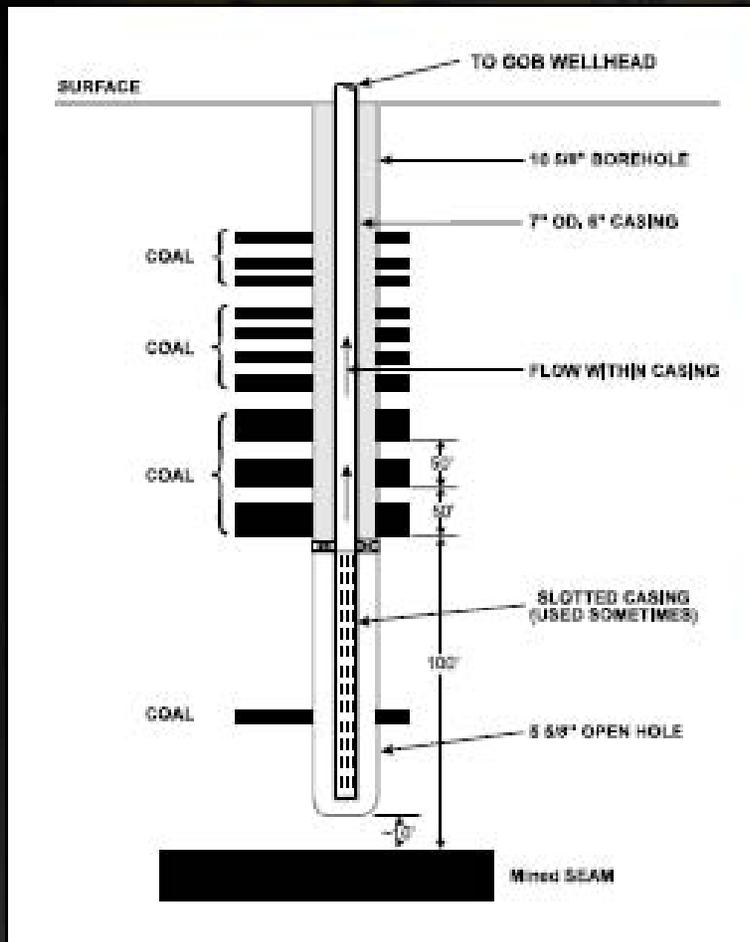


# *Gob Gas Drainage Techniques*



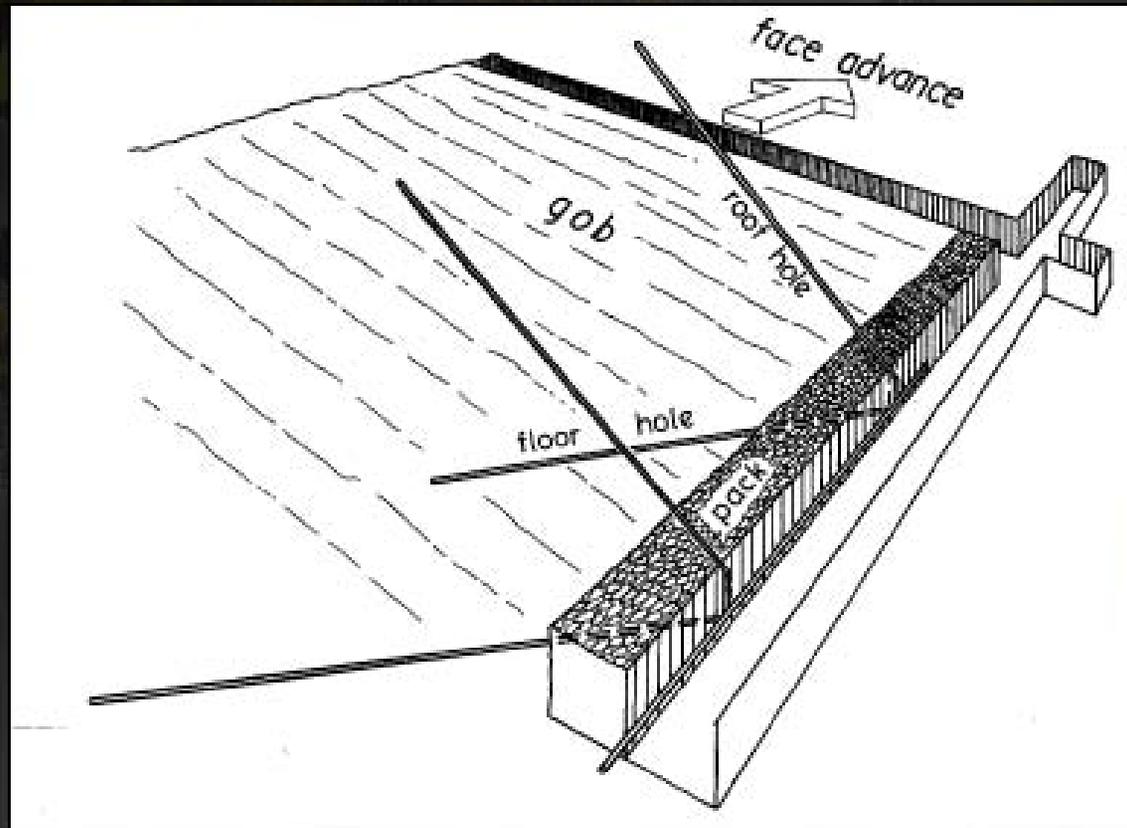
# Gob Gas Drainage Techniques

- Gob Gas – Vertical Gob Wells



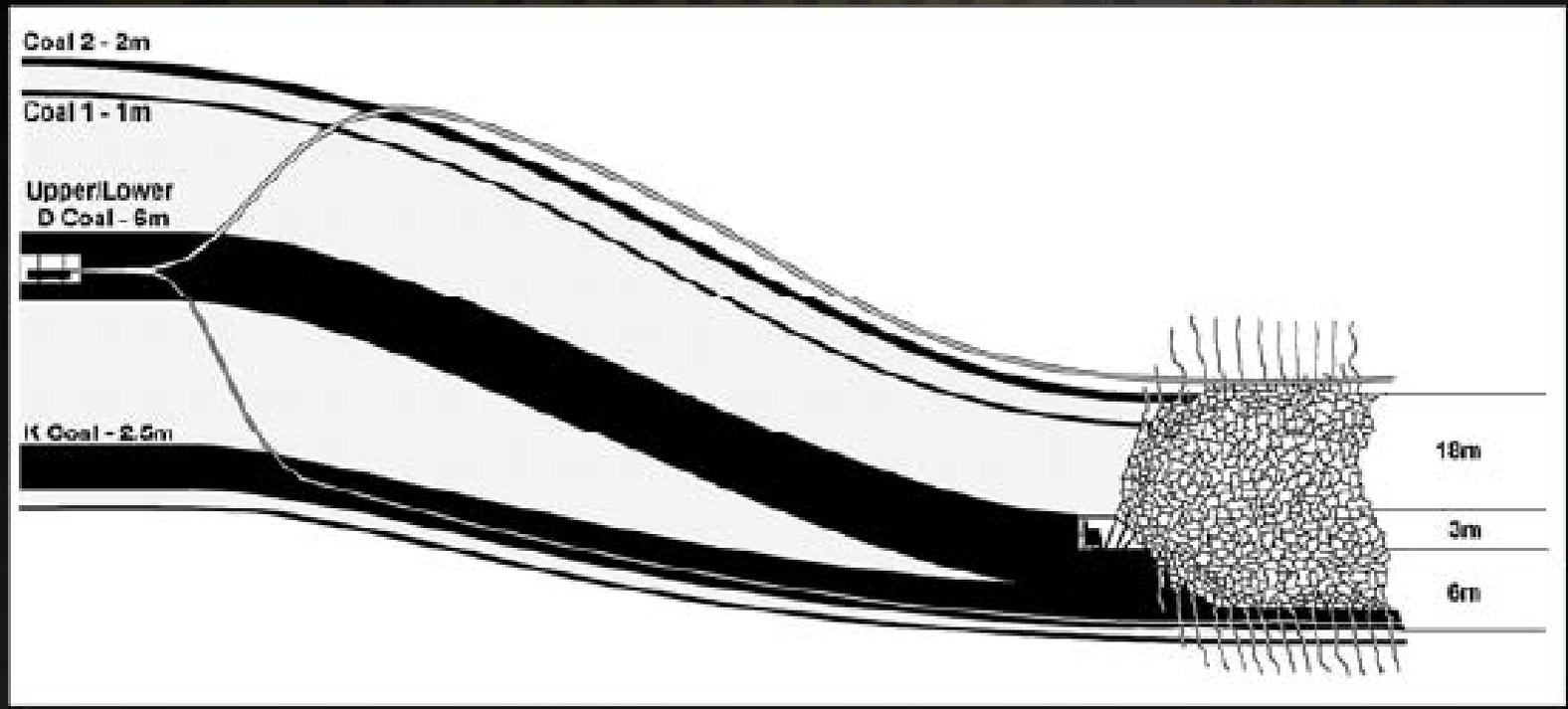
# *Gob Gas Drainage Techniques*

- Gob Gas – Cross Measure Boreholes



# Gob Gas Drainage Techniques

- Gob Gas – Long, In-Mine Gob Boreholes Willow Creek Mine



# *Gas Handling and Collection*

- Post Drilling



# 3. CMM Utilization Technologies

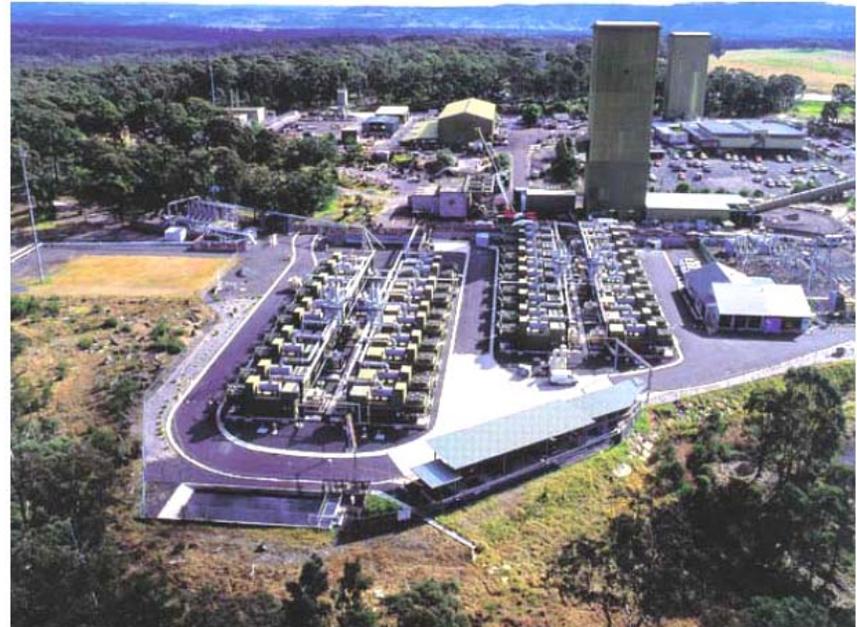
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# Appin-Tower Side (Australia)

## Engine-Based Power Project

- Located in New South Wales
- Operating since 1996
- Project uses 94 one-megawatt engines to produce electric power using drained CMM at Appin & Tower Collieries
- The 54 engines at the Appin site also consume mine ventilation air as combustion air
- GHG reduction of nearly 3 MM tons per year of CO<sub>2</sub> equivalent
- Through equipment redesign and management practices, thermal efficiencies of engines improved from 30% to 35%



# Appin-Tower Side (Australia)

## VAM Oxidation

- Demonstration project
- 12-month period in 2001-2002 at BHP's Appin Colliery
- Used MEGTEC Systems' VAM-to-energy technology
- Demonstrated thermal flow-reversal technology capable of handling variations in VAM flow
- Led to full-scale VAM oxidation project at West Cliff Colliery



# JWR Cryogenic Gas Processing

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- Jim Walter Resources operates on of the most extensive commercial programs for coal seam degasification in the U.S.
- Medium quality gas obtained from gob wells, vertical wells, and underground horizontal wells
- Low Quality gas plant installed to upgrade gas to pipeline quality
- BCKK cryogenic gas processing facility chosen over pressure-swing adsorption
- JWR sells an average of 23 MMcfd of pipeline quality gas, preventing 3.4 MM tons of CO<sub>2</sub> equivalent from being emitted into the atmosphere
- Plant has produced gas for 6+ years at a profit (breakeven gas price approximately \$3.50 per Mcf)

# JWR/BWM Low Quality Gas Plant





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