

EPA Coalbed Methane Outreach Program Technical Options Series

COAL MINE METHANE USE IN IC ENGINES AT COAL MINES



675 kW Synchronous Skid-Mounted Generator sets at Nelms No. 1 Mine, Ohio
(Photo courtesy Northwest Fuel Development, Inc. and U.S. DOE)

POWER GENERATION AT COAL MINES, A PRACTICAL APPROACH BECAUSE ...

- ◆ Economic benefits to coal mines, power producers and end users
- ◆ Improved on-site power supply reliability
- ◆ Modular design accommodates fluctuations in gas supply
- ◆ Commercially proven at the Nelms No. 1 Mine, Ohio, USA and at the Appin and Tower Collieries, New South Wales, Australia
- ◆ Reduces emissions of coal mine methane, a greenhouse gas

IC engines operate on gas at atmospheric pressure; they do not require compressed fuels like gas turbines

Why Consider Using Coal Mine Methane in IC Engines?

Mining of gassy underground coal deposits releases large quantities of methane gas, which presents a safety hazard to miners and therefore must be ventilated or removed. Mines can drain methane ahead of mining operations by drilling vertical wells down to the gassy coal seams and surrounding strata. Vertical wells usually produce high quality gas, (over 90% methane concentration) with a heating value of over 900 Btu/cf. In contrast; wells drilled into collapsed rock over mined-out areas produce medium quality gas that generally contains 30-80% methane.

Many methane recovery operations inject pipeline quality gas directly into a pipeline and sell it to utility companies. Mines often vent the medium quality gas they drain from gob wells into the atmosphere instead of using it, because gob gas requires enrichment prior to pipeline injection. However, fuel for power generators does not require pipeline quality gas. Generally, IC engines can be adapted to generate electricity using coal mine gas with a methane concentration as low as 20%. However, for safety reasons, mines usually cease production of gob gas if the methane concentration drops below 25%.

In Ohio, Northwest Fuel Development, Inc. (NW Fuel), with the assistance of the U.S. DOE, has developed power generators that use medium quality gas. The "prime mover" in NW Fuel's power generating set is a 100 hp IC light truck engine manufactured by General Motors. Properly configured carburetors in this engine allow use of fuels ranging from 20% to 100% methane. The engines generally provide service for over 12,000 hours (or one and one-half years) before any significant maintenance is required. After maintenance, the engines are placed back in service for another 8,000 to 10,000 hours before they are retired and replaced.

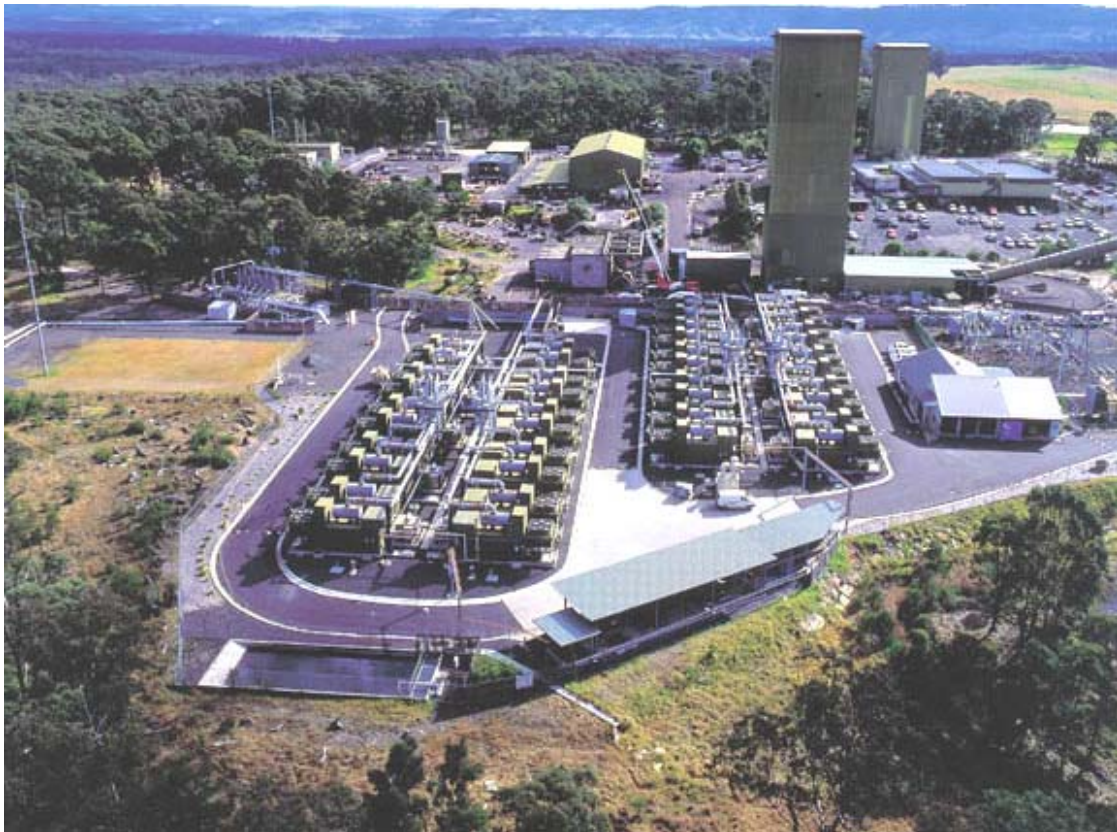
One of the longest running projects in the U.S. is NW Fuel 's CMM power system built in 1994 at Nelms #1 Mine in Ohio. They recover approximately 225,000 cubic feet per day of methane from the Nelms Mine No. 1 to operate twelve internal combustion engines that generate electricity for on-site use at the neighboring Nelms Cadiz Portal Mine. Through the use of common, mass-produced GM engines, the power-generating equipment developed at the Nelms Mines produces low-cost electricity by keeping capital and operating costs to a minimum. Currently, the project also sells some electricity directly to American Electric Power Company, a local utility.

SOME FACTS ABOUT POWER GENERATION AT THE NELMS COAL MINES...

- Current nine-unit system capable of generating 675 kW of electricity
- System uses about 225,000 cubic feet of coal mine methane per day
- Existing units produce three-phase electricity at 480 volts
- Installed costs of generator sets and utility-required protective relays are less than \$800/kW
- Produce power for less than \$0.025/kW-hr

Maintenance and parts for IC engines are readily available

IC engines can operate on gas with low methane content



Use of methane at the Tower Colliery for power generation in IC engines
(Courtesy of Energy Developments, Ltd.)

On a larger scale, Energy Developments Ltd. (EDL) has developed a power project in Australia that uses coal mine methane (supplied by BHP's Appin, Tower and West Cliff Collieries) to generate electricity for the local utility grid. The project cuts the mines' methane emissions in half and delivers a total of 94 MW of power to the utility grid during peak demand hours. Of this, 4-10 MW is fed back from the utility grid to meet the mines' equipment energy requirements, such as ventilation fans, power equipment, and other critical loads. The remaining power is supplied to Integral Energy Australia. By purchasing power from this project, Integral Energy, a local distribution company and energy trader, expects to save its customers more than \$US 2.4 million annually. To ensure consistent gas quality and quantity, EDL uses an electronic monitoring and control system to supplement the coal mine gas with natural gas when necessary.

As with the Nelms Mines, this innovative project converts coal mine methane to electricity using a conventional internal combustion engine. In this case, a 16-cylinder Caterpillar G3516 bulldozer engine is connected to a Cat SR4 brushless generator. Housed in soundproof sheds, the 94 generator sets convert over 20 million cu ft/day of coal mine methane to 97 MW of electricity. Each generator set is expected to operate up to 8000 hours a year. A gas turbine-based system was not considered as cost-effective because of the need to compress the gas before fueling, and because experience had shown that maintenance could be a problem at the site.

SOME FACTS ABOUT THE USE OF IC ENGINES AT THE APPIN POWER PROJECT...

- Each engine directly drives one 415 volt 1 megawatt generator
- Fuel gas composition varies from 50 - 85% methane, 0-5% CO₂, and up to 50% air
- Modular design provides for off-site fabrication, ease of relocation, and staged expansion
- Mine ventilation air from Appin Colliery, containing 0.5 -1.0% methane, supplies all of the combustion air to the 54 units at the Appin plant (mine design prohibits this option at Tower)

The economic success at the Nelms Mines in Ohio and the Appin and Tower Collieries in Australia is prompting coal and electricity producers worldwide to take a new look at using methane-fueled internal combustion engines for power generation. This approach has the added benefit of reducing methane emissions by converting a waste product into electricity.

For More Information...

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Or contact EPA's Coalbed Methane Outreach Program for information about this and other profitable uses for coal mine methane.

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