Market Segment: Coal Seam Methane

POWER PROFILE

Energy Developments Limited

POWER NEED

Coal seam methane, viewed for years as a hazard requiring removal from underground mines, has become a viable fuel source for generating a significant amount of electricity at the Appin and Tower coal mines in New South Wales, Australia.

Located near vast reserves in the world's major coal-producing regions, BHP Billiton's Appin and Tower longwall mines produce two million tons per year of clean coking coal within the 2.1m- to 3.5m-thick Bulli Seam that is part of the 49,000 m^2 Sydney Basin. A March 1996 report by the New South Wales Department of Mineral Resources estimates that the Sydney Basin and two other New South Wales basins have the combined potential to yield as much as 511 billion m^3 of recoverable gas.

The Appin and Tower sites constitute what is arguably the largest coal seam gas energy project in the world, and one of the world's largest reciprocating engine-generator installations of any kind. Consuming 600,000 m^3 of coal seam gas per day (supplemented when necessary by natural gas from Moomba, Australia), the generating equipment delivers a combined 94 MW of continuous capacity to the local utility grid.

To convert the Appin and Tower coal mines into this significant energy-generating resource, Energy Developments Ltd. (EDL), based in Brisbane, Queensland, looked to Cat dealer Energy Power Systems Australia to provide a total of 94 Cat® G3516 natural-gas-fueled generator sets driven by lean-burn, low-emission reciprocating engines. Dedicated to driving positive and sustainable change, these generator sets were designed by Caterpillar for coal seam methane energy projects and other low-energy fuel applications. An ideal fit for the Appin and Tower project, these engines would be capable of operating on methane gas, as a reliable and economic solution.

SOLUTION

The coal seam energy project began in 1994 with EDL's installation of two prototype Cat generator sets at the Appin site to test their performance on the coal seam methane. Previous engineering and feasibility studies had also evaluated the use of large-scale gas turbine prime movers. Despite some concern that multiple reciprocating generator sets would pose challenges with service, parts and consumable supplies, analysis found that the engine-based system was the most attractive solution based on both capital and long-term operating costs.

This initial evaluation was followed in December of 1995 by Energy Power Systems Australia's shipment of the production generator sets. 54 of the G3516 generator sets were delivered and installed at the Appin site, with the remaining 40 going to the Tower site.

The G3516 generator sets are driven by 16-cylinder, lean-burn engines operating at 1,500 rpm and rated to produce 1,030 kW of continuous power. The engines' lean fuel mixture is controlled by an electronic system designed by EDL that regulates the air/fuel ratio for maximum performance and minimum emissions under varying load, fuel and temperature conditions.

Aerial view of the Appin Power Station showing Caterpillar generator sets.

CUSTOMER
Energy Developments Limited

LOCATION
BHP Billiton's Appin and Tower Coal Mines
New South Wales, Australia

CUSTOMER BUSINESS ISSUE
Coal seam gas reciprocating engine-generator installation

SOLUTION
94 Cat® G3516 reciprocating engines (coupled to SR4 brushless generators)

CAT DEALER
Energy Power Systems Australia

CATERPILLAR®

The units are also equipped with a Caterpillar® Electronic Ignition System (EIS) that allows the engines to run at high load near the detonation limit. Sensors in the cylinder banks detect the onset of detonation and signal a microprocessor-based control module that retards ignition timing until the detonation is corrected. If the detonation persists, the system shuts the engine down. The EIS also includes a built-in self-diagnostic system that can alert the operator to potential problems involving engine components, facilitate troubleshooting, and provide an engine operating record for trend analysis.

An Electronic Control System monitors the amount of coal seam gas entering the system and communicates with an EDL-designed Programmable Logic Controller (PLC). The PLC regulates the volume of coal seam and pipeline gas fueling the generator sets during peak-demand hours. During off-peak hours, the PLC monitors the entire system and determines the number of generator sets needed to use the available seam gas.

At both power stations, each pair of generators is connected to a 2,500 kvA transformer that increases the voltage from 415 v to 22,000 v. A 25 MvA transformer connected to the local electric grid then boosts the voltage to 66 kv. Of the total 94 MW capacity, 4 to 10 MW is returned from the grid for mine use.

The complete power generation system consumes 437 tons of coal seam gas per day – 250 tons at the Appin site and 187 tons at the Tower site. All of the coal seam gas delivered to the generator sets is collected using underground "in seam" drilling and treated in an additional step at the surface where fine coal dust is removed in a wet scrubbing and filtration process. An underground system comprised of 8 km of pipes collects and transports the seam gas and is interconnected to enable the gas to be diverted as necessary between the Appin and Tower power stations. The adjoining West Cliff Colliery mine, also owned by BHP Billiton, serves as an additional source of coal seam gas for the Appin site when needed. A supplemental natural gas supply from the Moomba field approximately 1000 miles west of the site aids in subsidizing these fuel sources during periodic fluctuations in the coal seam fuel supply.

When operating each generator set runs at full capacity. During peak hours – 7 a.m. to 10 p.m. on weekdays – the coal seam gas is supplemented with natural gas as necessary to deliver the generators' full rated output. In off-peak hours, the units deliver the maximum output possible based on seam gas availability. In total, each unit operates approximately 8,000 hours on an annual basis.

RESULTS

Coal seam methane energy has proven financially attractive and operationally reliable at the Appin and Tower mines. After nearly a decade of operation, the Appin and Tower energy facilities have exceeded expectations for return on investment from the sale of electricity to Integral Energy's grid. The project demonstrates the viability of coal seam gas as a significant source of supply to help meet modern society's growing need for reliable and affordable electricity.

With today's ever-increasing concerns for the environmental effects of emissions, the project has additionally helped reduce both mines' methane emissions by half.

In addition to generating revenue and reducing emissions, the coal seam methane energy system provides the mines with a reliable source of standby power.

During the initial stages of the project, the local Cat dealer provided warranty service. Since then, EDL has handled service and overhauls primarily in-house. The company owns a highly sophisticated repair and overhaul facility one mile from the Appin site that includes a teardown area, wash bay, inspection area, re-assembly area, paint shop, and parts storage area. The facility has a staff of 10 and can process as many as four engines at a time.

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Through a progressive maintenance program, EDL has safely extended time between major overhauls from the standard 40,000 hours to more than 60,000 hours in some cases. Technicians perform a combination of condition-based, scheduled and unscheduled maintenance. Trending and analysis procedures, including coolant and lube oil analysis, help technicians monitor engine condition, detect potential operating issues and establish routine service intervals. Lube oil analysis by the oil supplier has enabled extension of the oil-change interval in some cases to in excess of 2,000 hours.

The power stations stock replacement components and consumables and replenish inventory based on an automatic ordering system. Westrac, the local Cat servicing dealer located in close proximity to the power house sites, makes deliveries of components and offers overhaul and repair support as necessary. "The sustainability of our business and the sustainability of our world are inseparable. This project is a solid example of Caterpillar's commitment demonstrated in practice."

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