EnergyWise Queensland

Birdsville geothermal power station

Fact sheet
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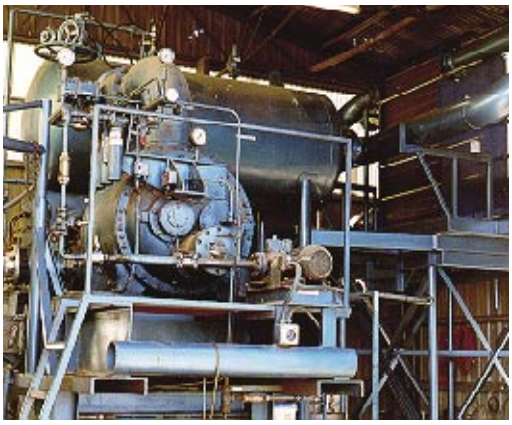


A new condenser, the major component installed during the QSEIF project, enabled use of isopentane "working fluid" and increaded power output.

New plate heat exchanger condenser and stand

Birdsville geothermal power station
Enreco Pty Ltd and Ergon Energy

QSEIF funding: $95,300

One of the few low-temperature geothermal power stations in the world is providing power for the town of Birdsville in western Queensland. The plant derives its energy from the near-boiling (98°C) water taken from the Great Artesian Basin (at a depth of 1230m) that provides a water supply for the town. Hot bore water is a "free" energy resource which would otherwise be wasted when water is cooled before use.

The geothermal power station has been upgraded to operate at increased capacity with a new "working fluid". Upgrading the power station allows geothermal power to provide the town's entire electricity demand at night and during winter periods, with diesel-powered generators brought on-line when required for peak demand periods (in summer and during the famous Birdsville Races, when the town is flocked with visitors). Operation of the geothermal power station reduces diesel consumption by about 160,000 litres per year, saves $135,000 in fuel costs, reduces emissions of 430 tonnes of greenhouse gases, and allows relatively noise-free operation. Modifications to the plant were undertaken with financial assistance provided by the Queensland Government through the Queensland Sustainable Energy Innovation Fund (QSEIF).

Hot bore water flows at about 27 L/s to provide a source of heat at 98°C which is transferred to the plant's "working fluid" of isopentane through a plate heat exchanger. As it is heated by the hot water, the isopentane boils into a vapour (similar to steam) at about four atmospheres pressure. The high-pressure vapour pushes against the vanes of a screw-type expander, converting some of its heat energy into mechanical power, turning the shaft of a generator and producing a net power output of 80kW.

After emerging from the expander at reduced pressure, the isopentane vapour is cooled and condensed back to liquid at about 30°C. The isopentane working fluid is continuously cycled through a closed loop, being sequentially heated, vapourised, expanded and condensed.

The Birdsville geothermal power station was originally constructed in the early 1990s, but was not able to operate at

full capacity due to a design problem. The screw expander was too large (by a factor of two) and needed to be run at lower speed through a gearbox, which significantly reduced its power output and efficiency. In addition, the geothermal power station's original R114 working fluid (a chloroflorocarbon compound which was damaging to the ozone layer) had to be replaced to meet Australia's environmental commitments.

Fixing these problems was made possible through the QSEIF grant and Ergon Energy support. The plant was modified to use a new working fluid, isopentane, a hydrocarbon with no ozone depletion potential. Isopentane was also well matched to the capacity of the existing screw expander, which could now operate efficiently at its design speed. Conversion to isopentane working fluid did require installation of a new heat exchanger to condense the vapour (replacing two heat exchangers which had been custom designed for the R114 working fluid), a new multi-stage liquid pump and larger diameter pipes and fittings to handle the larger volume of vapour.

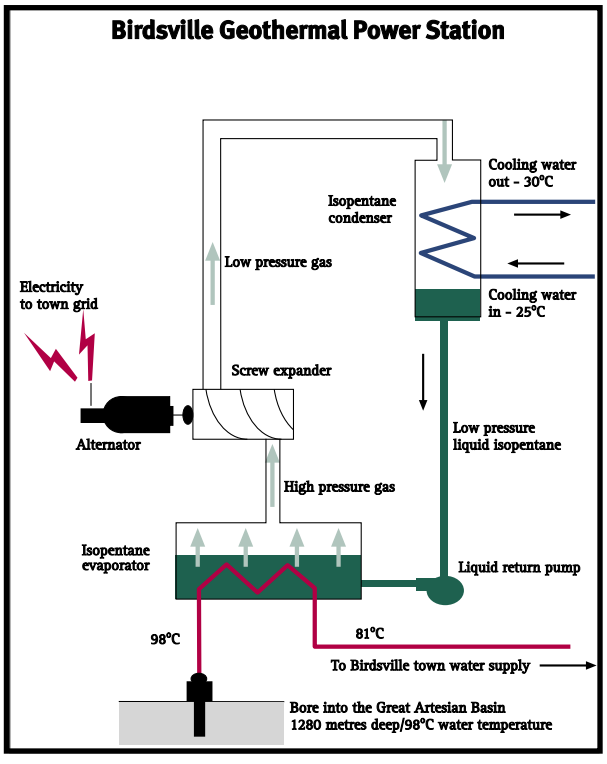
After an initial trial and "debugging" period to prove its reliability and performance, the geothermal power station was integrated with the town's diesel-powered generator station (located two km away) through a radio telemetry link. An automatic control system shuts down the diesel generators whenever the geothermal power station is able to take on the electrical load. This significantly reduces maintenance costs for diesel generators, which are subject to damage if operated for long periods at low load.

The relatively low temperature (less than 100°C) of water from the Great Artesian Basin limits the efficiency with which it can be converted into electricity. While the Birdsville geothermal power station only converts about six percent of the water's heat energy to electrical power output, this compares favourably with geothermal power stations in other countries using heat sources as hot as 250°C. The conversion efficiency in "real world" applications is always below the level that is theoretically possible (the "Carnot efficiency") due to the requirements to maintain stable operation with changing loads, the need to synchronise and operate in parallel with diesel generators, and by economic considerations.

Construction and upgrading of the Birdsville power station were undertaken by Enreco Pty Ltd, a company with 20 years experience using low-temperature heat engines to provide renewable power in remote outback areas. In the 1980s, the company installed low-temperature heat engines for a solar pond at Alice Springs and a small geothermal power plant at Mulka Station on the Birdsville Track. Since the Birdsville geothermal power station was upgraded and commissioned by Enreco, Ergon Energy has taken responsibility for its operation and integration with the diesel-powered generating station.

For remote communities with access to hot artesian water, geothermal power may be the most economical and reliable source of electrical power. Actual costs depend upon the capacity, water temperature, availability of existing artesian bores and other site-specific conditions. The low-temperature heat engines have an indicative capital cost of $4000/kW, but associated costs of bores and civil works for a power station can raise this to $6000 - $7000/kW. A major advantage of geothermal power stations over solar, wind or other renewable sources is that power output can be maintained continuously over an extended period of time, providing maximum energy production and fuel savings for each kilowatt of generating capacity.

Ergon Energy plan to operate the Birdsville Geothermal Power Station through 2008, and then replace the system with more efficient technology to recover a greater share of the geothermal energy.



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Printed on recycled paper.
BP1627.1 November 2005