John Smith, AAD

EXTREME POWER

After a ten-year planning phase, specially adapted wind turbines are now exceeding expectations at Mawson Station in Antarctica, showing the way ahead for wind power engineering in the most severe conditions.

One of two new 300 kW Enercon E30 turbines captures the freezing gusts of a spectacular July sunrise at Mawson.

WIND IS A RESOURCE Antarctica has in wild abundance. Driven by gravity as air cools above the Pole, its 300 km/h katabatic winds are infamous. Taking on the ultimate challenges such an unforgiving landscape throws down, scientists and engineers from the Australian Antarctic Division (AAD) have harnessed this resource to supply up to 80% of the energy needs of Mawson Station. Australia is the first nation to successfully attempt a large-scale wind power project in Antarctica to reduce the effects of diesel use.

Last summer, two 300 kW Enercon E30 wind turbines were installed at the station, and a third may be installed in the 2004–05 summer. In combination with diesel generators running at one-third capacity, the turbines are currently supplying 65% of the station's needs.

As glitches are ironed out of the system, it is expected that the need for diesel will continue to decrease.

'We can't run the whole station off wind power yet, as variations in wind gusts and turbine speed alter the consistency of the power supply,' says AAD engineer and Project Manager, Peter Magill.

'We need the diesel generators to stabilise the grid. But as technology improves, we may eventually replace them with hydrogen powered fuel cells.'

The AAD is planning for its bases to be powered totally by renewable sources. Hydrogen is already generated at the bases for weather balloon flights, and wind-hydrogen systems are the next test.

Reduced environmental effects

The $6.4 million wind farm project significantly reduces the environmental impacts of fossil fuels. Top of the list is the risk of spills during the annual transport of 700 000 litres of diesel from Australia to Mawson. Magill says diesel supplies will now only need to be topped up every 4–5 years. Greenhouse gas emissions – currently around 1800 tonnes of CO_2 – will also fall by about 600 tonnes. And economic savings are expected.

'The project should pay for itself in 10 years through savings in fuel, shipping costs, the ability to automate more processes which will reduce the number of staff needed, and other efficiencies,' Magill says.

Adapting technology

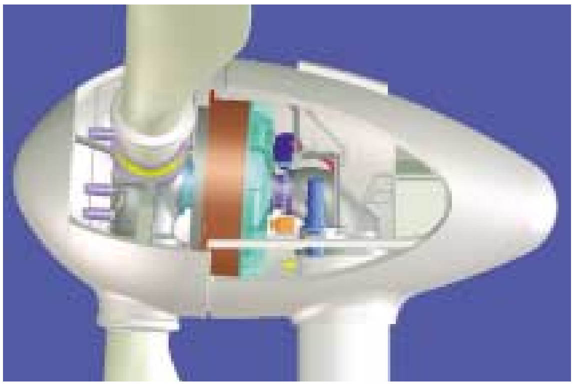
The installation of wind turbines in Antarctica has been about 10 years in the planning. A field trial at Casey Station, using a small 10 kW turbine gave engineers insights into the challenges and problems associated with the technology, in particular, temperature, wind speed and bird strike. These insights were used to modify the E30 turbine produced by German company, Enercon.

'Enercon were one of the few companies who made low maintenance turbines in the size we wanted,' Magill says.

'We had to present our data to the company and convince them to sell us their turbines. Fortunately, they were prepared to modify their design for our extreme wind and temperature regimes.'

Most turbines, for example, are built to withstand occasional wind speeds of 12 m/sec, and wind farms in Australia generally operate at wind speeds of about 5–9 m/sec. At Mawson, however, the new turbines have to cope with average monthly wind speeds of 19 m/sec. As the winds are so powerful, the Mawson turbines need not be mounted as high as those in other countries (usually 50 m) in order to catch the breeze. The shorter, 34 m towers, along with 64 ground anchors, re-engineered hold-down bolts, and 80 m^3 concrete foundations, ensure a more stable structure.

To cope with accelerated metal fatigue due to severe cold in Antarctica, the tower and turbine components were made of low temperature steel. Working parts in the 'nacelle' (behind the blades) were also insulated to retain some of the mechanically generated heat.



AAD

A cutaway of the re-engineered nacelle of the Enercon E30 turbine being used at Mawson showing its 'ring' generator, blade attachment and yaw mechanism.

Magill says the issue of bird strike was addressed by using a free-standing rather than a guyed tower. Experience and log book records at Casey and other stations showed that birds ran into guy wires on radio towers rather than the turbine towers or blades.

The final and most vital element in the efficient operation of the Mawson wind farm is the powerhouse control system designed by Powercorp Pty Ltd, of Darwin. This control system integrates wind and diesel power into the grid, and regulates energy output.

Preventing shut-downs

Magill says the turbines' performance have exceeded expectations. The biggest issue has been with software designed for European conditions.

Peter Magill, AAD

A heavy lift crane needed to be shipped to Mawson to install the turbines during the milder summer months.

'We had a few problems with the turbines shutting down and causing blackouts because the software was set to shut the turbines down if temperatures below 2°C and wind speeds above 25 m/sec, were detected, ' Magill says.

'In Europe these conditions would lead to ice forming on the blades. But we don't have an ice problem here as the atmosphere is very dry and the temperature very low. So Enercon have been ramping down the sensitivity of the software to accommodate our conditions.'

Once all the 'bugs' are ironed out of the Mawson installation, Magill says plans for wind farms at Casey and Davis will begin. As with Mawson Station, a model will be used to determine the best location for any turbines, the expected energy yield, and the environmental and economic benefits.

Wendy Pyper

MORE INFORMATION: www.aad.gov.au

Peter Magill, AAD

An engineer inside the self-contained nacelle looking towards the rear. The control equipment for the operation and maintenance of the turbine is in the background.