Australian Government

Department of the Environment and Water Resources
Australian Greenhouse Office

PUBLIC DISSEMINATION REPORT

GREENHOUSE GAS ABATEMENT PROGRAMME

Upgrade of Low Pressure Turbines at Liddell Power Station Project Macquarie Generation

Macquarie Generation

The Competitive Force in Energy

Report to the
Australian Greenhouse Office,
Department of the Environment and Water Resources
July 2007

PUBLIC DISSEMINATION REPORT

Project Name:

- Upgrade of Low Pressure Turbines at Liddell Power Station

Grant Recipient:

- Macquarie Generation

Project Associates:

- Nil

Location:

- Liddell Power Station, New England Highway, Muswellbrook

Contact:

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Background to Project:

In September 2000, Macquarie Generation applied for Commonwealth funding under the Greenhouse Gas Abatement Programme (GGAP) to upgrade the Low Pressure Turbines at Liddell Power Station. The GGAP grant for the project was approved on 1 May 2001.

The total cost of the project was $53,252,413.36 with up to $5,000,000 provided by the Commonwealth Government under the GGAP.

Liddell Power Station is situated near Muswellbrook, in the Upper Hunter Valley of New South Wales. The Power Station was commissioned progressively from 1971 to 1973.

Coal is fired in the boilers to produce steam. The steam is used to drive turbines which in turn drive the electrical generators. The steam turbine consists of three sequential stages: High Pressure (HP), Intermediate Pressure (IP) and Low Pressure (LP).

Technology advances in steam turbine design and manufacture since the 1960s have resulted in improvements in turbine efficiency. The efficiency improvements achieve greater energy extraction from the steam flowing through the turbine, allowing higher levels of electric energy production from a given rate of fuel consumption.

Project Description:

The four 500MW generating units at Liddell Power Station were first placed in service in the early 1970s. The steam turbines of these units were designed with 1960s technology. Advances in steam turbine design since the 1960s have resulted in more modern LP Turbines with higher operating efficiencies.

Macquarie Generation commissioned Hitachi Australia Ltd (Hitachi) to design, manufacture and install new LP Turbines on each of the four generating units at Liddell Power Station. The new turbines were designed to achieve a minimum efficiency improvement of 3% compared to the design of the original turbines.

The upgrade was successfully completed in July 2005, with an average efficiency improvement of 3.32% across the four units.

Technology Description:

The efficiency increase of the upgraded LP Turbines is achieved through improved control of the flow of steam through the turbine. Advances in computer modelling techniques allow for more detailed assessment of the impact of various steam path design options. This helps to achieve closer to optimum operating conditions than was possible when the Liddell turbines were originally designed.

Specifically, the detailed design of the shapes of the rotating turbine blades and stationary diaphragms allows for better use of the steam through:

- reducing steam leakages between stages of blades (leakages result in loss of steam energy without contributing to energy output);

- more evenly distributed steam flow so that all blade areas are optimally loaded; and

- more streamlined steam flow between stages of blades to reduce pressure losses due to turbulence.

The Hitachi design of the upgraded turbines achieves this improved steam flow control through the use of a number of proprietary blade shape design features, including:

- continuous cover blades,
- high twist rotor blades, and
- leaning diaphragms.

What did the Project Achieve?

The replacement of the LP Turbines at Liddell Power Station has the following beneficial outcomes:

- Greenhouse gas abatement

Total abatement of 1.66 million tones of carbon dioxide equivalent is expected in the Kyoto commitment period 2008 to 2012

- Other achievements:

    - increased the output capacity of Liddell by over 60MW with no increase in CO_2 emissions;

    - reduced sulphur dioxide and nitrous oxide emissions from burning less coal; and

    - potential catalyst for investment in similar large scale abatement projects by other coal fired generators.

Key Facts:

Key Fact	**Response**
Total emissions without project (2010)	11.107 Mt CO_2 -e
Total emissions to date without project 2003, 2004, 2005	2003: 8.161 Mt CO_2 -e 2004: 9.536 Mt CO_2 -e 2005: 10.095 Mt CO_2 -e Total: 27.792 Mt CO_2 -e
Actual abatement to date including 2003, 2004, 2005	2003: 0.046 Mt CO_2 -e 2004: 0.145Mt CO_2 -e 2005: 0.274 Mt CO_2 -e Total: 0.465 Mt CO_2 -e
Abatement estimate for 2010	0.336 Mt CO_2 -e
Abatement estimate for 2020	0.33 Mt CO_2 -e
5 year abatement estimate - 2008-2012	1.66 Mt CO_2 -e
Estimate of post Kyoto abatement - 2013-2017	1.66 Mt CO_2 -e
Total Cost of project	$53,252,413.36
Total GGAP Funding Received at end of Project	$5,000,000
Grant Recipient Funding	$48,252,413.36

Assumptions used in calculating actual abatement:

- Actual abatement based on actual electricity generated and heat rate improvement determined from pre and post-upgrade performance testing.