King Island

“Towards a sustainable, renewable energy future”

Hydro Tasmania

Hydro Tasmania

the renewable energy business

Hydro Tasmania

Hydro Tasmania is Australia's leading renewable energy business. Our vision is to be Tasmania's world-renowned renewable energy business. Hydro Tasmania is a Government Business Enterprise, owned by the State of Tasmania.

King Island

King Island is one of several inhabited islands located in Bass Strait, between the north coast of Tasmania and the south coast of Victoria on mainland Australia. It has a population of around 1700 people, and is notable for its beef and dairy industries, as well as kelp farming and tourism industries. Being a remote island community, King Island does not rely on either mainland Tasmania or mainland Australia for its electricity supply. Until recently, electricity generated on the island was generated entirely from diesel fuel; however wind power now contributes to a significant portion of the island's annual energy demand. Wind power is recognised as being cost effective and is an important electricity source on King Island due to the excellent wind resource present in Bass Strait.

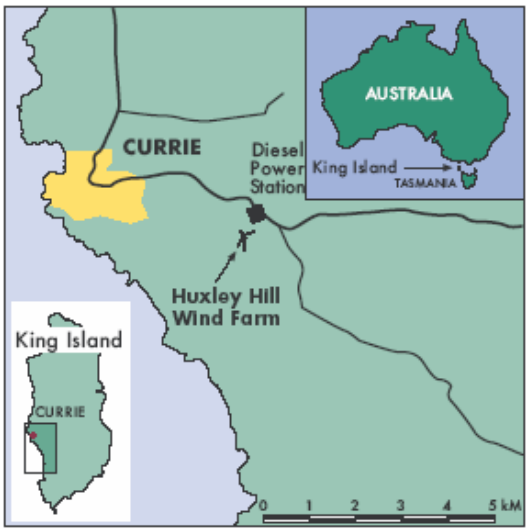
Hydro Tasmania is responsible for the generation, distribution and retail of electricity on the Bass Strait Islands. Currently the cost to supply electricity on these islands is much greater than the revenue derived from selling the electricity to customers.

To bridge the gap between the cost of production of energy and the revenue collected Hydro Tasmania has implemented over the last ten years a number of improvements to the King Island power system. This staged approach has allowed a progressive reduction in diesel fuel usage (and associated cost), utilising available technologies at the time.

Hydro Tasmania is currently planning a number of future developments to further reduce the dependency on diesel fuel for the continued generation of power on both King and Flinders Islands.

Current System

The load on King Island is characterised by a typical residential load profile, with daily peak demands occurring in the morning and the evening. Due to the moderate climate on the island, there is little or no air-conditioning load, with annual peak loads experienced during the cooler winter months. Due to the presence of industrial loads such as the dairy and abattoir, greater loads are experienced during the week, with lower demand on weekends.



The power station located at Currie on the west coast of the island currently comprises of the following:

- Three 1600 kilowatt (kW) diesel generators
- One 1200 kW diesel generator
- Three Nordex N29 Wind Turbine Generators (WTGs), rated at 250 kW each
- Two Vestas V52 WTGs, rated at 850 kW each
- 800 kWh Vanadium Redox Battery (VRB) storage rated at 200 kW

- Supervisory control sequencer
- 1500 kW Resistor for frequency control
- 100 kW of solar.

The Currie power station is the primary source of electricity on the island (some industry and medical facilities have backup power generators), and distributes power over 400 km of distribution network through four 11 kilovolt (kV) feeders.

Development

Diesel Installation 1985

Currie Power Station was originally constructed to accommodate 4 x 1200 kW diesel generator sets with provisions for adding a fifth machine if needed in the future. The initial installation comprised 2 x 1200 kW sets and 1 x 800 kW set giving a firm capacity of 2000 kW.

Station capacity has since been increased by adding a fourth set (1200 kW) and has been further upgraded with replacement of three 1200 kW sets to 1600 kW machines, giving the station an installed capacity of 6000 kW: a firm capacity of 4400 kW.

The generating sets are arranged for automatic operation and can operate for periods of time without supervision. Essential maintenance and daytime supervised operation of the station is carried out under contract by skilled operators from Aurora Energy.

Output from all the sets are fed into the distribution system via 11 kV metal-enclosed switchgear (one machine requires a step-up transformer) and power cables to the overhead feeder lines.

Huxley Hill Wind Farm 1998

In 1998 Hydro Tasmania commissioned three Nordex N29 WTGs at Huxley Hill near the Currie power station to establish Australia's second commercial wind farm. The three turbines were rated at 250 kW each, providing a total renewable energy capacity of 750 kW. The Huxley Hill wind farm provided a substantial reduction in annual diesel fuel use, and significantly reduced the cost of supplying electricity to the island.

Operation of the Nordex machines has resulted in a significant reduction in the level of diesel fuel use, and associated savings in operational expenditure. Penetration of renewable energy into the system reached an annual average of 13% in the years following commission. This resulted in a 16% reduction in annual diesel fuel use or approximately 590 kilolitre reduction in diesel use per annum.

The Huxley Hill wind farm was Hydro Tasmania's first experience in the process of gaining development approval, construction, commissioning and operation of a wind farm, which has paved the way for subsequent wind developments.

King Island Renewable Energy Expansion (KIREX) 2000

In 2000 Hydro Tasmania developed a proposal to enhance the existing Huxley Hill wind farm to increase the penetration of wind power, with the aim of further reducing cost of electricity supply through savings in diesel fuel use. The project was known as the King Island Renewable Energy Expansion (KIREX) project. This project has further reduced diesel use in addition to the original Huxley Hill project since its implementation in 2003.

KIREX supplemented the existing Huxley Hill wind farm with two additional WTGs, specifically Vestas V52s capable of producing a maximum of 850 kW of power each, increasing the total rated capacity of the wind farm to 2.45 MW. Operational experience with these turbines has been excellent, with effective regulation of power output facilitated through the Vestas Online (VoL) control system providing stable wind power output even in challenging wind conditions. In order to increase the level of renewable energy contribution to the load, a Vanadium Redox Battery (VRB) energy storage system was also installed. The objective of the storage system was to increase the recoverable portion of renewable energy and to smooth the variable output of the wind farm to enhance the use of wind power to displace diesel generation. Finally, a substantial upgrade to the existing control system was needed in order to optimise the operation of system components to deliver power with adequate system security at the least cost.

VRB Installation

Following a recent operational event, the VRB is currently out of service. Hydro Tasmania is currently evaluating the role and function of the battery with an aim to update the design and control system to improve availability, efficiency, and the effectiveness of the VRB to reduce diesel use.

Resistive Frequency Control 2008

Hydro Tasmania has recently completed construction and is currently commissioning a substantial upgrade to the power station control system. The new control system employs a large resistive load which can be varied rapidly in order to absorb excess wind generation rather than spill it through shutting down or throttling back wind turbines. Instead of reducing output, the wind turbines are allowed to produce as much power as possible, with the excess generation to be absorbed by the resistor. As the resistor can be adjusted rapidly, this will effectively convert spilled wind into spinning reserve that can be used to supplement diesel generation. Maintaining the power balance between generation and demand in this way will allow the resistor to maintain system frequency.

Shifting system reserve requirements away from the diesels enables the control system to reduce diesel output to minimum levels, reducing fuel use. Whilst this can occur only during periods of wind spill, a further increase in renewable energy generation will increase the amount of time that the system experiences spill, and thus increase the time that diesels can be run at minimum loading. This will in turn reduce the amount of overall energy contribution from the diesel generators.

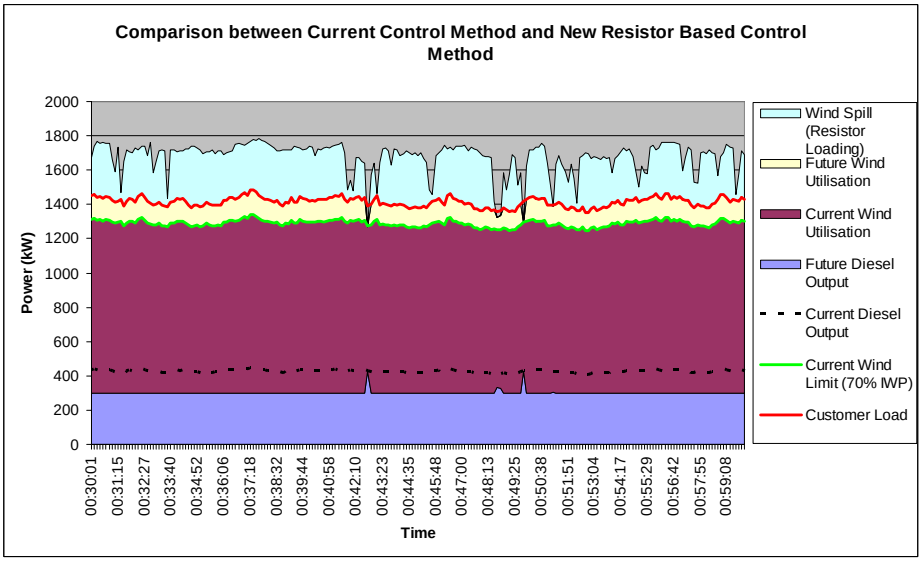


Figure 1: ***Comparison between current control method and new resistor control method***

Figure 1 shows a simulation of the effect of the new control method on diesel output and wind utilisation over a half hour time period. Note that under the new control method the diesel output remains at minimum output of 300 kW for the majority of the time, saving an average of around 120 kW. Over a year this equates to a substantial amount of diesel fuel saved. The wind spill component of the chart is treated as system reserve.

The resistor frequency control will enable the running diesel generators to remain on minimum loading whenever the island's load is less than the combined solar and wind output. Modelling of the King Island energy demand compared with historic wind data and expected solar output indicates that this will occur for about half of the year – resulting in significant diesel fuel and thus GHG emission savings.

Solar Installation 2008

In 2008, six dual axis tracking solar photovoltaic systems were installed on King Island by KI Solar Pty Ltd (a subsidiary of CBD Energy Ltd), adding approximately 100kW of renewable energy generation to the power station. The use of solar power on King Island has several benefits:

- to diversify the incoming renewable energy load such that power can potentially be generated from one power source (such as solar) when the other (wind) may not be generating and vice versa; and
- to demonstrate how a variety of renewable energy technologies may operate in such an integrated system.

Two of the SOLON Movers rated up to 16 kW each

The solar array is expected to deliver around 200 MWh a year to the Currie power station, resulting in CO_2 savings of around 180 tonnes per annum.

Diesel/Greenhouse Gas Savings

Each renewable energy and power station upgrade project has reduced the level of diesel fuel consumption needed to supply the power requirements for King Island. The following chart (Figure 2) shows a timeline of project implementation and the associated diesel and green house gas emission (**GHG**) savings associated with the operation of the new renewable energy projects.

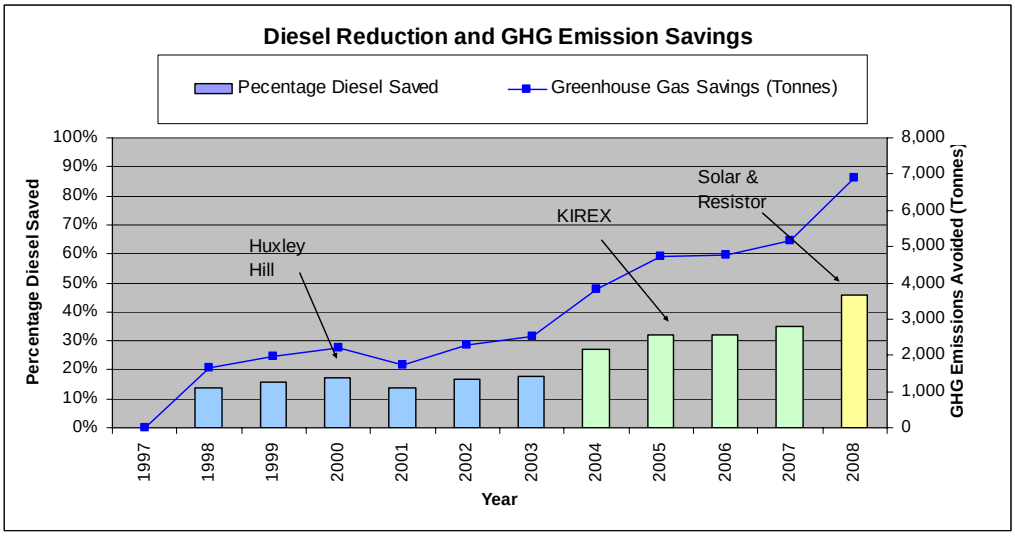


Figure 2: ***Diesel reduction and GHG emissions savings***

As a result of current projects plus all the projects implemented thus far, diesel fuel use will be reduced by nearly 50%, resulting in annual GHG savings of just less than 7,000 tonnes, equivalent to the annual emissions of about 1600 cars.

Future Opportunities

Carbon Block Energy Storage

A carbon block/steam turbine energy storage system has been proposed by Remote Area Power Systems Pty Ltd (which is a subsidiary of CBD Energy Limited) (**RAPS**) for possible implementation in 2009 – subject to satisfying a number of conditions, including successful commissioning of the resistive frequency control and performance testing of the trial carbon block.

- The function of the energy storage block system being developed by RAPS is to store large amounts of thermal energy for later use. The energy storage block is expected to take advantage of a patented process in which graphite is heated to high temperatures, with the heat extracted at a later time using embedded heat exchangers.

If the project proceeds, it is expected that:

- the proposed installation on King Island would comprise of 6 modules and would be used to provide power to drive a 250 kW steam turbine generator
- any energy produced would be used to reduce diesel consumption at times when there is insufficient wind or solar generation directly available
- all energy stored in the carbon would come only from wind and solar resource at times when wind would otherwise be spilled
- as such, all energy generated from the steam turbine would come from renewable resources.

Windfarm Expansion

Further wind development is planned for King Island. Development approval has been obtained with the King Island Council approving the construction of up to 4MW of additional wind turbines.

The future wind power development on King Island is now planned to consist of more modest wind turbines, around the same size as the turbines installed during KIREX. It is expected that they will provide 1.5 to 2.5 MW of additional wind power. This additional wind capacity combined with the resistor/Carbon Block could be expected to raise wind contribution to annual load from the predicted 45% up to around 60% of the yearly energy demand.

This development will only proceed once a number of conditions are satisfied including the resistive frequency control being proven. Timing for this wind expansion project is intended to be mid 2010.

Alternative Fuels

Hydro Tasmania is currently investigating the possible replacement of mineral diesel fuel for use in the diesel generators with alternative fuels such as biodiesel. There is the potential for biodiesel to be produced on King Island using tallow from the local abattoir, reducing the need to rely on imported diesel for power production. Biodiesel, being derived from biomass is almost GHG neutral, and has the potential to significantly reduce the net GHG emissions from use of diesel generators. LNG as a fuel also has the potential to reduce greenhouse gas emissions.

Ocean Power

Hydro Tasmania has been approached by a number of proponents for ocean power technologies for deployment in Bass Strait. Hydro Tasmania has had preliminary discussions with BioPower Systems Pty Ltd, who propose a pilot scale trial of wave power technology on King Island. The company has also proposed a pilot tidal power system for Flinders Island. BioPower Systems has recently received an AusIndustry Renewable Energy Development Initiative (REDI) grant of $5.0 million in support of both projects.

King Island: Low Emission Future

Hydro Tasmania is committed to creating a sustainable future. As part of our vision to be Tasmania's world renowned renewable energy business we are committed to becoming Australia's first greenhouse neutral power generation business. To achieve this ambitious goal, Hydro Tasmania has a plan in place to implement a number of GHG saving initiatives, including further developments on King Island as well as the establishment of a wind farm on Flinders Island. Hydro Tasmania's vision for King Island is to develop a world class renewable energy system fitting with King Island's green image.

Technology Summary

Wind

- 2 Vestas V52 wind turbines
  - 850 kW output
  - 60 metres tall
  - Rated wind speed of about 50 km/hour
  - 52 metre rotor diameter
- 3 Nordex N29 wind turbines

- 250 kW output
- 29 metres tall
- Rated wind speed of about 50 km/hour
- 29.7 metre rotor diameter

VRB

- 68,000 litres of electrolyte contained in four plastic tanks
- Six Sumitomo cell stacks
- Energy storage of 200 kW for four hours
- Peak short-term output of 400 kW

Solar

- Six SOLON Movers manufactured by SOLON AG, total rated power of approximately 100 kW
- Each Mover is designed to be capable of producing up to 16 kW in full sun conditions
- Precise 2-axis tracking of the sun to maximise power production
- Designed to withstand strong winds by stowing away into 'locked' position

Resistor Frequency Control System

- Three 500 kW fan cooled resistors
- Resistor output controlled through six Phase Angle Controllers
- Precise frequency control through PID controller
- Works in conjunction with the power station control system to maximise use of available renewable energy

Control System

- Allen Bradley Programmable Logic Controller based system
- Custom programming to control wind turbines, diesel generators, energy storage and resistor systems
- Maximises use of available renewable energy