CHAPTER 4

Project Justification

4. PROJECT JUSTIFICATION

There has been growing global recognition of the need to mitigate the environmental effects associated with fossil fuel energy generation. Such thoughts have manifested into international, national and state wide commitments supporting the development of clean and sustainable energy projects. The Boco Rock Wind Farm will play an important role in contributing to both the increasing local and global need for such renewable projects in tackling the issues of Global Warming and Climate Change.

4.1 Greenhouse Gas Emissions and Climate Change Science

There are naturally occurring greenhouse gases, including water vapour, carbon dioxide, nitrous oxide, methane and ozone in the atmosphere, which reflect and absorb heat from the Earth's surface. These natural greenhouse gases, in particular carbon dioxide, nitrous oxide and methane, in addition to human introduced gases such as halocarbons, chlorine- and bromine- containing substances and sulfur hexafluoride, are increasing in concentration and causing a rise in the normal levels of absorption, leading to the threat of elevated global temperatures.

Studies have found that the current rate of carbon dioxide emissions is greater than the natural rate of removal of carbon dioxide from the atmosphere (United Nation's Intergovernmental Panel on Climate Change (IPCC) 2007, pg 38). As a consequence of this increased concentration of carbon dioxide equivalent, it is predicted that the Earth will warm between 2 and 4.5 °C (IPCC 2007, pg 38). According to the David Suzuki Foundation, increased global temperatures will see changes in extreme weather patterns, shortage of water supplies, imperilled ecosystems, increase in risks on human health and potential for economic risks (David Suzuki Foundation, 2009).

The energy supply, transport and industry sectors are the primary drivers behind the rate of carbon dioxide equivalent emissions, which have increased by approximately 80 % from 1970 to 2004 (IPCC 2007, pg36). Central to this is a heavy reliance on coal for low-cost electricity production, which is also recognised as having the highest output of carbon dioxide equivalent emissions (Garnaut 2008).

The consensus of scientific opinion as presented to world governments by the IPCC is that there is a link between mankind's actions and a variety of climate-related issues. Industrialisation and the resultant emissions of greenhouse gases from the burning of fossil fuels, has created and continues to exacerbate a global environmental problem – Climate Change.

4.2 Global Response

The IPCC established by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) was set up in 1988 to provide a comprehensive forum in the fundamental understanding of linkages between greenhouse gas emissions and climate change.

The international consensus was summarised in the Geneva Ministerial Declaration, July 1996. This Conference of the Parties (COP2), addressing the United Nations Framework Convention on Climate Change (UNFCCC), concluded that there was a need for action from all tiers of government to avert the deleterious effects of climate change. This resulted in most participating countries to encourage renewable energy generation projects through sustainable development initiatives, in addition to complementary actions to develop energy conservation and efficiency measures.

In 1997, the Kyoto Protocol was established, which called for industrialised countries to reduce their collective emissions of greenhouse gases by 5.2 % below 1990 levels by 2008-2012. The year 2004 saw the Kyoto Protocol made legally binding in the European Union (EU) and ratified by the Russian government. This allowed for the Kyoto Protocol to establish the first binding international commitments to limit greenhouse gas emissions and an international emissions trading system to promote cost-effective reductions in 2005.

In 2008, the Australian government ratified the Kyoto Protocol and signed up to cut greenhouse gas emissions to 108 % of the levels they were is 1990. This was a watershed decision and an important step in determining Australia's position on climate change in the international arena.

4.3 Australian Greenhouse Gas Emissions and Response

Australia is the sixth highest emitter of greenhouse gas emissions in the world at 28.1 tonnes of carbon dioxide equivalent per person (Department of Climate Change (DCC) 2008). On a sectoral basis (energy supply, transport and industry) the greatest percentage of greenhouse gas emissions are attributed to energy supply at 49.9 % (Department of Environment and Climate Change (DECC) 2006). Collectively, New South Wales (NSW), Queensland and Victoria account for over 75 % of energy supply greenhouse gas emissions throughout Australia (DECC 2006).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) published *Climate Change in Australia* (2007) based on the IPCC report *The Regional Impacts of Climate Change: An Assessment of Vulnerability* (2001). The following was concurred:

- Annual temperature increases of approximately 1.0 °C by 2030, with warming as large as 1.8 °C for some inland regions;
- Annual warming ranging from around 1.0 to 2.5 °C for the lowest assumed emission scenario, and 2.2 to 5.0 °C for the highest assumed emission scenario by 2070;
- Decreases in precipitation of 2 to 5 % in most regions, with decreases reaching 10 % in south-west regions. Later in the century the projected precipitation changes are larger and more variable, with the range of annual precipitation change being -30 to +20 % in central, eastern and northern areas in 2070;
- Global seal level rise is projected to be 18 to 59 cm by 2100, with possible addition from ice sheets of 10 to 20 cm; and
- Storm surges occurring in conditions of higher mean sea levels will enable inundation and damaging waves to penetrate further inland increasing flooding, erosion and the subsequent impacts on built infrastructure and natural ecosystems.

In 2007 the IPCC released their fourth assessment report, but again there was not sufficient information to determine the effects on Australia, so CSIRO and BoM created an update to accompany *Climate Change in Australia* and concluded:

- Concentrations of greenhouse gases are on the rise, with an unexpected increase in methane;

- Carbon sinks remove considerable amounts of anthropogenic carbon dioxide, but they are becoming less efficient;
- Sea levels are rising, with current projections of up to 80 cm by the end of the century;
- Southern Ocean acidity has increased, while salinity has decreased; and
- Rainfall in southern Australia has declined over a 30 year period, caused by changes in climate systems over the region (CSIRO and BoM 2009).

To combat these recorded and potential impacts, the Australian government and other agencies and participants in the climate change and energy sectors have come up with a number of responses in the form of Acts and policies, funds, programs and schemes.

Department of Environment and Climate Change: In 1997, the Federal Government created the Australian Greenhouse Office (AGO) to provide a whole government approach to greenhouse issues. In March 2000, the AGO became an Executive Agency of Government and as a result the DECC was established in December 2007. In 2007, Australia ratified the 1997 Kyoto Protocol, which made a commitment to limit greenhouse gas emissions growth. The DECC also developed a strategy to further reduce national emissions through the Carbon Pollution Reduction Scheme (an emissions trading scheme), expected to come into effect 1st July 2011. Once implemented, this scheme will commit to participating industries to reduce greenhouse gas emissions by 25 % on 2000 levels by 2020.

Renewable Energy Target: The Renewable Energy Target (RET) legislation was passed through Federal Parliament on 20 August 2009, providing an expansion on the Mandatory Renewable Energy Target (MRET), aiming to acquire 20 % of Australia's electricity from renewable sources by 2020. The RET will commence with a target of 45,000 GWh to be generated from renewable sources by 2020. After that, each year the target will remain at 45,000 GWh until 2030 when the RET will cease operation.

For retailers to meet the existing MRET and the incoming RET, each must obtain a target amount of electricity in megawatt hours (MWh) from renewable energy sources, or otherwise incur a financial penalty. Renewable energy is obtained with Renewable Energy Certificates (REC), which are created from accredited renewable energy generators. Once a REC is bought by a retailer, it is surrendered to the government regulator. From 2001 to 2007 the largest REC generating sources were from hydro, wind and solar water heaters (Office of the Renewable Energy Regulator 2008, page 14).

Council of Australian Governments: The Council of Australian Governments (COAG), October 2008, agreed to develop a National Strategy for Energy Efficiency, to accelerate energy efficiency efforts across all governments and to help households and businesses prepare for the introduction of the Commonwealth Government's Carbon Pollution Reduction Scheme (CPRS).

COAG in 2008 stressed the urgency to create a uniformed scheme on renewable targets to provide consistency for investors looking to support Australia's renewable energy industry in early 2009.

Funds: The Australian Government has committed to establishing a $100 million Clean Coal Fund, and providing an additional $60 million to the Renewable Energy Development Fund (bringing the total for that Fund to $100 million), to help reduce greenhouse gas emissions associated with the energy sector.

GreenPower: GreenPower, started in 1997 to accredit and audit renewable energy retail products, and now manages the program nationally. Over 720,000 electricity customers in Australia now purchase accredited renewable energy through the program.

4.4 Need for New Power Generation in New South Wales

According to the Australian Bureau of Statistics (ABS) between 2001 and 2006, NSW 's main source of energy consumption was from black coal (53 %) and petroleum (38 %), with black coal increasing by 9 % since 2001. Energy demands in NSW are also increasing, with a peak summer demand recorded at 12,954 MW in January 2008, followed by a peak winter demand recorded at 14,274 MW in July 2008 (Transgrid 2008). It is predicted that NSW will have the largest projected growth in peak demand out of all the states (Transgrid 2008).

Compared to other states, NSW has a relatively unexploited wind resource, a large electricity market and an available transmission capacity, which makes it suitable to accommodate wind power technology. Under the expanded MRET, investors are seeking to utilise this wind resource as the demand for REC's increases.

The State Plan launched in 2006, provides the vision for NSW for the next ten years and includes goals and the provision of direction for delivery of priorities and targets. The State Plan has set targets for increased penetration of renewable energy rising to 10 % in 2010 and to 15 % by 2020. In addition, a long term goal of a 60 % cut in greenhouse gas emissions by 2050 and a return to year 2000 greenhouse gas emission levels by 2025 were detailed.

4.5 Suitability of Wind Power

4.5.1 *Evolution of Wind Technology*

The ability to harness wind power has evolved from research in the 1980s, expansion and consolidation in the 1990s, to a competitive, mature, advanced mainstream energy supply technology in the current market. At the end of 2007, the total international capacity of wind energy was more than 94,000 MW, with approximately 67 % being installed in the last five years and a global growth rate of 30 % over the last ten years (**Figure 4. 1**, GWEC 2008). It is predicted that by 2020 wind power will be supplying 12 % of the global demand for electricity (Martinez *et al* 2009).

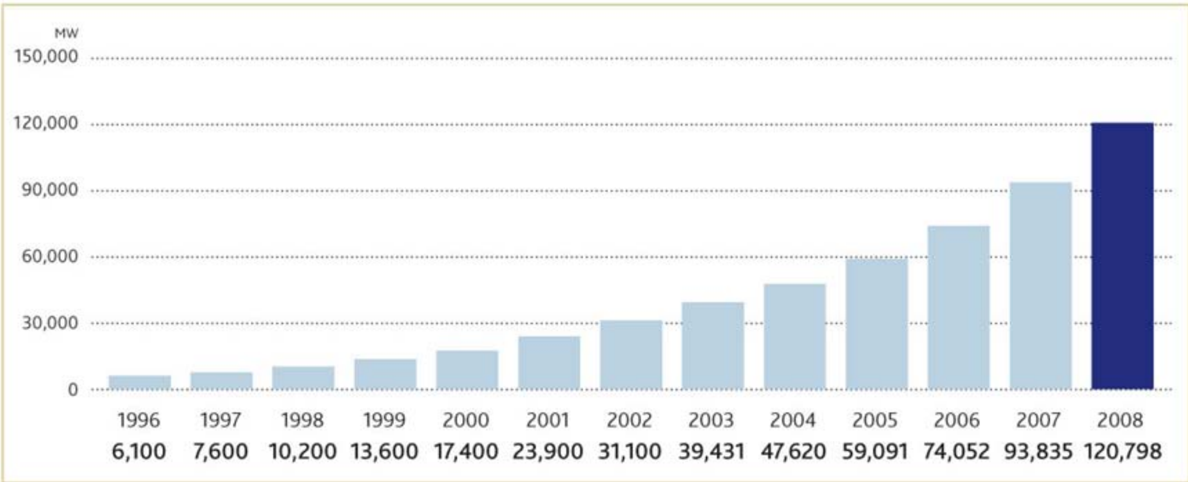


Figure 4.1 Global cumulative installed wind capacity 1996 – 2008

Source: Global Wind Energy Council (GWEC)

One of the advantages of wind technology is its high energy return on energy invested. As seen in **Figure 4.2**, wind technology both on and offshore has a high energy return on energy invested compared to existing conventional energy sources, such as coal, and other renewable technologies. Due to high energy return from wind energy, the requirement to harness the wind more effectively has helped to drive the evolution of wind technology.

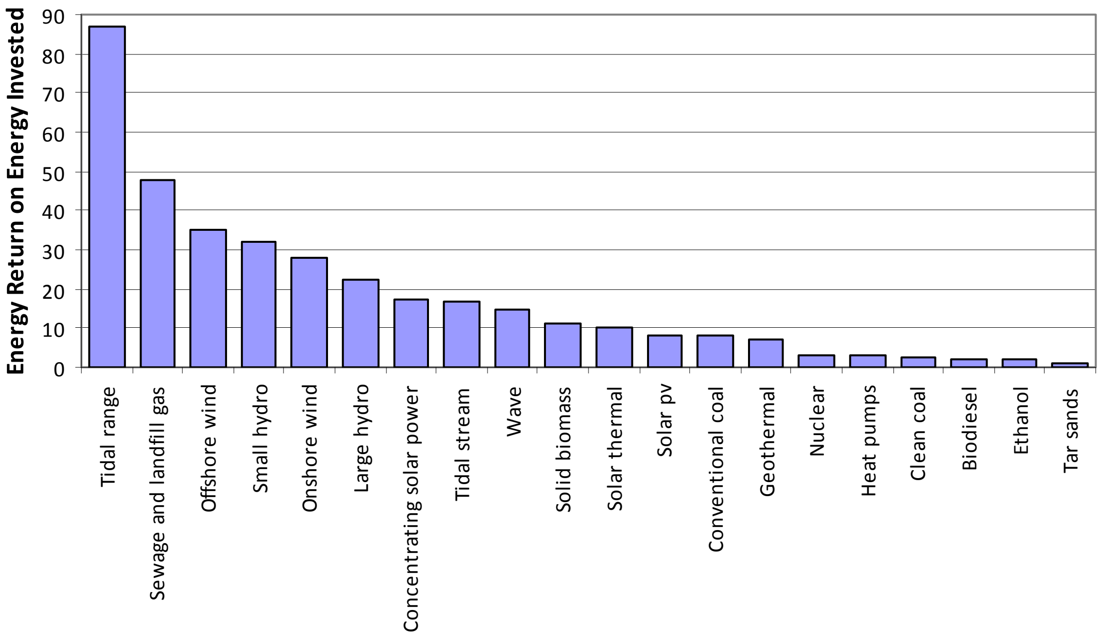


Figure 4.2 Energy return on energy invested

Source: Hughes and Anslow 2007

Wind energy is also well positioned to meet future targets and provide 12 % of the global demand for electricity by 2020, as it possesses one of the lowest production costs, uses no water during electricity production and is a mature technology acceptable to energy utilities in comparison to other renewable energy sources as seen in **Table 4.1**.

Table 4.1: Main stream renewable energy available in the MRET and RET

Generation Source	Technical Maturity	Water Use (L/MWh)	Cost ($/MWh)
Hydro	Mature	high	27-282
Wind	Mature	nil	75-90
Solid biomass	Research	2000 (wet)/ 700 (dry)	47-120
Solar thermal	Emerging	2000 (wet)/ 150 (dry)	120-150
Solar PV	Various	nil	400-800
Geothermal	Research	high	large range

Source: Garnaut Review, Owen Report, Gullen Range Submission Report

4.5.2 *Community Support*

National Telephone Survey: The Australian Wind Energy Association commissioned the Australian Research Group Pty Ltd (ARG) to conduct a telephone survey on renewable energy, in particular wind farms in August 2003. A total of 1,027 participants were surveyed with the following results:

- 94 % thought that a target to increase the contribution of clean energy from renewable resources was a good (32 %) or very good idea (62 %). Less than 3 % considered the current target to be too high or much too high;
- A substantial majority (76 %) said that they were prepared to pay 5 % more on electricity bills for 10 % more clean energy when faced with the option of having cheap electricity at any cost;
- 88 % said they wanted the government to increase support to the renewable energy sector, compared to 26 % wanting an increase in support for the fossil fuel sector;
- For 71 %, reducing greenhouse pollution outweighed protecting industries that rely on reserves of fossil fuel; and
- 95 % supported (27 %) or strongly supported (68 %) building wind farms to meet Australia's rapidly increasing demand for electricity and 91 % agreed it was more important to build wind farms for electricity than avoid building them in rural Australia.

The survey resulted in respondents supporting clean energy from renewable resources, even with a potential increase in price. It also highlighted that it is more important to reduce greenhouse pollution rather than support the fossil fuel sector, and instead place wind farms in rural areas.

NSW Southern Tablelands Survey: Wind farm developer Epuron Pty Ltd commissioned REARK Research to conduct a random phone survey on 300 residents in the Goulburn, Crookwell and Yass region to determine community perception on wind farm developments in the Southern Tablelands, July 2007. The survey resulted in:

- 80 % are concerned right now with the threat of global warming and its impact on the environment, while 16 % are unconcerned;
- 89 % are in favour of wind farm projects being developed in the Southern Tablelands, while 5 % were opposed;
- 71 % favour a wind farm within 1 km of their home and 87 % support a wind farm within 25km; and
- 9 in 10 have seen a wind turbine and more than 8 in 10 have seen the Crookwell Wind Farm.

This survey showed that respondents are concerned about global warming and have seen the alternatives, such as the wind farm at Crookwell. This has still resulted in the majority of respondents willing to have a wind farm within 1 km of their residence.

4.5.3 *"Taralga Wind Farm" Judgement*

The 2007 Land and Environment Court hearing of the Taralga Landscape Guardians Inc. v Minister for Planning and RES Southern Cross Pty Ltd, reviewed a number of key issues relating to wind farms in rural NSW. In particular, issues relating to visual impacts on the landscape from surrounding residencies and the village of Taralga were scrutinised.

The judgement made was that wind turbines were acceptable in the landscape at Taralga, and set out steps for determining how many wind turbines would be acceptable. Based on the economic viability, visual impact from the village and the broader public interest, it was decided that the original design of 69 wind turbines of the Taralga Wind Farm was acceptable. As for any residential visual and other associated impacts with the Taralga project, it was decided that any suggested mitigation measures need to be settled by RES Southern Cross Pty Ltd and the potentially affected residence.

In comparison, the Boco Rock Wind Farm will have less impact on Nimmitabel as the viewing shed is limited as discussed in **Chapter 8** Visual. However there have been concerns raised by individual properties on potential visual impacts as discussed in **Chapter 6** Stakeholder Consultation, and similar to the Taralga judgement, any mitigation measures will be between the Proponent and associated landowners.

4.5.4 *Interaction with the Electricity Network*

The NEM manages the supply and demand of the NSW market by ensuring power generation is available at each instant in time to meet the required consumption. The NEM is supported by baseload power stations, generally coal, to provide 100 % capacity at 100 % of the time. However, this is not always possible due to maintenance and failures of coal fired power stations which in NSW result in 28 days of planned maintenance per annum (Power System Planning and Development (PSPD) 2009), requiring the Australian Electricity Market Operator (AEMO) to source power from multiple energy generators to provide a secure baseload.

Wind energy, despite common misconceptions that wind farms are inefficient and unreliable, are in fact an efficient and reliable energy supplier in the NEM and can support baseload in the market. This is due to the fact that:

- Both wind farms and modern coal fired power stations are efficient in the order of 35 - 45 %;

- The NEM is strong enough to cope with output fluctuations of a wind farm;
- Wind turbines are reliable, with an availability of above 97 % which means that wind farms are able to operate for the majority of the year;
- Wind farms are in fact similar to hydro power and coal fired generators, which do no operate at 100 % capacity 100 % of the time;
- Wind is a free energy source and therefore mitigates risks to the existing electricity supply infrastructure from acts of terrorism and price risks from fossil fuels which are tied strongly to the international market; and
- Existing wind farms in NSW and Australia are providing evidence that wind energy production is clean, reliable and cost effective in meeting current market energy demands.

It is likely The Project will not result in the direct closure of any baseload or coal fired power stations, instead wind energy will become an increasing and important part of the energy mix as Australia transitions into a carbon constrained economy.

4.5.5 ***Finite Resource Market***

As previously mentioned in **Section 4.4**, the dominant fuel consumption in Australia is from fossil fuel combustion, through long term usage of oil, natural gas and coal. Post-2000 prices have reached record highs compared to coal in the 1970s and oil in the 1980s. Therefore, not only are these forms of energy emitting large concentrations of carbon dioxide, they are becoming more expensive. Such costs are expected to rise further with the emergence of the emissions trading scheme in Australia and a price on carbon. New, renewable energy technologies are required to extend the limited amount of oil and natural gas and help minimise the impact on mining in remote and sensitive areas. Wind technology, with significant market growths annually, increasing support from international communities and with decreasing component costs, is one such technology.

4.5.6 ***Life Cycle Assessment***

Wind turbines require energy to be spent during the manufacturing stage of its components and therefore a certain amount of carbon dioxide equivalents will be produced. In comparison to other forms of energy, such as coal and nuclear, onshore wind farms have relatively low carbon intensities, as seen in **Figure 4.3**.

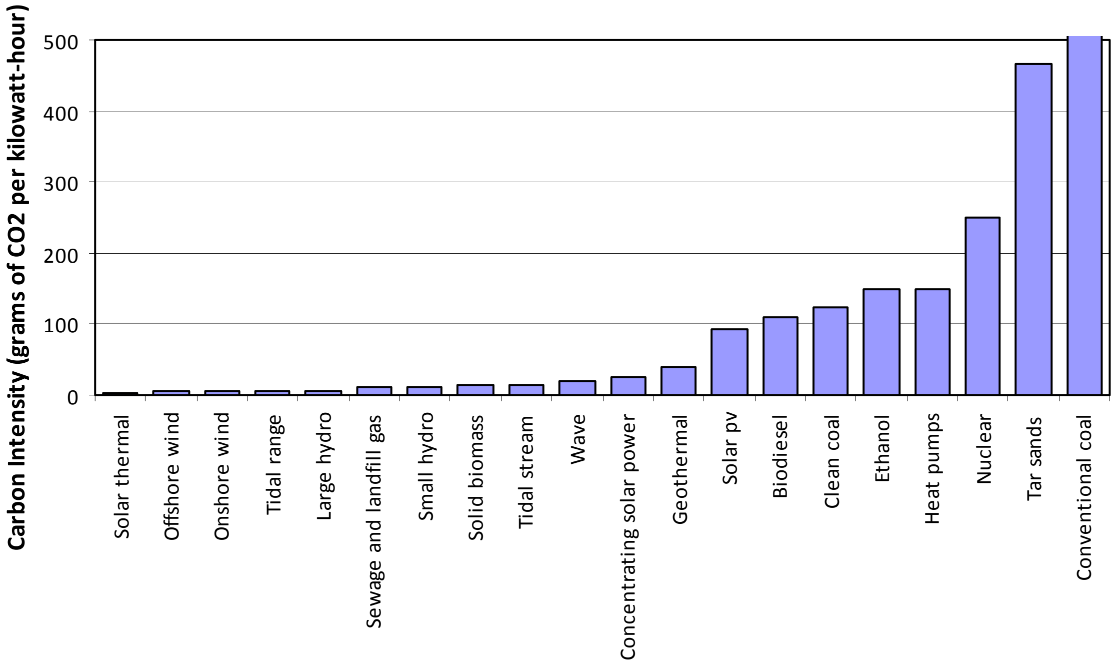
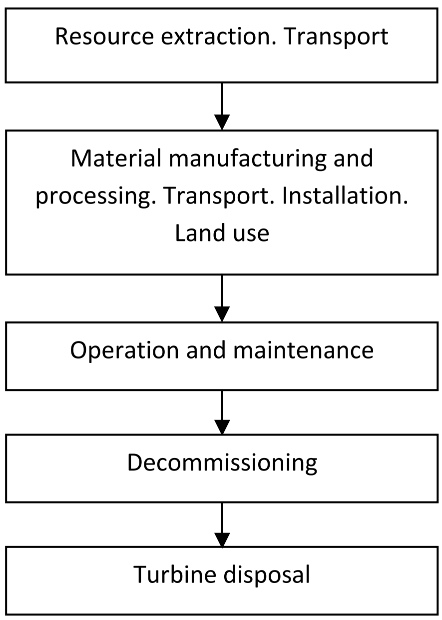


Figure 4.3 Carbon footprint

Source: Hughes and Anslow 2007

To further analyse the carbon footprint of a wind turbine a Life Cycle Assessment (LCA) can be undertaken which will identify areas in the manufacturing and construction of the wind turbine where carbon dioxide emissions can be reduced. The main steps of the LCA for a wind turbine are displayed in **Figure 4.4**.



Note: 10 % loss in material when recycling occurs at the turbine disposal stage

Figure 4.4 Life Cycle Assessment model of a wind turbine

Source: Adapted from Martinez et al 2009

In general the time for a wind turbine to repay the energy used in construction varies between five to eight months (Martinez *et al* 2009; Tremeac & Meunier 2009; Elsam 2004). The time it would take for a wind turbine to repay the amount of global greenhouse gases emitted is not as widely researched, however initial studies have found it would take approximately six months (Tremeac & Meunier 2009). Of the processes involved, manufacturing has the largest impact. However it is balanced by the decommissioning and turbine disposal stages which consist of mainly recycling with positive benefits for the environment (Martinez *et al* 2009; Tremeac & Meunier 2009).

4.6 Contribution of the Boco Rock Wind Farm

4.6.1 *Land Suitability*

The proposed wind farm is consistent with the Rural Lands State Environmental Planning Policy (SEPP) as it is a development which can occur in unison with the continuing use of the land for rural purposes.

Although the proposed development temporarily reduces the available land for agriculture during construction, the long term use of the land for agricultural purposes will not be compromised during operation of the Project. In addition, the potential diversity of income gained from land owners would assist in ensuring traditional rural communities can remain on the land and continue farming practices during times of drought or other hardship.

The Rural Land SEPP also restricts subdivision of rural land where conflicts occur. Currently the Bombala LEP identifies a minimum lot size of 40 ha (clause 19[1]), whilst Cooma-Monaro LEP identifies an average lot size of not less than 80 ha (clause 14[2A]). Bombala Council has advised that there are no pending development applications on neighbouring lots (personal communication G. Ingram 2009). Cooma-Monaro Council has advised there have been no approved subdivisions in the past five years (personal communication R. Dakin 2009).

Visual and noise impacts were assessed with respect to future dwelling entitlements in lots surrounding the proposed development site boundary in **Chapter 8** Landscape and Visual and **Chapter 9** Noise. Therefore as there are no pending developments and future impacts have been assessed in neighbouring lots, the Project is considered suitably placed in its current position.

The agricultural productivity of the rural land surrounding the Project is of high value and may be subject to minor impacts caused by the Project. Using the Rural Land Capability Mapping method, an eight class system formally used by the Department of Land and Water Conservation, the land can be classified in terms of its inherent physical characteristics or physical constraints, and determines measures needed to protect the proposed development site boundary and surrounds. 69 % of the Development Envelope is Class 6 or above, meaning that the land is not suitable for cultivation, but can be either well suited to pasture improvement or only careful pastoral use is possible. Based on the small area of rural land that would be impacted, wind energy generation and grazing will be able to co-exist, and it is considered that the Project would not significantly impact on agricultural activity.

There are seven nature reserves and two State Forests that occur within 18 km of the study area, as shown in **Figure 4.5** below.

FIGURE 4.5: PROXIMITY OF STATE FORESTS AND NSW PARKS AND WILDLIFE ESTATE DESIGNATED AREAS IN RELATION TO THE PROJECT 2009

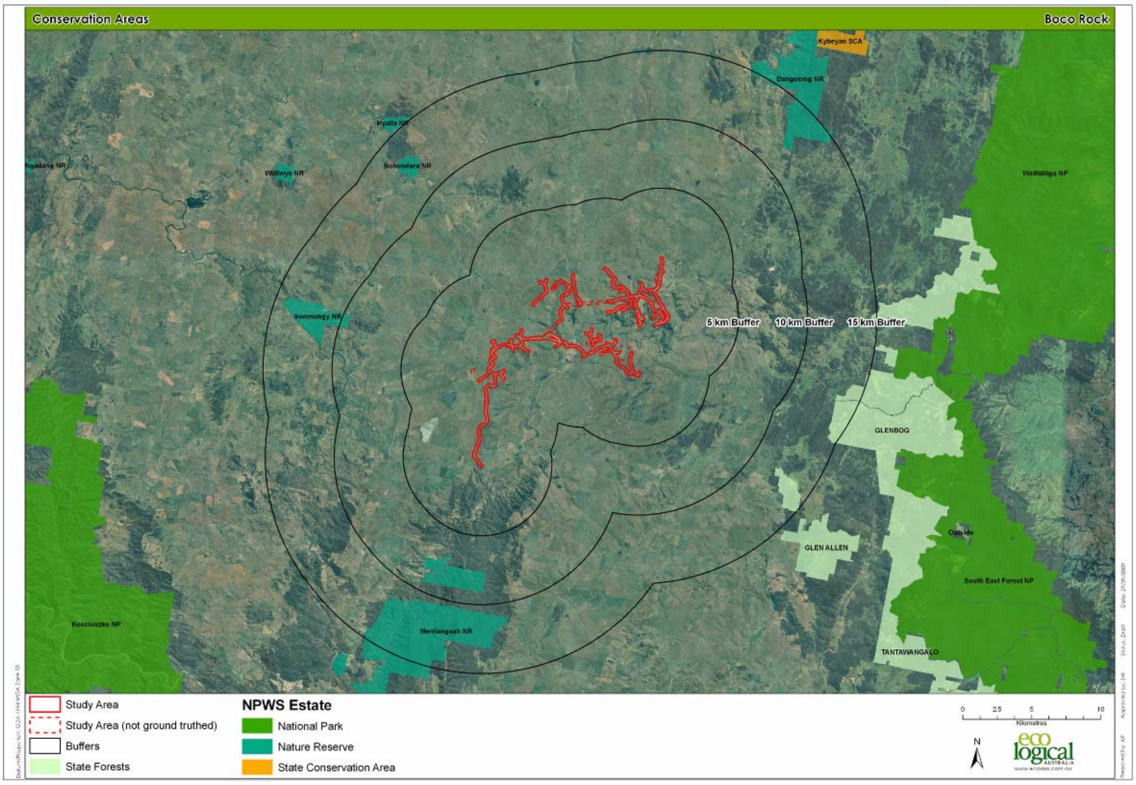


Figure 4.5 Proximity of National Parks and Wildlife Service Estate and State Forests in relation to the Project
(An A3 size version of this Figure is displayed in Volume 2)

All of the nature reserves are utilised for research due to their high conservation values, and no public access is available to these areas, which means there is minimal public amenity impact caused by visual impact from the proposed development. The Glen Allen State Forest is currently a pine plantation and predominantly used for industrial uses, which means like the nature reserves there is minimal visual impact from the Project. The Glenbog State Forest is used as a native forest reserve, with various tourist stops provided throughout the forest along the Snowy Mountains Highway; however there is minimal visual impact as only 2 % of the park is effected. Noise is also not expected to impact on either the nature reserves or State Forests as explained in **Chapter 9** Noise.

The Project site is covered by two mineral exploration licences (EL 7293 and 7294) held by Volcan Australia Corporation Pty Ltd (Volcan) and is also subject to a mineral title application (EL 3631) by Geogen Victoria Pty Ltd (Geogen). It is unlikely that the placement of turbines adjacent to mining operations (should they be economical, environmentally acceptable and approved) would result in conflict. Wind farms currently co-exist with mining areas in the region, including the approved Woodlawn Wind Farm, adjacent to Veolia's Woodlawn Bioreactor near Tarago, NSW (a disused open cut mineral mine). Both Volcan and Geogen have been consulted and their response is summarised in **Chapter 19** Socio-Economic Assessment.

4.6.2 ***Layout***

A range of factors are considered during the 'site selection' phase, which affects the suitability of an area for a wind farm, and which can potentially constrain development. These include:

- Suitable wind resource;
- Capacity within and ease of connection to the electricity transmission network;
- Access and general ground conditions;
- Proximity to residential properties and the nature of surrounding land uses;
- Availability of turbine sites;
- Presence (or absence) of nationally and locally significant areas with regard to environment, landscape, nature conservation, archaeology and cultural heritage; and
- Interest within the community.

Wind Resource: Numerous investigations into the wind resource potential at several locations across NSW have revealed some general principles which can be applied to assess the merit of an individual site's wind resource. Wind speeds are likely to be adequate in areas that are:

- Exposed to open water or large areas of open grassland without intervening obstructions. These areas receive a very smooth airflow with a high-energy content; and
- On significantly elevated locations, surrounded by a smooth and gently rounded landscape, thus promoting wind speed-up. The ranges that make up the Project area offer excellent speed-up due to topographical detail.

The Proponent installed one wind monitoring mast in June 2008 and acquired a second monitoring mast near the Project at Nimmitabel that had been in situ for over four years. The recorded wind data shows wind speeds that are high and consistent, which in combination with wind resource modelling of the area, making reference to the longer term data sets maintained by the BoM in the local area, has provided suitable justification for the location of the Project.

Land Use: As the Project is located in the agricultural area of Nimmitabel, there is a low population density within and around the Project. Associated landowners have wind turbines closer to their dwellings than neighbouring landowners, to minimise impacts as discussed in **Chapter 6** Stakeholder Consultation, **Chapter 8** Landscape and Visual and **Chapter 9** Noise.

Electricity Transmission Network: Capacity within and ease of connection to the grid can be difficult to assess, given the commercially confidential nature of certain information concerning the electricity distribution and transmission networks, coupled with the complexity and variety of connection options that may be available. However, on a broad scale, areas remote from high voltage overhead transmission lines or from existing population centres are unlikely to offer many feasible opportunities for grid connection. Together with grid connection factors, actual grid capacity, or the ability for the electricity grid as a whole to absorb wind generated electricity, seem to be the principal limiting factor for wind farm development in NSW.

The high voltage transmission network that the Project will connect in to is approximately 25 km east of the site. Country Energy are in the process of upgrading the existing 66 kV transmission line to a 132/66 kV double circuit line, which in combination with a second existing 132 kV line, the Project will connect into. The upgrade by Country Energy, in combination with local landowner interest, has enabled the Project to expand in scope and scale to up to 125 wind turbines.

Site Access and Condition: There is good road access to the Project site as discussed in **Chapter 12** Traffic and Transport, with the arterial roads intersecting with major State and Federal highways, making it a suitable site for the Project.

Community Interest: Landowners' interests are important in determining the location of wind turbines in addition to the above mentioned. Wind turbines are situated on land that is supported by an associated landowner. Neighbouring landowners are not always receptive to the placement of wind turbines and consultation was carried out during the assessment of this Project, as discussed in **Chapter 6** Stakeholder Consultation. Turbines have been moved to try and accommodate the varying views on wind turbines, to reduce the visibility from some properties and minimise impact on aerial activities, altering the layout of the Project (see **Chapter 6** Stakeholder Consultation).

4.6.3 ***Scale***

In NSW, it is common for proposed wind farms to be greater than 50 MW consisting of approximately 20 to 25 wind turbines. Recently larger wind farm projects have being proposed and partly approved, such as the Silverton Wind Farm near Broken Hill with 598 proposed wind turbines, to meet new target emission reductions of NSW, as discussed in **Chapter 5** Planning Context. Therefore the Project, with up to 125 wind turbines, is justified in comparison to current levels of proposed wind farms and is of a suitable scale to meet Australia's target emissions.

Generally, having a larger scale wind farm will result in higher energy production, leading to reduced capital costs and therefore lowering the cost per unit of energy generated. The Project was originally proposed with 73 wind turbines and then increased after communication with surrounding land owners to a maximum of 127 turbines. Following an assessment of the ecological sensitivity of the Grassland Earless Dragon as discussed in **Chapter 10** Flora and Fauna, the scale of the Project was reduced to up to 125 wind turbines. This is still significant, and allows for economies of scale to be achieved during the procurement, construction, operation and decommissioning of the Project.

The Project is designed into four separate Clusters as described in **Chapter 3** Project Description. By having four separate Clusters the potential impacts from various chapters can be reduced during construction, including visual, noise, and traffic and transport, as compared to a single large development.

4.6.4 ***Size of Proposed Wind Turbines***

Wind turbines come in various sizes depending on use and location. **Figure 4.6** below provides a timeline of the different styles of turbines from the 1970s to the present.

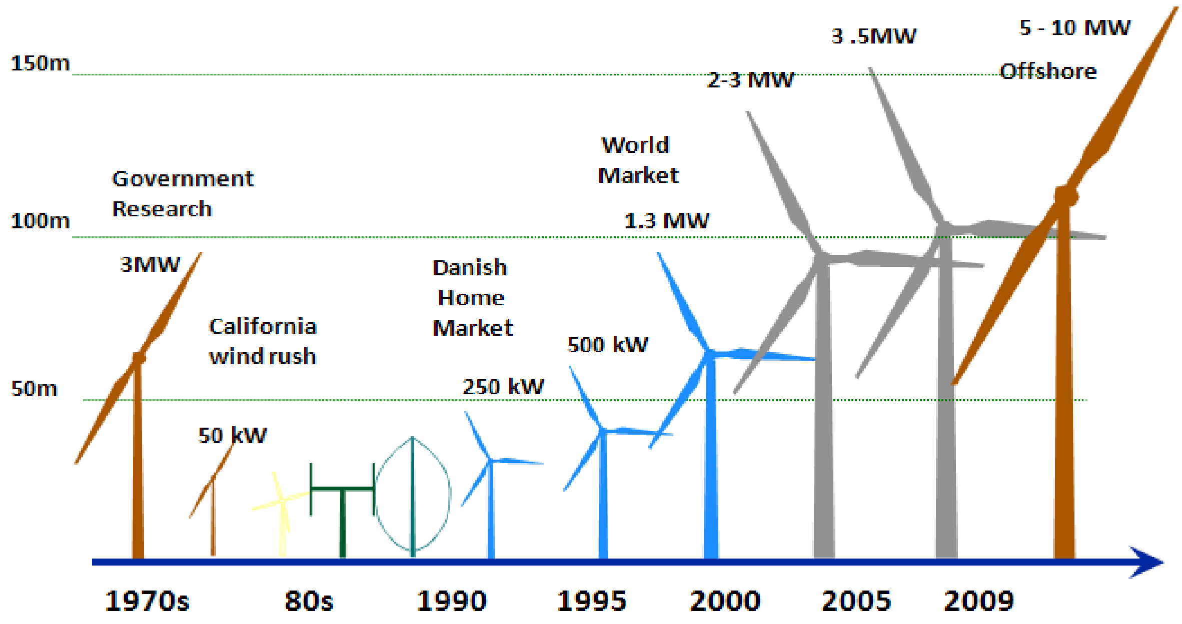


Figure 4.6 Evolution of wind turbine generators

The Great California Wind Rush in the early eighties saw the introduction of 1,000 x 55 kW wind turbines in Palm Springs, California. In 1995, 40 x 600 kW wind turbines were installed in Denmark, representing the largest wind farm in Denmark at the time. With the increasing generator and size of wind turbines, the demand of wind turbines for larger projects grew momentum to create a world market. Offshore wind farms became necessary for countries with high population density and limited suitable site onshore. Today with the demand for renewable energy sources, wind turbines are increasing in generator size and height both onshore and off to maximise the capacity of wind farms.

Bock Rock Wind Farm is a part of today's increasing trend of placing larger scale turbines in the landscape to capture the wind resource in NSW. The Proponent will be reviewing a number of wind turbine models as discussed in **Chapter 3** Project Description, which will ultimately determine the number of turbines installed and the capacity of the Project.

4.6.5 *Greenhouse Gas Emission Reductions*

The National Greenhouse Accounts (NGA) factors provide amounts of carbon dioxide equivalents (CO_2–e) for direct and indirect emissions. Indirect emissions are of primary consequence to this Project as they relate to the consumption of purchased electricity from the grid. These emissions are physically produced by burning of fuels (coal, natural gas, etc.) at the power station. By calculating the indirect emissions for the Project, it is possible to determine the amount of CO_2–e offset.

The MWh per year potentially produced by the Project, **based on both a conservative capacity factor and installed capacity**, can be calculated by:

Number of turbines x capacity factor x installed wind turbine capacity (MW) x 8,760 (h/y)

125 turbines x 0.35 x 2.05 MW x 8,760 = 785,663 MWh/y

Using the latest NSW indirect emission factor, Scope 2, from the NGA:

1 MWh produced for burning of fuels at the power station = 0.89 tonnes CO_2-e emitted

Wind energy is dispatched first into the grid, in doing so requiring less generation from fossil fuel power stations. As a result, wind generation can directly result in CO_2–e emissions savings in NSW. For example:

1 MWh produced from wind = 0.89 tonnes CO_2-e saved

Therefore the amount of CO_2-e emissions saved will be:

Predicted wind farm output per year (MWh/y) x Avoided CO_2-e emissions (tonnes/MWh)

Using the most recent figures published in the NGA Factors (2008) and the **conservative calculations above**, it is estimated that the Project will displace 699,240 tonnes of CO_2-e per annum and 13,984,793 tonnes of CO_2-e over a 20 year operational life of the Project. This means that the Project would result in an annual reduction in CO_2-e emissions, equivalent to taking approximately 161,487 cars off the road permanently (based on an average unleaded petrol car that emits approximately 4.33 tonnes of CO_2-e per year (Greenfleet 2006)).

Using the calculations above as a guide, the Project consisting of 125 x 2.05 MW wind turbines at a capacity factor of 35 % would supply energy for 113,436 homes (based on an average Australian household usage at 6.926 MWh/y (Electricity Gas Australia 2008)).

The Project and creation of wind farms are part of an upstream solution. It is part of the solution for not only reducing the generation of carbon dioxide equivalents from coal-fired power stations, but also providing alternate electricity to users in NSW for up to 113,436 homes, reducing the pressure on the finite resources of fossil fuels.

With respect to the above calculations, higher capacity factors and therefore renewable generation can be achieved through:

- Increasing the hub height to capture higher wind speed; and
- Selecting a wind turbine most suited to producing the greatest yield with respect to the wind resource across the Project site.

Optimising the Project site in this manner would displace more of the energy that would otherwise be generated from incumbent coal-fired power stations and thereby reduce carbon dioxide equivalent emissions.

Using the conservative generation figures presented above, **the Project would contribute approximately 1.75 % of the 45,000 GWh Renewable Energy Target**.

4.7 Summary

Increased greenhouse gases absorbing warmth from the earth are causing effects on the Earth's climate. Due to growing research and understanding International, National and State Governments are realising the benefits of clean, renewable energy generation. Policies are now providing encouragement to energy generation from renewable sources, in order to both reduce harmful atmospheric emissions as well as to meet future demand for energy with diverse and secure supplies.

In 2008, the Australian government ratified the Kyoto Protocol and signed up to cut greenhouse gas emissions to 108 % of the levels they were is 1990; a watershed decision and an important step in determining Australia's position on climate change in the international arena.

The RET legislation was passed through Federal Parliament on 20 August 2009, and aims for 20 % or 45,000 GWh of Australia's electricity to be generated from renewable sources by 2020. Wind energy generation is a low cost, viable renewable energy source and can be readily implemented to meet a substantial percentage of this target.

The Project will play an important role in contributing to both the increasing local and global need for such renewable projects in tackling the issues of Global Warming and Climate Change; contributing approximately 1.75 % of new renewable generation to meet the legislated Australian target. Moreover the Project site and size has been carefully selected using a number of factors and will displace carbon dioxide equivalents by a conservative estimate of 13,984,793 tonnes over the life of the Project.

4.8 Proposed Transmission Line

The proposed transmission line will be assessed apart from this EA under *Part 5* of the *EP&A Act*. Connecting the proposed Boco Rock Wind Farm to the electricity network is intrinsic to the delivery of renewable energy and response to the issue of climate change. The factors justifying the proposed Boco Rock Wind Farm also relate to the proposed transmission line.

A description of the proposed transmission line is included in **Chapter 3** Project Description and aspects relating to associated impacts are considered in **Chapters 8** to **19**.

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