2. Project Context and Alternatives Considered

This section of the EA reviews:

- the global, national and state context for wind energy developments
- Renewable Power Ventures role in wind farm developments and their consideration of alternative sites, and
- the alternative design options that have been considered by Renewable Power Ventures for the Capital Wind Farm project.

2.1 Context for Wind Energy Developments

Wind Energy has always been available for utilisation. In areas such as farm water supplies, wind mills are a common sight, but in Australia wind has been little used for electricity generation due to the abundance of Australia's fossil fuel resources. However, with mounting concerns over enhanced climate change arising from accumulating atmospheric greenhouse gases, there is a concerted global push to move to a more sustainable energy future. The responses have included a variety of forms including:

- diversification of energy generation sources to reduce greenhouse gas emissions
- improvements in efficiency of energy generation and energy use
- demand management to reduce our total consumption of energy
- adaptation to the changing climatic conditions.

It is generally agreed that an effective response to enhanced climate change will require that all of the above approaches are adopted and to that end many initiatives have been promulgated globally and locally. The following sections provide a context for the role of wind energy developments.

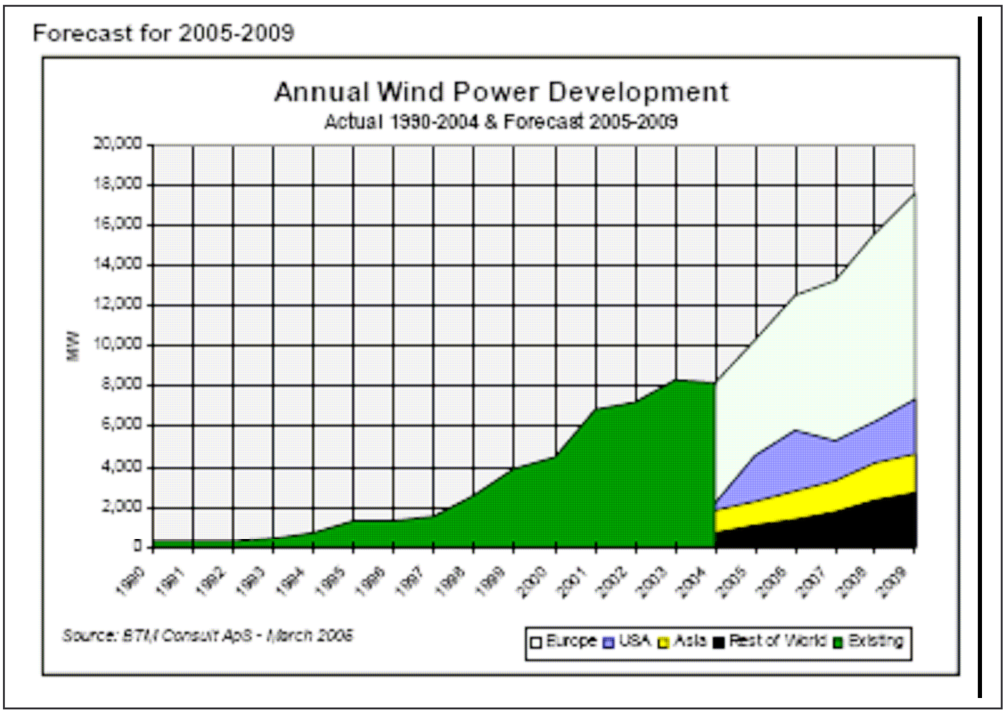
2.1.1 Global Growth of Wind Power Developments

Wind power is one form of renewable energy, which assists the diversification of electricity generation sources and that can reduce the overall emissions of greenhouse gases per unit of electricity produced. Due to its well known technology it has been promoted as one of the more readily available options to address enhanced climate change and as a consequence wind energy development has recently experienced strong growth worldwide.

Globally, the wind power industry has been growing at a consistently high rate of about 15 to 25% per year (IEA, 2004) and is forecast to continue this growth as shown in Figure 2.1. The generation of electricity from wind energy is considered a mature form of power generation with about 52,100 megawatts capacity installed globally at the end of September 2005 and about 235,000 megawatts expected by the end of 2014 (BTI/Consult Aps, 2005). The development and integration of advanced technologies into wind turbine designs is enabling the worldwide trend towards the use of larger turbines and the subsequent reduction in wind generation costs.

Australia has a relatively small proportion of the installed global wind energy capacity but is currently experiencing a significant expansion of its wind generation capacity such that it is amongst the fastest growing countries in terms of its wind farm installation. Despite this expansion, the overall percentage of electricity produced from wind energy in Australia is much lower than is the case for many other overseas countries.

Figure 2.1 – Annual Global Growth in Wind Power Generation



2.1.2 National Context for Electricity Generation and Emissions Reduction

Australia is experiencing steady growth in electricity demand of about 4% per year and the demand has doubled over the last two decades. The Australian Bureau of Agricultural and Resource Economics (ABARE, 2005) forecasts that electricity consumption will increase by around 2.1% a year over the medium term, with a long term predicted growth rate of 1.9% a year.

Australia has traditionally relied heavily on a publicly owned electricity supply industry that has used coal as the predominant fuel source. Some 84.5% of Australia's electricity generation is derived from coal with a further 7.5% from gas. The proportion of electricity gained from renewable energy sources has only constituted about 7.5% of the total supply and has been primarily sourced from hydro-electric generation. Due to limited capacity for Australia to significantly increase generation from hydro sources, the proportion of electricity from renewable energy sources will decrease unless other renewable energy sources are developed.

Electricity generation contributes some 35% of Australia's greenhouse gas emissions. In the context of increased global concerns regarding the consequences of enhanced climate change, there is considerable pressure for the electricity industry to reduce its contributions to the nation's greenhouse gas emissions inventory. In March, 2005, the Australian Greenhouse Office released a report entitled '*Climate Change, Risk and Vulnerability – Promoting an efficient response in Australia*'. The report recognises that "*our success in mitigating greenhouse gas emissions will determine the magnitude (and possibly the nature) of changes to which we must adapt"* and that "*adaptation is likely to be a progressively imperfect substitute for reducing global greenhouse emissions*".

The electricity industry has identified a range of measures to abate emissions including increased efficiency of generation, fuel switching, particularly from coal to gas, increased renewable energy generation and greater efficiency in the usage of electricity. All of these measures will need to be adopted to achieve a significant mitigation in the growth of greenhouse gas emissions for the electricity industry.

In parallel to the above issues, global markets for oil have recently shown significant price increases and media articles are giving greater attention to the finite life of oil supplies and associated issues of pricing and security of supply. A decline in the availability of oil or continued increase in its pricing is likely to be associated with a change in our energy consumption patterns. This may include increased utilisation of other energy sources, particularly coal and gas, renewable energy sources and possibly nuclear energy. There has already been increased effort directed toward research into new and more efficient energy technologies, but it appears inevitable that renewable energy technologies will play a greater role in future energy supplies.

In recent times, Australia's Federal and State governments have addressed electricity industry restructuring and given incentive for more environmentally and socially acceptable forms of generation. Over the last decade, the Federal Government, in conjunction with State Governments (Qld, NSW, Vic, SA and Tas) and electricity supply organisations, has implemented a competitive electricity market referred to as the National Electricity Market (NEM).

Wind farm projects aim to produce electricity from a renewable energy source for sale in the NEM. The financial viability of many renewable energy projects in the context of the market has been supported by the Federal Government's legislation of 2000 that introduced the Mandated Renewable Energy Target (MRET). The MRET is currently set at 9,500 Gigawatt hours (GWh) per year of new renewable energy generation by 2010. Australia's target for increased renewable energy generation, while significant, is nevertheless well below that of many other developed countries.

Associated with the MRET scheme is the facility for creation of Renewable Energy Certificates (RECs) from approved renewable energy generation. The RECs can then be sold in a market administered by the Commonwealth Governments' Office of the Renewable Energy Regulator (ORER). The value of these certificates can support the viability of wind energy generation and in many cases can make the difference between a project proceeding or being non-viable.

Renewable Power Ventures intends that the Capital Wind Farm become accredited as a renewable energy generator and that its operation will create RECs.

2.1.3 State Context for Electricity Generation and Emissions Reduction

The NSW Government has an active program to deliver reductions in greenhouse gas emissions for NSW. As part of this program, it has created the Sustainable Energy Development Authority (SEDA) which has recently been combined with the Ministry of Energy and Utilities to form the Department of Energy, Utilities and Sustainability (DEUS). SEDA initiatives have included 'Greenpower' and 'Energy Smart' programs as well as the establishment of a Wind Business Unit that is responsible for good practice wind energy development in NSW.

The NSW Government has also introduced the NSW Greenhouse Gas Abatement Scheme that sets a target or "benchmark" for greenhouse gas emissions in NSW.

The development of Capital Wind Farm is considered to be consistent with the National and State Government objectives for sustainable production of energy and abatement of greenhouse gas emissions.

2.1.4 Wind Energy Integration into the National Electricity Market

Wind integration in the NEM refers to the ability of wind farms to connect to, and operate within the NEM in a way that is consistent with the daily operation and short term security of the NEM. Due to rapid growth rates in electricity produced from wind energy and the variability in the wind energy source, wind energy integration has received considerable attention to ensure the developments do not adversely impact the security and reliability of electricity supplies.

Historically it was assumed that only very small amounts of wind generation would be present in the NEM and that such small amounts could be ignored. Accordingly the current National Electricity Code does not consider the impact of large amounts of wind generation. As a result, the connection and operation of Wind Farms in the NEM have been assessed on a case-by-case basis.

Issues that need to be considered with regard to the grid integration of wind energy include:

- Managing short term variation in output so that the balance of demand and various supply sources is effectively met
- Improvements in forecasting of wind farm output to assist generation scheduling
- Managing the frequency of the NEM such that it is maintained at constant frequency so as not to move outside normal safe limits
- Avoiding the clustering of wind farms on the same transmission or distribution line, within small geographical regions where the increase or decrease in their combined capacity could result in adverse network and/or supply impacts.

In April 2004, the Ministerial Council on Energy (MCE) established the Wind Energy Policy Working Group (WEPWG) to consider issues concerning the entry of renewable energy generation (particularly intermittent and non-scheduled generation such as wind) into the NEM. Areas under consideration by WEPWG include:

- Wind generation forecasting
- Release of non-scheduled generation data to the market consistent with data released for other generation forms
- Consideration of control systems to manage the effect of intermittent generation on network flows
- Inclusion of non-scheduled intermittent generation into the dispatch process to avoid the need for regular use of directions and instructions
- Provision of non-confidential and verified models
- Refining the treatment of the causer pays arrangements for regulation frequency control ancillary services (FCAS)
- Review of code connection procedures.

Technological developments of wind turbine generators have improved contributions to grid security through:

- Controlling voltage at output terminals of the wind turbine generator;
- Maintaining a consistent output during faults on the grid where voltage drops suddenly
- Maintaining output over a range of grid frequencies.

Following the recommendations of the WEPWG raised in the discussion paper 'Integrating Wind Farms into the National Electricity Market' (March 2005), the Standing Committee of Officials (SCO) has agreed to NEMMCO reviewing the technical standards for the connection of generators under the National Electricity Code. Capital Wind Farm will be required to meet the relevant standards to ensure that potential impacts on the NEM are reduced.

In general terms, the New South Wales part of the electricity grid is considered to have a greater capacity to integrate a significant proportion of Wind Energy generation than other States. At present, the approved NSW wind farms represent a small portion of the total NSW generation capacity (less than 5%). Overseas countries have successfully integrated much higher proportions of wind energy into electricity grids.

Overall wind energy has been a 'price taker' in the market and will generally be dispatched by the market and will displace marginal price generators that may well include coal and gas fired generators.

2.2 Renewable Power Ventures consideration of feasible alternatives

In formulating the Capital Wind Farm project, Renewable Power Ventures recognises the broad government and community support for development of renewable energy projects, but is also aware of the need to ensure that wind farm developments are appropriately planned and fully consider the environmental and social issues associated with their development. Based on its review of feasible options, Renewable Power Ventures has selected wind energy projects as being commercially viable forms of renewable energy development.

Renewable Power Ventures is committed to developing successful projects in an environmentally and socially acceptable manner. This Environmental Assessment outlines the measures to be adopted for this project to mitigate the project's potential environmental impacts.

The following sections review aspects considered by Renewable Power Ventures in the planning of the Capital Wind Farm project, including:

- reasons for Renewable Power Ventures selection of wind energy projects
- reasons for the selection of the Capital Wind Farm site over a range of possible sites
- potential design variants of the project at the Capital Wind Farm site and associated transmission infrastructure
- the impact of tender process on the project description.

2.2.1 Renewable Energy Generation Options considered by RPV

In Australia, the development of wind power has a number of advantages in terms of ease of generation and scope for development over other forms of renewable energy generation such as solar and hydro power. Solar based electricity generation is significantly more expensive per unit of power produced than wind generation and is only developed at much smaller scales than that currently occurring for wind projects. In the case of hydro-electric power developments, Australia has limited opportunities for further development due to lack of water resources. Tidal, current and wave power system technologies are less mature than wind energy systems and are not expected to show the same potential as wind energy.

Implementation of wind energy depends on access to a suitable wind resource, landowner agreements, the ability to deliver the power to the grid cost effectively and the ability to obtain the necessary approvals. Renewable Power Ventures has secured the landowner agreements for the Capital Wind Farm and is now seeking the required approvals for its development.

The Capital Wind Farm is Renewable Power Ventures' second Australian wind farm. Its first wind energy development is the 89 megawatt Alinta Wind Farm near Geraldton, Western Australia.

In addition, Renewable Power Ventures' parent companies have a diverse involvement in a range of wind energy projects in Australia, the United States and Europe. The combined experience gained from these projects enables Renewable Power Ventures to plan new wind farm developments confidently.

2.2.2 Alternative Wind Farm Sites

Renewable Power Ventures has undertaken a systematic process to identify suitable wind farm sites, and to assess their relative merits. This process has included identification of potential sites with suitable energy resources and transmission infrastructure and potentially acceptable environmental and social impacts. The preferred sites have been further evaluated in terms of technical, environmental, social and commercial factors relating to their potential development. In parallel, approaches have been made to landowners to ascertain their preparedness to allow wind farm developments to proceed on their properties.

Commercial viability considerations were reviewed for a range of potential wind farms including the cost of construction and operation, landowner readiness to participate in wind energy projects and transmission connection considerations.

The above process has involved detailed assessment of several potential wind farm sites. It was evident during the process that the Capital Wind Farm site was one of the more suitable sites and on that basis Renewable Power Ventures decided to conduct more detailed investigations of technical, environmental and financial viability of a wind farm at the locality.

Following Renewable Power Venture's decision to proceed with the Capital Wind Farm, the following actions have been implemented:

- negotiations have been undertaken to secure leases with relevant landowners to enable further planning studies and to seek approval for the construction and operation of a wind farm
- further wind energy resource assessment has been undertaken including installation of two additional 80 metre wind monitoring masts
- identification of the planning process, conduct of a planning focus meeting and obtaining the Director-General's requirements for the EA
- environmental impact studies undertaken and consultation with neighbours to the wind farm and the local community
- the project description modified to address the outcomes of the studies
- an EA prepared with a view to lodging a Project Application.

2.2.3 Design Options Considered for the Capital Wind Farm Project

The preliminary planning studies have reviewed a range of variations to the conceptual design for the wind farm and the associated grid connection. Consideration of these design options was undertaken in the context of environmental, social and commercial impacts for the proponent and stakeholders.

The overall objective of the conceptual design stage was to identify the size of the project that could deliver significant savings in greenhouse gas emissions while being commercially viable and socially and environmentally acceptable. The proposed design is described in Chapter 3 of the EA. The variables that have been considered during formulation of the Capital Wind Farm project are outlined below. Further refinement is also expected as part of the final design stage, prior to construction. The final design will be subject to review by the Consent Authority at the Construction Certificate stage of development.

Key variables considered in the wind farm design formulation have included:

- Properties to be included and scale of the project
- Number of turbines and their layout
- The type and size of turbines to be considered, including hub height and turbine diameter
- Site access arrangements
- Interconnection arrangements for turbines
- Substation and facilities building location
- Grid connection arrangements
- Construction methods.

2.2.4 Properties and Layout

The site's wind energy resource distribution largely determines the suitability of individual turbine sites and wind analysis software is used to optimise the layout for the site. The optimised layout is then reviewed in terms of practicality and important site constraints such as ease of access, tree cover and potential impact on neighbours.

The properties to be included were largely based on the available energy resources, suitable turbine locations, the agreement of landowners and proximity that allows interconnection of turbines to form a single project. A lesser number of properties are included in the development application than was originally considered during planning.

The number of turbines is influenced by the extent of the energy resource available at the site and the ability to export the power. In addition, the required spacing affects the number of turbines that can be accommodated at a site. Spacing is itself related to the size of the turbines, orientation of the layout to the prevailing winds and environmental considerations.

Review of the site's energy characteristics and commercially available wind turbine equipment indicated that a wind turbine with 80 metre hub height and 88-90 metre blade diameter is suitable and commercially viable. A lower hub height would marginally decrease the visibility of the wind farm over the taller structures, but would also greatly reduce the electrical output and economic returns of the site. The benefits of the additional energy generated and potential emissions savings were considered to warrant use of tower structures of about 80 metres height. The visual impact assessment in Chapter 6 and Appendix C has been based on an 80 metre hub height.

2.2.5 Turbine Selection

Consistent with the trend in recent years, larger megawatt class wind turbines are finding increasing use in Australia as well as overseas. This trend is a direct result of improved design of wind turbine components. The development of more advanced electrical technologies has enabled larger turbines to connect into sometimes weak transmission grids. The use of larger turbines has also resulted in increased competitiveness of wind farms, compared to other renewable technologies, as well as providing environmental advantages due to the fact that less turbines need to be constructed to achieve a given generation capacity. However, there are generally limits to the size that can be installed and the design process seeks to optimise the turbine for the site characteristics.

Turbines considered for the Capital Wind Farm project ranged from 1.8 to 3 megawatts, have 80 metre hub heights and rotor diameters of 80 to 90 metres.

2.2.6 Site Access

Due to the three separate groupings of turbines, a number of access points are required. In some cases, there is more than one option available for accessing a wind turbine group. The most suitable route is generally the most direct route, but issues of road surface curvature and traffic conflicts can influence the selection of the preferred routes. Use of the selected access routes will be managed to minimise disturbance to traffic on local roads and for the existing residences. A detailed review of advantages and disadvantages of each of the access route options is provided in Appendix I and a summary is provided in Chapter 9.

Where possible, access routes to the turbine sites will use existing property tracks that can be upgraded without appreciable soil disturbance or clearing. After a review of options for access track locations, the actual locations of the new tracks have been chosen to minimise the length of new tracks, ensure suitable grades, provide adequate curvature on bends, and avoid areas of vegetation, fauna habitat or archaeological sensitivity.

2.2.7 Electrical Collection System

The collection system is the arrangement of cables and overhead lines that are used to connect the wind farm to the substation. Both underground cables and overhead lines have been considered for the collection system.

The interconnection of turbines within each turbine group will use underground cables. The underground cables between turbines are favoured due to the elevated locations of the turbines and visual impact considerations. Consideration has also been given in the EA to aspects of ground disturbance and avoidance of environmentally sensitive areas.

The groups of turbines can be connected to the substation by underground cables or overhead lines. The further the distance involved and the greater the output of the combined wind turbines, the stronger the case for overhead lines over underground cables, but the choice is still subject to review against environmental criteria. Due to the distances involved, it is unlikely that the overhead cabling will be easily identifiable from public viewpoints.

Underground cables will be used to connect the Hammonds Hill Group of turbines to the substation. The Groses Hill Group of turbines is over 10 kilometres from the substation and a section of 33 kV overhead transmission line is proposed. The overhead line passes the Ellenden Group and could also be used to connect that Group to the substation, perhaps involving a double circuit arrangement for at least part of its length.

Use of the overhead line for connection of the Groses Hill Group to the substation is possible due to the low density of settlement along the proposed route and due to limited visibility of the route from viewpoints on public roads or neighbouring properties surrounding this part of the site. Additionally, the overhead line has been assessed as having a lesser ground disturbance and reduced cost compared to the underground cable.

The location of the substation and facilities building has been selected to be adjacent to the existing 330,000 volt transmission line on land accessible to the proponent and as close as possible to the turbine groups. The chosen location is within the base of a valley and has low visibility from surrounding public viewpoints and residences due to the screening by trees and topography. No ecological issues have been identified for the site, which is cleared grazing land. The site has been relocated a distance of several hundred metres from the initial location to avoid an area of potential archaeological sensitivity adjacent to Dry Creek. Access to the substation site can be easily gained by using an existing access track from the Tarago to Bungendore Road.

2.2.8 Grid Connection

Issues related to integration of the Wind Farm into the NEM are discussed in section 2.1.4. New South Wales is well placed to integrate the Wind Farm into the NEM subject to design consultation with TransGrid.

The site is crossed by 66,000 volt and 330,000 volt transmission lines operated by Country Energy and TransGrid respectively. The 66,000 volt transmission line would have insufficient capacity to enable connection of the Capital Wind Farm. As the 330,000 volt TransGrid transmission line passes through the southern part of the Capital Wind Farm site, potential for connection to that line has been reviewed with TransGrid. The review has indicated that sufficient capacity is available in the line for the connection of the wind farm.

A Connection Application has been lodged with TransGrid and data is being provided for required network studies. The wind farm grid connection option is further described in section 3.6 of the EA.

Connection to the 330,000 volt TransGrid line to the south of the site was assessed as being the only feasible option for a project of this size. That outcome has influenced the minimum viable size of the wind farm development.

Further information on the alternatives considered by the project is included in the following Chapters.

2.2.9 Construction Alternatives

A range of alternatives have been considered for the construction phase of the project as discussed below. These have included:

- Transport to site for equipment and materials and access alternatives, entry points and on-site routes
- On-site versus off-site sourcing of concrete and road base materials
- Construction methods

A range of variations have been assessed for transport to the site and on-site access arrangements. These are discussed in Chapters 3 and 9 and Appendix I provides a detailed review of access options. The chosen options all involve safe points of entry to the site from public roads. The actual arrangements and any conditions for access require confirmation with Councils through the development of the project Traffic Management Plan.

The decision to produce concrete on-site using a batch plant avoids the need for passage of many concrete agitator trucks on public roads during concrete pours for the turbine foundations. Concrete agitator trucks will transit between the on-site batch plants and the respective turbine sites using the on-site tracks. This option has also been favoured due to the long travel times to site from concrete production plants in Goulburn and Bungendore.

The formation of the access tracks will require a significant amount of road base material which could be supplied from off-site locations. However, suitable material is available on-site in the form of the weathered granite which can be recovered at the location of an existing borrow pit. The site is to the east of the Ellenden Group and can be transported to locations where it can be spread along the access tracks.

There are limited options for variation in construction methods. It is proposed that the type of crane to be used is a track based crawler crane that will be able to access all the turbine sites including the sites with steep access where a conventional rubber wheel mounted crane would have difficulty.

In the few sites where clearing of trees is required for the installation of turbines, this will involve selective pruning, copicing, or if necessary, clearing, to allow laydown and assembly of turbine blades. Areas between the blades will not need to be cleared thereby limiting the impact of clearing.

The construction period of eight months limits the period when construction activities will impact the local community.