Glen Innes

2

Project Context and Alternatives Considered

2. Project Context and Alternatives Considered

This section of the Environmental Assessment reviews:

- the global, national and state context for wind energy developments
- the proponent's role in Australian wind farm developments and their consideration of alternative sites, and
- the alternative design options that have been considered by Glen Innes Wind Power for the Glen Innes 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 large scale 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 Intergovernmental Panel on Climate Change (IPCC) released its fourth assessment report (4AR) in 2007. The 4AR provides comprehensive evidence of climate change, impacts and associated directions for mitigation of the social, environmental and economic costs. The debate globally is not whether a response is required but rather what are the best mechanisms to respond and the extent of that response.

Potential responses include a variety of approaches including:

- diversification of energy generation sources to reduce overall 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.

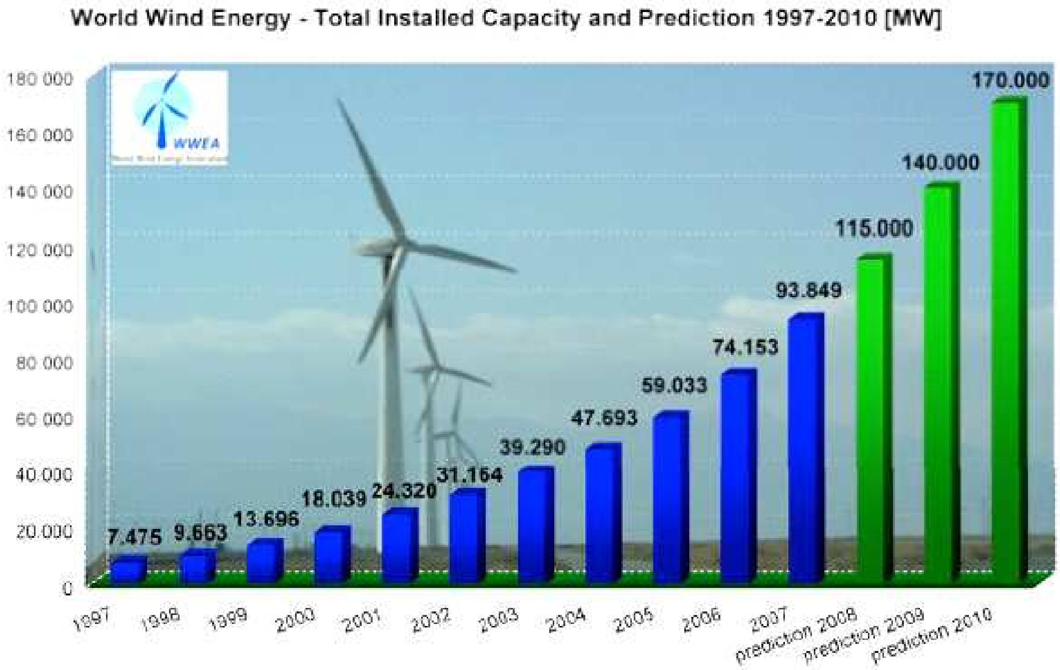
2.1.1 Global growth of wind power developments

Wind power is one form of renewable energy which assists in the diversification of electricity generation sources and which can reduce the overall emissions of greenhouse gases per unit of electricity produced. Due to its proven 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 and has reached 1% of global electricity generation (WWEA February 2008).

Globally, the wind power industry has been growing at an average annual rate of 28% (IEA, 2006) and is forecast to continue to grow strongly as shown in Figure 2.1. The generation of electricity from wind energy is considered a mature form of power generation with about 93,849 megawatts capacity installed globally at the end of 2007 and about 170,000 megawatts expected by the end of 2010 (World Wind Energy Association, February 2008). On this basis the global installed wind energy generation capacity could double in just four years. 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 has experienced a significant expansion of its wind generation capacity over the last decade. A number of wind farm projects have received planning approvals and are potentially able to be developed as conditions permit. 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

The Australian Bureau of Agricultural and Resource Economics (ABARE, 2007) has found that Australia has experienced a fourfold increase in electricity consumption since 1973-74 from 59 Terawatt hours (TWh) to 216 TWh in 2004-2005. Furthermore, ABARE (2007) has forecast that Australia's electricity consumption will increase from 216 TWh in 2004-2005 to approximately 386 TWh by 2029-30. This represents a 79% increase over the 2004-05 consumption levels.

Table 2.1 sets out Australia's current and projected electricity generation in relation to the energy source from which it is obtained. As can be seen in Table 2.1 coal is the predominant fuel source with some 76.9% of Australia's electricity generation derived from coal in 2004-2005. Gas supplied a further 14.3% and oil 1.4% with a total 92.6% of Australia's electricity generated from fossil fuel energy sources as shown below in Table 2.1.

The proportion of Australia's electricity gained from renewable energy sources has only constituted about 7.4% 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. Furthermore, extended drought conditions have limited the full utilisation of existing hydro assets and long term predictions based on climate change scenarios indicate continued dry conditions, resulting in reduced availability of hydro energy resources.

Electricity generation contributes an increasing proportion of Australia's greenhouse gas emissions from about 24% in 1990 to about 35% currently. 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.

Table 2.1: Current and projected Australian electricity generation by fuel sources

Energy Source	2004-05		2009-10		2019-20		2029-30	
	PJ	%	PJ	%	PJ	%	PJ	%
Fossil fuel, non-renewable energy sources								
Black coal	492	56.0	545	53.8	649	52.8	745	50.8
Brown coal	184	20.9	200	19.8	229	18.6	260	17.7
Oil	12	1.4	13	1.3	14	1.1	14	0.9
Gas	126	14.3	168	16.6	238	19.4	331	22.6
Sub-Totals	**813**	**92.6**	**926**	**91.5**	**1130**	**91.9**	**1350**	**92.0**
Non fossil fuel, renewable energy sources								
	PJ	%	PJ	%	PJ	%	PJ	%
Hydro	56	6.4	61	6.0	64	5.2	66	4.5
Wind / Solar	4	0.5	13	1.3	14	1.1	24	1.6
Biomass	4	0.4	6	0.6	15	1.2	20	1.4
Biogas	1	0.1	6	0.6	7	0.6	8	0.5
Sub-Totals	**65**	**7.4**	**86**	**8.5**	**100**	**8.1**	**118**	**8.0**
TOTALS	**878**	**100**	**1012**	**100**	**1230**	**100**	**1468**	**100**

Source: modified from ABARE, 2007 Note: PJ – Petajoule

In March, 2005 the Australian Greenhouse Office released a report entitled '*Climate Change, Risk and Vulnerability – Promoting an Efficient Response in Australia*'. The report indicates 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 from the electricity industry.

In parallel to the above issues, global markets for oil and gas have recently shown significant price volatility and media articles are drawing greater attention to the finite life of oil and gas supplies and associated issues of pricing and supply security. 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 primary energy sources, particularly coal and gas, renewable energy sources and possibly nuclear energy.

The most recent BP Global Energy Statistics released in June 2008 also indicated that the projected life of global coal reserves based on the proved reserves to production ratio has dropped from 192 years (end of 2003) to 133 years (end of 2007) which constitutes a 59 year reduction over 4 years. The greenhouse gas emission and energy supply issues have resulted in increased effort being directed toward research into alternative fuels, new and more efficient energy technologies, carbon capture systems and debates on the merits of nuclear energy. Given the current availability of viable renewable energy technologies it appears likely that renewable energy technologies will play a greater role in delivering future energy supplies. Additionally, countries integrating renewable energy technologies will to some extent reduce the impacts of global price volatility on national economies.

In recent times, Australia's Federal and State governments have addressed electricity industry restructuring and have provided incentives 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 into the NEM. The financial viability of renewable energy projects to participate in the NEM is supported by government introduced mandatory renewable energy targets.

The Commonwealth's Mandatory Renewable Energy Target Scheme (MRET) is currently set at 9,500 Gigawatt hours (GWh) per year of new renewable energy generation by 2010. However, Australia's target for increased renewable energy generation, of about 2% under the scheme has been offset by increased demand for electricity. Renewable energy electricity generation represents a small part of Australia's electricity supply and is 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 most cases make the difference between a project proceeding or being non-viable.

In 2006, Victoria implemented its State based renewable energy target (VRET) which aims to assist development of 3,274 GWh/year of new renewable energy by 2016. The scheme took affect from the 1st January 2007.

A Bill was also introduced to the NSW Parliament in June 2007 to establish the NSW Renewable Energy Target (NRET) Scheme. The NRET scheme aimed to increase renewable energy generation in NSW by 7,250 GWh/year as shown in Table 2.2 together with the MRET and VRET scheme details.

Table 2.2 -- Government renewable energy initiatives

Scheme	Target	Certificate	Administrator	Scheme Targets	
				GWh	Date
Commonwealth	MRET	REC	ORER	9,500	2010
Victorian	VRET	VREC	ESC	3,274	2016
New South Wales	NRET	NREC	TBA - Minister to appoint	7,250	2020

The NRET scheme was to have taken effect from the 1st January 2008 but implementation has been deferred due to the recently elected Commonwealth Government's commitment to expand the Mandatory Renewable Energy Target from 9,500 GWh to 45,000 GWh by 2020. It is indicated that the NSW government will work with the Commonwealth and other State governments through one of the COAG Working Groups to implement a single harmonised expanded national renewable energy target. The national approach is indicated to have been supported by the findings of consultation undertaken by the State government.

The Federal Government recently released a framework for a "Carbon Pollution Reduction Scheme", which includes preliminary information for commercial instruments that effectively set a price on carbon emissions. Such a Scheme, which is to take effect from 2010, could also potentially improve the viability of renewable energy projects and their competitiveness with fossil fuel based forms of generation.

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 created the Sustainable Energy Development Authority (SEDA) which was subsequently combined with the Ministry of Energy and Utilities to form the Department of Energy, Utilities and Sustainability (DEUS) and in April 2007 merged in the new Department of Water and Environment (DWE). SEDA initiatives have included 'Greenpower' and 'Energy Smart' programs as well as various initiatives to support wind energy development in NSW. The $100 million NSW Renewable Energy Development Fund administered by the NSW Department of Environment and Climate Change provides support for demonstration and commercialisation activities.

The NSW Government has also introduced the NSW Greenhouse Gas Abatement Scheme that sets a target or "benchmark" for greenhouse gas emissions in NSW and a system for creation of NSW Greenhouse Abatement Certificates (NGACs) that can provide a financial benefit to generators for reducing emissions. The financial penalty for benchmark participants that do not reduce their greenhouse gas emissions or buy enough abatement certificates to lower their attributable emissions towards their greenhouse benchmark has increased from $10.50 when the scheme was introduced in 2003 to $12.00 in 2007 for each tonne of CO_{2-e} by which a benchmark participant's attributable emissions exceeded its benchmark. The actual market price for NGACs has been less than $12.00 in late 2007. Over the first four years of the scheme's operation abatement of about 26 million tonnes of CO_2-e is indicated to have been achieved.

The development of Glen Innes 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 potentially 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.

Due to the variability of its energy source, wind generation is defined by the National Electricity Code as being '*intermittent generation'* which permits an applicant to apply for '*non-scheduled'* registration status. Generation from non-scheduled sources can impact other market participants in the areas of network flows and market outcomes such as market prices, dispatch targets for scheduled generation, NEMMCO forecasts of the demand to be met by scheduled generation and key operational decisions by other market participants such as self commitment of generating units.

Historically, it was assumed that only very small amounts of wind generation would be present in the NEM and that such small amounts would not generally impact system security. Accordingly, the National Electricity Code did not consider the impact of large amounts of wind generation. As a result, the connection and operation of wind farms in the NEM have generally been assessed on a case-by-case basis.

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 that were considered by the WEPWG included:

- 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

WEPWG raised a series of recommendations addressing the above issues in the discussion paper 'Integrating Wind Farms into the National Electricity Market' (March 2005). They also requested NEMMCO to establish the Wind Energy Technical Advisory Group (WETAG) to investigate the technical standards for the connection of generators under the National Electricity Code, which was agreed to by the Standing Committee of Officials (SCO).

The issues highlighted as most urgent by the resulting WETAG report included the management of network flows from wind farm generation and short term variability of wind farm generation at the sub five minute level. The recommendation to overcome these issues was the establishment of a conditional dispatch control to apply to wind generators. NEMMCO, in consultation with the Wind Energy Industry Reference Group has developed a Semi Dispatch Request for Rule Change and a set of draft Rule Changes. Request for Submissions were opened on the 10th May 2007 for this request for rule change.

Once established, Glen Innes Wind Farm will be required to comply with the applicable dispatch rule so that the potential impacts on the NEM are reduced.

In general terms, the New South Wales part of the National electricity grid is considered to have a greater capacity to integrate a significant proportion of wind energy generation than other States. At present, the existing NSW wind farms represent a small portion of the total NSW generation capacity (less than 0.2% and perhaps up to 0.5% by 2009). Even if all of the currently identified potential NSW wind farms were installed (unlikely to occur within 5 to 10 years) this still only represents about 8% of the total NSW generation capacity. 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. Where this occurs emission savings will accrue.

2.2 Glen Innes Wind Power's consideration of feasible alternatives

In formulating the Glen Innes Wind Farm project, the proponent 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, Glen Innes Wind Power has selected wind energy projects as being commercially viable forms of renewable energy development.

Glen Innes Wind Power 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 Glen Innes Wind Power in the planning of the Glen Innes Wind Farm project including:

- reasons for Glen Innes Wind Power's selection of wind energy projects
- reasons for the selection of the Glen Innes Wind Farm site over a range of possible sites
- potential design variants of the project at the Glen Innes 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 proponent

In Australia, the development of wind power has a number of advantages in terms of existence of a favourable energy source, 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 currently only developed at much smaller scales than that currently occurring for wind energy projects. In the case of hydro-electric power developments, Australia has limited opportunities for further development due to lack of water resources and even existing assets have been recently constrained by extended drought conditions. 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. Glen Innes Wind Power has secured the landowner agreements for the Glen Innes Wind Farm has potential for connection to the existing grid at the wind farm site, and is now seeking the required planning approval for its development.

Glen Innes Wind Power's parent companies have a diverse involvement in a range of wind energy projects in Australia, the United States and Europe. Australian examples are shown in Table 1.3. The combined experience gained from these projects provides Glen Innes Wind Power with the resources to plan confidently new wind farm developments.

2.2.2 Alternative wind farm sites

The proponent 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 respective cost of construction and operation, and the cost of transmission connection considerations.

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

Following the decision to proceed with the Glen Innes Wind Farm, the following actions have been implemented by Glen Innes Wind Power:

- 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
- wind energy resource assessment has been undertaken using three 80 metre wind monitoring masts installed by the proponent
- identification of the planning process and conduct of a planning focus meeting in January 2007 that involved key NSW Government agencies
- the Director-General's requirements for the Environmental Assessment issued in May 2007
- environmental impact studies undertaken
- consultation with neighbours to the wind farm and with the local community
- the project description modified to address the outcomes of the studies and consultation
- this Environmental Assessment prepared to support the Project Application

2.2.3 Design options considered for the Glen Innes 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 Environmental Assessment. The variables that have been considered during formulation of the Glen Innes Wind Farm project are outlined below. Further refinement of the design and project detail is also expected following the gaining of development approval, as part of the final design stage, prior to commencement of construction. The final design will be subject to review by the either the Approval Authority or the Principal Certifying Authority at the Construction Certificate stage of development. The final design will be consistent with the planning approval.

Key variables considered in the wind farm design formulation included:

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

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, agreement of landowners and proximity that allows interconnection of turbines to form a single project.

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. While 22 turbine sites were initially considered at the stage of the Planning Focus Meeting in January 2007, this has been increased to a possible 27 sites, however, not all of these may be developed. The increased number of turbine sites addressed by this Environmental Assessment has followed discussions with the landowners, surveys of potential sites and advice that the 66 kV line to which the wind farm will be connected is likely to be upgraded to 132 kV.

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 to 100 metre rotor 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 is 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 and the development of more advanced electrical technologies that 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 Glen Innes Wind Farm project range from 2 to 3 megawatts generation capacity, have 80 metre hub heights and rotor diameters of 88 to 100 metres.

2.2.6 Site access

Due to the relatively compact grouping of turbines along the Waterloo Ridge a single access point is adequate. Other less direct options for accessing the wind turbines have also been assessed but the most suitable route is the direct route via the former Gwydir Highway alignment. Issues of grade, road surface curvature and traffic conflicts have influenced the selection of the preferred route. Use of the selected access route will minimise disturbance to neighbours and traffic on local roads and for the existing residences. The use of the former Gwydir Highway alignment also facilitates access to the site for the oversize construction vehicles. A detailed review of advantages and disadvantages of the access arrangements 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. 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 the wind farm 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 location of the substation and associated buildings has been selected to be adjacent to the existing transmission line on land accessible to the proponent and as close as possible to the wind farm. The actual extent of the substation will be dependent on the connection voltage at either 132,000 volts or 66,000 volts. The chosen location provides relatively easy access close to the entry point to the wind farm site during the construction stage. Once operational, access may be via Rose Hill Road and the existing track to Ross Hill or subject to extension of approval by the Rural Lands Protection Board, by continued use of the former Gwydir Highway alignment.

2.2.8 Grid connection

Issues related to integration of the wind farm into the NEM are discussed in section 2.1.4. As mentioned in that section of the Environmental Assessment, New South Wales is well placed to integrate the wind farm's output into the NEM subject to design consultation with TransGrid (or Country Energy).

The site is near to an existing 66,000 volt transmission line operated by Country Energy. The 66,000 volt transmission line would have sufficient capacity to enable connection of the Glen Innes Wind Farm, although at its current rating of 66,000 volts, not all of the turbine sites could be developed. Some modification of the Glen Innes 66,000 volt substation located near Glen Innes may also be needed.

If the grid connection were to be a new 132,000 volt transmission line that is proposed between Glen Innes and Inverell, then a larger wind farm could be connected. Approval is being sought for 27 turbines based on grid connection at 132,000 volts being available.

Connection Applications have been lodged with Country Energy and TransGrid and data has been provided for required network studies. The wind farm grid connection option is further described in section 3.6 of the Environmental Assessment.

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

2.2.9 Construction alternatives

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

- Transport routes 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 has been assessed for transport to the site and on-site access arrangements. These are discussed in Chapter 9 and Appendix I provides a detailed review of access options. The chosen option involves a single safe point of entry to the site from the Gwydir Highway. The actual arrangements and any conditions for access require confirmation with Council through the development of the project Traffic Management Plan.

It is likely that concrete will be supplied from Glen Innes due to its close proximity to the site. That would involve a fleet of concrete agitator trucks cycling between Glen Innes and the site during the pouring of the turbine and substation footings. The alternative of using an on-site batch plant would avoid the need for passage of many concrete agitator trucks on public roads during concrete pouring. However, the decision as the whether to install an on site batch plant would be made by the contractor.

The formation of the access tracks will require a significant amount of road base material which could be supplied from off-site locations. Subject to material suitability some road surfacing gravel may also be sourced from this site. The construction phase will involve transport of gravel to locations where it can be spread along the access tracks.

There are limited options for variation in construction methods. The type of crane to be used may be a track based crawler crane that will be able to access all the turbine sites including the sites with steep access or a conventional rubber wheel mounted crane that would require a slightly higher standard of access track for reaching all sites. Depending on the nature of the individual turbine site it may be necessary to vary the construction procedures particularly where the site is constrained by either sensitive vegetation and/or steep slopes. This is discussed in more detail in Chapter 3 (section 3.9.7).

For some sites minor clearing of trees may be required for the installation of turbines, this will involve selective pruning, copicing, or if necessary, removal of specifically identified trees, to allow laydown and assembly of turbine blades on the ground. Alternatively the normal hardstand area requirements may be reduced to avoid clearing sensitive vegetation. This could involve delivery of individual components to the turbine site as required for erection of the turbine rather than laying all components on the hardstand ready for erection.

As far as possible the construction period will be limited to minimise any impact on the local community.