AusWEA Australian Wind Energy Association

Best Practice Guidelines for Implementation of Wind Energy Projects in Australia

www.auswea.com.au

March 2002






Acknowledgements

The Australian Wind Energy Association (AusWEA) would like to acknowledge the support of the Australian Greenhouse Office which funded the preparation of these guidelines under the Industry Development Component of the Renewable Energy Commercialisation Project.

These guidelines are modeled on the format for best practice guidelines already adopted by the British and European Wind Energy Association and AusWEA would like to thank these organisations for permission to use the framework and content of those documents as a basis for these guidelines.

AusWEA also thanks the many stakeholders who assisted with their input, and in particular :
Department of Industry, Tourism and Resources
Department of Infrastructure, Victoria
Hydro Tasmania
Stanwell Corporation
Sustainable Energy Development Authority, NSW
Western Power

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Cover Photos : *Windy Hill Wind Farm, Courtesy Stanwell Corporation*
Codrington Wind Farm, Courtesy Pacific Hydro

1 Preamble

1.1 The Australian Wind Energy Association

1.1.1 AusWEA – Introduction and Objectives

The Australian Wind Energy Association (AusWEA) is a public company limited by guarantee that was established in Jan 2000 and currently has a rapidly growing membership representing all aspects of the Australian wind community. AusWEA represents developers, consultants, manufacturers, research and development organisations, and members of the general community already involved with, or interested in developing wind turbine installations, from small RAPS to large wind farms.

AusWEA's vision is for a robust Australian Wind Community that makes a significant contribution to safe, reliable, energy supply in Australia that is economically and environmentally sustainable. Our mission is to represent the Australian Wind Community and promote the sensitive and appropriate uptake of wind energy.

The objectives of AusWEA are:

- To promote the development of the wind industry in Australia, including project development, construction, manufacture, operations, maintenance and associated services.
- To raise the awareness of, and educate the Australian public about, wind energy and its potential.
- To produce reports, media releases, a newsletter and an internet site for the dissemination of information on industry participants and industry activities and, organise seminars and workshops for members and other interested persons.
- To promote and facilitate research and development of wind technology in Australia.
- To contract, as Australia's representative, to the IEA Implementing Agreement for the Co-operation in the Research and Development of Wind Turbine Systems.
- To advocate policy, and represent the wind energy industry to appropriate Federal, State and Local Government officials, elected representatives, regulatory bodies, electricity industry and consumers, committees and the general public.
- To advocate policy with wind industry groups and other interested organisations.
- To provide feedback concerning barriers to the widespread adoption of wind as an energy source.
- To actively seek affiliation with like minded organisations throughout the world.

1.1.2 AusWEA, AGO and these Guidelines

One very important aspect of AusWEA's work is to promote excellence in wind energy development and the association recognises the importance of ensuring that projects are appropriately sited and sensitively developed.

In late 2000, the need for a national wind industry best practice document was identified and AusWEA successfully applied for Commonwealth Government support for such an undertaking through the Australian Greenhouse Office (AGO), the government's peak body on greenhouse matters. The AGO funded the project under the Industry Development Component of the Renewable Energy Commercialisation Program.

These Best Practice Guidelines guide the developer through the steps that should be taken to develop a wind turbine generator project. As each project will be unique, no attempt has been made to detail every step that may become appropriate during the various developmental stages. However, this document does give an overview of the various aspects that play a significant role in the development of wind energy projects. It is important to understand all of these issues if a new project is to be successfully completed.

Professional support is of great importance for the successful development of a wind energy project. Part, or potentially all of the work involved can be contracted out to various consultants, including engineers, planners and lawyers, as there are now a number of firms with experience in wind farm projects in Australia. For such professional support it is strongly recommended that firms with a good track record in the wind industry are used.

Regardless of whether the developer intends to resource the project team internally or outsource a large part of it, proponents are urged to base the whole process on quality management systems such as those outlined in the Australian Standards (eg AS / NZ 9000). There is a strong need for professional project management, programming and coordination expertise from the early site evaluation stages right though to implementation. As with any large engineering project, a successful outcome is largely dependent on the ability of the wind farm developer to track progress, to identify opportunities for proactive measures and to provide corrective action where necessary.

The document also builds on existing literature and on experience gained from the first wind farms constructed in Australia. AusWEA would also like to acknowledge the companies responsible for their support in providing case study material for the guidelines.

1.2 Nature of the Guidelines

The guidelines aim to establish the process and approach for identifying, developing and implementing appropriate wind energy projects and it must be acknowledged that each wind energy development will require assessment on its individual merits. Similarly the exact timing of the various activities outlined in these guidelines will vary depending on the individual developer's preferred approach. As a result no attempt has been made to define a checklist of project specifications or provide a schedule that can be universally applied to all developments equally. The developer will always need to investigate specific issues that may relate to a particular site and address these accordingly during the development process.

The guidelines primarily cover technical environmental and planning considerations and consultation with relevant parties. They cover all scales of wind energy development but apply to different sizes of development in different ways. Although the principles contained in the guidelines should remain the same for all sizes of development, the work required by a developer in project design and environmental assessment will vary from project to project.

The Best Practice Guidelines recognise that some wind energy developments are built as single one-off projects, possibly by a landowner, while others are built by specialist development companies, who may be looking to develop a number of sites. The approach adopted by these guidelines is to consider the issues relevant for the development of an individual site, whilst recognising that the site selection process for the development is likely to entail a process of considering other possible locations.

1.3 Implementation

AusWEA intends that assessors of wind power projects will be able to use these guidelines as a benchmark to judge whether or not a project is appropriate. Adherence with the guidelines is voluntary but AusWEA urges its members and all responsible developers to take them into consideration in their activities.

AusWEA also invites local planning authorities to encourage adherence to the Best Practice Guidelines by recognising that this will foster appropriate and commendable wind energy development. Experience overseas has demonstrated that inappropriate wind developments can have negative impact on the industry during its nascent stages.

The guidelines are to be widely distributed within the industry and will be made available to other organisations and individuals on request. They may be reviewed periodically to take into account changing circumstances, and comments to AusWEA on the content of the guidelines are welcome.

1.4 Structure of Guidelines

The guidelines follow a chronological flow through the following phases of project evolution

- Site Selection
- Project Feasibility
- Detailed Assessment
- Planning Application
- Construction
- Operation
- Decommissioning

During each of these phases, the following issues are addressed :

· **Technical and Commercial Considerations**
This element considers various technical aspects of the development such as wind speed, accessibility, infrastructure, electrical connections, construction issues and the developer's own analysis of the economic viability of the project

· **Environmental Considerations**
Environmental considerations include all effects of the wind energy development on various environmental and amenity interests. The selection and development of appropriate sites will depend on the impact on these

factors. Environmental assessment is required in the initial site selection phase and then is followed up with detailed studies which support the development application, monitoring of the project in operation and final site clearance. Environmental assessment provides essential inputs to the detailed design of the wind energy project. Minimising effects on the environment, by altering wind farm design is however an iterative process requiring continual re-evaluation and good consultation throughout.

· **Dialogue and Consultation**
Two way dialogue between the developer and stakeholders in the project is essential if universal approval is to be obtained. Stakeholders who should be consistently consulted include the local planning authority, the local community, local interest groups and State government officials.

· **Contractual Considerations**
The issues that should be investigated at each stage are highlighted.

Although they are discussed separately, all four elements above are interrelated and they should be considered as having an important influence on each other.Table 1 below summarises the development process.

Table 1 – Project Development Phases and Summary of Activities

Phase of Project	Technical / Commercial Considerations	Environmental Considerations	Dialogue and Consultation	Contractual Considerations
1. Site Selection	Desktop studies covering potential wind resource, potential size of site, electrical interconnection, land ownership & current usage and construction issues. Preliminary consideration of site potential based on estimated wind speeds and capital costs.	Desktop studies including visual amenity, proximity to dwellings, ecology, archaeological & historical heritage, conservation & recreational uses, electromagnetic interference, aircraft safety and restricted areas	Initial contact with landowners and local authorities. Establish likely development consent process.	
2. Project Feasibility	On site wind monitoring, existing land use issues, ground condition evaluation, design & layout options, site access, grid connection issues, economic studies, consideration of planning consent issues Reassessment of financial viability of the site (including site wind data)	Clarification and Scoping of EIA requirements, assessment of state agency involvement, consideration of EPBC Act implications	Ongoing dialogue with local planning authority, including development application for monitoring, strategy for initial dialogue with local community, dialogue with other agencies, and initial discussions with Native Title claimants	Preliminary landowner agreement & identification of Native Title position
3. Detailed Assessment	Ongoing wind monitoring, wind turbine considerations, NEC requirements on electrical interconnection, ongoing economic evaluation, tendering for wind turbines, power purchase agreements, detailed assessment of financial viability	Environmental Impact Assessment – studies, documentation and amendments to design	Ongoing dialogue with planning authorities, statutory agencies, and special interest & community groups.	Preliminary connection and access agreements, incorporate easement or lease provisions in landowner agreements, agreement with Native Title claimants resolved
4. Development Application	Development Application and Environmental Statement			
5. Construction	Site management, health & safety, compliance with planning conditions	Adherence to Environmental Management Plan and planning conditions	Landowner and community liaison, media and general public relations	Manage construction contracts Maintain landowner contacts
6. Operation	Performance testing including turbine power, sound and availability, compliance with development permit conditions	Ongoing environmental monitoring, fielding of and dealing with complaints	Ongoing dialogue with local authority and community, media and general public relations	Occupational Health and Safety issues, develop O & M contract. Maintain landowner contacts
7. Decommissioning	Site management, health & safety, compliance with planning conditions	Land reinstatement considerations, environmental impacts of decommissioning	Liaison with local planning authority and state agencies	Remove all legal obligations

1.5 Stakeholders

It is important that developers understand from the outset the range of stakeholders that may be involved during the development of a wind energy project and their different roles, interests and priorities. Stakeholders are likely to include the following parties:

1.5.1 Land Owners or Crown Land Agencies

Access to appropriate land for siting of wind turbines is a requirement of wind developments which can be both lengthy and difficult. Usually this involves negotiations with the landowner or, in the case of Crown Land, the appropriate State based land authority. It is sometimes necessary to negotiate with adjacent landowners, for example for sound buffers or site access for heavy machinery, and in such cases negotiations may lead to formal legal agreements for the life of the project. Often such landowners can be vocal supporters of the project due to a financial incentive.

1.5.2 Local Authorities

State planning law often designates the local council as being responsible for assessing an application for development and issuing a Development Permit. Councils will base their assessment on the town or district land use/ zoning plan, and any relevant policies which have been formed by the council. Often councils will have a stated responsibility to encourage appropriate social and economic growth within their jurisdiction, so are likely to be favourable to wind farm developments provided that they fit into the other aims and ideals of the community. Local councils may also be required to refer development application matters to state planning, environmental protection, natural resources or infrastructure departments during the development application process, depending on the issues involved. Other local authorities such as those listed in the appendices may also have input in the planning, approval and ongoing operation of wind energy developments.

1.5.3 State Government

State government involvement will vary considerably from state to state and, for a given state, may also depend on the scale of the project. Involvement may be either directly in the assessment and approval of development applications by the Minister for Planning or through one or more of the government departments that are responsible for advising local authorities on particular planning issues and promotion and facilitation of new developments. The structure of such departments varies widely between states.

Given that wind farms have a high profile and graphically display sustainable industry, politicians are likely to be interested in staying informed of the details of significant projects, and may be interested in any associated publicity.

1.5.4 Commonwealth Government

1.5.4.1 The Renewable Energy (Electricity) Act 2000

The Act was passed by Federal Parliament in December 2000 and regulations concerning its implementation have subsequently been developed. The legislation, which requires electricity retailers to purchase an additional 9500 GWh per annum of renewable energy by 2010, is seen as the main driver behind the Australian wind industry.

Energy generated from accredited renewable energy sources such as wind power is tracked through the allocation of tradeable Renewable Energy Certificates (RECs) at a rate of one REC per MWh. The Office of the Renewable Energy Regulator (ORER) is responsible for maintaining the registry of RECs and renewable generators must register with ORER before being entitled to RECs.

1.5.4.2 Commonwealth Government and Approvals

Direct Commonwealth Government involvement in the approval of wind energy developments is currently only triggered where projects are deemed to potentially affect matters of national environmental significance under the Environmental Protection and Biodiversity Conservation Act (2000). In such cases developers will need to refer their proposals to Environment Australia who administer the act.

Developers may apply to the Federal Minister for Industry Science and Resources for Major Project Facilitation(MPF) status. Under MPF, the Commonwealth Government offers assistance in the streamlining of approvals for large developments. Such assistance is provided as a service through the Department of Industry, Tourism and Resources under the Invest Australia scheme (see Appendix for web address).

In order to be eligible for MPF status, the project must :

- involve total capital expenditure exceeding $ 50 m ;
- need Commonwealth Government approval(s) ;and
- be commercially ready to proceed through government approvals processes

If MPF is granted, Invest Australia will :

- provide information on approval requirements and identify the appropriate approval agency;
- coordinate Federal and State/Territory Government approvals requirements and processes so they progress simultaneously as far as possible;
- identify government policies, programs or entitlements relevant to a project; and
- develop a critical path monitoring system for all Commonwealth and State approvals processes.

1.5.5 Network Service Providers

Network Service Providers (NSPs) are the owners of the electrical assets to which the wind farm is to be connected. They may be either a transmission company, a distribution company, an electrical utility or a small grid owner/operator and are normally regulated businesses under the Electricity Act, as applicable in each state. NSPs are required under the National Electricity Code (NEC) to give generators the opportunity to connect to, and have access to the network services provided by the networks forming the national grid. Such dealings are overseen by the National Electricity Market (NEM), ACCC and NECA. In those states not connected to the NEM (ie Tas, WA and NT), access to transmissions networks is controlled by the state energy utilities. To enter the NEM a generating company must obtain a generators license by applying to the National Electricity Market Company (NEMMCO). Each generator must also be registered with NEMMCO before generation can commence. A pre-requisite for registration is to have a connection agreement with the NSP.

1.5.6 Electricity Retailers

Retailers are required to purchase renewable energy as a result of their obligations under the Renewable Energy Act and a significant proportion of this may come from wind farms. In addition, almost all retailers in Australia now offer both commercial and retail customers the choice of purchasing renewable energy through Green Power Schemes. Since the energy sourced to meet this demand is not eligible for Renewable Energy Certificates, Green Power constitutes an important additional driver for wind power projects.

1.5.7 Community Groups

Community groups include all those groups set up voluntarily by members of the community to pursue the interests of a common purpose. Examples are the Wilderness Society, the Alternative Technology Association, progress associations and Rotary or Lions clubs.

Whether a community group will support or oppose a particular wind energy development is likely to depend upon whether the wind project conflicts with the interests of the group. Some groups support projects on economic grounds whereas others may be skeptical due to concerns about noise and visual amenity.

Environmental groups can greatly affect the outcome of a proposed wind energy development, but it is important to note that perspectives and priorities of such groups will vary. Local environmental groups may be concerned about potential ecology issues or impacts on scenic or environmentally sensitive areas. Regional and national organisations may also focus on such issues, but will usually also acknowledge the beneficial role of wind power from a broader perspective.

It is to be expected that community groups that are impacted will be keen to participate in information sessions and consultation about the effects of a wind energy development. Importance should be placed on consultation programs early in the project, as such groups can carry significant weight in the approvals process through lobbying at local or state government level.

1.5.8 The General Public

There will always be diversity in public attitudes towards any wind energy development. As members of the general public will often have little knowledge upon which to formulate their opinion, it is the responsibility of the developer to provide accurate information and open dialogue as early as possible in the project. This will enable members of the public to evaluate for themselves the relative merits and detriments of wind energy developments. Strong public support is important to the success of any wind energy development and a key feature of any successful project is education and provision of opportunities for early and meaningful public involvement.

On a broader scale, the choices offered to domestic consumers under Green Power schemes also underline the importance of the role the general public plays in creating a demand for wind power. It is expected that this will increase as retailers move to differentiate between their Green Power products and offer their customers the option of choosing between a spectrum of renewables (eg biomass, hydro, wind, solar) as surveys have shown that customers strongly support wind energy when offered a choice between renewable sources.

1.5.9 The Media

Most members of the public will get all their information on a wind energy development through the media, despite the best efforts and intentions of the developer. The editorial line taken by the media can, therefore, take a pivotal role in the success or otherwise of a wind development. Time must be spent by the developer keeping media stakeholders informed, allowing them access to information and involving them in key project milestones, and developers may find media training in advance helpful.

Figure 1 Tree Flagging - an important indicator during site selection (courtesy Aria Professional Services)

2 Phase 1 – Site Selection

2.1 Introduction

The first phase in any wind generation development is initial site selection. For many developers the starting point of this process involves looking at a chosen area in order to identify one or more sites which may be suitable for development followed by site inspections. Where a number of prospective sites or areas have been identified, developers may need to prioritise these and thus should gain an early appreciation of the full range of issues that may be associated with each opportunity.

To this end, developers should identify the nature and extent of any guides for wind developments in that particular state or region.

The Sustainable Energy Development Authority (SEDA) in NSW has developed a comprehensive guide to wind projects in that state which includes not only a comprehensive background of the wind industry, but also an insight into the state's wind regime and wind farm planning requirements in NSW.

The South Australian government has conducted some investigations into the state's wind resource, a summary of which may be obtained from the government's sustainable energy website. In addition Planning SA has prepared an Advisory Notice for Planning Wind Farms.

At the time of writing, the Victorian Government was working on policy guidelines for wind farms that include a set of planning criteria for the design, siting and assessment of wind farm proposals within the operation of the land use planning system.

As the wind industry matures, regional planning guidelines will emerge as well (such as the Glenelg Shire Siting and Design Guidelines for Wind Farms - in Western Victoria).

Site selection and initial analysis of a particular site should take account of all readily available published environmental and technical data as discussed later in this section. Subsequent phases will require more detailed investigation.

The purpose of this phase is to identify suitable sites and define any technical, commercial or environmental constraints in order that only the most appropriate sites for development are taken forward.

2.2 Initial Technical / Commercial Considerations

The site selection process will largely involve desk based studies to determine whether sites satisfy five crucial technical criteria for successful development :

2.2.1 Potential Wind Resource

The developer can determine some idea of the wind resource by using a combination of maps, publicly available information about the wind resource in Australia and computer modeling. There are a number of publicly available sources of information about the wind resource in Australia such as wind studies carried out for state energy departments and agencies, Bureau of Meteorology (BoM) general publications and raw data, the Internet, and technical publications. Developers should however use such information with caution. Some historical wind resource studies did not take the potential impact of local topography and prevailing wind direction into consideration when siting the meteorological masts. Results are therefore sometimes artificially low, resulting in unduly pessimistic estimates of the wind resource in the surrounding area.

The use of BoM data for modeling purposes can also pose particular problems in terms of producing information about wind speed that is representative of the surrounding area. BoM sites are often not located with the primary objective of obtaining representative wind speed data (they may be primarily intended to measure rainfall or sunlight for example) and data from these sites may be substantially influenced by local conditions such as buildings and trees, particularly as the measurement height is usually relatively low at often only 10m height above ground level. BoM data is however often used to predict long term wind speeds (see 3.2 below) and can be extremely valuable where no data exists from specialised wind monitoring stations.

2.2.2 Potential Size of Site

Consideration of the likely size of the site will help to establish whether the development will be commercially viable. Some of the key factors that should be considered in estimating the potential size of a site include current land usage (including adjoining properties), siting of existing dwellings, proximity to environmentally sensitive areas and possible grid interconnection constraints.

2.2.3 Electrical Interconnection

An examination of the local electricity distribution system and dialogue with the local Network Service Provider (NSP) will indicate whether an electrical connection to the proposed site is technically and commercially feasible. In order for this to be done the NSP may seek some rough indication of the potential generation capacity of the site. The network operator may in some cases be able to give an order of magnitude indication of the likely cost of connecting the wind farm to the electrical grid, although this will depend on the degree of other network planning and upgrade issues under consideration. The developer should also be aware of the potential impacts of other wind farm developments that may be under consideration in the area, as the capacity of the grid to accept the output of wind farms may be limited.

Wind Corporation Australia Limited is preparing guidelines and action items to assist the process of developing small embedded wind farms based on the experience gained in the construction, monitoring and operation of the Hampton Wind Park near Lithgow in NSW. Developers of similar systems may find this a useful reference source.

2.2.4 Land Ownership and Current Usage

Developers should consider the number of landowners likely to be involved in the development and their current and future options for usage of the land. In addition, the number, size and usage of adjoining allotments should also be taken into account, particularly in relation to the possibility of a noise buffer being required around the wind farm. If the land is under control of the Crown then advice from the relevant state based land authority should be sought. Consideration should also be given to the possible cultural and heritage value of the land and investigation of the Native Title status at this point is recommended. Developers are encouraged to consult the Native Title Representative Body to determine what claims are current. A listing of native title representative bodies may be found at www.ausanthrop.net/research. Examination of the town or district plan (available from the local council) and cadastral information (available from either the council or the land titles office) will provide information about the zoning of the land.

Figure 2 – Transport of Wind Turbine Blades On Site (courtesy Pacific Hydro)

2.2.5 Construction Issues

An overview of site access constraints should be carried out. In particular, elevated sites are often only accessible by narrow roads with sharp bends, which may make transportation of long wind turbine blades difficult. Gradients and dips in access roads may also be critical in determining suitability of equipment such as low loaders for large plant transportation. Further, many areas of Australia suitable for wind farm development may only be accessible by dirt roads and the suitability of such roads for the heavy loads associated with wind farm construction and seasonal constraints such as potential for flooding should also be considered. Developers should also be aware that at the location of each wind turbine a hardstand and flat lay down area will be required to position heavy lift cranes and pre assemble turbine blades.

2.3 Initial Environmental Considerations

At the same time as carrying out technical analyses, developers should consider the likely environmental acceptability of potential sites. Many of the initial environmental acceptability considerations will be assisted by studies of existing data. As well as looking at reports and maps of the area in order to determine specific environmental issues, developers should have regard to existing and emerging national regional and local planning policies.

Initially developers should contact the local planning authority (council) to ascertain knowledge of and attitudes towards wind farm developments, particularly with regard to environmental issues. If available, developers should obtain a copy of the strategic development plan for the locality. In addition, the relevant organisations should be contacted to gain an insight into key environmental issues that may need to be addressed during the course of feasibility studies.

Studies should be initiated at a preliminary level to address the following range of issues, each of which will be scrutinized in greater depth in subsequent phases of project development :

2.3.1 Visual Amenity

Developers should broadly assess the visibility of the proposed site and the potential visibility of the proposed development from important public viewpoints. Notice should be taken of important or valuable view sheds, such as tourist viewing platforms or views from neighbours houses, and developers should anticipate the impact that the project will have on these. In doing so they should make an effort to become aware of the visual settings that members of the community and special interest groups value. These may become an issue during subsequent stages of the development, in particular during the development application process.

A preliminary assessment of bird strike risk should be undertaken based on existing information and a site inspection. This will determine if there is a particularly significant feature of bird use of the site that increases the likelihood of birds colliding with the turbines, and possibly flag the need to initiate early baseline monitoring. In this assessment, the presence of bird groups potentially vulnerable to striking turbines should be determined and advice sought on how this issue should be addressed in later stages. (refer to Appendices for further information on Ecology issues)

Figure 3 A substantial laydown area will be required during construction (courtesy Pacific Hydro)

2.3.2 Proximity to Dwellings

Wind turbines should not be located so close to domestic dwellings that they unreasonably affect the amenity of such properties through sound, shadow flicker, visual domination or reflected light.

2.3.3 Ecology

Developers should take early account of existing information relating to both ecological designations that cover a particular area and particular protected species of flora or fauna that are found in the area, either year round or seasonally. This can often be ascertained through a literature search, or by refering to Environment Australia's website.

2.3.4 Archaeological / Historical Heritage

The existence of listed buildings, conservation areas and areas of cultural significance to local Indigenous peoples may have an influence on the acceptability of a particular site. In researching areas of Aboriginal heritage through consultation with the relevant Indigenous organisation, special care should be taken to preserve the confidentiality and integrity of certain sensitive resources.

2.3.5 Conservation and Recreational Uses

The developer should research proximity of the site to designated conservation areas such as national parks and conservation reserves. In addition proponents should be aware of areas on or close to the site that are identified in development plans, or commonly used for recreation.

2.3.6 Electromagnetic Interference

Microwave, TV, radar or radio transmissions may be affected by the presence of certain designs of wind turbines. The location of microwave, mobile phone, radio and TV antennas should be noted for input into the wind farm design. Although in many cases technical problems can readily be avoided or resolved, developers should nonetheless make themselves aware of the potential for such interference. Further information on Electromagnetic Interference may be found in the Appendices.

2.3.7 Aircraft Safety

Developers should assess potential for aircraft safety issues by noting the proximity of the site to any major airports, aerodromes or landing strips. Proponents should contact the authorities responsible for the operation of such facilities in the vicinity of the proposed site.

In addition developers should obtain advice from landowners on any farming related uses of aircraft such as aerial spraying or mustering. In such cases the district aerodrome supervisor should be contacted for advice on the potential impact of a wind energy development on these activities.

2.3.8 Restricted Areas

Research should be carried out to determine whether any restrictions may apply to the development of a wind farm in the proximity of security areas, such as military installations, telecommunications installations, etc.

2.4 Initial Dialogue and Consultation

2.4.1 General Approach to Consultation

The sensitive initiation and ongoing handling of consultation with any stakeholders plays a key part in the success of any wind energy development. Stakeholders need to be kept regularly informed of progress. Should the developer elect to abandon a particular prospect or should the project look like being delayed by a time frame outside that initially discussed, stakeholders, particularly landowners, should be advised of this. Apart from being discourteous, developers who leave stakeholders guessing as to their intentions give the industry a bad name.

2.4.2 Landowners

Discussion and negotiation with the landowner/s or vested land authority over the parcels of land suitable for placement of wind turbines will inevitably be part of the site selection process. Other than this, almost all contact in this phase should be focused on the gathering of information, in order to decide whether to take the project further. In these early stages it is important that the developer respects the landowners right of ownership, has in place strategies for managing the expectations of landowners and other stakeholders, and is prepared to respond to queries on the nature and timing of the project. Whilst proposals remain at a speculative stage it is not normally appropriate for developers to start a broad process of local public consultation as this may cause unnecessary concern or excitement about a proposal which may transpire not to be practicable.

2.4.3 Local Planning Authority and Statutory Stakeholders

Developers should have initial discussions with the officers of the local planning authority and statutory stakeholders to explain the nature of the project and ascertain the zoning of the land in question. The local authority may be able to indicate the level of support the project is likely to receive and this initial contact will help make it easier to identify and agree on the potential issues that should be addressed later on in the project. The developer should also research the approval mechanisms applicable to the prospect as these vary widely from state to state. In particular environmental considerations are likely to involve a variety of stakeholders other than the local planning authority itself. For example some community groups, such as the State or Territory National Trust may have policies on siting of wind farms and the developer should be aware of these.

The local planning authority may be able to suggest some of the stakeholders worthwhile approaching and clarification regarding building approvals and other regulatory measures should also be sought at this point. Good research and consultation at this initial selection stage could avoid unnecessary time and expense on unsuitable sites.

2.4.4 Native Title Stakeholders

It is timely at this stage in the project to consult with the Native Title Representation Body to assess the State Native Title legislation and to ascertain the current legal position.

2.5 Contractual Considerations

Sometime during this phase, developers may wish to enter into a preliminary agreement with one or more landowners which sets out the intent for both parties to cooperate on the project. The specific approach and content is up to the developer (and to some degree the landowner) to decide, however it is likely to include an outline of key issues that would form the basis of a more formal agreement in later stages. Such an agreement is likely to build trust between the parties and will protect the investment that the developer makes in the site from this point on.

3 Phase 2 – Feasibility

3.1 Introduction

By the beginning of Phase Two, the developer will have identified a site for further examination. This site should then be subject to :

- a more detailed technical assessment including on-site wind monitoring;
- consideration of design and layout options and preparation of a preliminary design for the installation;
- further consideration and evaluation of grid connection issues;
- an economic assessment to establish the commercial viability of the project;
- an appraisal and scoping exercise to identify specific environmental constraints that would form part of the statutory environmental assessment in Phase 3;
- an assessment of planning constraints ;
- a risk analysis

It is during this phase that dialogue with the local community about the project should commence.

In addition to the above, as the knowledge base of a particular site improves, developers should consider whether some of the investigations carried out during Phase One may need revisiting in greater detail.

3.2 Feasibility - Technical / Commercial Considerations

Whilst Phase One activities are largely desk based with limited field studies, the focus of technical work during Phase Two will be to visit and/or survey the site itself to gather specific information for a selected site and determine further its suitability and viability. In addition, some of the activities initiated during Phase One may now need to be investigated in greater depth as part of the feasibility study.

3.2.1 Wind Resource

An approximate estimate of the wind speed over the site can be obtained from databases and computer models, however sensitivity of energy yield (and hence commercial viability) to wind speed requires a more accurate determination by actual site measurements.

Wind speed varies with height above ground level (a phenomenon known as wind shear). In general the measurement of wind speeds as close as possible to the hub height of a modern wind turbine is desirable and indeed this type of

Figure 4 – 10m Pole Anemometry Mast (courtesy Aria Professional Services)

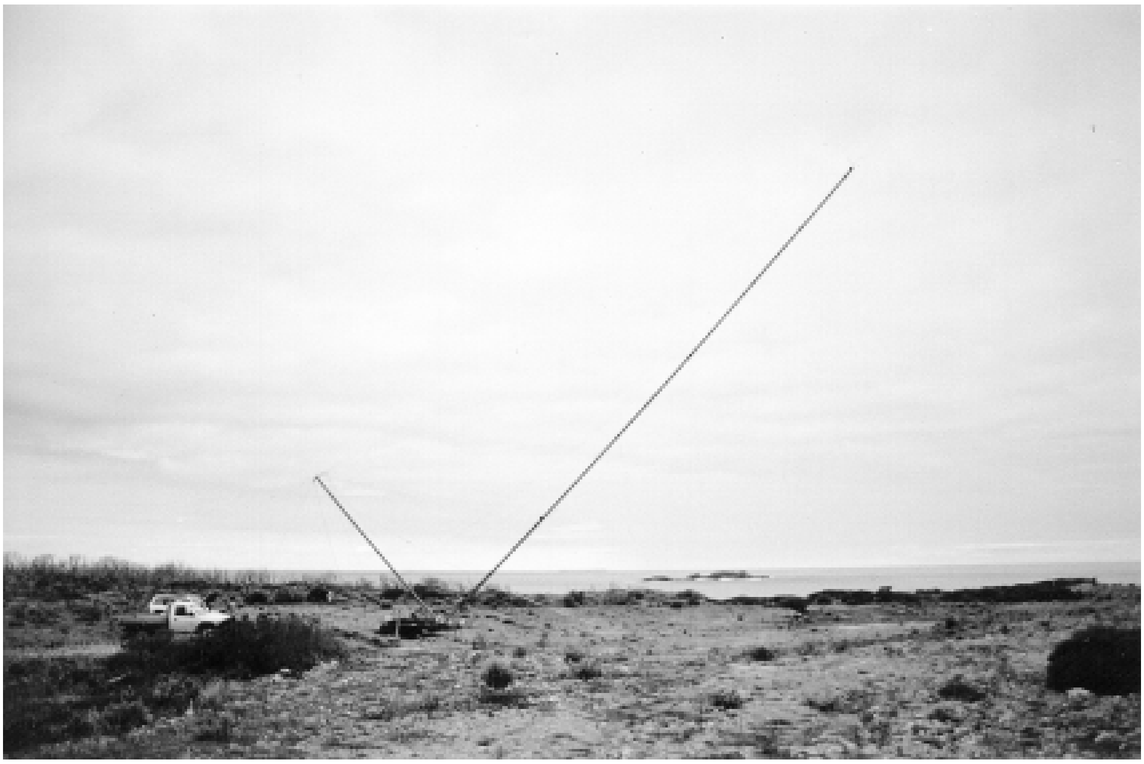

Figure 5 – Erecting 45m Pole Mast with Winch and Gin Pole (courtesy Envirometeorological Consultants)

data is sometimes necessary in order to obtain external finance for a project. However, the cost of wind speed data increases with its height above ground level due to increasing tower costs. Depending on the level of confidence inspired in the wind speed at the site from preliminary investigations, a developer may initially elect to monitor at a lower level to confirm a site's potential prior to investing in more expensive wind monitoring at, or close to hub height.

It should be noted that in some areas of Australia thermal inversion effects are present that may mean that measurements taken at lower levels bear little relationship to wind speeds at turbine hub height, particularly at night.

Wind anemometry equipment may be mounted on guyed pole masts or climbable lattice towers. The advantage of the latter is that instruments can be replaced without lowering the tower, although they are somewhat more expensive than pole towers. One or more of these masts may be required depending on the size and complexity of the topography at the site.

In siting of an anemometry mast it may be appropriate to consider security issues and the potential for vandalism or tampering with the equipment by curious parties. In addition, depending on the particular site, it may be necessary to fence the affected area to keep stock clear.

The duration of the wind monitoring program will depend on a number of factors, including the availability of suitable correlation sites for use in extrapolating the data gained during the measurement program over a longer period. Typically bankable projects require energy predictions based on at least one year of wind data, at (or as near as possible) to wind turbine hub height. As modern turbines may have a hub height in excess of 70m, in practice a compromise is often required that involves using a lower tower (often 50m or so in height) and utilising wind shear information deduced from data obtained from different levels of instrumentation on the tower to extrapolate wind speed to turbine hub height.

Once on-site data has been recorded, a long-term assessment is required to remove uncertainty due to the annual wind resource variability. This is usually done by comparing the data measured at the site, with a nearby long-term record. Since this analysis provides information crucial to the viability of the project, it is advisable for the developer to consult an expert with experience in wind data analysis for the purpose of wind farm development.

Many of these issues will be addressed in detail in the publication *"Wind Resource Assessment in Australia - a Planners Guide"* which is being produced by the Wind Energy Research Unit

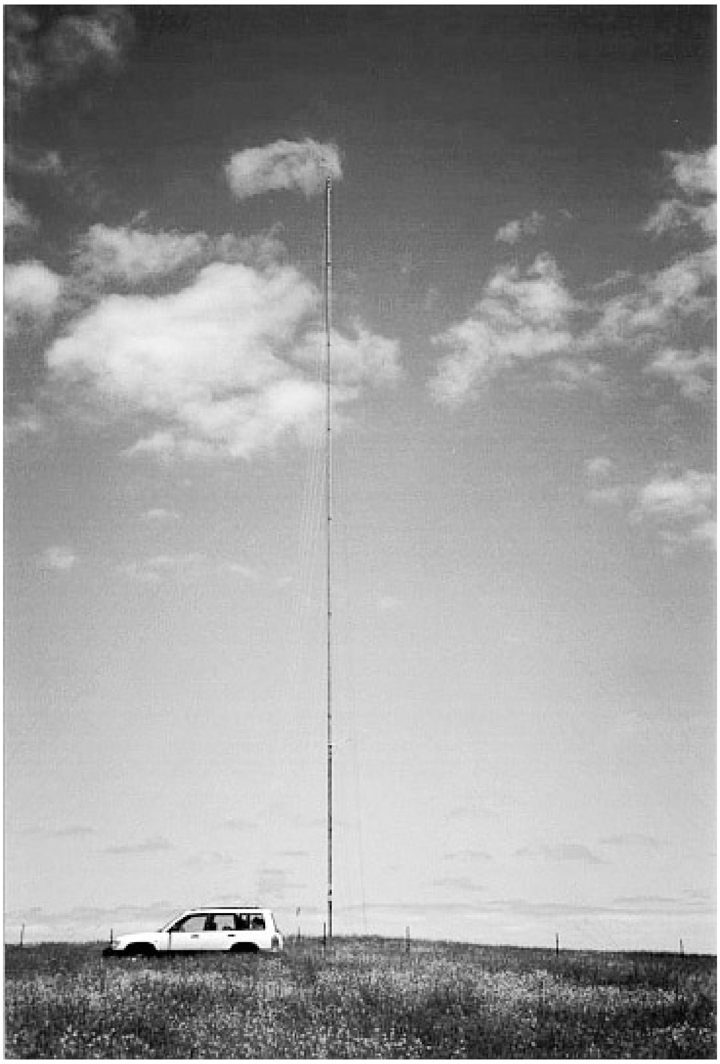

Figure 6 – 45m Pole Anemometry Mast (courtesy Pacific Hydro)

at CSIRO Land and Water with the support of the Australian Greenhouse Office and will be available in the second half of 2002.

3.2.2 Existing Land Uses

The existing uses of the land should be carefully discussed with the landowner, any tenants and all those with rights to occupy the land, to determine whether and how best the wind energy project can integrate with these existing uses. As an example, the importance to the landowner of the location of turbines and access roads will vary between arable land and pasture. Developers should do a title search through the Lands Titles Office. The developer should also discuss with the landowner the potential impact of aerial spraying operations on the project and identify whether any special constraints on the layout or operational precautions will need to be adopted.

Consideration should also be given to any ethnographic or archaeological significance the land may have to local Indigenous peoples. Developers should discuss this with the local Aboriginal community or organisation as there may be a need for a ground survey or even compensation before agreeing to a wind development. Legal advice during such discussions can be valuable.

3.2.3 Ground Conditions

Geotechnical engineering investigations should be carried out on the site to help assess whether construction of the foundations for the wind turbines, the erection of the machines and the provision of access roads is practical and economic. Such investigations may need to take into consideration the foundation design and could be required at each wind turbine location.

Figure 7 – Lower Section of 45 m Lattice Tower Anemometry Mast (courtesy Aria Professional Services)

As these details will not be known at this initial stage, some representative geotechnical testing may be appropriate, with more detailed investigations at a later stage.

Landowners may be able to give advice on features that may not appear on maps, such as fences, walls, streams and pipelines, which will need to be taken into account in the design and layout of the project.

It may be necessary to investigate any previous activity on the potential site that could influence the location of the turbines and their infrastructure (for example past mining activity under the site).

3.2.4 Draft Project Layout

All of the factors discussed above will need to have been taken into account in determining the scale of the proposed Wind Energy Project. Having made some initial determination of which allotments may be able to support a wind energy development, the proponent may wish to start developing some concept layouts of the wind farm (including possible locations, sizes and

Figure 8 – Geotechnical Testing at Wind Farm Site (courtesy Stanwell Corporation)

numbers of machines) to assist with broadscale financial modeling (based on potential energy yield) and also to use as a starting point for discussions with landowners and the local authorities.

Typically such concept layouts will need to be developed cognisant of minimum inter-turbine spacings and setbacks from roads and boundaries, and incorporate some conservative assumptions based on a preliminary assessment of potential environmental constraints.

At this stage of the project, all of these factors may be subject to change, and the developer will need to assess the level of refinement appropriate for such concept layouts, knowing that project design will possibly require reworking later as the constraints become better defined.

3.2.6 Site Access

The construction of a wind energy project requires access by heavy goods vehicles to the site. Access to the site must be assessed to determine the suitability of existing public and private roads and what improvements or special traffic control arrangements may be required to serve the development during construction. The local authority should be consulted.

Insofar as on site access is concerned, movement between turbines must also be practical and therefore the route of onsite access roads should avoid steep gradients, not only because of heavy vehicle considerations but also because of potential erosion issues.

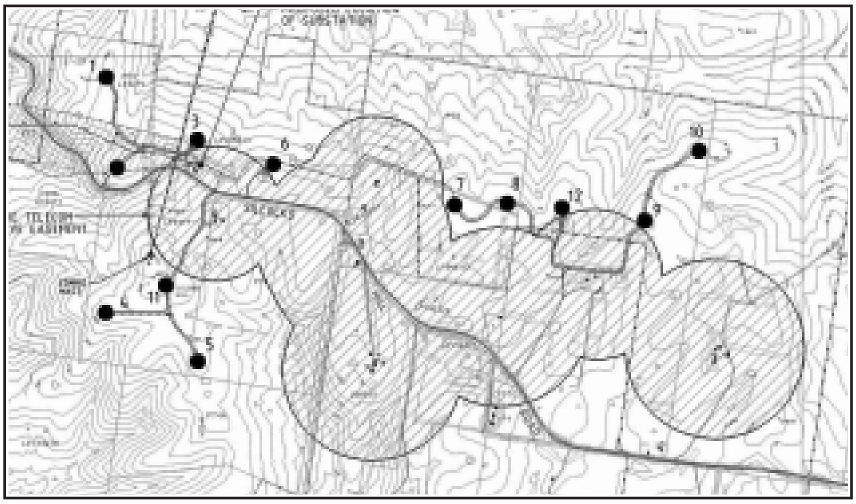

Figure 9 – Typical Preliminary Wind Farm Layout Showing Setbacks from Residences (courtesy Stanwell Corporation)

3.2.5 Energy Yield

Energy yield from the wind farm is of course an important input into the project layout. To obtain this information, analysis of the energy variation over the site is important. The most common method of mapping potential energy yield over the site is to use computer modeling programs designed specifically for this purpose. Such programs require wind data and detailed topographical information as inputs. It follows therefore that detailed contour data needs to be obtained at this stage of the project. This is done either by ground survey, or by mapping from stereo photographs taken from aircraft flying over the site. Again, it is advised that an expert in wind analysis for wind farms is consulted.

The location of and suitability for delivery of components from overseas should also be considered. Often it is most economic to off-load equipment at the nearest port rather than relying on long distance road transportation from major ports. Port authorities may also be contacted to ascertain the possibility of landing turbines.
The availability of large cranes, earthmoving equipment and concrete batching plants should also be investigated.

3.2.7 Electrical Connection

The cost of electrically connecting the output of the wind farm with the local electricity network will usually have a significant affect on the capital cost of any grid connected wind energy project. Interconnection may involve upgrading or re-routing of existing power lines, upgrading the existing substation or construction of a new one. It may also involve incorporation of capacitance or extra sub-station equipment to deal with the changeable power output from a wind farm. Often system studies are required to verify exactly what issues exist, and for this a suitable mathematical model of the turbine type being considered will be required. The need for such studies should be discussed with the NSP.

Further to the initial work carried out in Phase One, developers should consider the requirements set out in the National Electricity Code (or its state based equivalent) for negotiating connection to the network with the NSP. The Australian EcoGeneration Association is preparing a Guide for Connection of Embedded Generation to address some of the technical difficulties its members have faced in arranging connection for their embedded generation projects. Wind developers may find these and the guidelines Wind Corporation Australia is preparing to address technical, commercial and regulatory issues associated with the development of small embedded wind farms useful reference sources.

At this stage developers should carry out sufficient electrical investigations to determine potential cost implications of network interconnection. Studies may include consideration of a range of options for interconnection and substation location. A preliminary connection enquiry to the NSP would yield indicative costs, timing and other connection issues that the developer may face.

Wind turbines can be connected to each other by either overhead or underground on-site cabling. However because of the significantly improved visual effects (as well as operational convenience), under ground cabling is highly recommended and is often prescribed as a requirement by planning authorities. The routing of buried cables should be discussed with the landowner to identify any unforeseen constraints on the wind farm layout.

3.3 Feasibility - Environmental Considerations

The environmental issues identified during the Phase One (Site Selection) should be revisited in further depth at the feasibility stage. For some sites, with little or no published data available, it may already have been necessary to undertake some preliminary survey work in order to identify the environmental sensitivity of the site.

3.3.1 Local and State Planning Authorities

During Phase Two the developer should obtain formal clarification on the scope of environmental assessment that will be required by the local and state authorities during Phase Three (for more detailed information see section 4.3). It should be noted that in some cases these authorities may be unfamiliar with the assessment of wind farms and in such situations the developer can assist by providing background information based on past industry experience. It is also likely to be beneficial for members of the local authority who have not yet had exposure to planning and development of wind farms to contact planning personnel in other regions who have had such experience. This will help maximise the opportunity to capture all of the relevant issues.

Proponents should investigate which state government agencies the project may need referral to. Some guidance on the agencies that should be consulted may be available from the local authority or the state planning authority. As mentioned previously developers should be aware that the structure of such agencies varies significantly between states.

3.3.2 Commonwealth Authorities

3.3.2.1 EPBC Act

The developer should investigate whether any aspects of the project are likely to be subject to scrutiny under the *Environment Protection and Biodiversity Conservation Act 1999.* Sanctions under the EPBC Act are higher than any recent environmental legislation. Developers should be aware that third party provisions in the Act enable local environment groups to seek court injunctions to stop works immediately if they can show that a matter of national environmental significance will potentially be affected by a develop

The EPBC Act prescribes the Commonwealth's involvement in environmental matters where an action has or will have a significant impact on a "matters of national environmental significance". Detailed administrative guidelines are to be found at www.environment.gov.au/epbc, however a summary of key environmental considerations under the EPBC Act is as follows:

- World Heritage listed properties
- Internationally important wetlands
- Nationally threatened plant and animal species
- Listed Migratory Species (mostly birds)
- Commonwealth Marine Areas (unlikely to be relevant to wind energy developments)
- Nuclear Matters (again not relevant to wind energy developments)

Under reforms currently planned, the EPBC Act will be amended to identify, conserve and protect places of national heritage significance, provide for the management of Commonwealth heritage places and establish the Australian Heritage Council (see below).

If there is a question mark as to the impact of a proposed development, a referral should be submitted for a decision. Again, guidelines on the required format and content of referrals are available at the EPBC website.

At Commonwealth level, where involvement has been triggered under the EPBC Act, the Commonwealth Minister for Environment and Heritage may accredit the state environmental assessment process to satisfy assessment under the EPBC Act.

It is noted that the Commonwealth is currently negotiating bilateral agreements with the state governments which will allow states to assess compliance with the EPBC Act. However at the time of writing only Tasmania has such an agreement formally in place.

3.3.2.2 Australian Heritage Commission Act

The Australian Heritage Commission is an independent statutory authority administered as part of the Commonwealth Environment and Heritage portfolio. Protection of the National Estate at the Commonwealth level under the Act currently works through the identification and listing of significant historic, Indigenous and natural environment places in the Register of National Estate (RNE), (see www.ahc.gov.au). Developers should be aware of the existence of any such listed places and seek advice as to the impact of these on the project. The obligations to protect heritage values of places in the RNE can apply if an action is adjacent to or near to a place in the RNE if the significance of the place is likely to be affected. For example, if the landscape of the place has been identified in the heritage statement of significance as an important value then the consideration of a wind farm on a nearby site could have a significant effect on heritage values. Under reforms planned for the Commonwealth Heritage regime, the protection of places of national heritage significance will be the responsibility of the Australian Heritage Council – an independent expert body to advise the Minister for Environment and Heritage.

3.4 Feasibility - Dialogue and Consultation

During this phase the developer should consider opening early dialogue with the local community about the project. AusWEA has developed for its members a Wind Power Fact Sheet (refer Appendices) aimed at bringing new stakeholders or those generally interested in the industry quickly up to speed with some of the wind energy basics.

Best results are likely if the initial consultation is carried out in a formal, but open and low-key manner. Records should be taken of questions asked, numbers of attendees and the contact details of parties interested in receiving further information.

Where possible, stakeholders should be given the chance to feel part of the project development process. It is important to make clear that at this stage the developer will only have minimal information and that the project is still at the feasibility stage. Stakeholders should be advised that the success of the project will depend on the satisfaction of many criteria, only one of which is wind resource verification. Again it is important that developers openly and sensitively respond to stakeholder interest and expectations during the feasibility stage.

When starting detailed stakeholder and community consultation on the feasibility of wind energy projects in specific areas, developers should provide details of companies that would be involved. In particular local communities are likely to be interested in the proposed involvement of any local companies (such as engineering workshops for example). It is important however, that promises of jobs that may not eventuate, are not made.

The development company should also nominate it's representative for regular contact during these preliminary studies and a point of contact with a telephone number and /or address.

Figure 10 – Workers Atop 1.8MW Wind Turbine (courtesy Western Power)

3.4.1 Local Planning Authority

The developer should notify the local planning authority of its intention to initiate a feasibility study on the selected site. It is in the interests of all parties at this stage to communicate freely to avoid unnecessary work.

In particular developers should ascertain from such discussions whether development approval is required to erect an anemometry tower. In most cases 10 meter anemometry masts will not require planning permission, however developers should consult the local planning authority on specific planning requirements.

Developers should also obtain advice from the local planning authority on the extent to which publicity should be given to the erection of anemometry masts. Depending on the location, if mast-based anemometry is likely to be required for more than three months it may be appropriate that publicity be given to the intent to erect anemometry equipment and to the purpose behind this so that the local community is made aware. However for more remote sites or where developers intend to undertake short-term near ground measurement as part of initial site selection, publicity may well not be appropriate. Many sites are considered in this way and then rejected.

3.4.2 Local Communities

At this stage the developer should work with the local planning authority to consider how the informal public consultation should be conducted and how its results should be taken into account. In particular developers should be mindful that ill informed rumours regarding a potential development can spread quickly in small communities underlining the importance of opening appropriate dialogue early.

Public consultation should be kept general, with widespread advertisement, and be scheduled at a time and location that will be as convenient as possible for the community. One-on-one consultation may be more appropriate with non statutory groups (for example amenity groups, community organizations, environmental societies, and wildlife trusts) and individuals who have an interest in the proposed development.

“Respecting Indigenous Heritage Places and Values, A Practical Guide” is a publication available from the Indigenous Heritage Section of the Australian Heritage Commision and which deals with issues relating to the identification, management and use of Indigenous heritage places and values.

Education of the local community about wind energy should be initiated via a variety of means, which may include introductory presentations, information sessions, provision of published background material and so on.

It should be accepted that there will be a range of options for the proposed wind energy project itself, however the developer should be able to at least indicate the anticipated size of the proposed project and approximate number of turbines.

The public information provided should give a clear indication of the future stages of the consultation and development process so that individuals will know what opportunities are available for commenting on issues of concern to them. In addition, the developer should describe the purpose of wind monitoring masts, the likely period for which they will be needed, the environmental and planning studies to be undertaken for the project, and when a decision on whether the project is to proceed further is likely to be made.

General background information on existing wind energy projects should help answer many of the early local community questions at this stage.
Comments received from this consultation will give an indication of the breadth of local views. Such local feedback will be useful to the developer and subsequent reappraisals of the project design.

3.4.3 State and Commonwealth Agencies

The degree of consultation entered into at State and Federal Government levels will depend on the particular planning approvals processes involved. It is in the best interests of the proponent to identify the relevant stakeholders as early as possible to gain an insight into potential issues which may impact the decision to progress a particular project to the detailed assessment stage.

Planning legislation can be quite complex and, as mentioned earlier, varies considerably from state to state. Statutory legislation may require that all development applications are assessed by state agencies. Where there is no prescribed direct involvement at state level, integrated planning or similar legislation may require proponents to refer some aspects of development applications to state government agencies. Alternatively the local authority may also write to the State Minister for Planning requesting that he “call in” the application. Where applications are called in, the State Minister effectively takes over the assessment.

Involvement at Commonwealth level as a result of the EPBC Act or a request by the developer for Major Project Facilitation (see Section 1.5.4) will also determine whether Commonwealth stakeholder consultation will be necessary.

3.4.4 Other Agencies

Developers should provide the (AIS) Aeronautical Information Service with the timing, description and location details of any anemometry towers exceeding 20 meters in height.

3.5 Feasibility – Contractual Considerations

3.5.1 Wind Monitoring Agreements

As discussed, one of the important tasks at this stage of the development will be to measure the wind resource with equipment installed on the site. Given that the planned location for the anemometry mast on the site is normally owned by parties other than the developer, it is wise at this point to draft a simple but sound wind monitoring agreement which specifies the terms and conditions of the arrangement between the parties. Typically such an agreement would cover :

- Liability for damage to equipment or caused by equipment
- Right to enter the land for installation and maintenance
- Conduct of the developer on the site
- Ownership of data recorded
- The duration of the agreement
- Details of any payments to be made
-

3.5.1 Landowner Option Agreements

Depending on the approach adopted, the developer may need to enter into further landowner agreements which set out the terms between the parties that would be applicable in the event of the wind farm development proceeding, although in some cases this has already been done during the site selection phase. As an outcome of feasibility studies however, the developer may identify additional parcels of land that are suitable for the placement of wind turbines and agreements with the owners of these will also need to be negotiated.

For such agreements it is strongly recommended that the developer seeks legal assistance to ensure that the needs of both parties are documented in a fair and workable manner. The developer may also wish to recommend that the landowner also seeks independent advice from a solicitor on the agreement.

3.5.2 Native Title Agreements

Moves towards a legal agreement with Native Title Claimants will also be appropriate at this point, if the area of land is subject to Native Title Legislation.

3.5.3 Sub Consultants

Because of the range of issues that have to be addressed, it is likely that the developer will need the assistance of specialist subconsultants during the feasibility stage and these will need to be appointed under an agreed contract (normally based on standard terms of engagement).
Some of the engineering disciplines that may be required include :

- Geotechnical
- Wind Power
- Environmental
- Civil and Structural
- Electrical
- Project Managment
- Planning

In addition legal and financial advice may need to be outsourced.

4 Phase 3 – Detailed Assessment

4.1 Introduction

A developer will implement Phase Three only when the information obtained from Phases One and Two shows that the proposed wind farm will be commercially and environmentally viable. At the beginning of this stage the developer should have a preferred layout and should have conducted some financial analysis of the project using on-site wind data. The layout may well evolve further during the course of the environmental assessment process.

4.2 Detailed Assessment - Technical / Commercial Considerations

Throughout Phase Three the developer may continue to gather wind data and to re-appraise the economic viability of the project. The developer should take account of the economic implications of any recommendations that may arise as a result of the detailed studies and discussions with stakeholders that are an important part of this phase of the development. As an example the locations of turbines may need to be changed to reduce the visibility of the development from a particular viewpoint, affecting the energy yield and hence the overall economic viability of the project.

4.2.1 Selecting the Most Appropriate Wind Turbine Generator

A number of factors will determine the choice of wind turbine generator for a given site. The wind speed distribution of the site and the power curve of the turbines under consideration will be two of the most important, as they have a direct relationship to the amount of electricity and hence revenue that the site will generate. The wind speed distribution has a direct bearing on the optimisation of rotor and generator dimensions and tower height to maximise energy generation from a given site. Higher towers and larger rotors for a given generating capacity will usually provide higher overall capacity factors at lower wind speed sites.

The wind turbine offered needs to be designed for wind conditions in excess of the conditions found at the site. Discussions may be needed with the turbine suppliers on the need for site certification for a wind turbine model and tower height if the model is designed for a lower WTGS class. WTGS classes are defined in terms of wind speed and turbulence parameters. Expert advice should be sought on the wind monitoring requirements necessary to define the wind conditions so that the correct choice of turbine is made.

The prices offered by the different manufacturers will also have an obvious bearing on the selection process, however it is also important that the ability of the different turbines on offer to meet the environmental and planning constraints of the site, such as noise and visual impact, be considered. It is noted that is some cases the willingness of a manufacturer to customise their turbine to meet specific environmental requirements at a site may influence the eventual choice of turbine. A further consideration may be the capability of the turbine supplier to provide personnel for operations, maintenance and training of the owner's operators for some initial period post commissioning.

The usual mechanism for developers to obtain this kind of detailed information about possible wind turbines for the site is to go to tender. The tendering process includes scoping the requirements of the project, writing tender documents, issuing tender documents, receiving replies from tenderers, assessing the tenders, negotiating with the most attractive tenderers, and finally awarding the contract to the successful bidder. It is advised that this process be conducted by experts in the wind industry with experience at running tendering processes.

4.2.2 Electrical Interconnection

Developers will need to continue dialogue with the NSP working through network interconnection issues using the requirements set out in the National Electricity Code or, where relevant, alternative state based codes. At this stage of the project developers will have the opportunity to identify any significant technical, cost or schedule issues associated with network interconnection that may have an impact on the project.

Detailed assessment is likely to involve computer simulations of the wind farm and its interconnection. This is to verify that the output of the wind farm does not cause disturbance to the electrical system or to the adjoining customer/generators. Such studies are likely to be costly and take significant time.

4.3 Detailed Assessment - Environmental Considerations

4.3.1 Need for an Environmental Impact Assessment

During the feasibility stage the developer should have consulted local or state authorities on the scope of the environmental assessment that will be required. Where authorities believe that the proposed wind farm could have significant effects on the environment by virtue of factors such as its nature, size or location, a proponent may be required to submit a formal environmental assessment, sometimes including an environmental management plan. In some cases developers may be required to carry out a full Environmental Impact Statement (EIS) or equivalent, depending on the state environmental laws. In other situations an Environmental Effects Statement (sometimes known as a Review of Environmental Factors or Statement of Environmental Effects) may be considered adequate. This process may be overseen by either a local authority or state authority.

Irrespective of the level of reporting prescribed, it is recommended that developers as a minimum review and document potential environmental impacts and measures taken to eliminate or mitigate these. In the event of an appeal, such studies can be useful in allaying concerns that environmental implications of the project have been overlooked.

4.3.2 Topics for Inclusion in the Environmental Impact Assessment

It is very important to seek advice from the planning authority, and/or planning experts on the requirements of environmental impact assessment. Broadly, however, the issues that should be considered for environmental assessment are described below with guidance on the type of assessment required. It should be noted that during the course of detailed evaluation of these issues it may be necessary for the developer to amend the proposed wind project design.

4.3.2.1 Site Description and Reasons for Selection

The setting for the project should be described, summarising characteristics such as topography, climate, existing land use and allotments likely to be affected.

Following on from Phase One (Site Selection) developers should be prepared to explain why they have selected the particular site under assessment.

4.3.2.2 Development Controls

The developer should provide an appreciation and analysis of the development control framework and how it is understood to relate to the development. An analysis of the planning framework is important because in many cases existing planning policy will contain no reference to wind energy development.

4.3.2.3 Visual and Landscape Assessment

The existing landscape should be described, and the potential landscape and visual impact of the proposed development assessed and evaluated. It is important to bear in mind that visual amenity must always be considered in the context of the existing environment and with an appreciation of the value that the local community puts on rural character and landscape attributes, and the environmental assessment should reflect this.

Given that the visual impact of the development is likely to be one of the most significant issues in the assessment of the project, it is highly recommended that experts in the analysis of the visual characteristics of the environment are consulted. For example landscape architects may be able to provide professionally presented quantitative descriptions of the visual impact a project is likely to have and how this relates to the visual amenity the local community may value.

A “Zone of Visual Influence” or “Seen Area Diagram” should be defined and a map produced which indicates where the proposal may be visible from, within a radius agreed with the local planning authority. Such a study can then be used in consultation with the planning authority and relevant stakeholders to decide important and representative viewpoints from which the visual impact of the proposal can be

Figure 11 – Photo Montage of Proposed Wind Farm (courtesy Hydro Tasmania)

assessed. These points are likely to include local settlements, important public viewing points and should include a range of distances from the proposed project and may cross administrative boundaries.

Once these points are selected, visual simulations (or photo-montages) of what the proposed project is expected to look like from these viewpoints can be created and used for further consultation with stakeholders.

Developers should consider the proximity of the proposed project to already existing or other proposed wind energy projects and whether it will be possible to see one or more such projects from agreed viewpoints in the surrounding area. The significance of any cumulative impact should be assessed.

Other factors that may be considered in the visual impact assessment include turbine colour schemes and how these fit with the local environment, turbine markings and lighting, turbine size, the spacing between turbines and the colour of, and location, of step-up transformers and sub-stations.

It is also often advantageous to investigate the visibility of service roads and any overhead power lines. Roads can be visually intrusive unless cut and fill is minimized. Roads should follow land contours closely and the resulting colour should be sympathetic to that in the area. Overhead power lines can also be designed to follow land contours, such as gullies, to lower their visual affect and can be coloured and designed to blend into the landscape.

The developer should also assess the movement of the shadow of the turbine on sunny days at any time of year and the possible impact on residents. When the sun is just above the horizon, the shadows of the wind turbine generators can be very long and could move across a house for a short period of time. In some cases blade shadows can cause a flickering effect. The time at which this may occur and the exact position of the shadow can be calculated very accurately for each location, and the developer can if necessary put various mitigation measures in place.

4.3.2.4 Assessment of Turbine Sound

The advisable distance between residences and a proposed development to avoid any disturbance of neighbours of the wind farm will depend on a variety of factors including local topography, the character and level of local background noise and the size of the development.

Most state Environmental Protection Agencies (EPAs) have set limits for sound experienced by residents as a result of emissions from industrial sources in country areas. These limits are usually given in either absolute dB(A) or dB(A) above background noise, and require that sound emissions should be measured according to appropriate Australian Standards. Unfortunately neither the specified limits, nor the measurement and assessment methodologies contained in the current Australian Standards, are entirely appropriate for wind turbines as they rely on measurements/predictions at low wind speeds, when the wind farm is least likely to be producing any sound.

Wind turbines are unlike a typical industrial noise source, because the character of the sound is more natural (not mechanical, impulsive or tonal), and the level of noise is closely related to the wind, which also provides masking. For example the measurement of sound emissions at very low wind speeds (when there is no wind to mask the sound) is perceived to be the worst case scenario for conventional sound emissions but in these conditions a wind farm emits no sound at all, as there is insufficient wind for the turbines to operate.

Currently some local councils use the state EPA standard whilst others have required that wind farms meet the limits given in the draft Australian Standard DR96900, Assessment and Measurement of Sound from Wind Turbine Generators (also known as NZ:6808). AusWEA is currently actively pursuing the establishment of a national limit of acceptability for the sound of wind turbines at residential and noise sensitive locations surrounding wind farms combined with a consistent methodology for the prediction and assessment of this noise based on DR 96900. However until such a national standard is established, discussion will be required with the local council and the EPA to determine the measurement methodologies that should be employed and the limits that should be applied, in order to meet the common objective that the lives of those around the proposed wind farm are not detrimentally affected by sound from the installation.

A developer can expect that prediction of the sound levels at sensitive locations and assessment of the acceptability will require computer modeling of the sound propagation from each wind turbine. Usually this will be followed up with background noise measurements at any noise sensitive locations such as residences where it seems possible that the limits to be applied to the development may be exceeded. If in doubt, it is always best to measure background noise directly to verify or improve the accuracy of noise modelling and this is especially important if noise sensitive residences are close by.
The local authority may also require that measurements are taken at additional sensitive locations. These background noise measurements will usually involve a noise logger being installed in a position representative of background noise, close to the noise sensitive location and a temporary anemometry mast and logger installed at a location where it can provide wind speed information that will be representative of the wind speed experienced by the turbine(s) closest to the location.

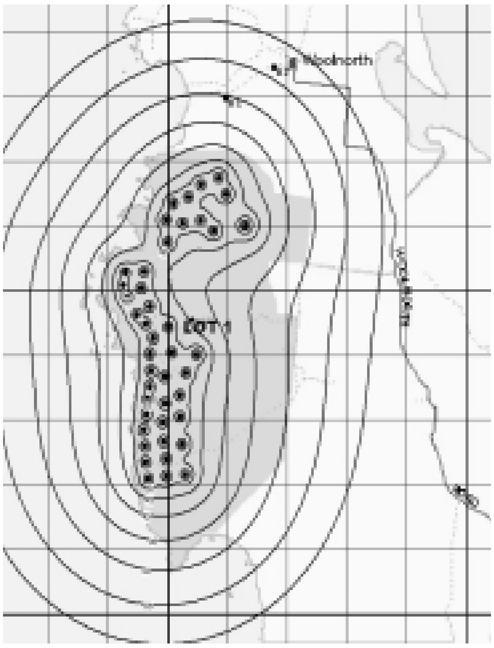

Figure 12 – Noise Contour Plot Showing Predicted Noise Levels at Residences (B1 & B2)(courtesy HydroTasmania)

Data is collected from the anemometry tower and noise logger over a range of wind speeds for a period of several weeks. The analysis of this data enables the relationship between the wind speed at the proposed turbine(s) and background noise levels at the location to be established. This information, combined with the wind turbine sound level predictions provided by the turbine manufacturers, enables a prediction of the conformity of the proposed project with any limits that will be applied.

In addition the environmental assessment should also include reference to the handling of noise during the construction phase of the project. Normally references are limited to a description of the hours in which construction activity will be undertaken.

4.3.2.5 General Ecological Assessment

The flora and fauna that are found at the proposed site (either year round or seasonally) should be considered in relation to loss of habitat, sensitivity to disturbance, and to their importance as identified by national and/or local law or policy. As there are significant seasonal changes in flora and the presence and/or detectability of many fauna due to migration, it is important that ecological survey work is undertaken at the appropriate time of year.

The developer should meet with the local planning authority and relevant stakeholders to discuss the timing of construction and scope for adjustment of wind turbine positions to avoid important species or habitats. Furthermore, there may be a requirement for ongoing monitoring or development of an overall environmental management plan to be followed during construction or for a defined number of years post construction. These issues should be discussed with the local planning authority and with the relevant stakeholders.

A well-designed project should aim to avoid significant impacts on native plants and animals. Any study should also include power line routes and any other areas that would be disturbed during construction, such as turbine lay down areas, site offices and storage sheds.

4.3.2.6 Vegetation

Sometimes it is necessary to disturb vegetation in a wind farm development. If so, it is common practice to involve a flora specialist who can advise on the types, locations and significance of species in the area. Normally this involves some type of information mapping, often referred to as vegetation mapping through field surveys. This can help the developer avoid critical areas and species by placing turbines and service roads appropriately.

It is good practice to also identify weeds in an area so that their dispersal can be avoided by instigating weed hygiene in construction practices. This can involve simply avoiding certain areas or be as involved as subjecting construction vehicles to high pressure cleaning.

If rehabilitation of disturbed areas will be required it is important that the local biomass be used for rehabilitation materials. Vegetation material to be disturbed can be mulched and kept aside with removed and stockpiled top soil, to be re-spread at the end of construction over those areas disturbed. It is good practice if a significant area of flora is to be disturbed to identify early on the supplies of seed available, or to initiate provenance seed collection early so that some is available from the local genetic material when required. Provenance seed collection will need to be just after flowering so will be seasonal in nature.
In some parts of Australia flora diseases exist and, if so, this needs to be identified early so that appropriate measures can be considered. This is particularly important if native vegetation disturbance is required. Fire is also a threat to land under crop or covered in remnant native vegetation. A fire mitigation strategy should be considered in such circumstances in consultation with the local fire brigade or fire control specialist.

In negotiations with contractors for work, it is good practice to include unauthorised vegetation clearing penalties per square metre if such clearing is unacceptable. Breaches of weed and disease hygiene principles can also be similarly dealt with. A more detailed discussion of vegetation issues is given in the Appendices.

4.3.2.7 Birds and Bats

Inappropriate developments may represent a risk to birds and bats if this issue is not taken into consideration at the site selection and feasibility stages. Detailed assessment should bring together the results of all previous bird investigations of the site and provide detailed input into the design and development application documentation for the project.

Given the lack of information on bird risks from such projects under Australian conditions, the planning authorities generally take a precautionary approach and may place conditions on development approvals that require modifications to operations after a period of monitoring. These conditions can represent a considerable risk to the economic viability of a wind energy development. To mitigate this, expert advice on bird and bat risks from the project should be obtained early in the feasibility study and such information should be provided to the relevant authorities at an appropriate time.

It is strongly recommended that during the detailed assessment phase of the project a scientifically rigorous study of the activities over all seasons of birds and bats is carried out. Such studies need to incorporate an assessment of cumulative impact from other wind developments such as effects on migratory routes and so on. By using these methods an objective and factual assessment of the effects of wind farms on birds and bats will be developed.

More discussion on how such studies might be approached is given in the Appendices.

4.3.2.8 Other Fauna

It is normal practice in wind farm development to assess the impacts, if any, on other ground based fauna living or passing through the area. It has been well established that such effects on domestic and grazing animals is small and on farming properties it is normal for such animals to graze up to the base of turbines.

Anecdotal evidence from operational wind farms in Australia is that effects on native fauna from operating wind farms is small if not negligible. However, often such effects are subtle and can involve disruption to migratory movements, an increase in the risk of feral predators being introduced and disruptions to feeding and breeding patterns. Construction noise and increased traffic can also disturb fauna resulting in changed behavioral patterns.

Assessing the effect on native ground based fauna will require expertise so that the process is rigorous and detailed. It may be a simple matter of a desk-top study if the region is well known, or it could be as involved as a trapping program over different seasons. It should not be necessarily assumed that grazing or farming land does not contain native fauna – while large mammals may not be present, smaller mammals and Herptofauna (such as lizards, frogs and snakes) may be present in large numbers. In this regard specialist advice may be required.

Again, the Appendices contain more advice about fauna work for wind farms.

4.3.2.9 Archaeological and Historical Assessment

Phase One will have identified the existence of any sites of significant archaeological or historical importance within or near to the site and the likelihood of further, as yet undiscovered, remains should be considered. To this end, consultation with Indigenous stakeholders is appropriate and should be documented in the assessment. It is recommended that investigations include a site visit at this stage, the results of which should be included in the development application. In the case of discovering Indigenous remains, it is necessary to comply with Section 20 of the Aboriginal & Torres Strait Islander Heritage Protection Act 1984.

Mitigating measures to minimise the effects on sites of significance should be discussed with the local planning authority and relevant stakeholders. This may in some cases result in conditions on the development approval or a legal agreement.

4.3.2.10 Hydrological Assessment

An assessment of the impact of the proposed development on water courses, their quality and quantity may be necessary. In some cases an assessment of spring water supplies may also be appropriate.

4.3.2.11 Electromagnetic Interference Assessment

Although rare, wind energy projects can potentially cause interference to nearby television and microwave systems. Communication system users should be approached for their views. Adverse impacts on microwave or television links can usually be avoided by re-siting wind turbines to avoid the line of sight between transmitter and receiver, however it is highly recommended that signal strength studies be performed in locations which are sensitive. These studies should be carried out before and after wind farm construction to enable a comparative assessment of the impact the wind farm has had.
If problems occur, there are some technical solutions available, such as improved aerials, or boosters if local television reception is found to be affected.

A more detailed discussion on electromagnetic interference is included in the Appendices.

4.3.2.12 Aircraft Safety Assessment

Wind energy projects need to be sited so as not to cause a hazard to aircraft safety. The first point of contact for wind farm developers seeking more information on air traffic issues should be the Civil Aviation Safety Authority (CASA). Developers may be passed on to Air Services Australia (ASA) who are more likely to be able to answer specific technical queries, such as the location of radar and communications equipment at the particular facility involved. Potential impact on aviation should also be verified through consultation with nearby airport and aerodrome operators.

Federal Airports Regulations require major capital city airport operators to notify the

Department of Transport and Regional Services of any potential infringement to the prescribed airspace of that airport. In the vicinity of other aerodromes, Civil Aviation Regulations require the operators to notify CASA (Civil Aviation Safety Authority) of any existing or potential structure that may infringe the aerodrome's obstacle limitation surfaces. In areas remote from an aerodrome, proponents of any tall structure 110 metres or more above ground level are required to notify CASA directly of such proposals.

As an adjunct to the above requirements, CASA has produced a Civil Aviation Advisory Publication (CAAP 89W-2, available from the CASA website) entitled *"Reporting of Tall Structures"* to inform those planning tall structures of the recommended notification process. This document defines tall structures as those within 30 km of a regulated airport and exceeding 30m in height, or 45 m in height elsewhere. However the RAAF Aeronautical Information Service (AIS), which is responsible for maintaining the database of such structures on behalf of CASA, have recommended notification of any planned structures as low as 20 meters in height. AusWEA recommends therefore that once layout options have been narrowed down, developers provide AIS with details and descriptions of any planned structures exceeding this lower limit.

4.3.2.13 Safety Assessment

The environmental assessment should include a safety assessment which describes potential safety issues and the means taken to mitigate these. This could include reference to access, construction, security, public crowd management, heavy haulage and emergency procedures.

Most of the safety issues associated with wind energy projects can be dealt with during the design phase through the provision of procedures for access to the turbines, enforcing safe work practices and the implementation of a fire control plan.

The safety assessment should include comment on the structural integrity of the wind turbines intended for use on the particular site, especially those that may be subject to extreme wind loading conditions due to cyclones for example. The conformity of the turbines with both State and Commonwealth safety requirements should also be investigated. As an example, ladders, fall arrest systems, access to towers and numerous other features of the turbine may conform to European or International standards, but fail to meet Australian requirements.

Other safety issues which should be addressed

Figure 13 – Transportation of Nose Cones for 1.8 MW Wind Turbines for Albany Wind Farm (courtesy Western Power)

in the environmental assessment include the effect of the wind farm on highway traffic through shadow flicker, and on recreational users such as kite flyers and hang gliders.

4.3.2.14 Construction Traffic Assessment

It is not expected that exact details of the traffic movements that will be associated with the proposed wind energy project during construction will be known at the time of submitting a development application. Some idea of the number of loads, size of loads and types of loads should however be provided and discussed with the local council and the main roads authority, to ensure that issues of concern are raised early. In some cases this type of information will be required as part of the environmental assessment of the project. Details of the planned liaison with the local police traffic department during the transportation of equipment should also be included in the environmental assessment.

The impacts of construction (including access roads within the site boundary) should be addressed as part of visual, ecological, hydrological and archaeological assessments. In particular, the issues of dust and erosion should be examined. Any essential road improvements needed to accommodate the development should be discussed and agreed with the local main roads authority and documented.

Developers should, in conjunction with landowners and the local authority, consider whether or not internal access roads are to be re seeded.

4.3.2.15 Electrical Connection Assessment

By this stage of the project, a connection enquiry should have been lodged with the Network Service Provider (NSP).

Of significant importance is the definition of the connection point. All electrical works on the wind turbine side of the connection point will be the responsibility of the developer, while electrical works on the network side can be the responsibility of the NSP (at the developers discretion). If responsibility is passed to the NSP for providing the connection point, then they will take responsibility for consultation work and environmental approvals required to secure easements for lines and substations. However developers should be aware that many connection assets are contestable, and there are likely to be many different companies prepared to build them. Developers should gain an expert opinion about the contestability of these assets from power engineers with experience in the deregulated electricity market. Public consultation relating to connecting works should be coordinated with the public consultation for the rest of the wind farm where possible. This is particularly important for electrical line routes as these may pass through residential areas close to sub-stations.

Careful account should be taken of the potential impacts on the environment and on land use and appropriate measures should be taken to avoid unnecessary adverse impacts during electrical installation work. Such details of the electrical works proposed within the wind farm boundaries and to the connection point as are available at the time should therefore be examined as part of the environmental assessment and the environmental management principles used for the wind farm should also extend to work on power lines.

4.3.2.16 Effects on the Local Economy

While not normally relevant to the scope of the environmental studies, environmental impact assessment may include an estimate of the number of temporary or permanent jobs created and the value of the contracts available locally. Projected impacts of the development on the local economy based on experience with other wind energy projects may also be of interest to the local community.

4.3.2.17 Social Impact

The environmental assessment may include a discussion on community attitudes towards the project and consideration of projected acceptance levels post installation. In addition the impact on local infrastructure such as health and emergency services, accommodation and community facilities should be addressed.

4.3.2.18 Global Environmental Affects

The environmental assessment may include estimates of the amount of electricity the wind energy project will produce and the quantity of polluting emissions that would be produced from a conventional power station producing the equivalent amount of energy. It is important that source data is reliable and referenced to ensure

Figure 14 – Windy Hill Visitors Viewing Area (courtesy Stanwell Corporation)

reputability. The Appendices of this document include some comments on statements by developers regarding emissions offsets.

4.3.2.19 Tourism and Recreational Traffic

Public rights of way within the site should be identified and clearly shown on the plan.

Because of the high visibility of most modern wind farms, many wind energy developments have become tourist attractions. In some cases the local road infrastructure near the wind development may need to be altered in anticipation of an increase in traffic movements around the site due to sightseers.

Visitor facilities, if appropriate should be discussed with the local authority and relevant stakeholders and any proposed developments should be reviewed in the appropriate assessment.

Efforts should be made to accommodate visitors to the wind farm by providing suitable signage and car parks and possibly access to walk near to a turbine. These measures can help reduce the desire for the public to access other parts of the site thereby causing a nuisance to landowners.

Existing nearby tourist and recreational facilities should also be identified in the environmental assessment.

4.3.2.20 Decommissioning

The environmental assessment should cover proposed decommissioning of the wind energy project. Consideration should be given to restoration measures including the removal of above (and possibly below) ground equipment, landscaping and rehabilitating any disturbed areas and discussion as to whether the remaining roads or tracks on the site will reseed naturally, will require additional treatment or can be left in place for other uses.

4.4 Detailed Assessment – Dialogue and Consultation

Open communication between and provision of information to all parties is very important during this stage, especially where no precedents to wind farm developments exist and knowledge of participants may be limited. It is usually a statutory requirement of the planning process, that the public be fully notified and are given a period (usually three weeks) within which to object to the project. Dialogue and consultation during this stage then is the developer's main chance to anticipate the concerns of possible objectors and address these before the public notification phase of the development application.
Ongoing dialogue with the local planning authority

is essential during the detailed assessment phase. The developer should also maintain a continuing dialogue with the appropriate statutory and non statutory stakeholders and the public throughout the environmental assessment process. The statutory consultees have a duty to assist with the provision of available information to the developer, the local planning authority and the public.

The parties involved can determine jointly where any problems are and how they should be addressed. Changes to the original design during the evolution of the project should be regularly discussed with all stakeholders.

Developers may find benefit in distributing AusWEA's Wind Power Fact Sheet and also find it useful to advise stakeholders on following matters :

- Commonwealth legislation supports an increased uptake in renewable energy and wind energy is currently seen as one of the most viable renewable energy generation sources
- Wind energy is clean. It does not pollute the atmosphere and is recognised as one of the solutions to global warming.
- The costs of extracting and utilising fossil fuels like oil gas and coal are set to increase dramatically in coming years and globally there is acknowledgement of the need to invest in more sustainable energy sources. Wind energy is already an important part of this trend.
- Many rural economies throughout Australia are currently in decline. Wind energy projects can have positive results for the local economy.

On the completion of Phase Three the developer will normally be in a position to submit a development application and, if required, a report on the environmental impact assessment. It is sometimes also necessary to prepare an Environmental Management Plan at this stage which shows how issues identified in the assessment are going to be managed.

All parties in the process should be prepared to discuss appropriate revisions to the application in the light of the responses received. The developer should be prepared to explain the way in which comments from the consultation process have been evaluated.

4.5 Detailed Assessment – Contractual Considerations

At this point in the project the developer should have a good idea of the economic viability of the site. It is therefore appropriate to formalise agreements with landowners or Crown Land Agencies and, if required, Native Title Claimants, as well as to draft a provisional connection and access agreement with the Network Service Provider. It is advised that legal help is sought from lawyers with experience in dealing with wind farm and/or Native Title contracts.

Having completed the detailed assessment, the developer will be in a position to provide information to parties that may be financially involved in the project. Prior to entering into contracts that commit development funds, financiers typically seek independent advice on the technical and commercial aspects of the project and the risks these present to the investor. Known as "Due Diligence", this process is likely to involve assessment by the financiers' own internal resources, independent engineering consultants that have not had an involvement in the development work (otherwise known as "Bankers Engineers"), lawyers and management consultants or a combination of these.

5 Phase 4 – Development Application

5.1 Processing the Application

By the beginning of this phase the detailed technical, commercial and environmental assessments will have been undertaken for both the wind farm site itself and any electrical grid extension works needed to accommodate the development. If a site is still considered suitable, the developer will normally submit a development application to the local planning authority, (although in some states there is also the opportunity to seek a development approval through the state government). The local planning authority will usually prescribe a formal public notification process during which formal objections to the development may be lodged. Often at this point it is worthwhile for developers to have a public display available, attended by a knowledgeable representative who can answer questions and show material on the project.

The developer should co operate with the local planning authority in printing and circulating, or making available sufficient copies of the environmental assessment (for example by lodging in the local public library). This allows the appropriate stakeholders and the public to inspect and assess the proposed project and to make any formal response to the local planning authority.

It is recommended that a non technical summary be made available to the general public free of charge. Public events may be organised by the developer, depending on the level of local interest, to provide a constructive forum for the local community to find out more about the proposed development.

The local planning authority has a duty to consider all representations from stakeholders and the public on the application in the light of development plan policies and other material planning considerations such as statutory, regional and national planning guidance. The planning processes in most states will list referral agencies, who may have the power of veto over a project, if triggered by the development application.

When processing the application, the local planning authority may seek to discuss conditions of a potential development approval with the developer and the major stakeholders, without prejudicing the decision.

The local planning authority has a statutory duty to process registered development applications and will be able to provide a timeline of the process. The exact timing will depend on the process, which differs from state to state.

Where a local planning authority requests further information from the developer following the submission of the environmental assessment and receipt of the stakeholders responses, the developer should, wherever possible provide this information in a professional and succinct manner to facilitate further consultation.

5.2 Development Application Decision

The planning officer of the local planning authority will normally summarise the background, details of consultation responses and key issues associated with the application in a written report, which is submitted to the local council. The report will contain an analysis of planning policy, and a recommendation on whether development approval should be granted. In the case of major applications, the local council may wish to visit the site before further consideration at a subsequent meeting.

The State Government may be involved via referral agencies, identified in the early part of the process.

Commonwealth assessment and approval may be required if the project triggers the provisions of the EPBC. In many cases this is not likely but where it does, an appropriate response is called for. Ordinarily, assessment under the EPBC act is a separate process to assessment of a development application, although often the same information will be required. Some states have formed a reciprocal agreement with the Commonwealth Government so that consideration of the development application and assessment under the EPBC act can be based on the same information and performed concurrently.

5.3 Development Approval Conditions

The local planning authority may wish to regulate the construction and operation of the wind energy development by granting the approval subject to certain conditions.

Similarly there may be conditions imposed by Commonwealth authorities as a result of EPBC Act considerations. In some cases developers may wish to seek expert advice on these. Other examples of development approval conditions may include measures to be taken should turbines become inoperative for a minimum period of time and for committments to leave the site as undisturbed as possible after decomissioning.

The developer will normally have the chance to appeal any conditions associated with the development approval and may want to take this opportunity if it is felt that the conditions are too stringent, unworkable, or may result in an unsatisfactory outcome. However developers should appreciate that conditions are normally imposed for the protection of the community and to improve the quality of the development, and these two objectives should be borne in mind when negotiating changes to conditions.

5.4 Approval

Once granted, the developer has a responsibility to accept the conditions of the development approval and to implement them as required. After approval has been granted, written reports resulting from environmental monitoring programs during and post construction should be published (except where the need to maintain commercial confidentiality prevents this occurring) so as to benefit future developments and the general state of knowledge on such issues.

Often a local authority's development approval is open to third party appeal *after* the approval has been granted, which is an avenue that project opponents may pursue to delay or halt a project. The possibility of this occurring should be discussed with the planning authority before lodgment of the application and varies from state to state. If such an appeal occurs, it may be followed by a lengthy and costly legal hearing before a tribunal or similar appeals court which decides, independently, the merits of the development consent. Developers should be aware that if such an appeal is possible, there is the potential for it to delay project construction many months. This then should be taken into account in terms of commercial issues such as the structure of tenders or contracts.

6 Phase 5 – Construction

6.1 Introduction

Environmental considerations continue into the construction phase and developers should refer back to the conditions and obligations under which development permission has been granted. Development approval conditions should cover any activities during the construction phase where major impacts could occur.

6.2 Construction - Technical Considerations

With the exception of some minor omissions, by this stage the technical requirements of the project should be covered by procurement and construction contracts. In some cases the developer may need to obtain advice on technical issues from specialist sub consultants during the construction phase.

The developer or future owner/operator may wish to clarify technical training needs for personnel in preparation for commercial operation.

6.3 Construction - Environmental Considerations

A small percentage of the total area occupied by the project will be directly affected by the construction activities. Depending on the nature, size and location of the project, an Environmental Management Plan (EMP) may be developed to identify risks, mitigation and monitoring processes during the construction of the wind farm. This would typically include such factors as erosion, dust and sediment control, storage of hazardous materials, weed control, waste management and so on.

Areas of construction work on site should be delineated in consultation with the landowner, and possibly the local planning authority. Measures for avoiding unnecessary impacts such as vehicle use on areas outside the defined working boundary should be identified and due regard should be given to the safety of those using public rights of way.

If the environmental assessment has identified areas of ecological or archaeological importance then pre construction site conditions in these areas should be documented (this may be a

Figure 15 Codrington Lower Tower Section Lift (courtesy Pacific Hydro)

requirement of planning conditions). Such areas should also be notified to contractors on site to avoid damage.

The construction work may include the building of temporary or permanent access tracks and storage compounds, turbine foundations and other on-site buildings. Before starting site works, the local council should be consulted to discuss the site inspections that they will require. Some councils will outsource this activity to registered engineers.

It is important for the developer to realise that environmental care is, ultimately, their responsibility. A nominated representative of the developer should be appointed to ensure on site environmental management is appropriate and who can undertake random audits to verify that documented procedures are being followed. Issues which arise need to be discussed immediately with the contractors to have them rectified. Contractual clauses involving financial penalties for environmental breaches can be used effectively to safeguard the developer in these circumstances.

6.4 Construction - Dialogue and Consultation

In view of the number of separate contractors involved in the construction works for a wind energy project, it may be beneficial for the developer to identify an individual with the overall responsibility for site management and liaison with the local planning authority.

A close dialogue needs to be maintained with landowners to coordinate construction works, particularly if ongoing farming operations are involved. Regular meetings may be organised to address safety issues, heavy vehicle movements, fencing arrangements, stock movements, and overall planning of construction activities.

Developers should ensure that on-site and off-site works are undertaken with a minimum of disruption to the local residents. Wind energy projects will continue to generate interest from the general public and media for some time and the developer should make provision from the start of the works for the handling of enquiries and visitors.

Although it is not possible to be prescriptive, the following suggestions may be helpful :

Figure 16 Open Day for Albany Windfarm (courtesy Western Power)

- Signage should be erected designating the area as a construction site and including restrictions to entry that are applicable.

- An information board should be displayed in a publicly accessible location at all times giving the name of and telephone number of the developer's site representative or other contact.

- Consideration should be given to the formation of a community liaison or advisory group providing the opportunity for dialogue between the developer and the local communities.

- In the event of any comments or complaints about the construction works, the developer or site representative should be accessible to the local community. Any complaints should be dealt with quickly and responsibly. Any complainant who is not satisfied with the handling of their complaint by the developer should be made aware of their option to seek guidance from local planning authority.

The developer should establish a program of emergency procedures for 24-hour support to the project works in case of unforeseen problems - for example problems with vehicles or with vandalism. These procedures should be registered with local emergency services and with local planning authority and be noted on the site information board.

It is often beneficial to hold open days to view turbine components before they are erected and to show the general public the environmental management of the site. Developers should ensure that such events are well managed as often several thousand people can attend. The safety of individuals and public risk insurance needs to be resolved before such events are held.

6.5 Construction – Contractual Considerations

At this point of the project the developer will need to enter into a number of construction agreements and it is recommended that the developer employ an expert in the management of engineering contracts to provide financial and legal security to the project.

Figure 17 Codrington Wind Turbine Nacelle on Public Display in Portland (courtesy Aria Professional Services)

Developers should be aware that legislation in some states places onerous requirements on either the developer or the primary contractor (or both) with regard to health and safety issues. Hence all parties need to be clear as to their obligations in this regard. For example developers should be vigilant in ensuring a safety management system is being used by the contractors on site. It is important that such requirements and responsibilities are highlighted in construction contracts and are audited regularly.

The developer should also ensure that all contractors are aware of and abide by the requirements of any planning conditions or agreed environmental measures. For example it may be appropriate for the developer to pass on obligations and requirements to contractors by way of the appropriate clauses in their contracts. It is important that developers ensure that responsibility is taken for each requirement, and that there is a path of recourse in the case of non-compliance.

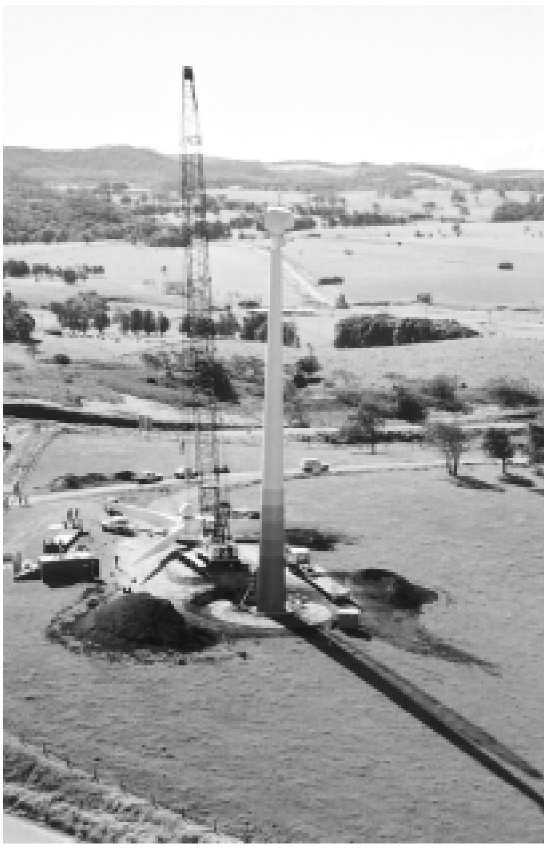

Figure 18 Wind Turbine Under Construction (courtesy Stanwell Corporation)

7 Phase 6 – Operation

7.1 Introduction

Developers of wind energy projects and/or the owners and operators should accept that their responsibility for satisfactory and safe operation of a project continues on throughout its lifetime. Public notice should be given of any changes of operator.

There should be no significant environmental problems encountered with the operation of a wind energy project if the developer has sited and designed the project well and has followed these guidelines. However, where appropriate, it should be the responsibility of the owner/operator to monitor the project for any key impacts as agreed with the local planning authority, and to keep local people informed of the results of any such monitoring and the general performance of wind generation project.

7.2 Operation – Technical Considerations

The owner/operator should comply with any constraints placed on operation of the wind farm as a result of the imposed development approval conditions.

Formulating plans for operations and maintenance of the wind farm will be the main responsibility of the owner/operator at this stage of the project. Such considerations should include employment of local representatives, and the on-going interaction with landowners, and the local community. Depending on the structure of the organisation, some of these activities may be outsourced.

In addition to the required ongoing environmental effects monitoring, the owner/operator may also wish to initiate formal performance tests on the power, sound emissions or availability of one or more of the wind turbines. This may require the erection of an independent hub height anemometry tower some distance clear of neighbouring machines. It is important for ongoing liaison with the local planning authority with regard to such activities as further approval may need to be gained for such additional structures. As mentioned earlier, AIS should be notified of such structures exceeding 20 meters in height.

Ongoing performance monitoring of the grid interconnection may also be required by the NSP. It may take some time, for example, for the wind farm to reach and sustain its maximum output or for the effects on the local network to be fully realised. Such effects may need to be understood to verify that modeling work has been successful.

7.3 Operation - Environmental Considerations

Potential environmental issues during the operational phase relate to effects on human activities and the site's flora and fauna.

The owner/operator should have a formal procedure for recording and dealing with complaints from the public and should investigate any complaints from individuals and work with the relevant authorities (for example, planning officers or environmental health officers) to address the issues raised.

Through good planning and design, the wind farm should have no significant ecological impacts. However if ecological impact does become apparent either as a result of specific studies performed by the owner/operator, or where concerns are raised by individuals after the facility has been built, the results of any monitoring and reports should be made available regularly to the community either directly through community newsletter or via the regulating authority. Owner/operators should co-operate with the relevant statutory and voluntary conservation bodies and other stakeholders to determine the nature of the problem and to work towards a solution.

It is often a requirement of approval authorities that a periodical environmental report be written about the wind farm's operation. Such a report can report on the success of rehabilitation work and that approval conditions are being complied with. Where appropriate, means of addressing any non-compliances can also be discussed.

7.4 Operation - Dialogue and Consultation

An owner/operator has a responsibility as a member of the community to allow local individuals to raise any concerns they may have about the operation of the project. The owner/operator should have a local representative to whom individuals can voice their concerns. The owner/operator should make themselves, and their representatives, easily accessible to local people within the community through a variety of methods.

In addition to keeping the local community informed about the operation of the wind energy project and any problems which may have occurred, the owner/operator should also work towards disseminating to the wind industry as a whole the results of any studies and the success of any mitigation measures in order that lessons are learned and acted upon. The annual Australian Wind Energy Forum held by the Australian Wind Energy Association provides one such opportunity for sharing of findings of this nature. Such information should also be made available on request to planners and environmental officers.

Figure 19 Conveying the Importance of Wind Power for Future Generations (courtesy Stanwell Corporation)

During the operation phase, the owner/operator should operate a good neighbour policy and encourage a greater understanding of wind energy (and specifically their wind energy project) within the local community. Following commissioning there is likely to be a high level of local community interest in the wind farm and the owner/operator should consider conducting tours or open days at which project specific and general literature relating to wind developments in available. In addition, ongoing information in the form of project fact sheets made available at local council and visitor or information centers will be a useful way of keeping members of the public informed.

Public opinion surveys should be conducted early in the development of the project, during operation and regularly thereafter. Surveys have shown that the most opposition occurs before a project begins. Once the public is informed about wind energy, the support within a community generally grows. Similarly past experience shows that the support to wind energy from local communities tends to increase after the wind farm is built (ref Appendices).

7.5 Operation – Contractual Considerations

Contractual arrangements need to be made with the party responsible for the on-going operations and maintenance of the wind farm. This must include issues of operational safety including maintenance, climbing, tower top rescue and public safety.

The owner/operator also needs to remain aware of the obligations and conditions comprising part of the development approval, and that these last throughout the lifetime of the project.

8 Phase 7 – Decommissioning

Wind farms typically have a design life of at 20 - 25 years and development applications and commercial agreements with landowners are often made on this basis. Options available to the owner /operator after this time may include upgrading of the wind turbines with more efficient machines or removing them altogether.

The subject of the decommissioning and site clearance should be adequately covered in the conditions and/or agreements accompanying the development approval. However, should the wind energy project cease to generate electricity, the owner/operator should remove all the turbines and return the site as close as practical to its original state. It is not good practice to have wind turbines non-operational for extended periods of time as the machines can be deteriorate or be damaged. Inactive wind turbines are also a bad advertisement for wind energy.

Unlike most power generation projects wind turbines can be decommissioned easily and rapidly. Despite this, developers still need to approach the issue of decommissioning responsibly. Notice should be given to the local planning authority in advance of decommissioning work. The decommissioning process will require similar attention with regards to site management, health and safety, and environmental management undertaken during the construction phase.

Normally the scrap value of the turbines themselves will be sufficient to cover the costs of their dismantling. Where this may not be the case, consideration should be given to the setting aside of funds over the life of the project in order to ensure adequate funds are available at the end of its life to pay for decommissioning and other reinstatement requirements.

Figure 20 Wind Power - Dawn of a New Era (courtesy Western Power)

APPENDIX 1 Glossary And Abbreviations

ACCC
Australian Competition and Consumer Commission

AGO
Australian Greenhouse Office

AIS
Aeronautical Information Service (RAAF)

Anemometer Mast
A mast upon which anemometry equipment is mounted and which is erected to measure the wind speed and wind direction over a particular site. Anemometry masts are usually either tubular or lattice tower structures fixed to the ground with guy wires. Foundations, if needed at all, are usually minimal.

ASA
Air Services Australia

AusWEA
Australian Wind Energy Association

Availability
The availability is the number of hours the wind turbine is available to generate electricity in a year divided by the total number of hours in the year.

BoM
Bureau of Meteorology

Capacity Factor
Capacity factor is a measure of the energy actually delivered by a wind farm expressed as a proportion of the theoretical maximum wind farm energy output possible. It depends on the wind speed distribution at the site, and is also affected by the time wind turbines are not productive due to maintenance downtime or other outages.

Capacity of Electrical Grid
This is the capacity that can be connected to the electrical grid at any nominated interconnection point. In some rural areas this capacity can be limited and the costs of uprating grid capacity can be high.

CASA
Civil Aviation Safety Authority

Certification
The design and production of the wind turbine generators are usually certified processes. The norms applied are a result of regulations for safety, damage etc.

Community Liaison Group
A community liaison group could comprise representatives of the development company (or of the owners and operators as appropriate), planning authority representatives or a cross section of local community representatives. A third party facilitator may be appropriate. The frequency of the meetings in their remit should be agreed by all parties on a basis which is relevant to each site.

dB(A)
The unit used to express the level of sound as percieved by the human ear. "A weighting" is a weighting (adjustment) of measured sound to match perception by the human ear which does not perceive sound at low and high frequencies to be as loud as mid-range frequencies. "A"-weighted sound levels are indicated by a unit of dB(A)

- 3 dB(A) is the smallest difference one can hear
- 5 dB(A) is a difference which is noted
- 10 dB(A) is heard as a doubling of the noise

NB Sound is generally used in the context of objective assessment/measurement, whilst noise is generally used in the context of subjective assessment and/or nuisance.

Decommissioning
This is the final phase of the development when a site is cleared of above ground equipment associated with the wind energy project and the land is restored to its original use or some other agreed use.

Electromagnetic Interference
Telecommunications systems broadcast information at a variety of frequencies and in a number of ways. Telecommunications systems currently in operation over land use microwave, very high frequency (VHF) and ultra high frequency (UHF) systems. Interference with telecommunications systems is known as electromagnetic interference (EMI).

Energy Production
The energy production of a wind turbine generator is very sensitive to the local wind speed conditions at the height of the rotor shaft and the Power – Windspeed curve of the wind turbine generator. The following rules of thumb are applicable :

- Doubling the wind speed increases the available energy by a factor of 8
- Doubling the rotor diameter increases the available energy by a factor of 4

Energy Yield
This is the term to describe electrical output from a wind energy project. It is strongly influenced by the wind speed of the site.

Environmental Management Plan
An Environmental Management Plan (EMP) is a document which crystallises agreed proposals to minimize the environmental impacts of construction activities and working practices. It may specify a method of construction, and it may contain provisions for monitoring environmental effects during operation.

EPA
Environmental Protection Agency

EPBC Act
Commonwealth Environmental Protection and Biodiversity Conservation Act

GWh
Gigawatt hour - a unit of energy (equal to 1000 MWh)

Hub Height
This is the height of the wind turbine rotor axis above the ground

Installed Capacity
The installed capacity is the product of the number of machines and the nominal WTG rating. It is normally measured in MW.

Local Electricity Distribution System
This is the electricity distribution network, normally incorporating overhead poles and wires but also sometimes underground wires, which connect individual properties to the regional grid at various voltages.

Megawatt (MW)
A megawatt is unit used to measure of power. One MW equals one million watts.

MPF Status
Major Project Facilitation (MPF) status, which may be granted by the Federal Minister for Industry, Tourism and Resources

NEC
National Electricity Code

NECA
National Electricity Code Administrator

NEM
National Electricity Market

NEMMCO
National Electricity Market Management Company

NSP
Network Service Provider

ORER
Office of the Renewable Energy Regulator

Power Curve
The power curve is a way of showing the relationship between power output from a wind turbine as a function of wind speed. It can be used to estimate the power delivered to the grid at a certain wind speed. It can be used in combination with a wind speed histogram to calculate the expected yield in a year.

REC
Renewable Energy Certificate

RAPS
Remote Area Power Supply

Reflected Light
Under certain circumstances sunlight may be reflected from wind turbine blades when in motion. The amount of reflected light will depend on the finished surface of the blades and the angle of the sun.

RNE
Register of National Estate

SEDA
Sustainable Energy Development Authority

Shadow Flicker
Under certain combinations of geographical position and time of day, the sun may pass behind the blades of a wind turbine and cast a shadow. When the blades rotate, the shadow flicks on and off. The duration of this effect as a function of season can be calculated from the machine geometry and the latitude of the site.

Substation
The electrical substation connects the electrical system of the wind energy project to the local electricity network through a series of automatic safety switches.

Water Interest Study
For wind turbines which require substantial foundations, it may be important to establish the uses of water (eg drinking or agricultural purposes) from below ground sources within the relevant catchment area. A water interest study will reveal this information and may help to determine the potential effect of the development on spring water supplies.

Wind Speed
The wind speed of the site is a crucial factor in determining the economic viability of a wind energy project. This is underlined by the fact that the energy yield varies as the cube of the wind speed (see also “Energy Production” above)

WTG
Wind Turbine Generator

WTGS
Wind Turbine Generator Specification (a means classify turbines in terms of wind speed and turbulence)

Zone of Visual Influence
A zone of visual influence provides a representation (usually presented as a map with markings or colorings) of the area over which the site and/or a proposed development may be visible.

APPENDIX 2 Approach To Birds, Bats And Other Ecological Issues

This appendix provides a framework for addressing the ecological issues during the planning, design, operation and decommissioning of wind energy development sites. Ecological issues include potential impacts on flora and fauna on and near wind energy development sites and mitigation strategies.

Information in this appendix is based on the likely expectations of regulatory agencies involved in approving wind energy developments in Australia, including local, state and Commonwealth governments, as well as broader community concerns. It is presented in a format similar to the main body of the Best Practice Guidelines :

Section A2.1 describes the ***nature and context*** of potential ecological impacts.

Section A2.2 presents an approach to gathering appropriate information on ecological impacts as part of ***site selection*** exercises.

Section A2.3 examines the scope and timing of investigations to determine the nature of ecological risks at the ***project feasibility*** stage.

Section A2.4 gives guidelines for ***detailed assessment*** and mitigation of the ecological impacts of wind energy developments during design and operation, including bird and bat collision risk, and provides guidance on the ecological content of development applications.

Section A2.5 examines the issues that arise during ***construction***.

Section A2.6 deals with ***operational matters***, particularly flora and fauna monitoring requirements.

Section A2.7 briefly discusses ecological issues associated with ***decommissioning***.

The nature and extent of ecological impacts and the sensitivity of the landscape affected will vary significantly across a continent the size of Australia. The approaches and techniques chosen for assessing and mitigating the ecological impacts of a particular wind energy development will vary depending on the region it is in and the history of past land use of the site. It is recommended that expert assistance be sought in identifying and responding to ecological issues associated with wind energy developments.

A2.1 Nature and Context of Potential Ecological Impacts

This section provides background information on the impacts of wind energy developments on flora and fauna. It describes the potential impacts on general responses to:

- Potential impacts on birds and bats;
- Ground-based fauna issues;
- Impacts on vegetation and plant populations.

A2.1.1 Birds, Bats and Wind Turbines

A2.1.1.1 Background

Overseas experience with wind energy facilities has shown that the vast majority of them do not cause a significant impact on birds or bats, despite the potential for birds to collide with rotating turbine blades. Indeed, compared with other human structures, wind turbines account for only a small percentage of collision-related mortality in wild birds (Erickson et al., 2001).

A small number of wind energy developments (Altamont Pass in the USA and Tarifa in Spain) have been notable for the amount of bird mortality that they cause. These wind energy developments were established in the 1980s and generally involved older style (smaller) wind turbines that were arranged in dense arrays in mountain passes used by many migrating birds and soaring birds of prey (e.g. eagles).

These early problems focussed the attention of regulators and the wider community on the impact of wind energy development on birds. Community perceptions can lead to significant public opposition to wind energy development and views are somewhat coloured by the exceptional but high profile experiences mentioned above.

Although most wind energy developments do not significantly affect birds and bats, it is important that this issue is dealt with professionally throughout the planning, operation and decommissioning of wind energy developments. This will ensure that the community, as well as the regulatory agencies, are well informed about the nature of the potential problem, if any, at a particular development site. It also ensures that the developer embarks on a course of studies and investment with the best possible knowledge of potential constraints. In Europe and North America, extensive studies have since been undertaken on the impacts of wind energy developments on birds. The United States National Wind Co-ordinating Committee has been instrumental in compiling information about bird-strike issues at wind energy developments and in developing guidelines for addressing the issue. Two recent publications are of particular value and have been referred to extensively in the development of these guidelines:

- National Wind Coordinating Committee (NWCC) (1999) *Studying Wind Energy/ Bird Interactions: A Guidance Document. Metrics and Methods for Determining or Monitoring Potential Impacts on birds at Existing and Proposed Wind Energy Sites.* (NWCC, Washington).

- Erickson et al. (2001) *Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States*. National Wind Coordinating Committee Resource Document (NWCC, Washington). Prepared by Western EcoSystems Technology Inc.

In Australia, some wind energy developers have adapted American methods for assessing bird risk to Australian conditions and have undertaken extensive site studies of the issue to appraise themselves of potential risks. AusWEA acknowledges the support of such organisations in providing material upon which this Appendix is based.

A2.1.1.2 The Nature of the Problem

Investigations in the United States (Erickson et al., 2001) found that the wind energy industry at its current level of development is responsible for a very small proportion of bird mortality caused by collisions with artificial structures. The table below summarises the findings of the review by Erickson et al. (2001). The wide range of estimates reflects the challenges of estimating the figures, but it is more accurate to present figures in this manner than as definitive totals.

Source Of Collision Mortality	Lower Estimate	Upper Estimate
Vehicles	60 million	80 million
Buildings & Windows	98 million	980 million
Powerlines	0.1 million	174 million
Communications Towers	4 million	50 million
Wind energy developments	10,000	40,000

In Australia, the numbers of birds killed by collisions with artificial structures is likely to be lower than in the United States, for reasons explained in section A2.1.1.4

Until data is available on the impacts of wind energy development in an Australian setting, it is not possible to determine whether the problem is a significant issue. For this reason, investigations should be undertaken at an early stage in the development of the industry to see if overseas findings are relevant to the Australian setting.

A2.1.1.3 Risk Identification

The impacts of windfarms represent a risk from a number of viewpoints.

Without adequate site assessments and mitigation measures, there is a risk of removing or disturbing important indigenous vegetation or fauna habitat with the construction of windfarms. This is often a significant issue at the planning permit stage and, in some states, separate, specific permits may be required for removal of native vegetation.

Rotating wind turbines represent a risk to bird and bat populations. This is a significant issue to the industry as a whole, to regulators and to the wider community.

There is commercial risk to projects from encountering unanticipated flora and fauna impact problems. For example, without adequate knowledge of the risk of bird collision, there is a possibility a developer may agree to planning permit conditions that turn out to require costly responses in the event of a problem developing. For example, agreeing to shut down turbines regularly to lower the risk of bird collision could have a significant impact on capacity factor and may be more costly in the long term than the opportunity cost of avoiding a risky turbine site at the outset.

The foregoing risks point to a need to assess adequately the potential impacts of wind energy developments on indigenous flora and fauna and specifically on birds and bats. These guidelines provide a framework for doing so.

A2.1.1.4 The Australian Setting

With a few exceptions, studies of the impact of wind turbines on birds have been confined to the Northern Hemisphere. In the United States, a recent review of bird collisions with wind turbines has been undertaken (Erickson et al. 2001). Out of all bird collisions, the following is a list based on Erickson's findings, which shows the relative percentages of different bird groups that collide with wind turbines in the United States. This excludes the Altamont Pass site (which has experienced unusually high bird of prey mortality amounting to over 47% of total bird mortality).

Bird Group	Percentage Of Total
Waterbirds	1.9
Ducks	4.3
Shorebirds/Rails	0.5
Birds of Prey	19.6
Owls	6.4
Songbirds	44.7
Others	14.2
Non-protected species	8.4

This shows that songbirds represent the most affected group of birds by number. The birds of prey make up the second most numerous group, yet they are among the rarest in the landscape, so the effects of mortality on local populations are likely to be higher. This supports the conclusions of most researchers in the field that the birds of prey are disproportionately susceptible to colliding with wind turbines (National Wind Coordinating Committee 2000). Similarly, numbers of owls struck are disproportionate to their abundance in the landscape.

Of the songbirds recorded, the largest proportion was of night-migrating species (almost 45 percent of the total). Larks made up a further third of the total. The remaining birds affected were resident species.

The night-migrating songbirds are represented in Australia by only a handful of species and in much smaller numbers, generally involving birds migrating between Tasmania and the mainland across Bass Strait.

This fundamental difference between Australia and other areas of the world where bird-strike has been studied at wind energy sites means that the risk of songbird strike in Australia is generally lower than elsewhere. Notwithstanding this, a number of other bird groups in Australia are likely to be vulnerable to striking wind turbines and these are considered below.

Based on the results of the Erickson review, some conclusions can be drawn about the vulnerability of Australian birds other than songbirds. There are many fewer native lark species in Australia than elsewhere. The introduced Skylark is likely to be affected and it makes up a significant proportion of the individual birds flying at turbine height in investigations by Stanwell Corporation Limited in south-eastern Australia sites.

Based on overseas experience with these groups, susceptible groups of native Australian birds, are likely to include:

- Birds of prey and owls, particularly soaring species like eagles and kites;
- Nocturnal migrating songbirds;
- Locally-breeding high-flying songbirds (eg. larks).

In addition, some waterbirds, such as Straw-necked and White Ibis that commonly soar at turbine height, may be susceptible to collision with wind turbines but there is no Australian data to confirm this.

Shorebirds and ducks represented less than 10 percent of fatalities in Erickson's review, suggesting strongly that these bird groups are less vulnerable to colliding with wind turbines. This is supported by other sources (eg. Crockford 1992; National Wind Coordinating Committee 2000). Therefore, wetland birds in Australia may be less vulnerable to collision with wind turbines than birds of other environments.

A group of birds with no equivalent overseas is a group of small parrots, a little larger than Budgerigars, called the *Neophema* parrots. This group has a number of night-migrating species, among them the critically endangered Orange-bellied Parrot (*Neophema chrysogaster*). There are less than 200 Orange-bellied Parrots left in Australia and they migrate across Bass Strait between south-western Tasmania and mainland Victoria and South Australia. Their rarity in the landscape is likely to make collision with a wind turbine a very rare event. However, any chance of regular collision has the potential to affect its already critically low population.

A2.1.1.5 A Note on Bats

There is little data on the impact of wind turbines on bats. Bats fly at night, and, like might-migrating songbirds and owls, may be subject to higher collision rates than many birds.

A recent report by the National Wind Coordinating Committee (2000), provided an overview of the limited information on bat collisions with wind turbines. This indicated that the higher-flying "tree-bats" (e.g. Hoary Bat, *Lasiurus cinereus*) were disproportionately affected. There is a record in Australia of the White-striped Freetail-Bat (*Tadarida australis*) being killed in some numbers by a small wind turbine (Hall and Richards 1972). This species is also a higher-flying species of bat (Churchill 1998) and it may be more vulnerable to collision with wind turbines than other bats.

The investigation of bat usage of potential wind energy facilities is considered an important component of the risk management strategy for new developments, although it presents considerable technical challenges.

A2.1.1.6 Conclusion

The Wind Energy Industry is likely to contribute a very small proportion of global mortality caused by collisions with human made objects. Notwithstanding this, in the Australian setting, some uncertainty remains about the impacts of wind energy developments on birds and bats as no facilities have been studied long enough to generate definitive information. AusWEA encourages developers to take a responsible and pro-active approach to this important issue.

Until data is available on bird collisions with wind turbines at Australia wind energy facilities, it will not be possible to identify with certainty which birds are most affected and how significant this effect is for total populations. The procedures recommended in this Appendix are aimed at helping individual wind energy operators and the industry as a whole come to understand and manage their effects on birds and bats.

A2.1.2 Ground based Fauna

A2.1.2.1 Background

As large, operating, man made machinery there is little doubt that a wind turbine is foreign to a natural setting and, because of this, ground based fauna can be affected in some way by a wind farm.

There is little evidence that domesticated animals or grazing stock are influenced much at all by operational wind farms and it is typical practice for stock to graze up to the base of wind turbines on farmland. This is particularly the case in Europe where many farmers have installed wind turbines.

The influence of wind turbines on Australian native ground based fauna is more difficult to comment on, as there is little or no published information in this regard. However, it will be important for developers to ascertain what ground based fauna occurs or is likely to occur on a development site. Once this has been ascertained, it will be necessary to assess the risk to this fauna from a wind farm, and in particular the risk to fauna populations at a regional, state or national level.

Obviously there will be regional differences between proposed wind farm sites and it can be expected that any work required to ascertain effects on such fauna will be different between these. AusWEA strongly recommends that throughout the planning, construction and operational phases of a development that this issue be included. While birds and bats may dominate the debate, the effect of other native animals and their habitat on how construction is executed and on operational activities will need to be determined.

A2.1.2.2 The Nature of the Problem

The potential impacts of wind farms on ground based native fauna can be broadly classified as;

- Direct disturbance or removal of habitat
- Removal of fauna from area due to removal of suitable habitat
- Indirect disturbance to adjacent areas from noise and activity at a wind farm
- Introduction of pest animals and plants
- Disturbance to breeding and migratory patterns
- Greater risk of disease or the introduction of such
- Disturbance to food and water resources

The approach to these issues in wind energy developments that have occurred in Australia to date has differed widely, and usually reflect the type of land over which the development has occurred and the different regulatory requirements between states. In more remote areas, wind farms have been built in areas of native vegetation that is habitat for a diverse ground based native fauna. In this case, studies were required to ascertain the likely impact. These studies have involved trapping surveys and turbine locations have been altered before design is completed to avoid known fauna breeding areas.

In the more settled parts of Australia, wind farms are generally built in agricultural areas from which indigenous vegetation and fauna habitat has long been removed. Wind farms built on farmland generally require a slightly less intensive approach to assessment. However, where native vegetation and habitats occur nearby, knowledge of fauna present can alert developers and regulators to potential indirect impacts from noise and nearby disturbance.

Often the fauna that exists in an area is not well known. The difficulty for developers and regulators alike is that survey results for fauna are never definitive: the absence of a species during a particular round of trapping surveys for example is not definite proof of absence.

With development of a wind farm, an area may experience increased human activity, more traffic movements and generally greater interest, especially recreationally. Often controls are necessary to ensure the area is protected from the impacts of visitation, such as release of feral animals, introduction of weeds and disturbance to habitat and fauna. Controls may include directing visitor traffic away from sensitive areas.

A2.1.3 Vegetation and Wind Turbines

A2.1.3.1 Background

To construct a wind farm it is impossible not to disturb a site. Australian vegetation can be sensitive to disturbance and difficult to rehabilitate, especially in windy areas where wind turbines will be sited. Wind farms also bring attention to areas that previously may have seen little human activity. This invariably means more people, cars, rubbish and associated environmental pressures. Nonetheless wind farms can be sited in areas of native vegetation provided proper planning is used to sensitively manage the impacts.

Many windy sites are farm and pastureland, and while the disturbance to native vegetation from a wind development is low, without good design and environmental management practices, the potential exists for considerable damage to crops and to any small pockets or remnant vegetation that still exist there. Often such small remnants of native vegetation are of regional or higher significance in a largely agricultural landscape.

A.2.1.3.2 The Nature of the Problem

The highest potential risk to native vegetation from wind farms arises at the construction phase of development. Without careful planning and environmental management measures, this disturbance can lead to removal of vegetation, loss of plant species, weed invasion, erosion and downslope sedimentation or waterway pollution and elevated fire risk.

Notwithstanding this, modern wind energy developments that involve large, well spaced turbines are unlikely to directly affect more than five percent of the total area of a site.

Disturbance to vegetation and plant populations from a wind energy development can be related

to:
- Actual physical removal of vegetation, including roots;
- Wind erosion and further loss of flora due to topsoil disturbance;
- Damage to surrounding areas and watercourses from construction site run-off;
- Soil or water contamination due to fuel, lubricant or other liquid spills;
- Introduction of disease (e.g. Cinnamon Fungus), or pest plants;
- A higher fire risk and threat during construction and operation; and
- Increased pressure from higher human visitation after development.

All of these aspects can and have been managed successfully in wind energy developments in Australia in both cleared and vegetated settings. In Western Australia, for example, wind farms have successfully been constructed in sensitive native flora reserves while in Queensland, New South Wales and Victoria, wind farms have been installed on a variety of farms with minimal disruption to crops and pasture.

With correct planning and post-construction rehabilitation, operating wind farms will not have any ongoing effect on vegetation, other than the loss of the footprint of the turbines and their associated infrastructure. Once installed, the main risk to vegetation from a wind farm is human visitation and this needs to be carefully controlled. Lightning strike on wind turbines can be an issue requiring earthing design to prevent an increased fire risk to flora and changes in fauna patterns may alter the distribution of seeds. Maintenance work on the turbines also has to include procedures for the disposal of wastes and for rehabilitation if vegetation disturbance is required.

A2.2 Site Selection

This section contains information on:

- ***Undertaking a regional risk assessment to determine if there are any bird and bat collision risks associated with a site;***
- ***Opening discussions with state, regional and local wildlife authorities;***
- ***Determining the need for and scope of any targeted bird and bat studies;***
- ***Identifying any requirement for other ecological investigations; and***
- ***Assessing the applicability of Commonwealth environment legislation to a new development.***

Given the potential impacts of wind farms on flora and fauna, AusWEA recommends that an initial risk assessment be undertaken addressing the matters discussed in this section. A proponent needs to consider the likely environmental acceptability of potential wind energy development sites, as much time, energy and money can be wasted if such issues do not emerge until later in the planning cycle.

It is particularly important that these issues are addressed at an early stage as many plants and animals are only present or detectable in an area for part of the year. Often, regulators will not accept impact assessments if data on the seasonal occurrence of significant plants and animals has not been collected at the correct time of year. This can lead to lengthy delays while proponents and regulators wait until the correct time of year before undertaking investigations and finalising impact assessments.

An example of this approach is the “regional risk assessment”, designed to collate and review available information on the known or possible fauna and flora at potential sites. It is an inductive investigation that aims to identify potential impact issues at a development site, based on information from the nearby region and an initial site assessment.

The following is based on the “regional risk assessment” protocol developed by Stanwell Corporation Limited.

In selecting the region for review, a radius of up to 30 km from the potential site should be chosen. Information on flora and fauna present should be obtained from a range of sources and cover the three broad areas considered in this appendix:

- Bird and bat collision risk;
- Ground based fauna; and
- Native vegetation and plant populations.

The table overleaf summarises a range of sources for this information.

Group	Information to be compiled and/or mapped	Sources of information
Identifying potential bird and bat strike risks*		
Songbirds	• Location of native vegetation remnants • Location of headlands near island chains	• Topographical maps. • Aerial Photos. • Vegetation mapping by state environment agency. • Regional state environment agency personnel.
Neophema parrots	• Location of feeding, roosting and breeding sites; • Location of flight paths between / known and potential habitats	• Orange-bellied Parrot Recovery team (c/- NRE, Victoria). • Aerial Photos. • Topographic Maps. • Regional state environment agency personnel.
Birds of Prey	• Location of significant known breeding sites. • Areas where birds of prey are known to congregate or migrate (e.g. parts of Bass Strait coast).	• State and Commonwealth wildlife databases. • Australasian Raptor Association. • Local naturalists/birdwatchers. • Regional state environment agency personnel.
Shorebirds	• Location of large coastal and non-coastal wetlands. • Location of principal feeding areas and roosting sites. • Migration sector from main feeding and roosting sites (NW to NE).	• Topographical Maps. • Wetlands International Oceania Program (at Environment Australia, Canberra). • Australasian Wader Studies Group. • Local naturalists/birdwatchers. • Regional state environment agency personnel.
Waterfowl	• Location of large coastal and non-coastal wetlands; • Flight paths between wetlands; • River valleys and coastlines • Location of waterfowl breeding colonies or roosting sites and dispersal routes	• Topographic Maps. • State and Commonwealth wildlife. databases. • Local naturalists/birdwatchers. • Regional state environment agency personnel.
Bats	• Location of roosting and maternity caves; • Location of native vegetation, particularly with old growth, hollow trees. • Location of areas with high insect abundance (e.g. wetlands). • Location of flight zones around and between the above.	• Topographical Maps. • Aerial Photos. • Vegetation mapping by state environment agency. • State and Commonwealth wildlife databases. • Local naturalists/birdwatchers. • Regional state environment agency personnel.

*Source: Stanwell Corporation Limited – Protocol for Bird and Bat Risk and Mortality Assessment (Windfarm Sites).

Group	Information to be compiled and/or mapped	Sources of information
Identifying if significant fauna and habitats may be present		
Habitats	• Location of remnant vegetation and wetlands. • Location of roadside vegetation. • Location of old-growth, hollow-bearing trees, including isolated dead trees in farmland. • Landscape-scale vegetated habitat links between remnants of native vegetation.	• Topographical Maps. • Aerial Photos. • Vegetation mapping by state environment agency. • Site inspection.
Fauna Species	• Presence of rare and/or threatened species; • Location of regional occurrences of rare and threatened species; • Habitat preferences and movement patterns of rare or threatened fauna.	• National and State wildlife atlases or data-bases (e.g. Atlas of New South Wales Wildlife; 'List of the Vertebrates of South Australia). • Atlas of Australian Birds (Birds Australia, Melbourne) • Local naturalists/birdwatchers. • Regional state environment agency personnel. • Published literature and reports e.g. Comprehensive Regional Assessments on Regional Forest Agreement (RFA) web site). • Technical specialists in wildlife agencies or research institutions/universities. • Site inspection to determine if habitats on the development site are suitable.
Identifying if significant vegetation and plant species may be present		
Vegetation	• Presence and extent of vegetation (remnant or otherwise) of regional, state or national significance.	• Aerial Photos • Regional, state or national bioregional assessments (e.g. Victorian 'Native Vegetation Plans', 'Conservation status of Queensland's Bioregional ecosystems') • Comprehensive Regional Assessments on 'RFA' web site. • Vegetation mapping by state environment agency. • Site inspection.
Plant Species	• Occurrence of rare and/or threatened species; • Population sizes and locations on-site.	• Aerial Photos; • Local naturalists/amateur botanists. • Regional state environment agency personnel. • Published literature and reports (e.g. Comprehensive Regional Assessments on 'RFA' web site). • Technical specialists in nature conservation agencies, herbariums or research institutions/universities. • Site inspection.

Once significant vegetation and habitats in the region have been located, their proximity to or presence on the development site should be determined.

An initial site inspection by a qualified and experienced ecologist is recommended as most areas are likely to have regionally representative vegetation and fauna populations, but usually in a unique mix not determinable from desk top studies.

The initial site inspection should determine the extent to which the proposed development site is likely to support significant numbers of birds and bats, ground based fauna or native vegetation and plants, or to support any rare or threatened species from the region. An initial site inspection also enables more precise scoping of further studies to inform the development approval process by making the investigation :

a) focussed on the key risks
b) relevant to the particular setting and regulatory expectations
c) cost-effective.

Such inspections would rarely require more than a day on site, unless a number of alternative sites are being considered.

In the case of bird and bat habitats, possible bird movement patterns to and from surrounding habitats should be estimated relative to the development site. It would be reasonable to conclude that a site in a location with one or more of the attributes listed below might have a higher bird and bat collision risk than a site without these:

- Wetlands supporting large numbers of waterbirds, particularly if either side of where turbines are proposed to be located.
- High densities of birds of prey or owls;
- Prominent coastal headlands or islands on Bass Strait (northern Tasmania or central Victoria), where migrating songbirds might first make landfall;
- Narrow zones of vegetation or wetlands used by migrating songbirds or birds of prey (eg. Swamp Harriers *Circus approximans*).
- Regularly used habitats of the endangered Orange-bellied Parrot;
- Large concentrations of roosting or breeding bats (eg. maternity caves, old mine shafts).

If a site has any of these attributes, or any other feature considered to increase the potential risk of bird or bat collision with wind turbines, then more thorough investigation of bird and bat use of the site is warranted during project feasibility studies.

At this early stage, it is considered informative to open discussions with relevant state and regional wildlife authorities, such as state environment departments, national parks and wildlife services or nature conservation agencies. Local government environment officers (if available) can also usefully be approached at this stage. The aim of these discussions is to seek local knowledge and information on vegetation, habitats and species of significance, and on bird and bat usage of the region. In addition, it is useful to inform these agencies that a regional risk assessment is underway and to discuss the methodology for further investigations if the assessment identifies potential risks to flora and/or fauna.
It is also possible at this stage to identify specific bird or bat risk issues at a site and whether any targeted studies might be required to address the impact assessment requirements of regulatory and planning approval agencies (e.g. Orange-bellied Parrot surveys, studies of bat usage where caves are present).

At this stage, it will also be opportune to collect general information on other ecological attributes of the site to determine the need for and scope of any additional flora and fauna investigations as part of project feasibility studies. Attributes that should be considered include native vegetation, rare plants, fauna habitats, and mammals, reptiles and frogs present. Such information will assist in assessing impacts, identifying development constraints and mitigation measures, and in informing the development approval process.

In addition, it is an appropriate time to determine if a wind energy development at the site could have an impact on any matter of national environmental significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* that could trigger the requirement for a Commonwealth environmental assessment and approval (see Box 1).

Box 1: The Commonwealth EPBC Act – the Controlled Action

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* more clearly defines the Commonwealth government's role in development assessment and approval. It identifies the following matters of national environmental significance that trigger the provisions of the Act:

- World Heritage Areas (listed on the World Heritage Convention);
- Internationally Important Wetlands (listed on the Convention on Wetlands, also known as the Ramsar Convention);
- Nationally Threatened Species (protected under the Biodiversity Convention);
- Listed Migratory Species (listed under the Japan – Australia and China – Australia Migratory Bird Agreements, and the Convention on Migratory Species (also known as the Bonn Convention);
- Commonwealth Marine Areas (generally not applicable to wind energy developments); and
- Nuclear matters (likewise not applicable).

Proponents having a significant impact on matters of national environmental significance can be fined up to $5.5 million. In addition, the Act enables third parties (including environment groups) to seek injunctions to stop activities if they believe actions are or may be having a significant impact on these matters. Proponents should therefore carefully consider the application of this Act to their project and follow the required procedures.

The first step in the Commonwealth assessment and approval process is the **Referral**. This is a brief document that describes the proposed development and summarises the potential impact of the proposed development on matters of national environmental significance. The Commonwealth uses this to assist it in deciding if a proposal will have a significant impact on a matter of national environmental significance, in accordance with **Administrative Guidelines** it has issued on the Environment Australia (EPBC Act) web site.

Based on the referral document, the Commonwealth Minister then decides if the development is a **Controlled Action** (i.e. may or will have a significant impact) or not (ie. considered not the have a significant impact). If a development is deemed not to be a controlled Action then no other assessment or approval is required under the Act and the proponent can proceed with the usual state/local government development approval processes.

For wind energy developers, an important consideration in the regional risk assessment is the need for a referral under the Act and, if so, what additional investigations might be required (see Section A2.3).

A2.3 Project Feasibility

This section provides information on:

- ***Detailed ecological investigations at wind farm sites;***
- ***Approaches to studying flora and fauna (including bird and bat) usage of wind farm sites;***
- ***Approaches to assessing bird collision risk;***
- ***Approaches to assessing risks to other flora and fauna;***
- ***Ecological risk and project feasibility.***

A2.3.1 Background

The regional risk assessment may in many cases have identified potential flora and fauna risks for the site. Furthermore, initial discussions with state, regional and local authorities should have identified ecological issues likely to be of concern to them during the development approval process (either as a responsible authority for approving development or as a referral agency under planning approval procedures).

The outcome of these initial investigations should have enabled any detailed investigations to be scoped. An important consideration at this stage is the likely seasonal constraints to gathering adequate information to address these requirements.
Where native plants or bird and bat usage are involved, the time of year in which investigations are undertaken is critical to a full understanding of potential risks. For example, some plants only emerge and flower for brief periods in spring. Bird migration is strictly seasonal, usually occurring in the same weeks each year, but for a limited period. It will be important that any further studies required are undertaken during the appropriate seasons when target species are present and/or detectible.

Bat activity also follows seasonal trends, with the highest activity occurring at the warmest time of year (or time of maximum insect/fruit abundance). Some bat species migrate into areas to feed or breed in summer and depart for the winter (eg. Southern Bent-wing Bat *Miniopterus schreibersii*) while others hibernate over the colder, winter months.
A critical consideration here is also the time required to gather accurate and comprehensive information to address risk issues versus the timing of development approval applications.

Such information will guide proponents on how to avoid or reduce the risk of bird and bat collision and how to minimise impacts on other flora and fauna. The same information will need to be presented in any documentation submitted to planning and development approval agencies.

The development approval process is usually open to public comment and the work of proponents can be subject to rigorous third-party technical review at this stage, which informs the decisions made by approval agencies as much as any documentation provided by a proponent. It is therefore better for the proponent to have done adequate investigations and to have designed a wind farm to demonstrably reduce risks to flora and fauna, than to have economised excessively and face valid technical criticisms that leave unanswered questions and doubts in the minds of regulators. The latter scenario increases the risk that proposals will not be approved.

A2.3.2 Studying Flora and Fauna of a Site

Information on flora and fauna of a potential wind energy development site will inform internal decisions on the design and operation of the facility, as well as the impact assessment required by the relevant planning authorities. There are two types of studies usually required:

- Targeted investigations of flora and fauna; and
- Bird and bat utilisation studies.

These are considered separately below.

A2.3.2.1 Targeted Investigations

The regional risk assessment would have indicated the potential occurrence of rare, threatened or otherwise significant bird and bat species on a development site. Other significant ecological issues may also have been flagged at that stage for further investigation (eg. rare plants that only emerge and flower in spring).

The aim of targeted investigations is to gather site-specific information on the occurrence of any significant species or communities on the site and in nearby areas.

It is not possible to prescribe a particular methodology for such investigations. Instead, investigations should aim to meet the general requirements described below.

- The methods and seasonal timing of the investigation should be appropriate to the targeted species or community (where time constraints are an issue, the implications of this for investigations need to be documented).
- The design of the investigation should aim to gather data to address well defined questions related to the impact of the proposed development and the means available for reducing this to acceptable levels.
- The investigation should include a thorough review of available information on the target species, including discussions with recognised experts.
- The data should be presented and reported in plain language, clearly addressing the questions of impacts and mitigation measures.

Issues for which targeted investigations have been necessary in the past or for which they might be necessary include but are not limited to:

- Behaviour of migratory birds that use habitats on or near proposed development sites;
- Behaviour of bats that use caves on or near the site;
- Occurrence and behaviour on and near the site of rare or threatened species (eg. Orange-bellied Parrot);
- Occurrence in possible development footprint of rare or threatened plant species.

The methods appropriate to particular targeted investigations will depend on the particular development site and proposal, as well as on the species or communities involved. Methods involved could range from trapping small ground-dwelling fauna (e.g. pit-fall trapping), to detailed mapping of individual rare plants based on comprehensive site surveys. It will be important to obtain technical advice on the most appropriate approach and methods for targeted investigations from flora and fauna specialists.

A2.3.3.2 Bird and Bat Utilisation Studies

In addition to targeted investigations, it is necessary to obtain general data on bird and bat use of sites and their surrounding region to enable a risk assessment of bird collision to be undertaken.

The aim of bird and bat utilisation studies is to quantify general bird and bat usage of the site under a range of conditions, times of day and times of year.

A bird utilisation study involves collecting data on bird utilisation of a site in a consistent manner that accounts for all known potential sources of variation. It involves a very tightly controlled and timed series of observations of bird presence and movements, usually involving:

- Surveying places on the site where wind turbines are proposed to be located, as well as sites where none are proposed to be placed;
- Surveying these sites for birds at all times of day and in all seasons;
- Surveying these sites at night for bats.

The number of survey sites and the survey technique will vary according to the size and shape of the proposed development site, the proposed array of wind turbines and the likely bird use of the site. It is appropriate to design the survey after the regional risk assessment and when a reasonably clear turbine layout or development envelope has been identified.

The bird and bat utilisation studies are designed to provide:

- quantification of bird and bat use of the site for bird collision risk assessment;
- a baseline for future monitoring to determine the disturbance impacts on bird use of the site; and
- quantification of the relative abundance of species on the site (for comparison with the results of bird collision monitoring).

Although Australian regulators are not currently so concerned with the disturbance effects of windfarms, there is consensus overseas that these are likely to be much more significant for bird populations than the impact of, in most instances, a comparatively small number of bird collisions with turbines. In view of these two types of impact (disturbance and collision), studies of bird utilisation of wind energy development sites should be undertaken with a view to determining both types of impacts once operations commence, as the monitoring requirements of the authorities before a development is approved can be difficult to anticipate.

With these potential requirements in mind, good experimental design is important in setting up

bird utilisation studies. This involves a:
"before-after, reference-impact, matched pairs design." This comprises an arrangement of survey sites that measures bird usage before and after operations commence, on both the sites being impacted and on nearby reference sites. Matched pairs refers to the survey being done so that each impact site has an equivalent, off-site reference site, in terms of landscape setting and habitat characteristics. This also enables a broader landscape-scale comparison of bird utilisation of the development site with other sites in the region. This is important information for determining if bird collision risk at the site is different or exceptional compared with other potential development sites nearby.

The utility of this design is that it enables comparison of before and after disturbance impacts at sites where all other variables are held as constant as is feasible in nature. In this way, any changes at the impact site can be more certainly related to the impact of the wind energy development.

An important consideration in designing the survey is the survey unit. The survey unit is the scale and method used to quantify bird and bat utilisation. The scale and methods used are likely to vary from site to site, depending on the size of the site, the layout of turbines and the aim of the monitoring program. A range of methods has been used, both in Australia and overseas and methods are constantly being refined so it is not proposed to recommend a specific method here. However, the same survey unit should be used at each location in a bird and bat utilisation study of a particular development, and through time as part of post-operational monitoring.

The method used can involve a range of units, including but not limited to single point counts of birds for a fixed period, counts of birds in fixed-width transects walked over a fixed period, or linear transects similarly surveyed along which distances to birds sighted on either side are estimated. These rely on visual detection of birds and usually include an estimate of bird flight height relative to turbine height. There is a tendency to use fixed-point counts in current investigations but this may change in future. A blend of fixed point counts and transect surveys can be used during the one survey period, with birds located on either survey unit separately recorded.

Bat surveys present challenges, as the animals are active at night and often not visible. Some of the larger, higher-flying species (e.g. *Tadarida australis*) are audible to some people, but not all, while many species can only be detected using ultrasonic detection equipment called 'Anabat'® bat detectors. This equipment has its limitations in that the range at which it can detect bats is limited and may be mostly below the height of the blades on modern wind turbines.

Consistency of method and survey locations in both space and time is important to drawing meaningful conclusions about bird and bat utilisation of development sites and about the impacts of developments once they are operating.

The method used should follow the rules below:

- The method should be applied consistently throughout the area of investigation (impact and reference sites) and for the duration of the study (both before and after operation commences) for a particular development;
- The number of observers undertaking the work should be limited, thereby reducing differences between observers;
- The height at which birds are first observed should be recorded relative to the height range of the turbines in the proposed development (eg. below, within or above the relevant height range);
- The method should generate a bird density per unit time measure (e.g. birds per hectare per hour.

Guidance on mortality monitoring programs is provided in Section A2.6 on Operations.

Modelling collision risk

The technique chosen should be able to generate figures on the number of bird movements by area and turbine height of the wind energy development site. From this, the potential risk of birds striking the turbines can be quantified based on the footprint of the turbines and the cross-sectional area of the turbine blades, using a simple spreadsheet model.

Rates of bird collision can be expressed as a potential "encounter" rate and reduced based on documented and reasonable assumptions about the probability of birds avoiding turbines (see Section A2.2). Alternatively, modelling can be done based on the 'encounter rate' by

using estimates of the proportion of the air space occupied by the turbine blades and the birds and, therefore, the probability of birds that encounter a turbine colliding with a turbine blade (see Tucker 1996).
The predictions of collision rate generated from bird and bat utilisation studies can be tested using data collected from bird and bat mortality monitoring programs once operations commence. However it is necessary to commence such a program during the feasibility study in order to gather pre-operational data on background bird mortality levels. The approaches used in such studies are described in Section A2.6.

Statistical considerations

It is important that estimates of collision risk are also presented with estimates of precision. Conventional estimates of precision include statistical measures of variability, such as standard deviation and standard error of the mean. The data gathered during bird utilisation studies can be analysed statistically to derive these figures.

In comparing before and after effects, it will also be important to be able to determine if any differences are statistically significant; that is, if the differences are due to chance variation in observations or to some systematic effect (e.g. the impact of the wind farm). The purpose of the rigour recommended in the investigation approach described here is to ensure that the varied assumptions of statistical analysis techniques are met.

Once a year of data has been obtained, and if development approval requires on-going monitoring of bird utilisation to detect indirect impacts, it will be important to undertake a statistical power analysis. The purpose of the power analysis is to determine the level of impact (i.e. percentage change) that can be detected given a particular number of survey units and sampling periods. Unfortunately, this will forever be set by the intensity of sampling before construction, so it will be important to ensure that a good quantity of data is collected at this stage.

Between-year differences

The Australian climate shows significant differences between years. Such changes can affect the abundance, breeding success and movements of many Australian birds, as well as the emergence and flowering of plants and the breeding and abundance of many rare and threatened ground-based fauna species.

Differences between years (in addition to seasonal differences) can contribute significantly to natural variability in bird numbers recorded during bird utilisation studies. The source of variability can only be accounted for in very long-term studies which are difficult, costly and provide no guarantee that other than the coarsest changes will be detectable with any rigour.

A2.4 Detailed Assessment

This section contains information on:

- ***Describing the ecological attributes of development sites;***
- ***Assessing conservation significance; Impact assessment;***
- ***Mitigation measures;***
- ***Potential requirements under the Commonwealth EPBC Act ;***
- ***The ecological content of a development application.***

It is important that technically valid information and interpretations are presented in documentation that accompanies a development application. To this end, the use of qualified ecologists with experience in the development approval process for the particular jurisdiction is recommended.

However as mentioned earlier, the variability of natural ecosystems and their components (climate, plant and animal populations, etc.) means that only the coarsest changes will be predictable or detectable in any investigation, such as a before – after bird utilisation study and so it is important that proponents, regulatory agencies and the wider community understand the limitations of ecological investigations.

Development approval and on-going management decisions related to ecological matters will inevitably be made in an environment of partial uncertainty. Thus, proponents need to carefully manage wider community and regulator expectations and not just rely on technical investigations to address ecological issues.

A2.4.1 Site Description

The site description should include the following information:

- Location and extent of site;
- Land-use history of site;
- Type, extent, and condition of native vegetation;
- Type, extent and condition of fauna habitat;
- Presence of rare or threatened species of flora and fauna and the location of their habitats; and
- Presence of any threatened communities.

Threatened species and communities should be determined based on state legislation and lists (usually available through the relevant state wildlife authorities) as well as the lists of threatened species on the Commonwealth EPBC Act.

A2.4.2 Conservation Significance

In any assessment of the ecological attributes of a development site, it is important to place the site in its wider context by undertaking an assessment of its conservation significance. Significance is based on the rarity and condition of vegetation and fauna habitats, and on the rarity and size of plant and animal species populations.

The most usual way of determining rarity is the listing of a community or species on state or Commonwealth legislation, or in widely accepted accounts of rare and threatened species at scales from regional (eg. Comprehensive Regional Assessments), state (e.g. state threatened species lists) or national (e.g. EPBC Act list).

The condition of native vegetation and fauna habitat is usually assessed based on the degree to which it has been altered from its pre-European condition. The most common causes of alteration are weed invasion and disturbance due to partial clearing or logging.

The size of a rare species' population on a site should be related to the estimated size of the population, usually available in accounts such as state or Commonwealth recovery plans or action plans. This will assist in determining if a significant proportion of the estimated population is present on the site.

It is important that a set of acceptable criteria for conservation significance be developed by the proponent, in consultation with the relevant state conservation agency, and consistently applied to information on the flora and fauna of the proposed development site.

These criteria are generally based on the above considerations, tailored to meet individual state legislation and listings.
The usual scales at which significance is assessed are:

- International;
- National;
- State;
- Regional; and
- Local.

Assessing conservation significance at the first three scales is generally straightforward, being based on international treaties, and Commonwealth and state legislation and listings. Examples of sources are provided below. Note that this listing is not nationally comprehensive but provides a guide to the types of sources that will be useful.

Regional significance can be assessed at the bioregional level, based on the Interim Biogeographical Regionalisation for Australia (Thackway & Cresswell 1995). In some states, smaller scale regionalisation has been undertaken (eg. Conn 1993; Sattler & Williams Eds. 1999) that can be used to assess regional significance of ecosystem types on the development site.

The bioregional approach is not necessarily useful for all conservation values, particularly regionally rare and threatened species. There has been no comprehensive assessment of the regional rarity of plant and animal species populations in many parts of Australia. Therefore, such assessments must sometimes be based on the judgements of experts with good knowledge of the region's flora and/or fauna (e.g. regional conservation agency staff). The role of any habitats on the site as part of a wider, regional network of linked habitats through which fauna can move in the landscape also needs to be considered.

Local significance is usually easy to determine in the settled regions of Australia. In many areas, the extent of vegetation and habitat degradation

GROUP	SOURCES
Nationally significant plants	Briggs & Leigh (1995); Commonwealth EPBC Act list of extinct, critically endangered, endangered and vulnerable plants
Nationally significant fauna	Stranger et al. (1998); Commonwealth EPBC Act list of extinct, critically endangered, endangered and vulnerable fauna; National Action Plans, such as Maxwell et al. (1996), Lee (1995), Duncan et al. (1999), Garnett and Crowley (2000), Cogger et al (1995), Tyler (1997) or Wager and Jackson (1993).
Nationally significant communities	Commonwealth EPBC Act list of threatened communities
State significant plants and animals	State legislation, such as *Threatened Species Conservation Act 1995* (NSW), *Flora and Fauna Guarantee Act 1988* (Vic.), *National Parks and Wildlife Act 1972* (SA). State lists, for example: Gullan et al. (1990), DNRE (2000a, 2000b)
State significant communities	State legislation: *Threatened Species Conservation Act 1995* (NSW), *Flora and Fauna Guarantee Act 1988* (Vic.)
Regionally significant plants, animals and communities	Comprehensive Regional Assessments (see RFA Web Site): e.g. Anderson & White (2000); Regional inventories of biodiversity, including regionally significant species, such as Vic. Environment Conservation Council reports; SA Regional Biodiversity Plans (e.g. Croft et al 1999); Regional vegetation and ecosystem mapping (e.g. Sattler & Williams 1999; WGCMA 2000)

places a priority on retaining what remains and all remnant areas of vegetation and habitat can be considered to be of at least local conservation significance.

It will be important to assess the conservation significance of birds that regularly use the site so that the impacts of any predicted collisions on the populations of the species involved can be assessed. Data on bird usage will have been generated by the bird and bat utilisation studies.

It will also be possible to review the data from the bird and bat utilisation studies to determine if there are any particularly unique or significant features of the site in terms of bird usage compared with comparable landscape settings in the region (i.e. the reference sites).

A2.4.3 Impact Assessment

In assessing the impacts of a wind energy development, the potential for works and activities to reduce the quantity and quality of vegetation and habitat needs to be determined and whether the impact is temporary or permanent. The time scale for recovery in the event of temporary impact needs to be identified. In addition, based on the assessment of conservation significance above, the wider implications of the impact should be assessed.

Impacts can take the form of **direct** effects, such as the removal of native vegetation and habitat for the development footprint, or **indirect** effects, such as noise and movement disturbing wildlife.

The impact of predicted collisions on the populations of bird species involved needs to be assessed. For rare and threatened bird species that might be involved, a detailed Population Viability Analysis (PVA) may be warranted (Boyce 1992; see also useful overview in Burgman & Lindenmeyer 1998). The PVA method uses all available parameters and values for population processes known for the species (e.g. birth rate, natural mortality rate, numbers of young produced each year, generation time, etc.). From this, the likelihood can be determined that the predicted mortality from the wind energy development will lead to significant population decline that prejudices the future survival of the species.

Development approval authorities, particularly state referral agencies with responsibility for wildlife, will be examining the development in terms of **incremental impacts** on wildlife, such as birds and/or rare and threatened species. Incremental impact involves the cumulative impact of the proposed wind energy development on wildlife, together with known current and forthcoming impacts elsewhere in the region or within a species' range. Some of the approaches to impact assessment mentioned above do not consider incremental impact (e.g. Population Viability Analysis), although they can be adapted to do so. It is recommended that incremental impacts also be considered before definitive conclusions about the significance of the impact are made, although there is a limit on the extent to which future land use changes and associated impacts can be anticipated.

Wind energy developments involve a range of works and activities that potentially affect ecosystems adversely and for which mitigation measures will need to be developed. The issue of bird collision with wind turbines has been discussed in detail in section A2.1. Some of the other potential impacts are listed below. Mitigation strategies for these are discussed in more detail later in this section.

- Access tracks or roads linking turbines may remove native vegetation and fauna habitat or lead to changes in surface water runoff patterns. Construction of these roads can encourage the spread of weeds.
- Underground power cables involve trenching and associated earthworks which may remove native vegetation and fauna habitat, lead to changes in surface water runoff patterns or encourage the spread of weeds.
- Overground power cables may require the removal or lopping of native vegetation, and may lead to an increased risk of bird collision.
- Construction of switchyards can result in disturbance to wildlife and direct loss of habitat.
- Construction activities may temporarily disturb wildlife. The soil disturbance associated with these works may promote weed invasion or alter surface water runoff. Works could also lead to erosion and down-slope sedimentation, which magnifies the area of disturbance, weed invasion and altered surface water runoff.
- Construction vehicles may harbour weed seeds and propagules from previous works areas beyond the region. This creates potential for the introduction of new weeds into an area.

A2.4.4 Mitigation Measures

Mitigation measures can be implemented at three stages:

- Design-stage mitigation, generally focussed on refining turbine and associated infrastructure location where significant risk of collision or other impact on flora and fauna of a site are possible.
- Construction-stage mitigation, involving careful planning and management of construction works to avoid sensitive areas, minimise disturbance to wildlife and rehabilitate disturbed land.
- Operation-stage mitigation, including land management practices to reduce the attractiveness of development sites to birds and bats, as well as ensuring that construction-stage rehabilitation is maintained.

The following table summarises the steps that can be taken during design and operation of wind energy developments to mitigate impacts on ecosystems and flora and fauna populations. Construction-stage mitigation measures are given in Section A2.5.

It will be important that documentation provided to development approval authorities demonstrates how:

- the design of the development has taken into account the need to mitigate potential impacts; and
- mitigation measures will be implemented during construction and operation.

In the description of the proposed development, a section documenting environmental constraints and how the design of the development has responded to these is appropriate.

An **environmental management plan** is a means of ensuring that environmental commitments are fulfilled and of giving assurance to all interested parties that mitigation measures will be effectively implemented. It includes:

- Policy level commitment to good environmental practice;
- Detailed description of mitigation measures and the way in which they will be implemented;
- Identification of roles and responsibilities of corporate and site personnel, and contractors for implementing mitigation measures;
- Clearly identified lines of communication between responsible personnel;
- An auditing process to monitor compliance with the procedures and outcomes of the plan; and
- Mechanisms for dealing with non-conformances, including contingency plans.

Box 2: The Commonwealth EPBC Act – Assessing Controlled Actions

The investigations undertaken as part of feasibility studies and the detailed assessment should also form the basis for a Referral under the Commonwealth EPBC Act, if there is any potential for a significant impact on a matter of national environmental significance. Guidelines for the preparation of a Referral can be found at the Environment Australia website: www.ea.gov.au/epbc/.

Should the Commonwealth Minister for the Environment make a project a controlled action Information for Proponents will be provided outlining the reasons for the decision. The proponent must then furnish the Minister with a response to the issues raised in the Information for Proponents in the form of Preliminary Information. This is used by the Minister to determine the level of assessment that applies to the development under the Act.

The levels of assessment possible are:

Preliminary Documentation (based on the Preliminary Information and responses to any further questions that the Minister may have);
A Public Environment Report;
An Environmental Impact Statement; and
A Commission of Inquiry.

These levels of assessment require increasingly comprehensive and detailed impact assessment and associated investigations, as well as increasing levels of community consultation.

Impact Mitigation For Wind Energy Developments During Design & Operation

(See Section A2.5 for construction related mitigation)

POTENTIAL IMPACT	DESIGN	OPERATION
Bird Collisions with wind turbines	• Avoid development sites and turbine sites with high bird usage; • Locate turbines well away from wetlands and other bird-rich habitats; • Consider widening turbine spacing to permit movement of birds around and between turbines.	• Investigate collision minimising strategies for turbines found to have significant bird and bat collision problems. • Avoid human disturbance to any wetlands or other habitats that hold bird groups potentially vulnerable to collision, as increased rates of movement will increase the risk of collisions; • Undertake an extensive rabbit control program to minimise the attractiveness of the site to birds of prey; • Clear away sheep and cattle carcasses rapidly to avoid attracting scavenging birds of prey; • Provide alternative habitat off-site to attract at-risk birds from near turbines.
Wind Turbines	• Consider using larger, wider spaced turbines to reduce risk of bird collision.	• Monitor and repair any erosion and reduce surface water pooling or concentration of runoff; • Do not illuminate wind turbines as this can attract insects, a source of food for birds and bats, and confuse night-flying birds, leading to greater collision risk. • Monitor for any downslope deposition of material from construction areas and ensure weeds are controlled and areas are re vegetated; • Control weeds that invade areas disturbed after construction.
Access tracks and roads	• Avoid areas of native vegetation and fauna habitat; • Where unavoidable (eg. on largely vegetated sites), use existing tracks wherever possible; • Place roads well clear of wetlands to avoid disturbance to birds (disturbance increases risk of collision); • Design roads and tracks so that changes to surface water runoff are avoided and erosion is not initiated.	• Monitor and repair any erosion and reduce surface water pooling or concentration of runoff; • Monitor for any downslope deposition of material from construction areas and ensure weeds are controlled and areas are re vegetated; • Implement strict speed limits where tracks are within 200m of wetlands or other habitats where birds could be disturbed. • Control any weeds that invade areas disturbed after construction.

Impact Mitigation For Wind Energy Developments During Design & Operation (cont.)

(See Section A2.5 for construction related mitigation)

Underground power cables	• Route power cables to avoid the need to remove native vegetation and habitat (e.g. along existing tracks and roadsides; • Where unavoidable (eg. on largely vegetated sites), do not route cables through significant vegetation or habitats.	• Monitor and, if necessary, repair any erosion and reduce surface water pooling or concentration of runoff; • Monitor for any downslope deposition of material from construction areas and ensure weeds are controlled and areas are re vegetated; • Control any weeds that invade areas disturbed after construction.
Overground Power Cables	• Route power cables to avoid the need to remove or lop native vegetation and habitat; • Ensure that power cables are not places across regular bird flight paths. • Where unavoidable (eg. on largely vegetated sites), do not route cables through significant vegetation or habitats;	• Monitor and, if necessary, repair any erosion and reduce surface water pooling or concentration of runoff; • Monitor for any downslope deposition of material from construction areas and ensure weeds are controlled and areas are re vegetated; • Control any weeds that invade areas disturbed after construction. • Monitor and if necessary take mitigation measures for any consistent and significant bird collision problems.
Switchyard	• Locate switchyard to avoid areas of native vegetation and habitat; • Where unavoidable (eg. on largely vegetated sites), do not locate switchyard on significant vegetation or habitats.	• Monitor and, if necessary, repair any erosion and reduce surface water pooling or concentration of runoff; • Monitor for any downslope deposition of material from construction areas and ensure weeds are controlled and areas are re vegetated; • Control any weeds that invade areas disturbed after construction;

A2.4.5 The Development Application

Based on the forgoing considerations, the development application should contain a range of information on flora and fauna. As a minimum this should include :

- A description of the methods used to compile information on the flora and fauna of the development site and the sources of information, as well as an overview of the reliability of or limitations associated with the sources of information;
- Identification of vegetation types and fauna habitats on and near the site;
- A listing of flora and fauna species on the site;
- Indication of any rare or threatened species on or near the site;
- A description of the conservation significance of any vegetation, habitats or species on or near the site;
- A description of the potential impacts of the proposed wind energy development on flora and fauna, including threatened species (potential impacts should be identified, together with the likely net impact after implementation of mitigation measures);
- Analysis of the implications for the development of any state regulations and legislation related to native flora and fauna, and threatened species;
- Details of impact mitigation measures that have been incorporated into the design of the development to address regulatory or legislative requirements and to meet general best practice environmental management targets;
- Details of impact mitigation measures to be implemented during the construction and operation of the development, including the flora and fauna-related content of any environmental management plans (construction and operation);
- Details of any environmental management plan or commitments and procedures that will be applied.
- Proposals for any monitoring of development impacts on flora and fauna and, if necessary, contingency plans in the event that significant impacts occur.

A2.5 Construction

This section provides information on construction related impacts on flora and fauna and mitigation responses.

Construction of wind energy developments has a range of potential impacts on ecosystems on and near the development site. These are listed below.

- Removal of native vegetation may have to occur where it cannot be avoided. The area to be removed should be minimised and identified areas of conservation significance avoided altogether. Where possible, disturbed areas need to be re vegetated with plants sourced from local seeds and cuttings.
- Disturbance of sensitive wildlife on the site is possible during construction. This can be avoided by timing construction to avoid the most sensitive times of year (eg. breeding and dispersal), and/or staging construction work to ensure adequate distance between works and sensitive habitats over the construction period.
- Disturbance to the ground can expose earth to erosion from rainfall and surface runoff, and to invasion by weeds. This, in turn can affect nearby native vegetation and habitat, transporting sediment and weeds into previously undisturbed areas. Appropriate erosion and sedimentation control measures, combined with post-construction monitoring and control of erosion and weed invasion can prevent long-term damage to nearby ecosystems.
- Disturbance of the ground can change surface water runoff, leading to pooling of water in some places and concentration of runoff in others, increasing the risk of erosion during rainfall events. Site rehabilitation should aim to restore the pre-existing topography wherever possible and avoid the creation of pools and rills.
- Disturbance of a larger than necessary area of vegetation can occur due to poor planning of construction areas. This can be largely avoided through locating storage areas and

vehicle standing areas away from native vegetation and habitat and at least 200 m from wetlands. Where this is not possible, identified areas of conservation significance should be avoided. All such areas should be clearly identified and marked before construction commences and revegetated after construction is completed.

The foregoing measures can be implemented as part of a **construction environmental management plan**, which forms a component of the full environmental management plan for the development.

Information on precise construction impact mitigation measures is not provided here as they are not unique to wind energy developments. Generic environmental practice guidelines for construction sites are applicable to wind energy developments and can be obtained from the relevant state environment agency.

Implementation of the construction environment management plan will need to be an obligation of the construction contractor. The proponent will need to make provision for inspection and auditing to ensure that provisions of the plan that mitigate impacts on flora and fauna are implemented.

A2.6 Operation

This section provides information on flora, fauna and bird use monitoring, as well bird and bat mortality studies that may need to be implemented during the operational stage of a wind energy development.

Provided that the necessary precautions and mitigation measures have been implemented, the operation of the wind energy development should not have a significant impact on flora and fauna. Notwithstanding this, monitoring of impacts from bird collisions is considered wise to ensure that, where unanticipated problems arise, they are identified and addressed. Indeed Environment Australia and other development approval agencies (e.g. Victorian Department of Natural Resources and Energy) have already required this for some wind energy developments in Australia.

With regard to general flora and fauna impacts, unless a specific matter of conservation significance is likely to be affected, or if the planning authority has required it as a condition of approval, monitoring of general flora and fauna is not considered necessary in many cases.

The bird and bat utilisation studies should be continued for at least two years after the wind energy development commences operating. This will provide information on the impact of the facility on bird use of the site. Similar studies overseas have revealed that bird use can decline noticeably around wind energy facilities (e.g. Winkelman 1994). Continuing monitoring will enable the significance of this effect to be determined.

This deterrence effect is also likely to reduce the risk of bird collision with operating wind turbines, as fewer birds would encounter turbines and any changes in bird and bat usage will be reflected in the results of mortality monitoring. In this regard, the species composition of birds and bats found to have collided with turbines may be different from the pre-operational bird and bat species composition, not just due to selective vulnerability of species but also due to changes in species composition due to disturbance. A full understanding of the impacts of wind energy developments therefore depends on both types of data being collected after operations commence.

Little data is currently available on the impact of operating wind energy development on birds in Australia. It is therefore recommended that the impacts of any wind energy development on birds be monitored through the design and implementation of a bird and bat mortality-monitoring program. The essential features of such a program are described below.

The before-after, reference-impact, matched pairs design should again be used. This will involve:

- Searches of the same number of 50m radius sites at and away from the turbines (impact and reference sites respectively);
- Equal numbers of sites from representative landscape settings (and proximity to bird and bat habitats) at turbine sites and away from turbine sites; and
- Searches of all sites before and after operations commence.

At the time of feasibility studies, it will be necessary to incorporate pre-operation mortality surveys into the field study program, provided that turbine locations have been finalised. If turbine locations have not been finalised then mortality monitoring should commence as soon as possible after this is known. The purpose of pre-operational mortality surveys is to provide data on background levels of bird mortality, which will provide an important benchmark against which to compare the results of post-operational studies. It is likely that only a minimal number of bird and bat carcasses will be found during the pre-operational phase of the program.

The detection of bird and bat carcasses at both impact and reference sites has been found to be influenced by the behaviour of scavenging animals (e.g. foxes, Tasmanian Devils) and the ability of the person doing the searches to find carcasses (searcher efficiency). Site-specific estimates of these will need to be made before meaningful estimates of mortality are possible.

A2.7 Decommissioning

When a wind energy facility is decommissioned, a number of precautions need to be taken to avoid any long-term degradation of natural ecosystems. The extent to which these measures are implemented will depend on the particular site characteristics. Where no native vegetation has been removed, it may only be necessary to restore the pasture and cropping capacity of the affected land.

Where native vegetation has been removed for any element of the wind energy development then regulatory authorities will almost certainly require re vegetation of the affected areas. An appropriate plan, involving sourcing of planting material of local provenance should be developed and implemented for re vegetation of such sites.

Additional mitigation measures to be implemented during decommissioning are the same as those described for construction in section A2.5.

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Appendix 3
Electromagnetic Interference

Telecommunication systems often use high points in the landscape the in vicinity of prospective wind farm sites and telecommunications service providers and users may have concerns about electromagnetic interference as a result of a proposed wind farm development. A diverse range of telecommunications including radio and television companies, mobile phone companies, local and national utilities, and emergency services such as ambulance and coastguard using microwave communication systems could be involved in any particular development. In rare cases developers may be faced with complying with statutory separations from certain communications equipment associated for example with microwave sites or airports.

The scope for wind turbines to impact such systems is summarised as follows :

- the turbine tower may obstruct, reflect or refract the electromagnetic waves used in a range of communications systems for transmission.
- the rotating blades may have similar effects, on a time-variable basis. In some cases ghosting of TV receivers close to the wind farm may occur where metal blades (or those with metallic cores) act as an aerial to on-transmit the communication signal.
- the turbine's electrical generator itself can produce electromagnetic interference, which may need to be suppressed by shielding design and maintenance of turbines (although in practice, a generator is little different from a typical electrical motor and it is quite rare for a wind turbine generator to present such a problem).

Figure 21 Thursday Island Wind Turbines (Courtesy Ergon Energy)

The electromagnetic radiation resulting from generation and export of electricity from a wind farm does not pose a threat to public health. Typically electrical cabling between wind turbines will be direct buried in the ground and grid connection cabling is usually made at no more than 66kV or 132kV; similar voltages to those routinely used by utilities in existing distribution networks. As part of the engineering specification however, developers must require that installation contractors adhere to prescribed electrical cabling standards.

It is normally possible for the potential for the electromagnetic interference effects mentioned above to be minimised, if not eliminated altogether through special technical solutions and appropriate turbine siting. This is shown quite dramatically above where at Thursday Island in Far North Queensland, wind turbines were sited in close proximity to a microwave tower, radio masts and an airways corporation satellite tracking station without interference. Another example is Trustpower's Tarurua Wind Farm in New Zealand (see below) where wind turbines were carefully placed to avoid the line of sight of several microwave beams traversing the site. Despite the telecommunications facilities being located virtually within the wind farm boundary, no interference has been reported.

Figure 22 Telecommunications Facilities at Trust Power's Tararua Wind Farm in New Zealand (Courtesy PB Power)

In general, the effects of wind turbines on electromagnetic waves will usually be relatively limited. The tower and blades are slim and curved, and consequently will disperse rather than obstruct or reflect the waves. Where blades are of a material transparent or absorbent to the waves, as is commonly the case, problems are likely to be minimal. However, the location, size and design of the turbines may be important, depending on the location and nature of the communication transmission facilities.

Generally, the communications systems most likely to be affected are those which operate at super high frequencies (particularly microwave systems operating at frequencies above about 300 MHz). These rely on line of sight between transmitter and receiver. Any obstruction in the vicinity of a straight line between these two points may cause interference and signal degradation.

The key area of potential interference is called the first Fresnel zone. This is an ellipsoid around and forming a path between the transmitting and receiving stations based on transmission, frequency, distance and local atmospheric conditions. A turbine within the first Fresnel zone may be acceptable, particularly if it is a solitary obstacle with a width less than 0.3 times the radius of the zone. However, every case needs to be considered on its particular circumstances. Potential effects can be calculated from information about the signal, the local conditions, and the turbine design and location.

For all electromagnetic effects, means of mitigation, avoidance, and remedy can be found. These may include specific location of particular turbines, choice of wind turbine generator type, tower design, or specific blade material. Relocating, adjusting or enhancing existing communications installations may also present as options for reducing the potential for interference. For example a small change in a line of sight radio path can make a large difference to whether the path is obstructed by the turbine or not. For domestic receptors it may be possible to enhance reception by upgrading the quality of existing television aerials or installing a repeater.

Whilst the presence of telecommunications structures on a proposed site is an obvious indicator that electromagnetic interference issues will need to be taken into consideration, even if there are no such structures present, it is advisable for developers to identify and consult with communications operators at an early stage so that any potential adverse effects can be identified and addressed. Developers should seek to identify and address any electromagnetic interference issues through private agreements with the stakeholders prior to seeking planning approval for the project.

Telecommunications stakeholders are best identified through a search of the Australian Communications Authority's Register of Radiocommunications Licences. This can be searched in a number of ways; probably the most useful for a proposed wind farm site is a search by postcode. This will identify all license holding sites within the postcode district and these can be individually examined in detail and contacted if required. The database can be accessed on-line www.aca.gov.au, or through the purchase of a CD of the database. (It should be noted that on-line search results are now limited to 100 records.)

Appendix 4 Wind Turbine Standards

This appendix lists some of the standards, procedures, codes of practice and guidelines that have been developed specifically for wind turbine generators and wind farms. However it is not exhaustive and developers should ensure that any proposed development conforms with relevant State and Federal Laws and Regulations as well as applicable Australian and International Standards and Codes.

A.1 Organisations Involved in Producing Wind Standards

The following organisations are or have been involved in the preparation and publishing of standards relevant to wind energy systems :

- SA - Standards Australia,
  SNZ - Standards New Zealand
- IEC – International Electrotechnical Commission
- IEA – International Energy Agency
- AWEA – American Wind Energy Association
- NWCC – National Wind Coordinating Committee (US based)

A.2 Standards Australia and Standards New Zealand

Standards Australia (www.standards.com.au) is an independent, not for profit organisation. It has a memorandum of understanding with the Commonwealth Government that recognises Standards Australia as the peak standards writing body in Australia.

Standards Australia is the Australian representative in the International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC). Standards Australia often works with Standards New Zealand in the preparation of joint Australian/New Zealand Standards and related documents. Both Australian and joint Australian/New Zealand Standards are recognised as being authoritative documents. They have wide legislative acceptance in all states and territories in Australia with an increasing legislative acceptance by the Federal Government.

Because of the fairly recent evolution of the wind industry in this country, Standards Australia has not (with the exception of a draft standard on measurement of sound levels)to date published any standards specifically targeting wind turbines and wind farms. However at the time of writing SA was putting together a technical committee (TC88) to assess the need for domestic standards.

Having said this however, many of the existing Australian Standards do hold relevance to the civil, structural, mechanical, electrical and instrumentation engineering of wind farms. Although by no means an exhaustive listing, some of the key standards that developers wish to refer to are listed in this section. Developers can access titles and summaries via www.standards.com.au where all of the standards published by SA can be purchased on line in either hard copy or electronic form.

AS/NZS 3000:2000 SAA Wiring Rules

Provides requirements for the selection and installation of electrical equipment, design and testing of electrical installations, especially with regard to the essential requirements for safety of persons and livestock from physical injury, fire or electric shock. Many of the prescriptive work practices contained in previous editions of AS 3000 have been removed and this Standard incorporates internationally accepted practices. (290 pages)

AS/NZS 3008.1.1:1998 Electrical installations - Selection of cables

Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions

Sets out the procedures to be followed for the selection of cables to satisfy typical Australian installation conditions where the ambient air temperature is 40 degrees Celsius and ambient soil temperature is 25 degrees Celsius. Criteria given are current-carrying capacity, voltage drop and short-circuit temperature rise. (95 pages)

AS/NZS 3100:1997 Approval and test specification - General requirements for electrical equipment

Specifies essential safety requirements for approval and test purposes. It is a parent specification for a series of approval and test specifications. (87 pages)

AS/NZS 3820:1998 Essential safety requirements for low voltage electrical equipment

Specifies a set of outcomes-oriented criteria for the safety of electrical equipment for use by electrical regulators in relation to products for which regulatory approval before sale is not required (non-declared articles). This Standard is intended to be consistent with the criteria of the European Union low voltage directive. (5 pages)

AS 60038-2000 Standard voltages

Specifies standard voltages for 50 Hz AC transmission distribution and utilization systems, standard voltages for AC or DC traction systems and nominal voltages for AC and DC equipment less than 120 V AC or 750 V DC This Standard is based on, and contains, the full text of IEC 60038:1983 incorporating its Amd. 1:1994 and Amd. 2:1997. Text not applicable in Australia has been struck through for clarity. Added text for Australian conditions has been shaded and inserted in its appropriate place. An appendix summarizes variations for Australian conditions. (8 pages)

AS 1768-1991 Lightning protection

Sets out guidelines for the protection of persons and property from hazards arising from exposure to lightning. In particular, it covers: the protection of persons from both direct and indirect effects of a lightning strike; the protection of various buildings and structures from the risk of physical damage or fire; and the protection of sensitive equipment from overvoltages resulting from a lightning strike to a building or its associated services. The nature of lightning and the principles of lightning protection are discussed and guidance is given to assist in determining if a particular building or structure should be protected. Identical with NZS 1768:1991 and produced as a Joint Australian/New Zealand Standard. (91 pages)

AS 1170.1-1989 SAA Loading Code - Part 1: Dead and live loads and load combinations (Amdt 1 January 1993)

Sets out requirements for establishing the minimum dead and live loads in the structural design of buildings and structures. This edition is presented in limit states format. A new section on load combinations has now been included. (24 pages)

Currently under Revision see DR 99309-99310

NB : AS 1170 series standards are fully titled "Minimum design loads on structures (known as the SAA Loading Code)".

AS 1170.2–1989 SAA Loading Code – Part 2: Wind loads (Amdt 3 December 1993)

Sets out requirements for establishing the minimum wind loads in structural design, and is in a limit states format. It provides a simplified procedure for the determination of wind loads on a limited range of small structures and buildings, and a detailed procedure on a wide range of structures. Windspeeds are specified for the serviceability and ultimate strength/stability limit states, and for permissible stress design. Explanatory material is given in the appendices. (90 pages)

See also HB 21-1990 Commentary on the Australian Standards for Wind Loads (This is published by the Australian Wind Engineering Society). Under Revision see DR 99419.

AS 1170.4-1993 SAA Loading Code - Part 4: Earthquake loads (Amdt 1 October 1994)

Sets out data and procedures for determining minimum earthquake loads on structures and their components, and also minimum detailing requirements for structures. It does not consider related phenomena such as settlement, slides, subsidence, liquefaction or faulting in the immediate vicinity of a structure. It does not include nuclear reactors, dams, transmission towers, bridges, piers and wharves, which may require special consideration. The Standard is in limit states format. New earthquake maps are defined in terms of an acceleration coefficient instead of the zoning system used in the previous Standard AS 2121. Domestic structures are now included. (54 pages)

NZS 6808:1998 Acoustics - the assessment and measurement of sound from wind turbine generators

Provides methods for prediction, measurement, and assessment of sound produced by WTGs, specifically dealing with the presence of wind. Does not specify limits, but states: "As a guide to the limits of acceptability, the sound level (L_{eq}) of the WTG (or wind farm) should not exceed, at any residential site, and at any of the nominated wind speeds, the background sound level (L_{95}) by more than 5 dBA, or a level of 40 dBA L_{95}, whichever is the greater."

This standard was originally intended as joint Australian/New Zealand Standard, but has not as yet been approved in Australia although it has been the basis of planning conditions for several Australian wind farms. It currently exists as draft Australian Standard 96900, AusWEA are actively pursuing the approval of this standard in Australia.

Refers to NZS 6801:1991 and NZS 6802:1991.

A.3 International Electrotechnical Commission (IEC)

The IEC, (http://www.iec.ch/home-e.htm) is a global organisation that prepares and publishes international standards for all electrical, electronic and related technologies. Its membership consists of more than 60 participating countries, including all the world's major trading nations and a growing number of industrialising countries. The IEC's mission is to promote, through its members, international cooperation on all questions of electrotechnical standardization and related matters, such as the assessment of conformity to standards, in the fields of electricity, electronics and related technologies.

The IEC produces standards relating to all electrotechnologies including electronics, magnetics and electromagnetics, electroacoustics, multimedia, telecommunication, and energy production and distribution, as well as associated general disciplines such as terminology and symbols, electromagnetic compatibility, measurement and performance, dependability, design and development, safety and the environment.

The IEC is one of the bodies recognized by the World Trade Organization (WTO) and entrusted by it for monitoring the national and regional organisations agreeing to use the IEC's international standards as the basis for national or regional standards as part of the WTO's Technical Barriers to Trade Agreement.

Around 200 technical committees (TCs) and subcommittees (SCs), and some 700 working groups carry out the standards work of the IEC. The technical committees prepare technical documents on specific subjects within their respective scopes, which are then submitted to the full member National Committees (IEC's members) for voting with a view to their approval as international standards. The main technical committee for wind turbine systems is TC88, which publishes the standards listing in this section.

A.3.1 IEC Published Standards

IEC 60050-415 (1999-04) Ed. 1.0 International Electrotechnical Vocabulary - Part 415: Wind turbine generator systems

IEC 61400-1:1999 Wind turbine generator systems Part 1: Safety requirements

Deals with safety philosophy, quality assurance and engineering integrity, and specifies requirements for the safety of Wind Turbine Generator Systems (WTGS), including design, installation, maintenance, and operation under specified environmental conditions. Its purpose is to provide the appropriate level of protection against damage from all hazards from these systems during their planned lifetime.

This standard is concerned with all sub-systems of WTGS such as control and protection mechanisms, internal electrical systems, mechanical systems, support structures and the electrical interconnection equipment.

This standard applies to WTGS with a swept area equal to, or larger than, 40 m^2. (57 pages)

IEC 61400-2:1996 Wind turbine generator systems Part 2: Safety of small wind turbines

Deals with safety philosophy, quality assurance, engineering integrity and specifies requirements for the safety of small wind turbine generator systems (SWTGS), including design, installation, maintenance, and operation under specified external conditions. Its purpose is to provide the appropriate level of protection against damage from hazards from these systems during their planned lifetime. (51 pages)

IEC 61400-11:1998 Wind turbine generator systems Part 11: Acoustic noise measurement techniques

Presents sound measurement procedures that enable noise emissions of a wind turbine to be characterized. This involves using measurement methods appropriate to noise emission assessment at locations close to the machine, in order to avoid errors due to sound propagation, but far enough away to allow for the finite source size. The procedures described are different in some respects from those that would be adopted for noise assessment in community noise studies. They are intended to facilitate characterization of wind turbine noise with respect to a range of wind speeds and directions. Standardization of measurement procedures will also facilitate comparisons between different wind turbines. (39 pages)

IEC 61400-12:1998 Wind turbine generator systems Part 12: Wind turbine power performance testing

Specifies a procedure for measuring the power performance characteristics of a single wind turbine generator system (WTGS) and applies to the testing of WTGS of all types and sizes connected to the electrical power network. It is applicable for the determination of both the absolute power performance characteristics of a WTGS and of differences between the power performance characteristics of various WTGS and of differences between the power performance characteristics of various WTGS configurations.

The WTGS power performance characteristics are determined by the measured power curve and the estimated annual energy production (AEP). The measured power curve is determined by collecting simultaneous measurements of wind speed and power output at the test site for a period that is long enough to establish a statistically significant database over a range of wind speeds and under varying wind conditions. The AEP is calculated by applying the measured power curve to reference wind speed frequency distributions, assuming 100% availability.

The standard describes a measurement methodology that requires the measured power curve and derived energy production figures to be supplemented by an assessment of uncertainty sources and their combined effects. (44 pages)

See also MEASNET. See RISO "European Wind Turbine Testing Procedure Developments - Task 1: Measurement Method to Verify Wind Turbine Performance Characteristics" Riso National Laboratory, January 2001.

IEC TS 61400-13:2001 Wind turbine generator systems Part 13: Measurement of mechanical loads

Acts as a guide for carrying out measurements used for verification of codes and for direct determination of the structural loading. Focuses mainly on large electricity generating horizontal axis wind turbines (69 pages)

IEC TS 61400-23:2001 Wind turbine generator systems Part 23: Full-scale structural testing of rotor blades

This technical specification provides guidelines for the full-scale structural testing of wind turbine blades and for the interpretation or evaluation of results, as a possible part of a design verification of the integrity of the blade. The following tests are considered in this technical specification:

- static strength tests;
- fatigue tests;
- other tests determining blade properties.

It is assumed that the data required to define the parameters of the test are available. In this technical specification, the design loads and blade material data are considered starting points for establishing and evaluating the test loads. The evaluation of the design loads with respect to the actual loads is outside the scope of this technical specification. (63 pages)

IEC WT 01:2001 System for Conformity Testing and Certification of Wind Turbines – Rules and procedures

Defines a certification system for wind turbines (IEC WT). It specifies rules for procedures and management to carry out conformity evaluation of WTs, with respect to specific standards and other technical requirements, relating to safety, reliability, performance, testing and interaction with electrical power networks. (52 pages)

Produced by TC 88 in conjunction with CAB

A.3.2 IEC Standards Work in Progress

IEC TS 61400-3 Ed 1.0 Wind turbine generator systems Part 3: Design Requirements for offshore wind turbines

IEC TS 61400-11 Ed 2.0 Wind turbine generator systems Part 11: Acoustic noise measurement techniques

Presents measurement procedures that enable noise emissions of a wind tubine to be characterized with respect to a range of wind speeds and directions. Allows comparisons between different wind turbines.

IEC TS 61400-21 Ed 1.0 Wind turbine generator systems Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines

Provides a uniform methodology that will ensure consistency and accuracy in the measurement and assessment of power quality characteristics of grid connected wind turbine generator systems (WTGS). In this respect the term power quality includes those electric characteristics of the WTGS that influence the voltage quality of the grid to which the WTGS is connected.

IEC TS 61400-24:2001 Wind turbine generator systems Part 24: Lightning protection for wind turbines

This Technical Specification provides the following information:

- Background on the current understanding on lightning and its impact on wind turbines;
- Examples of lightning damage to various wind turbines;
- Risk evaluation;
- Appropriate methods for protection against lightning damage; and
- Areas of further research.

IEC TS 61400-25 Ed 1.0 Wind turbine generator systems Part 25: Communication Standard for remote control and monitoring of wind power plants.

A.4 International Energy Agency (IEA)

The IEA, (http://www.iea.org/index.html) based in Paris, is an autonomous agency linked with the Organisation for Economic Co-operation and Development (OECD). The IEA is the energy forum for 26 member countries, who have agreed to share energy information and to co-ordinate their energy policies. One of the IEA's aims is to stimulate the development and deployment of new energy technologies through a network of Implementing Agreements. The Implementing Agreement on Wind Turbines aims to promote and foster collaborative research. Current activities under the Agreement include the development of recommended practices for wind turbine testing and evaluation. The IEA co-operates closely with the IEC.

IEA Recommended Practices for Wind Turbine Testing and Evaluation - 1. Power Performance Testing (2. Edition 1990)

Superseded by IEC 61400-12 Wind Power Performance Testing

IEA Recommended Practices for Wind Turbine Testing and Evaluation - 2. Estimation of Cost of Energy from Wind Energy Conversion Systems (2nd Edition 1994)

IEA Recommended Practices for Wind Turbine Testing and Evaluation - 3. Fatigue Loads

Part of IEC 61400-13 Measurement of mechanical loads

IEA Recommended Practices for Wind Turbine Testing and Evaluation - 4. Acoustic Measurement of Noise Emission from Wind Turbines (3. Edition 1994)

Superseded by IEC 61400-11 Acoustic Noise Measurement techniques

IEA Recommended Practices for Wind Turbine Testing and Evaluation - 5. Electromagnetic Interference (Preparatory information, Issue 1 1986)

IEA Recommended Practices for Wind Turbine Testing and Evaluation - 6. Structural Safety

Status given as invalid in the IEA Wind Energy Annual Report 2000. See also IEC 61400-1:1999 Wind turbine generator systems Part 1: Safety requirements

IEA Recommended Practices for Wind Turbine Testing and Evaluation – 7. Quality of Power Single Grid-Connected WECS

See also IEC TS 61400-21 Ed 1.0 Wind turbine generator systems Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines

'EA Recommended Practices for Wind Turbine Testing and Evaluation – 8. Glossary of Terms (2. Edition 1993)

See also IEC 60050-415 (1999-04) Ed. 1.0 International Electrotechnical Vocabulary - Part 415: Wind turbine generator systems

IEA Recommended Practices for Wind Turbine Testing and Evaluation – 9. Lightning Protection

Notes: See also IEC TS 61400-24:2001 Wind turbine generator systems Part 24: Lightning protection for wind turbines

IEA Recommended Practices for Wind Turbine Testing and Evaluation – 10. Measurement of Noise Emission from Wind Turbines at Noise Receptor Locations (1. Edition 1997)

Notes: Current

IEA Recommended Practices for Wind Turbine Testing and Evaluation – 11. Wind Speed Measurement and Use of Cup Anemometry (1. Edition 1999)

Notes: Document will be used by IEC MT 13 for updating power performance measurement.

A.5 Europe

In addition to national standards bodies within some member nations, there are two regional bodies. The European Committee for Standardisation (CEN) performs a similar function to ISO. The European Committee for Electrical Standardisation (CENELEC) is similar to the IEC and in fact some 90% of all CENELEC standards are identical or very closely based on IEC international standards. The CENELEC website can be found at http://www.cenelec.org

EN 45510-5-3:1998 Guides for procurement of power station equipment – Part 5-3: Wind turbines

Notes: CENELEC

ETSU-R-97 The Assessment & Rating of Noise from Wind Farms

Notes: A publication of the UK Energy Technology Support Unit, this was an important source for the NZ Standard 6808.

A.6 USA

The American Wind Energy Association (AWEA) has been designated by the American National Standards Institute (ANSI) as the lead organization for the development and publication of industry consensus standards for wind energy equipment and services in the United States. The AWEA website is at www.awea.org

AWEA 1.1:1988 Standard Performance Testing of Wind Energy Conversion Systems

Notes: Describes a standard method of determining and reporting primary performance characteristics of wind energy conversion systems (WECS). Sections include general information, field test method, noise treatment method, formulation of parameters, and WECS performance test report.

AWEA 2.1:1989 Procedure for Measurement of Acoustic Emissions From Wind Turbine Generator Systems, Tier I

Notes: Presents measurement and reporting procedures for sound pressure levels from wind turbine generator systems (WTGS). It is intended to facilitate WTGS noise characterization specifications and development of noise propagation calculations.

AWEA 3.1 :1988 Design Criteria Recommended Practices: Wind Energy Conversion Systems

Notes: Describes the criteria to be used for the design of wind energy conversion systems (WECS). It consists of eight sections: scope and application of the document; applicable reference publications; significance and use of these criteria; general design criteria for WECS; environmental and service condition design criteria; system design considerations; component design criteria; and mechanical, structural, and electrical attachment conditions between WECS and other systems.

AWEA 5.1 :1991 Wind Energy Conversion Systems Terminology

Notes: Consists of an alphabetical listing of terms and their definitions to help the newcomer to the industry understand the basic as well as the more technical terms he or she will encounter in the wind energy industry.

AWEA 6.1 1989:Recommended Practice for the Installation of Wind Energy Conversion Systems

Notes: Presents recommended practices for the installation of wind energy conversion systems with regard to safety of installation personnel and the public. It is a general guide to be used with manufacturers' installation manuals and is organized to follow the installation process.

AWEA 8.1:1986 Standard Procedures for Meteorological Measurements at a Potential Wind Turbine Site

Notes: Provides procedures and methods for obtaining meteorological measurements at a site that has been proposed for wind energy use. Standards are provided for meteorological measurement systems and installation, operation, and calibration of equipment. Guidelines for sampling strategies, data processing and site evaluation practices are given in the appendices.

AWEA 8.2 :1993 Guidebook for the Siting of Wind Energy Conversion Systems

Notes: Provides guidelines for the proper siting of a wind turbine or group of turbines. These guidelines are recommended for siting programs that begin with large-scale land assessments as well as for site-specific applications where optimized wind turbine placement within a given parcel of land is the objective. This standard addresses such siting topics as meteorological measurements at candidate sites, instrumentation, and wind flow modelling.

NWCC Permitting of Wind Energy Facilities - A Handbook (Mar 1998)

NWCC Wind Energy System Operation and Transmission Issues Relating to Restructuring (Apr 1998)

A.7 Miscellaneous

MEASNET Power Performance Measurement Procedure, Version 3 Nov 2000

Scope: Measurement procedure agreed by MEASNET members. Based on IEC 61400-12:1998. Defines additional requirements, including disallowing site "calibration" by flow model (numerical) and strengthening the site calibration procedure (requires 10 min max and min, ie NRG 9300 not suitable without reprogramming).

Appendix 5 Useful Website Addresses

Associations

Alternative Technology Association
www.ata.org.au

American Wind Energy Association
www.awea.com

Australian Conservation Foundation
www.acfonline.org.au

Australian EcoGeneration Association
www.ecogeneration.com.au

Australian Wind Energy Association
www.auswea.com.au

Birds Australia
www.birdsaustralia.com.au

British Wind Energy Association
www.britishwindenergy.co.uk

CADDET Centre for Renewable Energy
www.caddet-re.org

Danish Wind Energy Association
www.windpower.dk

European Wind Energy Association
www.ewea.org

Greenpeace Australia Pacific
www.greenpeace.org.au

National Wind Coordinating Committee (USA)
www.nationalwind.org

Standards Association of Australia
www.standards.com.au

National Bodies

Australian Communications Authority
www.aca.gov.au

Australian Greenhouse Office
www.greenhouse.gov.au

Australian Heritage Commission
www.ahc.com.au

Civil Aviation Safety Authority
www.casa.gov.au

Department of Anthropology
University of Western Australia
www.ausanthrop.net

Department of Industry, Tourism & Resources
www.isr.gov.au

Major Projects Facilitation :
www.isr.gov.au/invest/About_us/about_us.html

Renewable Energy :
www.isr.gov.au/invest/About_us/about_us.html

Department of Transport & Regional Services,
National Office Local Government
www.nolg.gov.au

Environment Australia
www.ea.gov.au

Greenpower
www.greenpower.com.au

Office of the Renewable Energy Regulator
www.orer.com.au

NEMMCO
National Electricity Market Management Company
www.nemmco.com.au

RAAF Aeronautical Information Service
www.raafais.gov.au

RFA Regional Forest Agreement
www.rfa.gov.au

State Planning Authorities

Department of Urban Services (ACT)
www.act.gov.au

Department of Urban Affairs & Planning(NSW)
www.duap.nsw.gov.au

Department of Lands, Planning & Environment
(NT) www.lpe.nt.gov.au

Department of Communication and Information,
www.dcilgp.qld.gov.au
Local Government, Planning & Support (QLD)

Department of Transport, Urban Planning & Arts (SA) www.planning.sa.gov.au

Dept. of Primary Industries, Water, & Environment (TAS)
www.dpiwe.tas.gov.au

Department of Infrastructure (VIC)
www.doi.vic.gov.au

Ministry for Planning (WA)
www.planning.wa.gov.au

Other State Authorities

Australian Local Government Association
www.alga.com.au

Australian Capital Territory

ACT Local Government Association
www.lgaq.asn.au

New South Wales

Sustainable Energy Development Authority
www.seda.nsw.gov.au

NSW Local Government Association
www.lgsa.org.au

Northern Territory

NT Local Government Association
www.lgant.nt.gov.au

Queensland

QLD Local Government Association
www.lgaq.asn.au

Environmental Protection Agency - Sustainable Industries
www.env.qld.gov.au

South Australia

Energy SA
www.energy.sa.gov.au

SA Local Government Association
www.lga.sa.gov.au

Tasmania

TAS Local Government Association
www.lgat.tas.gov.au

Victoria

Sustainable Energy Authority
www.seav.vic.gov.au

Municipal Association of Victoria
www.mav.asn.au

Victorian Coastal Council
www.vcc.vic.gov.au

Western Australia

Sustainable Energy Development Office
www.sedo.energy.wa.gov.au

Office of Energy
www.energy.wa.gov.au

Local Government Association
www.wama.wa.gov.au

• Appendix 6 Wind Energy Development Case Studies

Windy Hill

STANWELL
CORPORATION LIMITED

Codrington

PACIFIC HYDRO LIMITED

Woolnorth

Hydro Tasmania
the renewable energy business

CASE STUDY 1 - Windy Hill Wind Farm

Developer	***Stanwell Corporation Limited***
Capacity :	***12 MW***
Number of turbines:	***20***
Type of turbines:	***Enercon E40 (600 kW)***
Height to hub:	***46m***
Turbine Diameter:	***44m***
Location :	***Ravenshoe, Far North Queensland***
Completed :	***September 2000***
Capital Cost :	***Aus $ 20 million***

The site was initially identified as a result of local knowledge of the area and wind modeling by specialist consultants in mid 1998. The site's abundant wind resource is thought to be due to its high elevation (1000 m) and exposure to the trade winds which are prevalent in Far North Queensland. The site was also deemed suitable because it had already been substantially cleared for dairy farming, had good road access, and was located close to existing 66 kV electrical infrastructure.

In September 1998, preliminary discussions were held with key landowners and possible commercial agreements were discussed. The Herberton Shire Council was also approached and briefed on the implications and advantages of the potential project.

By late 1998, preliminary landowner agreements guaranteeing Stanwell exclusive development rights and rights to erect wind monitoring equipment had been put in place. All landowners were notified of the purpose and timing the erection of anemometry equipment, with 50m pole style masts being erected in December 1998.

In early 1999, consultants were appointed to provide initial advice on potential environmental and planning issues. Following board approval of a proposal to fast track the project, a consultant was commissioned to carry out a Review of Environmental Factors and to lodge an application for a Development Permit for a Material Change of Use under Queensland's Integrated Planning Act.

Community consultation was commenced in mid May 1999 when an information evening was held at the Ravenshoe hall. A display accompanying the event comprised large photographs of wind turbines and wind farms, typical photomontages of the completed project and location maps of the proposed development. Attendees were provided with a hand out package including corporate literature, a summary of environmental terms of reference and project fact sheets.

Because of the desire to fast track the project, expressions of interest for the supply and installation of wind turbines were invited as early as March 1999. Tender documentation was then prepared in conjunction with specialist consultants and short listed suppliers were issued with tender documentation in April 1999 and given six weeks to respond.

Once tenders and subsequent clarifications had been received, a detailed technical and commercial analysis was performed with the best options being fed into Stanwell's economic model.

In parallel with the tendering process described above, Stanwell approached a number of electricity retailers to establish potential wind power sale prices. This and ongoing wind modeling work based on wind data now flowing from the monitoring tower enabled the financial model to be progressively refined.

With the project showing promising signs of being viable, preliminary soil testing was commissioned in May 1999. In addition there was a continuation of community consultation, and final landowner contract negotiations were completed. At this time there were also discussions with the utility regarding the electrical interconnection of the wind farm with the network.

Development approval was granted in September 1999 and Powercorp was awarded the contract for the supply and installation of twenty Enercon E40 (600kW) wind turbines after successfully winning the tender. This contract included construction of all on site access roads, electrical interconnection between the turbines within the wind farm boundaries and a five year maintenance agreement. The project schedule required the first two wind turbines to be operational within five months and the remaining machines within twelve months.

The land accommodating the wind farm is considered some of the best dairy farming land in Queensland so a number of measures were put in place to minimise its impact. These included a foundation design that enables cows to graze right up to the base of the turbine towers, special wash down procedures for all vehicles entering the site to minimise introduction of weeds, and re seeding of all access roads.

As part of the tendering process, the successful contractor was encouraged to maximize the local content. As a result, concrete was prepared locally, a local (Ravenshoe) contractor won the tender for on-site road construction and foundation excavation, and several extra local personnel were employed as labourers. In addition the wind farm operator and maintainer, Enercon Power Corporation, has employed three locals from Ravenshoe to look after the wind farm on a long term basis.

Due to Queensland electricity regulations, Ergon Energy were responsible for designing and building the network interconnection works. This was also in two stages, with the first comprising connection directly into the local 22 kV network adjoining the site, and the second requiring some 3km of 22kV reticulation and construction of a new 22-66kV substation.

Being located adjacent to the Kennedy Highway which provides access to Queensland's far north west, the wind farm has attracted significant interest from passing tourists. In the light of this, visitor facilities have been designed to accommodate caravans and tour buses. Visitors can stand within 40m of one of the wind turbines to gain an appreciation of the scale of the machines.

For More Information Contact:

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Website: www.windyhill.com.au

Media enquiries: Janice Holland, Corporate Communications, Tel: (07) 3335 7435 or

email: jholland@stanwell.com

PACIFIC HYDRO LIMITED

CASE STUDY 2 - Codrington Wind Farm

Developer :	**Pacific Hydro Limited**
Capacity :	**18.2 MW**
Number of turbines:	**14**
Type of turbines:	**Bonus 1300/62 (1.3 MW)**
Height to hub:	**50m**
Turbine Diameter:	**62m**
Location :	**Codrington, south-west coast Victoria**
Completed :	**June 2001**
Capital Cost :	**Aus $ 30 million**

Codrington is Australia's first privately developed wind farm and at the time of commissioning was Australia's largest wind farm. This site is located on two adjoining coastal grazing properties in western Victoria. With excellent exposure to the Southern Ocean, the wind farm is arranged on two low (35m above sea level) limestone ridges that run parallel to and less than 1km from the coast. Both properties are completely cleared of native vegetation, run to the high water mark and have been grazed for over 100 years. The neighbouring properties in the area are almost exclusively agricultural in nature and relatively large in size. The site is also adjacent to the Princess Highway (approx. 1.5 km) providing good road access to the site. An existing 66 kV distribution line, approximately 3km to the north helped simplify interconnection with the electricity network.

The site was initially identified in October 1998 by Sustainable Energy Australia (SEA) Pty Ltd – a private company specifically set up by Grant Flynn to develop a wind farm. SEA applied to Moyne Shire for planning permission in early 1999 and then sold the project to Pacific Hydro Limited when Grant joined Pacific Hydro as Wind Power Development Manager.

Discussions began in October 1998 with the two landholders involved, their neighbors, the Moyne Shire Council and various local referral authorities. The project was put forward to the Shire at the time that the nearby Cape Bridgewater Wind Farm proposal was coming to the end of its appeals process to Victorian Civil and Administrative Tribunal (VCAT). While the Shire was very supportive of the Codrington Wind Farm project, consideration of the town planning permit application was postponed until VCAT handed down its decision on Cape Bridgewater. Local stakeholders and referral authorities were brought together by the Department of Infrastructure (DoI) to advise the Minister for

Planning as to the necessity or otherwise of an Environment Effect Statement. The Minister decided that an EES was not required.

Although the Codrington proposal received quite a lot of local and state press (due to the VCAT appeals against Cape Bridgewater), no objections or adverse comments were made regarding the development application and the Moyne Shire issued a planning permit with conditions in April 1999.

Once development approval had been granted, a 45 metre anemometry mast was installed on the site to collect detailed hub height wind data. Local firms were used to manufacture, install and maintain the anemometry equipment. Wind consultants Garrad Hassan Pacific were used to independently process the wind data, assess the wind resource and assist in the wind farm layout development.

By November 1999 Pacific Hydro were ready to begin negotiations with contractors and invited expressions of interest for the Engineering Procurement and Construction (EPC) contract for the wind farm. Six short listed companies from around the world were then invited to tender in April 2000, a process that resulted in German company AN Windenergie Gmbh being successful in their offer to supply and install fourteen AN Bonus 1.3MW machines. One of the key factors attributing to AN Windenergie's success was the high level of local content in their tender. Local firms from Portland and its surrounds were used for the construction of the roads, foundations, electrical work and wind turbine towers, resulting in around $8.5M being spent in the area. Because Australian firms were used for the manufacture of other times such as cables and transformers, approximately 40% of the project was able to be sourced from within Australia.

During the negotiation of the EPC contract, wind monitoring continued to confirm the wind resource. In addition discussions with retailers regarding the power purchase agreement were initiated, resulting in Powercor Australia (later to become Origin Energy) agreeing to purchase the entire output of the wind farm for the first ten years of its operation.

It is worth noting that at this time, the Renewable Energy (Electricity) Act was not even in draft form and formal legislation still seemed a long way off. Pacific Hydro had committed itself to the construction of the Codrington Wind Farm, convinced that wind energy was a cost effective form of renewable electricity generation and that this would be the first of many wind farms in Australia. Powercor Australia (Origin Energy) shared Pacific Hydro's belief that Australia had to begin sourcing more electricity from renewable sources and were prepared to make the financial commitment to the project.

Now that a long term power purchase agreement had been finalised, construction could begin in earnest. The first step was to perform archaeological studies and geotechnical core sampling. Aboriginal communities have used this area for tens of thousands of years and Pacific Hydro needed to be sure that no important archaeological sites would be disturbed and that the soil conditions were suitable for the turbine foundations. The first foundation was then poured in December 2000, wind turbine nacelles arrived in the Port of Portland (a deep sea port) in March 2001 and the turbine towers were soon being erected using a 400 tonne crane brought in specifically for this project from Germany. The first of the wind turbines was erected by May 2001 and by the end of June commissioning was almost complete.

The wind farm was opened by the Premier of Victoria, The Honourable Steven Bracks on 21 July 2001, and was followed by the "Catch the Wind" festival on 22 July 2001, an open day which allowed the public a chance to see a modern wind farm in operation. The festival gave the local business operators a chance to show off their wares and was attended by over 7,000 people, exhibiting strong support for the Codrington Wind Farm. In anticipation of the level of interest in the wind farm, a viewing area was installed adjacent to the Princess Highway to accommodate visiting cars, caravans and tour buses.

A local operator began wind farm tours in August 2001 and the development has attracted significant interest from passing tourists with several thousand visitors in the first few months. The tours allow visitors to enter the property and stand at the base of one of the wind turbines to see , hear and feel one of the machines, and of course feel the strength of the Southern Ocean winds!

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CASE STUDY 3 - Woolnorth Wind Farm

Woolnorth Wind Farm (Stage 1) under construction, January 2002

The Woolnorth Wind Farm in the North West of Tasmania, was the largest development of its time to achieve statutory approval, at 138 MW and comprised of 79 Vestas V66 1.75MW machines. Woolnorth also represented the first wind farm in Australia to be assessed under the new Environment Protection and Biodiversity Conservation Act (1999). Woolnorth is remote from urban or rural residential areas, minimising the visual impact on rural communities. The coastal site is situated on a vast dairying and cattle property.

Developer :	**Hydro Tasmania**
Capacity:	**138 MW**
Number of turbines:	**79**
Type of turbines:	**Vestas V-66 (1750 kW)**
Height to hub:	**60m**
Turbine Diameter:	**66m**
Location :	**Woolnorth, NW Tas.**
Completed :	**Stage 1 - June, 2002**
Capital Cost :	**AUS $ 200 million**

Hydro Tasmania, through the use of its internal Consulting Division, provided the necessary technical and scientific expertise to assess and design the project, and to complete environmental impact studies and environmental management plans to the requirements of State and Federal legislation.

In selection of the wind farm site, Hydro Tasmania used meso-scale modelling combined with GIS mapping of topography and infrastructure to locate and select one of the world's best wind farm sites. Design and optimisation of farm layouts, grid connection, transmission routes, communications and control was all completed by Hydro Tasmania. To estimate the wind resource at Woolnorth, 50m and 70m wind monitoring towers were erected on the proposed site. The wind data from these towers was correlated with 13 years of wind data from a nearby atmospheric research station to give Hydro Tasmania extra confidence in predicting the wind resource at Woolnorth.

Hydro Tasmania has consulted with a range of stakeholders as part of the planning of the project. This approach is consistent with Tasmania's sustainable development principles, which encourage public involvement in resource management and planning. In 1998, preliminary discussions were held with the landowner, Van Diemens Land Pty Ltd. By July 1999, the landowner had agreed to sell the land to Hydro Tasmania, guaranteeing Hydro Tasmania exclusive development and wind monitoring rights. The landowner now leases the land from Hydro Tasmania to continue its previous activities. Landholders adjacent to the wind farm and along the powerline corridor were also consulted, as well as Aboriginal groups and non-government organisations. As part of the Circular Head Council approval process, lengthy negotiations took place regarding the specification of the proposed upgrade to the Montagu/Woolnorth Roads and Hydro Tasmania's level of contribution. These issues were resolved in September 2001.

Three public meetings were held during the planning phase of the project - to discuss heritage issues associated with the wind farm and power line development, to provide an opportunity for the general public to learn about Hydro Tasmania's wind farm proposal, to seek community feedback and to update the community on the status of the proposed wind farm. Other public meetings will be held prior to construction commencing on future stages of the wind farm.

As part of the preparation for the Woolnorth wind farm development, Hydro Tasmania spent three years undertaking a comprehensive Development Proposal and Environmental Management Plan covering all environmental matters associated with developing a wind farm. The species of birds on site were thoroughly examined, including modeling the potential risk of bird collisions with wind turbines, and developing management strategies to minimise the risk of bird collisions. These studies have concentrated on the Orange-bellied Parrot and Wedge-tailed Eagles but other species have also been considered as a matter of best practice.

The extensive bird studies have revealed that Orange-bellied Parrots rarely use the site where the wind farm will be built. To further minimise any potential collision risk, Hydro Tasmania has developed detailed vegetation management plans to attract Orange-bellied Parrots to areas away from the turbines. Hydro Tasmania also relocated wind turbines away from the nest sites of Wedge-tailed Eagle and White-bellied Sea Eagle, in accordance with stipulated buffer zones.

Hydro Tasmania obtained state approval from the Board of Environmental Management and Pollution Control in June 2001. Approval from Environment Australia, under the Environment Protection and Biodiversity Conservation Act (1999), was gained for the full development in August, 2001.

Tender documentation for Stage 1 was prepared and issued in May 2000. Vestas has been awarded the contract for the first stage of the wind farm. Shaw Contracting is completing the civil works under the project management of Hydro Tasmania. Construction is now well under way and the first stage of the project is expected to be completed by June 2002.

Woolnorth will be developed in stages. The first stage consists of 6 turbines (10.5 MW) in the northern section of the site, connected to a 22 kV line. The second stage consists of 31 turbines (54 MW) to be added around the original six to complete the northern section of the wind farm. The final stage will consist of 42 turbines (73.5 MW), located 15 km to the south, giving a total of 79 turbines and an installed capacity of 138 MW.

The Woolnorth wind farm investment has two sources of income. Renewable Energy Certificates (RECs) will be generated and sold, while electricity will be sold to the power retailer of Tasmania, Aurora Energy. Electricity sales are also expected to be realised from energy export to the mainland via the proposed Basslink cable. This will significantly contribute to reducing Australia's greenhouse gas emissions.

For More Information Contact:

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Woolnorth - Key Milestones

State Environmental Approval	26-06-01
Circular Head Council Approval	24-07-01
Commonwealth Ministerial Approval	26-08-01
Civil Construction Commences	01-11-01
Turbines arrive on site	11-03-02
22kV Power line complete	29-03-02
Turbines generate	13-05-02
Commissioning & completion	17-06-02

Appendix 7 Wind Power Fact Sheet

(SEE OVERLEAF)

Appendix 8 Suggested Protocol For Statements On Wind Farm Outputs

Developers often make announcements in the media or environmental statements regarding the output of wind farms that are directed to a wide audience, typically the equivalent number of homes energy needs that the wind farm will meet and the greenhouse gas savings.

Some suggested standard protocol aimed at standardising the basis of such statements is outlined below. The objective of this is to provide transparency in the relevant calculations and to minimise confusion amongst the readership. Where different means are used to calculate the parameters, developers should clearly state the source of information used and briefly outline the alternative methodology adopted.

(i) Home Energy Needs Met by Wind Farm Developments

Statements about the delivered electricity from a wind farm in terms of equivalent electricity consumption of domestic homes helps the public understand the scale of wind farm's output and provides a useful and easily identifiable reference point in terms of typical domestic consumption. Developers should qualify such statements however in the knowledge that average domestic household electrical energy consumption figures will vary significantly from state to state, depending not only on climate, but also on the usage of other forms of energy in the home such as gas or solar hot water heating.

It is recommended therefore that developers make the distinction as to whether such statements are based on equivalent household *electrical* energy needs or *total* energy needs. The annual kWh per year figure used to calculate number of domestic home needs met should also be stated. The latter may vary in a range from less than 15 kWh per day per household in Victoria (where gas penetration for cooking and water and space heating is high), to figures as high as 24 kWh per day in other states. It is appropriate that although the energy is being fed into the national grid, figures for the state in which the development is being progressed should be used when calculating the number of homes energy needs met. An example of the recommended way to express this would be :

"The output of the "WindWorth" wind farm will be around 100 GWh per annum or enough to meet the energy needs of around 18,000 homes *

*** based on an average domestic energy consumption of 15kWh per day per home in the state"**

Developers should contact the relevant state energy authority to obtain figures on the average domestic householder energy consumption.

(ii) Calculation of Equivalent Greenhouse Gas Savings

The electricity industry contributes significantly to Australia's greenhouse gas emissions with almost 90% of the national energy supply originating from the burning of fossil fuels (largely coal). Every unit of electricity produced by wind generation displaces a unit of electricity which would otherwise have been produced by a power station burning such fossil fuels, with the savings on greenhouse gas emissions being dependent upon the emissions intensity of the particular fuel usage that the wind farm offsets.

Emissions savings are not limited to CO_2 alone but also SO_2 and NO_x emissions which can be translated into equivalent tonnes of CO_2 (CO_{2}-e) by applying the relevant conversion factors. The emissions intensity varies not only between fuel type, but also specific fuel properties (eg brown vs black coal).

In media announcements or environmental statements developers usually state the emissions savings that will result from their wind farm outputs and AusWEA encourages a transparent and consistent approach to derivation of such figures. The Australian

Greenhouse Office publishes average marginal emissions intensities for electricity production by state at www.greenhouse.gov.au/ggap/internet/electval.html and predicted values for these over the next 20 years. It is noted that in most cases emissions intensities are set to fall from around 2004. AusWEA encourages developers to the figures from the AGO website and to cite the emissions intensity used in reaching tonnes of greenhouse gas saved :

"The "WindWorth" wind farm output will save around 97,000* tonnes of CO_2 per annum "

*** based on an average emissions intensity of 0.97tCO_2/MWh for South Australia in 2002"**

Where alternative figures or methodologies are used, developers should provide appropriate references.

Appendix 9 Typical Environmental And Industry Sound Levels

Source / Distance From Source	A - Weighted Sound Level	Environmental Noise	Subjectivity / Impression
Defence Siren Pain	140 – 130		Threshold
Jet Takeoff at 60 meters (Broadband & Tonal)	120		
	110	Rock Concert	Very Loud
Pile Driver at 15 meters (Impulsive)	100		
Ambulance Siren at 30 m (Tonal)	90	Boiler Room	
Freight Cars at 15 meters (Broadband & Impulsive)	80		
Pneumatic Drill at 15 meters (Broadband)	80	Kitchen Garbage Disposal Unit	Loud
Freeway at 30 meters (Broadband)	70		Mod. Loud
Vacuum Cleaner at 30 meters (Broadband & Tonal)	60	Department Store	
Light Traffic at 30 meters (Broadband)	50	Private Business Office	Quiet
Large Transformer at 60 m (Tonal)	40		
Soft Whisper at 1.5 meters	30	Quiet Bedroom	
	20	Recording Studio	
	0-10	Threshold of Hearing	

From National Wind Coordinating Committee, March 1998
www.nationalwind.org

Appendix 10 Reference Publications On Wind Energy Development

Australian Publications

Sustainable Energy Development Authority, ***NSW Wind Energy Handbook,*** 2002

Department of Urban Affairs and Planning, ***EIA Guideline for Wind Farms,*** NSW Government, Sydney, 2002

Planning SA, ***Advisory Notice, Planning Wind Farms,*** Department for Transport, Urban Planning and the Arts, 2002

Greenpeace Australia Pacific, ***Wind Force 10: The Australian Contribution,*** Greenpeace, Sydney, 2001

Australian EcoGeneration Association, ***Guide for Connection of Embedded Generation,*** 2002

CSIRO, ***Wind Resource Assessment in Australia – A Planners Guide,*** (scheduled 2002)

Wind Corporation Australia, ***Comprehensive Guidelines for the Development of Small Embedded Wind Farms in Rural Australia,*** (scheduled 2003)

International Publications

Pasqualetti et al, ***Wind Power in View: Energy Landscapes in a Crowded World,*** Academic Press,2001

Bishop et Proctor (1994), ***Love Them or Loathe them? Public Attitudes Towards Wind farms in Wales,*** Cardiff.

Gipe, P. (1995) ***Wind Energy Comes of Age,*** New York

Omnibus Report (1995). ***Public Attitudes Towards Wind Energy,*** Canadian Wind Energy Association and Environmental Monitor, Toronto.

Wolsink, M (1988). ***The Social Impact of a Large Wind Turbine,*** Environmental Impact Assessment Review no. 8.

Wolsink, M. (1996). ***Dutch Wind Power Policy*** , Energy Policy Vol. 24 No. 12

Simon, A. M. (1996), ***A Summary of Research Conducted into Attitudes to Wind***

Wolsink & Sprengers (1993). ***Windturbine Noise: A New Environmental Threat?,*** University of Amsterdam

H Nacfaire (1988), ***Grid Connected Wind Turbines,*** Elsevier Applied Science, London

P Gipe 1993, ***Wind Power For Home & Business,*** Chelsea Green Publishing

Journals

Wind Power Monthly - Monthly by Vrinners Hoved, 8420 Knebel, Denmark

ReNew - Quarterly by Alternative Technology Association

Australian Energy News - Quarterly by Department of Alternative Technology Association

Australian EcoGeneration - Quarterly by Department of Industry, Tourism & Resources

Caddet Renewable Energy Newsletter - Quarterly by CADDET Centre for Renewable Energy

Wind Directions - Quarterly by British and European Wind Energy Associations