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Guidelines for Wind Farm Development

1. Purpose

This Planning Bulletin is intended to provide local government, other relevant approval authorities and wind farm developers with a guide to the planning framework for the balanced assessment of land-based wind farm developments, throughout the State of Western Australia.

This Planning Bulletin replaces *Planning Bulletin No. 59 Draft Guidelines for Wind Farm Development*, released in draft form in September 2003. This Planning Bulletin incorporates a number of changes in response to the submissions received during the consultation period.

For land use planning purposes, a wind farm or wind energy facility, can be defined as any turbine, building or other structure used in, or in conjunction with, the generation of electricity by wind force.

This Planning Bulletin is not intended to apply to turbines used principally to supply electricity for a domestic property, rural use of the land or anemometers.

The Western Australian Government's *State Sustainability Strategy* reflects on the imperative of ensuring land use and development are consistent with the efficient use of energy and minimisation of greenhouse gas emissions. Wind energy is a renewable energy technology, which fits closely with the ideals of the strategy. Electricity generation from wind energy is considered a mature technology and is economically feasible, particularly in remote areas. Worldwide, the wind energy industry is a multibillion dollar enterprise with some major companies employing up to 5,000 people.

The climatic conditions in Western Australia and incentives through State and Commonwealth energy policy are likely to make wind turbines an attractive source of renewable energy for a variety of purposes, from the isolated rural station to regional towns and cities. Planning has an important role in the development of renewable energy by facilitating the appropriate siting, establishment and operation of wind farms in a way that balances the environmental, social and economic benefits with any demonstrated environmental, landscape and amenity impacts.

These guidelines identify the planning issues relevant to wind farm developments. The discussion of these issues is intended to assist proponents in their design and siting, as well as assisting the responsible authorities in their assessments. Measures to reduce the impact of wind farm development are also suggested. The full range of issues and measures may not always apply equally to every proposal to install a wind energy facility. Each proposal should be considered on its merits having regard to the scale of the operation.

2. Objectives

The objectives of these guidelines are to:

- Facilitate the development of wind farms in an efficient, cost-effective and environmentally responsible manner that meets community needs; while taking into account the needs of developers, and State and national imperatives.
- Promote community understanding of the issues involved in the design and installation of wind farm infrastructure and provide opportunities for community input to decision-making.
- Promote a consistent approach in the preparation, assessment and determination of applications for planning approval for wind farm developments.
- Minimise disturbance to the environment (including landscape) and loss of public amenity in the establishment, operation, maintenance and decommissioning of wind farms.

3. Background

This Planning Bulletin has been prepared in the context of existing international agreements on limiting greenhouse gas emissions, such as the Kyoto Protocol and the State Government's commitment to a sustainable, secure, affordable electricity supply. A move towards sustainable development has also been witnessed with a number of State policy initiatives already finalised or in progress, including the draft *State Greenhouse Strategy*, *State Sustainability Strategy* and *State Planning Strategy*; while at a national level, a number of strategic initiatives are under way.

The *Commonwealth Mandatory Renewable Energy (Electricity) Target (MRET)* requires that 9500GWh (gigawatt-hours) of electricity must be generated from new renewable sources by the year 2010 for Australia. Western Australia currently has more than 28Mw (megawatts) of installed wind generation capacity, with potential for significantly more. This equates to an annual energy supply for about 15,000 homes.

Wind farm developments have the following advantages:

- Contributes to national and international efforts to reduce emissions of greenhouse gases and other air pollutants through the potential displacement of those created by fossil fuel power sources.
- Improves sustainable production of electricity in Western Australia.
- Assists Western Australia in meeting its MRET obligations.
- Increases energy supply, diversity and security.
- Provides greater electricity distribution network efficiency, through reduced transmission losses.
- Reduces cost of electricity supply in certain circumstances such as remote, off-grid rural communities.
- Provides a source of income and employment in regional areas.
- Encourages redevelopment and niche ancillary industries that manufacture energy technologies.
- Reduces regional community and government dependence on fossil fuels.

The key issues concerning wind farm developments include:

- Land use and planning controls.
- Visual impact on landscape.
- Other amenity issues, such as noise, "shadow flicker", blade glint, overshadowing and minor electromagnetic interference.

Environmental considerations include:

- Potential impact on fauna, such as birds, vegetation, soil drainage, erosion and water quality.
- Construction issues including provision of infrastructure and utilities to these facilities.
- Public health and safety, including airfield and aircraft safety.
- Socio-economic considerations.
- Impact on items of Aboriginal significance.

4. Technical Issues

Wind turbines can be deployed singly, in clusters or in larger groups. Wind turbines convert the kinetic energy of the wind into mechanical energy by using the wind to turn blades attached to a rotor and generator. The wind passing over the blades creates differences in pressure, which cause the rotor to turn. As the rotor turns, the generator attached to the rotor converts mechanical energy into electrical energy.

Each turbine comprises of a rotor, nacelle, tower and concrete footings. Footings on large turbines can be up to 15m in diameter, are about 2.5m thick and invariably are below ground. The towers can be steel or concrete and typically are between 3m and 5m in base diameter and taper to about 2m at the top. The total height varies and is increasing with advances in technology. Some towers may be as high as 100m but a common size in Australia is about 70m. On top of the tower are the nacelle and rotor. The nacelle is a weatherproof cover which contains the gearbox, generator and other ancillary equipment. The turbine blades, normally three up to 45m long (made of reinforced plastic or wood epoxy), attach to the hub and together, this assembly is known as the rotor. The rotor sits in front of the nacelle and a shaft passes through it to connect the large bearings and the generator inside. The whole nacelle and rotor assembly turns on top of the tower to face the wind as it changes direction, an action called yawing.

A small substation or transformer is required at each turbine to step up the voltage of the electricity produced by the wind turbine and this equipment may be housed inside the tower. The output is distributed from each tower, usually via underground cables, to a central substation located at the nearest suitable point of connection to the electricity network.

Modern wind turbines have a life span of approximately 20 years, although certain parts may need to be replaced and serviced during this time. Turbines may be re-powered with new equipment at the end of their design life.

The energy produced by wind turbines depends upon:

- The strength of the wind. A turbine located on a site which has an annual mean wind speed of 6m/s will produce less than half as much energy as the same machine on a site where the annual wind speed is 8m/s. Sites with a mean wind speed above 7.5m/s are favoured.
- How well the turbines are micro sited. Turbines have to be arranged so that they sit on the windiest locations in an area but avoid the wakes behind other turbines.
- The area swept by the rotor. A turbine with a 15m-diameter rotor will only produce a quarter of the energy of a machine with a 30m rotor.
- Obstacles in the wind area such as trees, houses and cliffs, which can cause turbulence and lower the amount of energy produced.
- The capacity of the local electricity distribution network. The ability to connect wind turbines to a system will depend on the configuration of the network and generators. There will be less ability to connect wind turbines to some systems than others. Problems may occur in balancing the network system and this may restrict the output of a wind farm.
- The organisation undertaking the development. Larger organisations are investing in larger, more expensive, more efficient machines.

Proponents assessing the potential of sites to harness wind power use historical meteorological data and information derived from anemometry masts. These masts, sometimes called wind monitoring masts or wind prospecting masts, monitor wind speed at the tower height for at least 12 months in order to help determine the suitability of the site.

It is important to note that the price paid for wind-generated electricity also can determine the location of wind farms. If legislation makes extra subsidies available for renewable energy, less windy, inland sites with lower output could become more attractive to proponents. Locations close to high-voltage transmission lines or power stations reduce costs and therefore are favoured in the selection process.

5. Planning Issues

The following matters should be considered by decision-making authorities in assessing wind farm proposals. An assessment of the impact of a wind farm development in relation to these matters should be weighed against the benefits of wind energy.

5.1 Land Use and Planning Controls

The *Model Scheme Text* does not include a definition of wind farms or wind energy facilities; hence these developments are usually "a use not listed " in town planning schemes. In rural, non-urban and similar zones, local government should consider wind farm proposals under the provisions of Clause 4.4.2 (b) *Model Scheme Text*; that is, the use is considered as a discretionary use for which the approval of local government is required and the public advertising procedures of Clause 9.4 apply.

Alternatively the following definition could be inserted into a scheme by way of an amendment :

"**wind farm or wind energy facility**" means premises used to generate electricity by wind force and includes any turbine, building or other structure used in, or in conjunction with, the generation of electricity by wind force but does not include turbines used principally to supply electricity for a domestic property, rural use of the land or anemometers.

In this case, wind farms should be considered as an AA or SA in rural, non-urban and similar zones.

The Western Australian Planning Commission (WAPC) is the responsible authority for determining development applications for wind farms within regional reserves under a region scheme.

Where a proposal would have a significant effect on the environment, it must be referred to the Environmental Protection Authority (EPA) by the decision-making authority. The proponent, or any individual, may also choose to refer a proposal to the EPA. The EPA will then decide if the proposal should be subject to an environmental impact assessment. Referral to Environment Australia, under the *Environmental Protection and Biodiversity and Conservation Act* (Cwlth), may also be required.

Local government may consider appropriate locations for wind farms as part of the local planning strategy.

It is sometimes possible for the agricultural use of land to continue after installation of a wind farm.

Where an area is particularly well suited to wind energy production, there may be a cumulative effect, as multiple proposals for wind farms are generated. Each proposal must be determined on its merits, having regard to the overall context of the area and its ability to accommodate future development.

5.2 Public Health and Aircraft Safety

The wind farm development should be highlighted on all navigational maps and be equipped with tower safety lighting or marking, to minimise any impact upon the safety of aircraft and the operation of airfields. The Civil Aviation Safety Authority (*Manual of Standards 139*), Air Services Australia and the RAAF, should be consulted, as appropriate, on wind farm proposals, in the vicinity of airfields and flight paths.

Public access to the site during construction should be prohibited and the perimeter visitor traffic should be carefully managed.

5.3 Socio-economic Benefits

Wind farm developments may have direct and indirect benefits for the community and its economy. The assessment and consultation process should allow for any potential negative impacts, such as visual impact, to be considered in the context of their benefits.

Wind farms can be of considerable public interest and a tourist attraction. A management plan for visitors should be considered if the wind farm is to be accessible or visible to the public.

5.4 Construction, Infrastructure and Utilities

The transport of equipment and freight to the site should be carefully managed and may need to be co-ordinated with adjacent local governments. If ongoing disruption to traffic is likely to occur, police escorts may be required for the transport of large turbines.

Towers and foundations should be designed and constructed in accordance with the manufacturer's specifications. Site clearance works, earth moving, cutting, filling and stockpiling of topsoil should be kept to a minimum wherever possible.

Once turbines are in operation, there may be one or two utility vehicles based continuously at the site. The need to replace machine components will generate heavier commercial vehicle movements, but these are likely to be infrequent.

Infrastructure, such as a substation maintenance building and service roads required for the operation of the wind farm development, should be designed with care, having regard to any environmental and landscape impacts. This infrastructure will need the same consideration, in terms of siting and design, as the turbine towers. It is recommended that equipment with minimal visible support be selected and that power cables should be installed underground where possible.

If visitor facilities are planned as part of the development, additional services may be required, including gas, water, telecommunications and on-site or off-site sewage treatment.

When a site is decommissioned, the demolition work will need to be managed and the site should be reinstated to its original use and condition, or other agreed use.

6. Environmental Issues

6.1 Landscape and Visual Impact

Visual impact is based on a number of factors which affect the perceived visual quality. The degree to which a wind farm development will impact on the landscape will depend upon:

- Siting, layout and design of the turbines, infrastructure, signage and ancillary facilities, including provision for tourism.
- Number, colour, shape, height and surface reflectivity of the towers and blades.
- Visibility of the development, having regard to the location, distance from which the development is visible, skyline and view sheds.
- Significance and sensitivity of the landscape, having regard to topography, the extent and type of vegetation, natural features, land use patterns, built form character and community values.

Methods to ameliorate visual impact include:

- Ensuring all turbines look alike, have a clean, sleek appearance and that the blades rotate in the same direction.
- Minimising the number of turbines, as appropriate, by using the largest possible model (subject to the visual absorption capabilities and environmental considerations of the site) rather than numerous small ones.
- Siting the wind farm, ancillary buildings, access roads and transmission infrastructure to complement the natural landform contours and landform backdrop, including ridgelines.
- Ensuring the choice of materials and colour (e.g. off-white and grey for turbines, low contrast for roads) for the development complements the skyline and the backdrop of the view sheds.
- Minimising removal of vegetation and using advanced planting of vegetation screens as visual buffers where appropriate.
- Ensuring good quality vegetation and landform rehabilitation, on-site and off-site, where appropriate.
- Locating turbines to reflect landscape and topographical features (e.g. a random pattern may suit a rolling, varied landform and a linear pattern may suit a coastal edge, farm or industrial site).
- Avoiding clutter, such as advertisements and apparatus.

6.2 Noise

A wind energy facility can create noise from the turbine gearbox (if used) or generator (mechanical noise), movement of the blades (aerodynamic noise) and during construction. Mechanical noise has been analysed and reduced in modern machines and usually is similar to, or less than, aerodynamic noise. Aerodynamic noise generally is unobtrusive, broadband in nature and similar to the noise of wind in trees. The noise characteristics of machines vary according to the make and model. Turbines with dual wind speed blades reduce noise emission when wind speeds are lower, however this may not be less than that generated by fixed speed machines. Some turbines have the ability to reduce their sound output at night.

To avoid adverse noise impacts on the amenity of the surrounding community, wind farm developments should include sufficient buffers or setbacks to noise-sensitive premises. As a guide, the distance between the nearest turbine and a noise-sensitive building not associated with the wind farm, is likely to be 1km. The ultimate distance between sensitive uses and the wind turbine, may be determined on the basis of acoustical studies. It is expected that the proponent will undertake noise monitoring and acoustical modelling against the relevant criteria, to enable the relevant planning authority to determine the acceptability of the development and the merits of a lesser separation distance. Until such time as a formal policy is adopted in Western Australia, the Department of Environment (DoE) endorses the criteria and approach of assessing wind farms based on background noise levels, as described in the South Australian guidelines *Environmental Protection Authority – Wind Farms Environmental Noise Guidelines*. These guidelines provide that wind farm developments should be constructed and designed to ensure that noise generated will not exceed 5dB(A) above the background sound level or 35dB(A) using a 10-minute $L_{A\ eq}$, whichever is the greater, at surrounding noise-sensitive premises.

Acoustical consultants are encouraged to discuss the noise modelling methodology with the DoE Noise Section within the Response and Audit Branch, in the first instance.

6.3 Other Possible Amenity Effects

A wind energy facility can affect local amenity due to:

- Shadow flicker, which occurs when the sun passes behind the blades and the shadow flicks on and off, although in Australia this is uncommon.

- Glint, which occurs when the sun's light is at low angles and is reflected off the blades.
- Overshadowing which affects adjacent developments.

Modelling can determine areas where these issues require further consideration. Careful siting and design, including the use of low-reflectivity materials, can minimise or avoid any impact.

Electromagnetic interference caused by wind turbines, which may effect home appliances (such as televisions and radios) is likely to be limited. The effects can be minimised through appropriate turbine siting, avoiding the line of sight of telecommunications transmitters and receivers or through technical modifications to turbines, repeater station or receivers.

6.4 Vegetation and Fauna

The types, locations and significance of flora and fauna, particularly endangered or threatened species in the development area, should be mapped. Field surveys will help avoid highly sensitive areas of vegetation, including remnant native vegetation and enable roads and services to be placed appropriately. During construction, disturbance and vegetation clearance can be avoided or minimised, through careful siting and consideration of issues such as erosion, drainage run-off, habitat or food source destruction, dieback, weed hygiene, introduction of feral animals and contractor guidelines or penalties.

Where a proposed wind farm involves the clearing of remnant vegetation, the proposal should be examined against the EPA's *Position Statement No. 2 Environmental Protection of Native Vegetation in Western Australia*.

Development issues to be addressed include controlling run-off, maintaining water quality, stabilising topsoil and retaining existing vegetation, particularly in coastal areas where vegetation can be hard to re-establish. Any construction, particularly on slopes, should not cause degradation and careful attention will be required, especially in sensitive areas. As a general principle, steep slopes and ridgelines should be avoided.

The impact of wind farms upon birds and bats should be considered. The cumulative effects of wind farms may have an impact on the migratory routes of certain bird species. A full avian study is recommended when a large wind facility is proposed. Solid towers and round nacelles prevent birds from nesting in the structure. The positioning of turbines away from migratory routes and the use of larger, slower turning turbines, may reduce the risk of avian strikes.

7. Information Requirements

The following "check list" is recommended for applicants and decision-making authorities considering wind farm proposals.

7.1 Site Analysis

A site analysis or audit will be required, including plans, photographs and any other material, which describes the site and matters that influence the proposal. Applications for wind farms should include:

- A context statement for the locality including current planning framework, significant features, sites of cultural significance, characteristics, contours, existing land uses and ownership.
- A technical assessment on the suitability of the site having regard to alternative potential sites in the area (to address possible cumulative impact) including wind information, landscape significance, ground conditions, erosion factors, surface and groundwater conditions.
- Access to the electricity network.

7.2 Wind Farm Design Statement

The design statement should be in written and illustrative form, including details of:

- turbine design, including dimensions, height, colour and materials;
- layout, orientation and siting arrangements;
- road design;
- topsoil, overburden, vegetation clearing and rehabilitation areas;
- small-scale plans and cross-sections showing the layout of the turbines, infrastructure, ancillary buildings and equipment;
- power output and description of electrical specifications and connections; and
- operational and maintenance arrangements, including tourist-management facilities and amenities.

7.3 Impact Assessment and Mitigation Measures

The application should be supported by various impact assessments of the proposal, a design response to the site analysis and methodology statements on how any adverse impacts will be managed. The latter can be made through an environmental management plan. Expert advice on these matters should be sought. The assessments should be presented using best practice techniques and should include:

- A landscape and visual impact statement to address specific issues outlined in Section 6.1, as well as using (where appropriate), computer visualisation/simulation, view shed analysis, static seen area diagram and other modelling data.
- Noise impacts including the sound power level of the turbine and sound propagation modelling for the expected range of wind speeds and directions.
- Environmental impacts on vegetation, fauna/avifauna, biodiversity, ground erosion/stability, surface water/groundwater and aquifers.

- Amenity impacts including blade glint/shadow flicker, overshadowing, Aboriginal artefacts, heritage/archaeology, electromagnetic interference, vehicular and non-vehicular access and transport corridors, aviation flight paths and air fields, railways and any cumulative effects.
- Construction impacts including staging, phasing and freight transportation proposals.
- Power network connection and transmission line infrastructure.
- Decommissioning and reinstatement proposals.
- Social and economic benefits, tourism potential, relationship to other similar developments and design life span.

7.4 Consultation

Applications also should include proposals for:

- consultation with the relevant local government, EPA, DoE, WAPC, Department for Planning and Infrastructure, Department of Conservation and Land Management, Civil Aviation Safety Authority, Air Services Australia, Commonwealth Department of Defence, electricity network provider, Department of Land Information, Department for Industry and Resources and Main Roads WA
- stakeholder meetings
- community consultation.

8. Relevant Considerations

The full range of issues and measures may not always apply equally to every proposal to install a wind energy facility and each should be considered on its merits, having regard to the scale of the operation.

In determining an application, the responsible planning authority should take into account:

- relevant local and region scheme provisions;
- relevant local planning strategies;
- relevant Statements of Planning Policy;
- outcomes of consultation with agencies, stakeholders and the community;
- outcome of the impact assessments including:
  - effect of the proposal on significant landscapes, views, visual characteristics and skyline;
  - impact of the proposal on local amenity including shadow flicker, blade glint and noise;
  - impact of the proposal on the local flora and fauna, effects on avian safety and environmental values;
  - economic benefits to local and regional areas; and
  - criteria for decommissioning and reinstatement of the site to its original use and condition or other agreed use; and
- the environmental and social benefits of wind farm development, in particular their ability to increase the sustainability of energy supply in Western Australia and to contribute to efforts to address global climate change.

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10. Glossary

W = watt = a unit of power. The power generation capacity of a wind turbine is measured in watts.

Wh = watt-hour = a unit of energy. The amount of electricity a wind energy facility generates in a prescribed period of time. Energy is measured in watt-hours.

GWh = giga-watt hours

k = kilo 10^3

M = mega 10^6

G = giga 10^9

m/s = metres per second, 1m/s = 3.6 kilometres per hour.

dB = decibel = a unit of sound. The decibel describes the sound pressure level of a noise source. It is a logarithmic scale referenced to the threshold of hearing. A 10dB increase in sound level approximates to a doubling of noise, as perceived by a listener.

dB(A) = an A-weighted sound pressure level. An A-weighted noise level is adjusted in such a way so as to represent the way humans hear sound. Since the human ear is not very sensitive in the lower frequencies these frequencies are filtered more than the higher frequencies.

$L_{A\ eq}$ = an $L_{A\ eq}$ level is an equivalent, continuous A-weighted sound pressure level. It is the constant noise level that would result in the same amount of sound energy as the actual, fluctuating noise measured, assuming that both noises operated over the same time period. An $L_{A\ eq}$ level is commonly considered to represent the average noise level during a measurement period.

Further information regarding the matters set out in this Planning Bulletin should be directed to the Department for Planning and Infrastructure Business Unit responsible for your region or to:

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Department for Planning and Infrastructure
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469 Wellington Street
Perth, Western Australia 6000

Please quote file reference 553/1/1/8 in all correspondence.

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