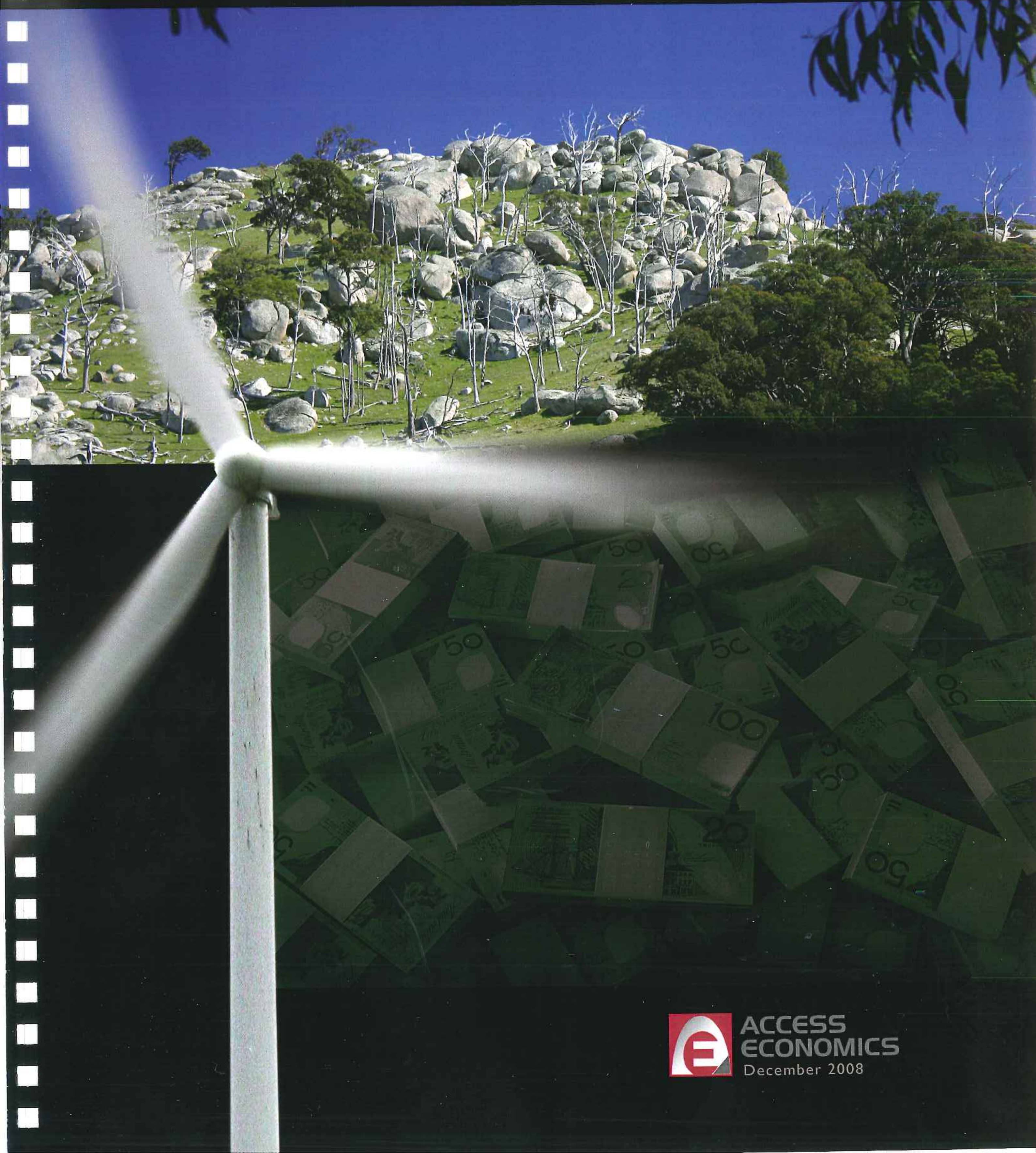
An economic assessment of the proposed McHarg Ranges wind farm

Report by Access Economics Pty Limited for Residents Against Turbines of Tooborac



ACCESS ECONOMICS

December 2008

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KEY FINDINGS

- A 200 MW McHarg Ranges wind farm does not represent a cost effective approach to greenhouse gas abatement in the long term. To that extent, it fails against a key government objective of wind power in Victoria.
- Access Economics has reached this conclusion after considering and modelling three key variables; the existing energy market in Victoria, the wind resources and abatement potential of a wind farm in the McHarg Ranges region, and finally the local area characteristics of the area in which the wind farm is to be located.
- The McHarg Ranges area itself is highly unique relative to other areas of operational or approved wind farms in the State. Land in this area is valued well above what it would be valued purely on the basis of agricultural productivity. Hence, the area displays the characteristics of a rural amenity zone, where land values are driven by lifestyle and aesthetic values rather than agricultural productivity.
- This enhances the likelihood that declining land values, themselves a reflection of a variety of detrimental local area impacts arising from a wind farm development, will add substantial additional costs to the project.
- Even without these local area impacts, the project represents an expensive way to approach greenhouse gas abatement for the State – we estimate approximately $39 to $45 per tonne of CO_2e, roughly double the recently established Commonwealth benchmark of approximately $20 per tonne.
- The cost of the project becomes even higher given local area impacts, reflected in land value declines in areas surrounding the proposed wind farm – up to $50 to $56 per tonne for a general 10 percent decline in land values within 10 kilometres of the wind turbine sites.
- Not only does this figure represent an expensive way to approach greenhouse gas abatement from a whole-of-state perspective, there are likely to be serious equity and distributional issues surrounding this project, insofar as local area and land value impacts are involved. In particular, a large part of the cost of the project is likely to be disproportionately borne by those neighbouring the wind farm sites.
- The government's objective of cost effective greenhouse gas abatement can only be achieved when the costs of that abatement are fully recognised and compared against alternatives. Critical to this is full recognition of the local area impacts of wind farm developments, particularly in a lifestyle and amenity area such as the McHarg Ranges.

EXECUTIVE SUMMARY

This report presents the findings of a study evaluating the economics of a proposed wind farm in the McHarg Ranges area.

The report assesses the proposal against the government's main objective of wind farm developments; to deliver cost effective greenhouse gas abatement in the long term. This is in the context of two key policy developments. First, the development of an emissions trading scheme (ETS), which is a key plank of the Commonwealth Government's Carbon Pollution Reduction Scheme. The second is a mix of subsidies for the renewables sector, and, most prominently, mandating that a certain proportion of all electricity generation is from renewables through mandatory renewable energy targets. Although the nature of these policies is different, their intention is the same; to make what would otherwise be uneconomic unviable investments in renewable electricity viable and able to compete with fossil fuel based generation.

In that context we note the planning regulations do not consider the marginal cost of abatement explicitly as an economic aim, which is a major oversight given the potential for wind farms to impact on land values in certain regions. These regions are likely to be those in which the amenity value of the land is greater than its agricultural productivity value.

THE PROPOSED WIND FARM IN THE MCHARG RANGES

The proposed Baynton/Tooborac wind farm is a proposed joint venture between Transfield Services Infrastructure Fund (TSIF) and Windlab Systems. The project was initially developed by Stanwell Corporation Limited, a Queensland Government Corporation; however the Baynton/Tooborac wind farm project, together with a basket of other energy infrastructure projects, was sold to TFIS in late 2007.

Publicly released information on the proposed Baynton/Tooborac wind farm is limited. As the project remains in the 'pre-feasibility' stage – as it has since mid-2004 – the information disclosure requirements imposed on the developers remain minimal. A 2004 press release by Windlab Systems suggested that the estimated potential installed capacity of the project would be in excess of 200 MW, provided by approximately 100 turbines. Recent suggestions in the local media have indicated the project may be more in the 70 turbine stage, however there has been no formal announcement from the developer.

After four years on the table, the project has not progressed to any formal State Government planning or approval processes. From publicly available information, it is not evident how far the developers have progressed with the proposal, however several land owners have been approached and potentially signed up to host turbines. Discussions with the developers, Transfield, yielded little additional information to that available in the public domain. Indications were that the project remained in the very early stages of consideration, with no decision yet made as to whether it would proceed to the planning process.

The only clear evidence that the project is under consideration is the erection and maintenance of several monitoring towers in the region. A single tower was put in place in September 2004, and this was followed by several more over the following years. Three monitoring towers remain in place at the time of writing. Guidelines specify a three year limit on the duration which a monitoring tower can be erected, however an extension was recently sought to allow monitoring to continue.

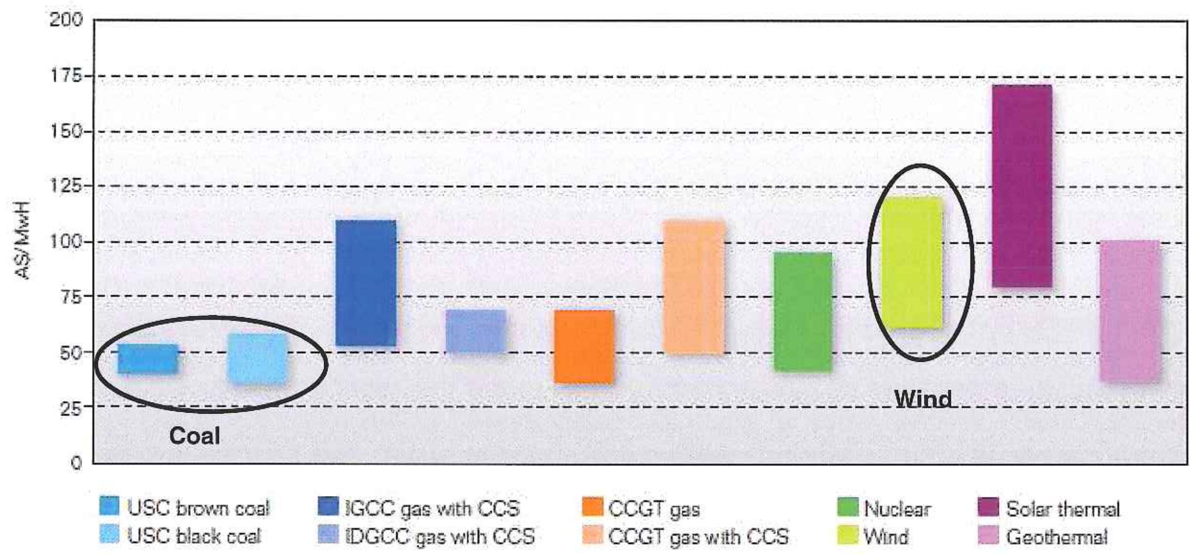
THE ECONOMICS OF WIND POWER

The costs and economics of wind energy depend on a number of factors including capital costs (site preparation, acquisition and installation of wind turbines), operating costs (including system integration such as transmission, backup or – as a future possibility – storage, land rental as well as administration and general costs), maintenance and decommissioning costs, the wind energy market (including scale and associated learning curves, subsidies or other incentives and consumer behaviour (e.g. consumers may be willing to pay a premium for green power)). Of course this must be taken in the context of the total costs of other forms of electricity generation (e.g. the cost of coal will include the cost of carbon once an emissions trading scheme is in place) and thus the market price of electricity.

Currently (and excluding the cost of greenhouse gas emissions and other externalities), wind energy is not competitive with other technologies, as the financial cost of wind energy is estimated to be around twice as much as that of coal, the cheapest source of power (see analysis from the Garnaut Review in Figure A below).

As long as the value of wind energy (electricity price) is below the financial cost of wind energy, the use of a market/regulatory premium is needed to ensure that wind energy is viable. Current estimates suggest that wind energy is not financially profitable without government assistance in any country where it used. Although wind energy is widely believed to become increasingly cost-competitive over time, it is likely to continue to need government support beyond 2020, leading to financial uncertainty (Simpson, 2004). That said, in the case of Victoria, the Victorian Renewable Energy Target (VRET) scheme ensures some certainty until 2030. The introduction of an ETS in 2010 will also improve the cost competitiveness of wind power, by decreasing the competitiveness of fossil fuel fired generation (depending on the size of the carbon price applying).

FIGURE A: COST RANGES FOR VARIOUS TECHNOLOGIES



Notes: USC = ultra-supercritical; IGCC = integrated gasification combined cycle; IDGCC = integrated drying gasification combined cycle; CSS = carbon capture and storage; CCGT = combined cycle gas turbine.

Source: Garnaut Climate Change Review (2008)

THE COST OF ABATEMENT

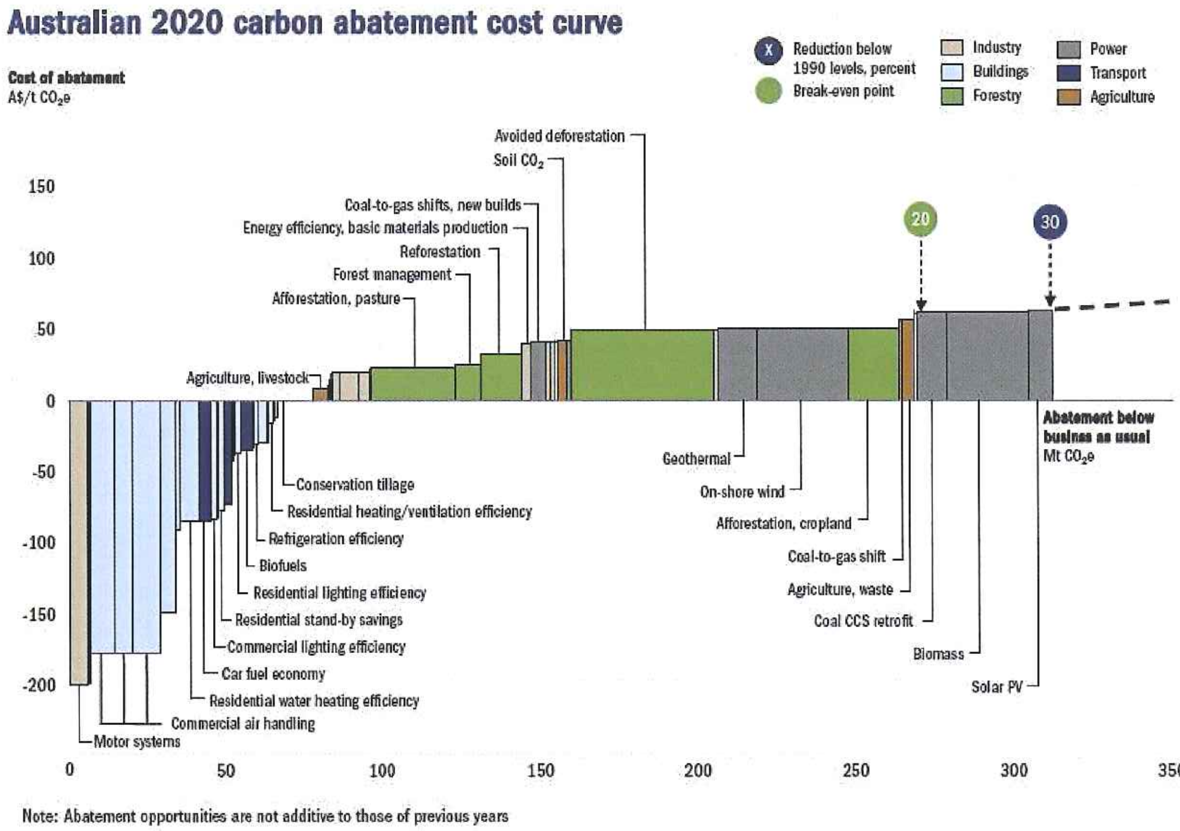
One of the key concepts in the economics of climate change policy is the concept of a cost of abatement of different policy and investment options. It is a commonly quantified figure for different policy and investment options, and hence it is a fundamental unit of measurement in any cost effectiveness review, especially when the primary aim of a type of investment in a state is to "deliver cost effective greenhouse abatement in the long term" (as it is in Victoria).

We believe the cost of abatement is a critical calculation in considering the appropriateness of a wind farm in the McHarg Ranges (and more generally).

The comparison of different cost of abatement figures for different climate change responses is often presented as a marginal abatement cost curve, an example of which is given as Figure B. This (stylised) curve shows the cost (say in dollars per tonne of CO_2) of reducing greenhouse gas emissions for a particular economy. At low levels of abatement, emission abatement may actually provide benefits (so-called 'no regrets' policies). Curves such as this allow assessment of the cost of one option to reduce emissions against other options.

The relative cost of on-shore wind, according to McKinsey, is at the higher end of the abatement options they recognised.

FIGURE B: ABATEMENT COST CURVE



Source: McKinsey Australia Climate Change Initiative (2008)

THE MCHARG RANGES

One of the key considerations in determining the abatement cost of wind power is the impact on land prices. This is a location specific issue.

The McHarg Ranges are located on the northern slopes of the Great Dividing Range, approximately 85 kms north - north west of Melbourne (just over 100 kms by road) and approximately 65 kms from Melbourne airport.

In terms of its economic characteristics, **it is clear that the broader McHarg Ranges region is not a typical agricultural-based economy**. This is because:

- The broader area has a low dependency on agriculture as an employment base. Only approximately 6 % of the employment in the region is in the agriculture sector. This compares with over 9 % for all of regional Victoria. Many regional Victoria areas that do not contain major regional cities have an equivalent proportion over 30 %.
- Residents of the McHarg Ranges region have a broad diversity of employment base. Compared to most other rural areas that do not contain any sizeable towns, a relatively high proportion of workers in the area are employed in manufacturing, construction, retail trade, transport, health, public administration and education.

- In fact, almost 25% of the workforce in the McHarg Ranges is employed in either financial and insurance services, public administration and professional, scientific and technical services, education and health. For an area with no large towns or cities, this is a very high proportion and evidence of an area that is not a typical agriculture based community.
- Many of the residents of the area surrounding the proposed development are new to the area. Almost 32% of the region's residents have moved into the area in the 5 years between 2001 and 2006, with the vast majority of these (24%) coming from another Statistical Local Area (SLA) within Victoria.

Land values in the McHarg Ranges: the likely impact of a wind farm

There is no universally agreed and applicable relationship between proximity to wind farms and land values. Critically, what matters is the specific characteristics of the region in which the wind farm is being located.

What can be concluded, and what is certainly consistent with land valuation theory, is that in areas where agricultural productivity is the dominant driver of land value, wind farms will have negligible effect. This is understandable, for there is little evidence that wind turbines undermine agricultural productivity and the presence of a wind operator in the region can open up another revenue stream to the land owner and enhance their overall revenue. This is not only beneficial as an additional revenue stream, but also minimises agricultural and seasonal risk to the farmer's income. Any loss of amenity due to the wind farm (such as noise or aesthetic impacts) will have minimal, if any, impact upon land values when amenity is not driving the land value. If the value of the land is tied to its income earning potential, then an additional income earning option is, all other variables remaining the same, likely to enhance property values or at least ensure that any impact is negligible.

However, there is a great deal of anecdotal evidence, often backed with the conclusions of real estate agents, that wind farms in some areas would and do undermine land values where amenity value, rather than any cost to agricultural productivity or revenue earning potential per se is an important determinant of land values. Once again, these studies and their impacts on the local area property markets cannot be verified, however the perception of many that, in areas where amenity value is driving property prices, wind farms are not a desirable attribute of an area, can be confirmed.

There are various ways to quantify the amenity value of an area. The Victorian Government publication *Understanding Rural Victoria* (Barr, 2005) disaggregates rural Victoria into four distinct zones: the agricultural production landscape; the rural amenity landscape; the rural transitional landscape; and the irrigation landscape. This publication defines a rural amenity zone as one where demand for land has been driven by amenity rather than production purposes. Such purposes include hobby farms, rural residential properties, weekenders or bush retreats.

According to Barr (2005) these areas have a "more secure future … the diminished capacity to maintain population through natural increase is more than offset by migration from Melbourne". However, they warn that "this bright future depends on protection of the amenity features and landscapes that attract migrants" and that the management of "planning schemes that enhance amenity values will be crucial for the future, lest the migrants it attracts help destroy the very features that draw them".

According to this Victorian Government publication, the site of the McHarg Ranges wind farm proposal sits on the edge of, and partially in, a 'rural amenity' zone.

This figure highlights a key difference between a wind farm in the McHarg Ranges and almost all other approved wind farms. With the exception of two small facilities at Winchelsea (28 MW capacity) and at Leonard's Hill (4 MW capacity), all Victorian wind farms are located in either 'production' or 'transitional' landscapes.

Despite the lower agricultural productivity of the McHarg Ranges region compared to other wind farm locations across the State, the rural land is considerably more expensive, almost double the value on a per hectare basis than regions where other Victorian wind farms have either been located or approved (Table A).

TABLE A: RURAL LAND VALUE ($ PER HA)[1]

Land Values	All rural land	Land wo buildings*
McHarg Ranges	$15,311.81	$15,470.08
Areas of operational wind farms	$8,287.24	$10,125.35
Areas of approved wind farms	$8,234.87	$9,029.64
Areas of wind farms lodged with minister	$7,284.85	$7,420.17

Source: Access Economics

In terms of quantifying the extent to which amenity value, rather than agricultural productivity, is land value in an area, it is the ratio between land value and agricultural productivity that is most important. No single measure of this is conceptually perfect but, as revealed in Table B, all ratio measures used show the same consistent trend; **that land in the McHarg Ranges is valued well above what it would be valued purely on the basis of agricultural productivity. This is strong evidence of a region of high amenity value, and confirms the findings from the Victorian Government report (Barr, 2005).**

[1] NOTE: "Land wo buildings" refers to those categories of land for which there were no buildings involved, a more pure measure of the underlying unimproved value of the land. These categories are "Farm land (without buildings)" and "hobby farm land (vacant)". Such land may be more expensive, on an average per hectare basis, than other land which may have buildings (or other improvements such as vineyards or orchards), because they will typically be smaller allotments and, even though they may have no building, they may have building permits (or at least be large enough such that a planning permit would be provided).

TABLE B: RATIO MEASURES OF LAND VALUE COMPARED TO AGRICULTURAL PRODUCTIVITY

	All rural land value/NPP	Land value wo buildings/YPP
McHarg Ranges	$4,798.86	$3,192.98
Areas of operational wind farms	$1,878.86	$1,164.50
Areas of approved wind farms	$2,035.46	$1,087.44
Areas of wind farms lodged with minister	$1,965.21	$879.32

Source: Access Economics calculations, NPP = Net Primary Productivity, a measure of the biomass growing potential of the area, reflecting soil, climatic and aspect variables. YPP = Yield of Primary Production at full profit equity (conceptually, this is a similar concept to the carrying capacity of the land as measures by units such as the dry sheep equivalent (DSE)).

On a more local area level, the McHarg Ranges region has a consistently higher ratio than all other individual wind farm regions in Victoria, including areas that are operational, approved or have been lodged before the Minister.

The impact of a wind farm in the McHarg Ranges on land values is therefore an important consideration in determining the location specific cost of abatement. In our view, given the consultation that has been undertaken and the importance of amenity value in underpinning land prices in the McHarg Ranges, any wind farm proposal will have detrimental impacts on land prices depending on the scale and nature of the development.

THE COST OF ABATEMENT IN THE MCHARG RANGES

The analysis in this report is predicated on the argument that the reason wind power is being encouraged by government is in order to reduce greenhouse gas emissions. Therefore, to assess cost effectiveness of a facility against other options to abate greenhouse gases, the abatement potential of the facility needs to be combined with its cost in a measure known as the greenhouse gas abatement cost.

To model the abatement potential impact of the proposed wind farm, we have drawn together a range of data to estimate the wind resource available in the region (capacity factor), capital expenditure and the likely energy generation from the facility at different times throughout the year. A summary of the analysis is presented in Chart A.

Commonwealth benchmark

The starting point for the analysis is an abatement cost of $20 per tonne of carbon dioxide equivalent (CO_2e). This is a figure that has been quoted in the recently released Garnaut Review as the starting point price for an ETS in 2010. This establishes a benchmark against which other policies aimed at greenhouse gas abatement can be assessed.

Victorian Government benchmark

In the first instance, the benchmark has been compared with the cost of wind power in Victoria using the Victorian Government's own assumptions. This yields an abatement cost of $26.2 per tonne of CO_2e. This cost estimate is based on three key assumptions. First, each megawatt hour of wind power results in 1.3 tonnes of CO_2e being displaced in the electricity system. Second, a rated capacity factor (CF) of 35% (as identified in the Victorian Government's Policy and Planning Guidelines for the development of wind energy facilities in Victoria) is assumed, and that the wind farm achieves this rated capacity such that marginal cost of wind power is approximately $34 per MWh. Thirdly, wind farms have no costly local area impacts or do not affect land prices.

Access Economics' estimates

Using location specific information and our in-house modelling capabilities, we have considered the three key assumptions underpinning the Victorian Government benchmark discussed above.

First, using our in-house electricity dispatch model of the Victorian power system we estimate that the upper bounds of the abatement potential of the wind facility is 0.85-0.90 tonnes of carbon dioxide equivalent per megawatt hour of energy generated (tCO_2e/MWh). This is substantially less than the equivalent figure used in the Policy and Planning Guidelines for the development of wind energy facilities in Victoria (the standard for which the abatement potential of wind facilities in Victoria is assessed) of 1.3 tCO2e/MWh.

This increases the cost of the abatement for the proposal to between $31 and $47 per tCO_2e. Taking a midpoint of the ranges of both the cost and the abatement potential, we arrive at an estimate of approximately $39 per tCO_2e (which is roughly double the Commonwealth benchmark).

Second, the capacity factor of the wind farms installed may not be 35%. A lower capacity factor for the same sized wind farm means that the marginal cost of wind power will be higher (higher than the $34 per MWh used above) which raises the cost of abatement. Assuming a lower rated capacity, say 30%, the abatement cost increases to just over $45 per tCO_2e. The possibility that the capacity factor may be even lower than 30% in the McHarg Ranges would raise the cost of abatement even higher.

Third, is the local area effects, especially the impact on land prices. Our research and local consultation revealed a broad range of potential local area impacts of a wind farm in the McHarg Ranges. The main potential impacts most likely to arise from the facility include loss of visual amenity, noise, erosion and demands on local infrastructure. Collectively, these act to undermine the amenity for residents of the area. It is the loss of amenity that is critical in the case of the McHarg Ranges, because, as discussed, the area is one where amenity value, rather than agricultural value, drives property prices. There is strong evidence of a premium being paid for land in the area due to amenity value, making a detrimental impact on property prices in the region more likely than other areas of the State where wind farms are operating or have been approved.

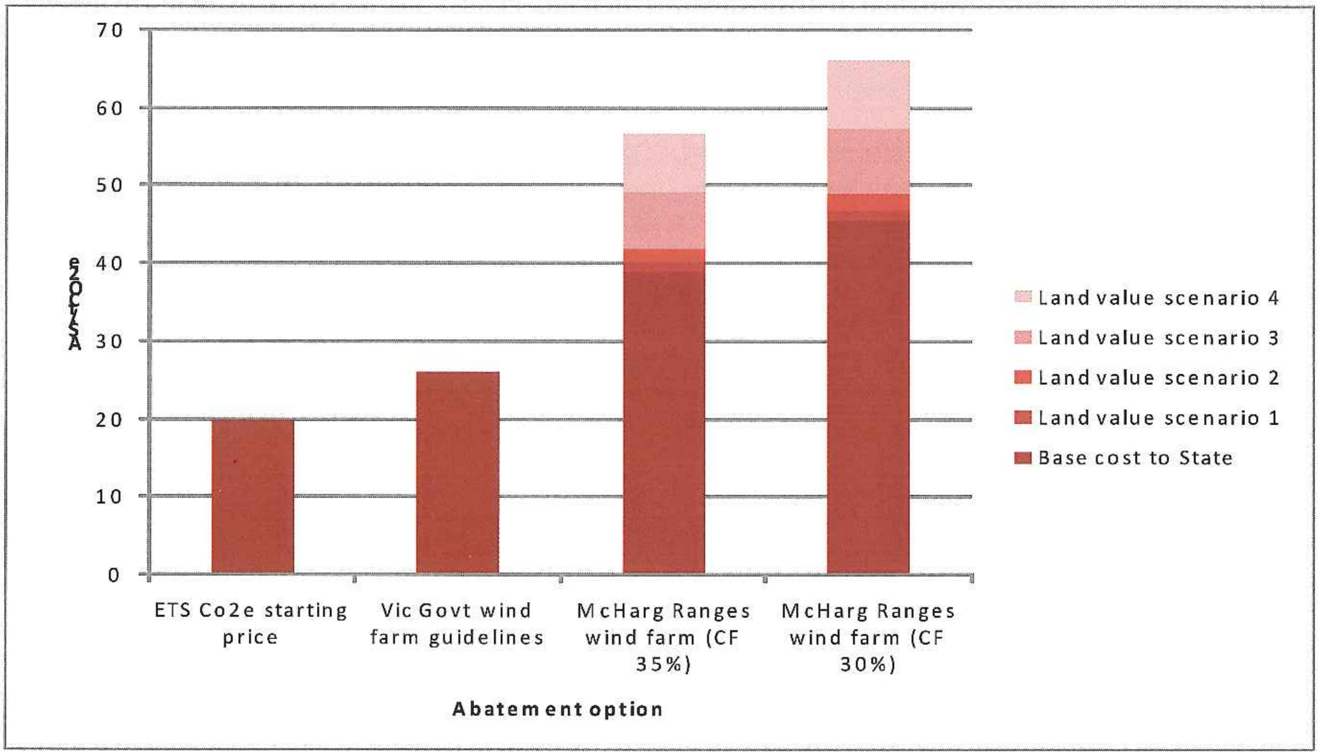
In aggregated dollar terms, the cost of declining property values is not likely to be great relative to the marginal direct cost of wind power. For example, the total cost of a 10% decline in property prices within 10 km of the properties that have signed wind agreements is only $121.2 million, which increases the cost of abatement by approximately $9 per tCO2e under standard wind farm capacity factor assumptions. However, distributional issues and the burden of who pays is relevant here; whereas the marginal direct cost of wind power is met though millions of power users, the cost of declining land values on properties surrounding wind farms is met by the relatively few surrounding property owners.

In any case, with the cost of abatement due to the direct marginal cost of wind power in the McHarg Ranges already high ($39 to $45 per tCO2e), any further increase in those costs due to local area impacts acts to further undermine the cost effectiveness of the project in the region. This is evident in the chart below, illustrating the costs involved in various McHarg Ranges wind farm scenarios versus other pertinent cost of abatement measures. The chart illustrates the cost comparison of the McHarg Ranges wind farm (under several land value scenarios) versus other key abatement costs (in terms of $ per tonne of CO2e).

The four cost scenarios are:

- The starting price of an emissions trading scheme of $20 per tCO2e.
- The cost of abatement through wind power using the 1.3 tonnes of CO2e displaced and a capacity factor (CF) of 35% (as identified in the Victorian Government's Policy and Planning Guidelines for the development of wind energy facilities in Victoria), combined with an additional cost of wind power of $34 per MWh = A$26.2 per tCO2e.
- The cost of the McHarg Ranges wind farm with an assumed CF of 35% using Access Economics calculations, combined with an additional cost of wind power of $35 per MWh = $39 tCO2e. On top of that cost, we have calculated the cost of declining land values under four different hypothetical land value decline scenarios.
- The cost of the McHarg Ranges wind farm with an assumed CF of 30% using Access Economics calculations, combined with an additional cost of wind power of $35 per MWh = $45.5 tCO2e. On top of that cost, we have calculated the cost of declining land values under four different hypothetical land value decline scenarios.

CHART A: COST OF ABATEMENT OPTIONS



Land value scenario 1: 10 percent drop in land values within 1.5km

Land value scenario 2: 10 percent drop within 1.5 km, 5 percent within 3.5 km, 3 percent within 5 km and 1.5 percent within 10 km

Land value scenario 3: 10 percent drop within 10 km

Land value scenario 4: 25 percent drop within 5km, 10 percent within 10 km.

Although we do not believe that the higher level land value impacts (land value scenario 4 on the above chart) are the most likely scenario, the key point from this is that detrimental land value impacts (themselves a function of several local area impacts) are likely, and they do not have to be high to make the project not cost effective. At a cost of upwards of $40 per tCO2e, above $50 given moderate land value impacts, a 200 MW wind farm in the McHarg Ranges is an expensive way to approach greenhouse gas abatement. The cost of abatement is not only significantly higher than the starting cost from the proposed emissions trading scheme but also significantly higher than the cost of abatement from wind power using assumptions with the Victorian Government's guidelines for wind development within the State. This conclusion that the proposal is not a cost effective approach to greenhouse gas mitigation is even more likely, given that our calculated emissions savings from the wind farm are likely to be too high; meaning the calculated cost of abatement from the project is likely to be correspondingly too low. Hence, to the extent that the main objective of wind farm developments in the State is to "deliver cost-effective greenhouse abatement in the long term", this project fails against that key objective.

1. INTRODUCTION

This report presents the findings of a study considering the economic implications of a proposed 100 turbine wind farm in the McHarg Ranges area in Victoria. It explores both the impacts on the State as a whole, most prominently the impacts on the State energy sector and resulting greenhouse gas emissions, and local area impacts specific to the McHarg Ranges area.

The McHarg Ranges wind farm proposal is in its early stages, formally a 'pre feasibility' phase. This means there is little publicly available information on the specifics of the project, in particular its precise location within the McHarg Ranges, size and nature.

As a result, the study assesses the suitability of this particular region for a wind farm development, and whether the aims of a wind farm development are likely to be better met, from an economic perspective, through a wind farm in the McHarg Ranges or some other location.

In particular, the report assesses the proposal against the government's main objective of wind farm developments; to deliver cost effective greenhouse gas abatement in the long term. This is in the context of two key policy developments. First, the development of an emissions trading scheme (ETS), which is a key plank of the Commonwealth Government's Carbon Pollution Reduction Scheme. The second is a mix of subsidies for the renewables sector, and, most prominently, mandating that a certain proportion of all electricity generation is from renewables through mandatory renewable energy targets. Although the nature of these policies is different, their intention is the same; to make what would otherwise be uneconomic unviable investments in renewable electricity viable and able to compete with fossil fuel based generation.

On this basis, the report proceeds as follows:

- Section 2 outlines the approach to the assessment, detailing the methodology, the scope of the study and underlying analytical framework;
- Sections 3, 4 and 5 provide background on the McHarg Ranges region, the wind farm proposal, the State and Commonwealth policy context and national and international wind farm experiences; and
- Sections 6, 7, 8 and 9 analyse the economic impacts of the proposed McHarg Ranges wind farm, including State and local area issues.

2. APPROACH TO ASSESSMENT

The study is undertaken in two stages. The first stage involves the collection and analysis of background material and establishment of the conceptual framework for the analysis. The second stage involves a quantitative review of the economics of wind power in Victoria and the specific costs and benefits of the McHarg Ranges proposal.

The areas under consideration focus around an analysis of the greenhouse and planning policy environment as it relates to the wind farm. This includes:

- a review of the legislation that relates to the development of this wind farm (this does not constitute a legal opinion, but rather, serves to inform the economic analysis);
- a review of the literature concerning other wind farm developments across Australia (with particular emphasis on the economic impacts);
- background economic information for the region (data such as economic activity, population and population projections and land values); and
- a review of the economics of wind farms across their life cycle.

2.1 SCOPE OF THE ANLAYSIS

An important step in a project evaluation such as this, especially where the costs and benefits are to be considered not just at a local level but also at a state level (even at a global level when it comes to greenhouse gas emissions), is to carefully define the scope of the analysis and the scenarios being considered.

This review does not analyse the science of climate change, or the economic impacts of it becoming a reality. Although we acknowledge there is doubt in both the science and in the magnitude of the estimated impacts, we start this review from the premise that the Government *has* targets to reduce greenhouse gas emissions and to mitigate the risk of climate change. **Our key interest here is support for a least-cost approach to achieving those targets, not in whether the targets are legitimate or not.**

Consequently, in conducting the analysis, the focus is not on the ultimate benefits of greenhouse gas abatement and any consequential reduction in the impacts of climate change. Nor are the externality effects of other power plants and the mining of the minerals that support them considered in any great detail. To do this is to effectively undertake analysis of every power supply option to the Victoria grid, clearly a task well beyond the scope of this review. In terms of costs and benefits, we focus on those directly applicable to the project in question.

We do, however, explore impacts beyond just those experienced on site (in the McHarg Ranges). In defining the scope of the analysis, it is not just about what is being constructed or not constructed *on site*, but also about the broader implications of the development, relative to the status quo. In particular, a key consideration here is from where and how will the same amount of usable power be generated if the wind farm does not proceed. In other words, what energy source would the McHarg Ranges wind farm be replacing?

We explore this issue in some depth, as it is crucial to the main argument made in support of wind farms; that, through the additional power generation that is added to the grid, they allow for a reduction in the emissions from polluting (fossil fuel burning) power sources.

Distributional issues are also considered, especially in cases where the benefits and the costs are experienced across different spatial regions. This is a particularly relevant consideration in a wind farm proposal such as this, where the main benefits in the form of greenhouse gas abatement will tend to be experienced globally (shared amongst many), while many of the costs of the wind farm will tend to be experienced locally (shared amongst relatively few).

3. POLICY BACKGROUND

In assessing the impacts of a wind farm development, it is important to keep in mind their basic objectives in a national and Victorian context. According to the Victorian Department of Infrastructure and Department of Sustainability and Environment Issues Paper *"Driving Investment in Renewable Energy in Victoria: Options for a Victorian market-based measure" (2005),* the push to drive investment in renewables in Victoria is to:

- deliver cost-effective greenhouse abatement in the long term;
- drive regional investment; and
- contribute to the diversity and security of energy supply.

The Victorian Government's position therefore has objectives beyond simply reducing greenhouse gas emissions such as: encouraging the development of the renewable energy sector (particularly wind energy); regional development; and security of supply. The rationale behind these objectives is analysed below, however it is important to bear in mind that pursuing these multiple objectives involves trade-offs as well as possible synergies.

The renewable target, assumed to be met by wind power, dictates that emission abatement be undertaken through the adoption of high-cost renewable technologies, and is almost certainly not the least-cost approach to emission abatement in the short term. However, it should be noted that one of the key issues of this policy design is that it has objectives that extend well beyond reducing greenhouse gas emissions (i.e. to regional development and security of supply).

The policy instruments used by government to achieve these targets comprise a mixture of subsidies for the renewables sector, and, most prominently, mandating that a certain proportion of all electricity generation is from renewables, through mandatory renewable energy targets (see discussion below). Although the nature of these policies is different, their intention is the same; to make what would otherwise be uneconomic, unviable investments in renewable electricity viable and able to compete with fossil fuel based generation. In the case of direct subsidies, it is the taxpayer who meets the burden of the more expensive renewables. In the case of the mandatory renewable energy targets it is the energy users. From a public policy perspective, the efficiency with which renewable energy is generated is therefore not just a concern for the energy generators and those whose land or resources they employ; it is an economic concern for the entire state, its taxpayers and energy users.

3.1 COMMONWEALTH MRET SCHEME

In 2001, the *Renewable Energy (Electricity) Act*[2] was passed as one of the measures proposed by the Government to reduce greenhouse gas emissions. The Act sets targets for the increased use of renewable energy through the Mandatory Renewable Energy Target (MRET). Eligible energy sources for renewable electricity generation include hydro, wave, tide, ocean, wind, solar, geothermal-aquifer, hot dry rock, energy crops, wood waste, agricultural waste, waste from processing of agricultural products, food waste, food

[2]www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrumentCompilation1.nsf/0/6A827616D1C965C3CA2573870011861A/$file/RenEngEleReg2001.pdf

processing waste, bagasse, black liquor, biomass-based components of municipal solid waste and sewage, and landfill and sewage gas.[3]

The MRET creates a legal liability for wholesale electricity purchasers to contribute to Government's renewable energy target by purchasing renewable energy certificates (RECs) or pay a penalty for non-compliance of $40 per REC (which is currently equivalent to one MWh), known as the 'Renewable Energy Shortfall Charge'. The MRET therefore distorts the electricity market to favour renewable energy sources and encourages the adoption of renewable energy sources that are cheaper than electricity from coal fired power stations that have a $40/MWh penalty (Productivity Commission, 2008). The cost of the scheme falls on electricity companies who pass it on to consumers in the form of higher electricity prices overall.

The current MRET target of 9,500 GWh per year already affects the mix of electricity generation. Currently, the share of renewable energy in Australia is 8%. Biomass is the largest source of renewable energy, followed by hydro, wind/solar and biogas/liquids (ABARE, 2008).

If, as planned, the MRET target were expanded to 45,000 GWh in 2020 (equivalent to 20% of electricity generation), it could have a substantial impact on abatement costs (Productivity Commission, 2008), and on the renewable energy industry, as 20% of electricity generation will be reserved for relatively expensive energy sources.

Continuation of the MRET under an emissions trading scheme

The Productivity Commission (2008) has questioned the efficiency of the proposed MRET, as it could potentially increase renewable energy generation at the expense of gas-fired electricity, but not drive any deeper cuts in emissions. If the MRET were to operate in conjunction with an emissions trading scheme (ETS) – as it is proposed by the Government given the ETS starting date of 2010 – the MRET would not encourage any additional abatement to the ETS, but constrain how emissions reductions are achieved, increase electricity prices and impose additional administration and monitoring costs.[4] Reserving a proportion of electricity generation for renewable energy sources changes the generation mix in a way that increases abatement costs for no additional emissions reduction benefit. These problems would be further compounded if State-based renewable energy target schemes were retained (or introduced).

The Productivity Commission (2008) also notes that while MRETs may be a useful means to diversify energy sources in the European Union (which is a net importer of energy), the rationale is irrelevant in Australia which has sufficient resources to meet electricity generation and heating energy needs for hundreds of years. Hence, its rationale is more likely to be in reducing greenhouse gas emissions and developing new technologies. However, if the rationale of the Australian MRET were to develop new technologies and address spill-overs that arise from 'learning-by-doing', it is flawed as it tends to bring online mature technologies (such as wind technology). If the main purpose of the Australian MRET were the reduction of

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[3] www.orer.gov.au

[4] Modelling by CRA International (2007), for instance, concluded that the MRET would increase the cost to the economy by a further $1.8 billion in 2020 (estimate of lost GNP) and lead to electricity prices increasing by an additional 6%.

greenhouse gas emissions, then the ETS is likely to achieve the same goal in a much more efficient way.

Hence, the Productivity Commission (2008) concludes that there appears to be no case for continuing with the (expanded) MRET in the presence of an ETS. However, if MRET is to continue, it could be made less damaging if the eligibility criteria were widened to include low emissions, rather than specified renewable, technologies (e.g. clean coal and gas).

3.2 VICTORIAN GOVERNMENT VRET SCHEME

In addition to the MRET scheme, states such as Victoria, New South Wales, Queensland, Western Australia and the ACT have set up, or are in the process of implementing, their own state-based mandatory renewable energy deployment schemes.

In Victoria, the State Government has set an ambitious target of increasing the share of renewable energy in Victoria by 10% by 2016, estimated to support an additional $2 billion of new investment in renewable energy projects (particularly additional wind power generation) over the next ten years. To achieve this policy objective, the *Victorian Renewable Energy Act 2006*[5] has been enacted by the Victorian Parliament. In 2005-06, the share of renewable energy in Victorian primary energy consumption was around 2% (29 of 1,444 PJ) (ABARE, 2008).

The Victorian Renewable Energy Target (VRET) can be characterised as an extension of the MRET scheme, especially as the scheme is meant to run until 2030 (compared with 2020 for MRET).

3.3 FUNDING AND INVESTMENT SUPPORT

In addition to the quota-based market support through MRET and VRET, there are a number of other climate change related technology policies in place, including[6]:

- **Funding for low emissions technologies and abatement** (Australia-wide): $27 million over 2005-2009, targeted at small-scale, low-emissions technologies and aimed to encourage investment in the development, demonstration and deployment phases.
- **Low Emissions Technology Demonstration Fund (LETDF)** (Australia-wide): $500 million available to technologies at the commercial and development stage, where they have potential to lower long-term emissions by 2% and would be commercially ready by 2020 to 2030, aimed to facilitate private investment where size and risk of the investment required may be a barrier. $435 million of this is for the Renewable Energy Demonstration Program, which is designed to fill the gap between post-research and commercial uptake for renewable energy technologies, while the remaining $65 million is directed towards geothermal energy and biofuels.
- **Victorian Renewable Energy Support Fund**: $10 million over three years for demonstration and human capital building for the installation and maintenance of, and access to, medium-scale renewable energy technologies.

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[5] www.legislation.vic.gov.au/Domino/Web_Notes/LDMS/PubStatbook.nsf/f932b66241ecf1b7ca256e92000e23be/101DBC6D2CBD1601CA2571EE001E5A5E/$FILE/06-072a.pdf

[6] Productivity Commission (2008).

- **National taxation and depreciation** (Australia-wide): accelerated depreciation allowances, tax credits and tax offsets that allow small companies to cash out investment equivalents.

Given that technology and renewable energy funds are aimed at the development of new technologies, while much wind energy represents a mature technology, it is unclear to what extent these government policies would apply to future wind farms. It is clear, however, that the major Government policies working as incentives for the development of wind energy facilities (State and federal) are the renewable energy targets (MRET and VRET).

3.4 PLANNING POLICY AND WIND FARMS

3.4.1 INDUSTRY BEST PRACTICE GUIDELINES FOR WIND FARMS

In 2002, the Australian Wind Energy Association, Auswind, with funding from the Commonwealth Department of Environment and Heritage, developed best practice guidelines for wind farm developments in Australia. The guidelines set out attributes of a best practice wind farm in relation to site selection, application, construction, operation and decommissioning. The current guidelines (Auswind, 2006) are based on a review that was undertaken in 2006 and were benchmarked against wind development documentation implemented by international wind development organisations. The (voluntary) guidelines are for use by wind farm proponents and operators and are meant to ensure that projects are appropriately sited, sensitively developed and operated from an environmental and community perspective.[7]

Under the guidelines, a 'best practice wind farm' should be:

- **safe** (i.e. it should not negatively affect health and safety of the community, employees, contractors and other stakeholders during development, construction, operation and decommissioning);
- **reliable** (i.e. it should supply clean electricity);
- **economically sustainable** (i.e. it should make a positive economic contribution to the community in which it is located);
- **environmentally sustainable** (i.e. it should be sensitive to the environment); and
- **socially sustainable** (i.e. development should actively seek stakeholder participation and support through a well-planned, open, inclusive and responsive engagement process that respects local knowledge and concerns and should be based on sound and consistent methodologies to assess and identify the most appropriate siting of the wind farm for landscape, amenity and environmental impacts).

The guidelines focus particularly on the site planning process. In addition to adhering to existing regulations and legislations, the site planning process is recommended to involve an early, open and ongoing dialogue as well as community and stakeholder engagement, so that members of the community and affected stakeholders can participate in the discussion about decisions which may affect them and voice their needs, aspirations and concerns. This is likely to help reduce the potential for conflict and improve the final outcome. International best practice guidelines for wind energy developments – such as those for

[7] The introduction of a National Code for wind farms has been discussed in the past (AGO, 2006), but there are currently no mandatory guidelines in place.

Europe (EWEA, 1999), the UK (BWEA, 1994), Ireland (IWEA, 1994 and 2008) or the US (NWCC, 2002) – are generally quite similar, although they can vary in terms of detail or specification of certain issues. An overview of these guidelines can be found at Appendix B.

3.4.2 Victorian Planning Policy and wind farms

The Victorian Government – through the Sustainable Energy Authority (2003) – has developed its own set of guidelines in relation to the establishment of wind farms in Victoria. The guidelines aim to 'provide the framework and criteria for the balanced assessment of proposed wind energy facilities (typically consisting of a number of wind turbines, a substation, cabling, wind monitoring equipment and access tracks) throughout the State'. The Minister for Planning (rather than the local council and in line with the *Victorian Planning and Environment Act 1987*) is the responsible authority for the assessment and planning approval of all proposed wind energy facilities of 30MW or greater.

The guidelines state that the benefits of wind farms – such as reduced CO_2 emissions and increased employment and regional development – need to be weighed against any possible negative effects on recognised environmental and cultural values as well as landscape values. Responsible authorities are to balance environmental, social and economic matters in favour of net community benefit and sustainable development.

Theoretically, a wind farm can be constructed on any land except in National Parks (which are protected by the *National Parks Act 1975*). However, significant environmental values are protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the Victorian *Flora and Fauna Guarantee Act 1988*. An Environmental Effects Statement (EES) may be ordered by the Minister of Planning if a wind energy facility could have a significant effect on the environment (under the *Environment Effects Act 1978*), although, in most circumstances, the Victorian Government considers an assessment based on the *'policy and planning guidelines for development of wind energy facilities in Victoria'* to be sufficient.

Cultural (heritage) values are protected under the Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* and the Victorian *Archaeological and Aboriginal Relics Preservation Act 1972*. Where wind energy proposals are on Crown land, the provisions of the Commonwealth's *Native Title Act 1993* apply.

In contrast, the landscape value of a site or location (other than a National Park) is considered to be highly subjective and is not protected under any Act. However, 'Significant Landscape Overlays' within the existing planning system help to identify which landscapes are considered to be of critical value and should thus be given some 'objective' landscape value. This measure seems to imply that any landscape that is not within a 'Significant Landscape Overlay' has little 'objective' value, which in turn would suggest that the construction of a wind farm has little impact on the land value. This, however, can be a false conclusion, as land values (as a reflection of landscape values) may well be driven by subjective judgements about a landscape, in which case the construction of a wind farm can negatively affect land and landscape values.

Five matters are considered by responsible authorities in assessing permit applications for wind energy facilities. These five matters are:

1. **Contribution to Government policy objectives** (such as the reduction of greenhouse gas emissions highlighted in the *Victorian Greenhouse Strategy* (2002), a contribution to

MRETs/VRETs, an increase in security and diversity of Victoria's energy supply, the encouragement and support of the development of sustainable industries, and other economic and employment benefits from renewable energy generation in Victoria);

2. **Visual amenity** (including visibility, locations and distances from which the development can be viewed, significance of the landscape, sensitivity of landscape to change, visual impact (through number, height, scale, spacing, colour and surface reflectivity of the wind turbines, removal or planting of vegetation, location and scale of other buildings and works) and current features of the landscape)[8];
3. **Amenity of the surrounding area** (through noise (with noise levels recommended for dwellings in the *New Zealand Standard NZ6808:1993 Acoustics – The assessment and measurement of sound from wind turbine generators*[9]), blade glint, shadow flicker and electromagnetic interference);
4. **Aircraft safety** (the Civil Aviation Safety Authority (CASA) strongly discourages the siting of wind turbines in the vicinity of an aerodrome and needs to be notified about any planned structures exceeding 30m in height within 30km of a regulated airport or 45m in height elsewhere, while tall structures above 110m generally require obstacle lighting as they may infringe aerodrome's obstacle limitation surfaces[10]); and
5. **Flora and fauna** (such as the presence and impact on protected species and communities, sensitivity of any protected species to disturbance and the potential loss of habitat of protected species).

If the impact is assessed to be acceptable (or in the case of the first matter assessed as making a significant contribution), planning may proceed.

[8] Impact reduction measures specific to wind energy facilities (such as siting and design of wind farms, undergrounding of electricity lines, minimising earthworks, removal of vegetation and additional clutter on turbines) are suggested in the guidelines, but they are not mandatory.

[9] The standard provides methods for prediction, measurement and assessment of noise produced by wind turbines, specifically in the presence of wind. It does not specify limits, but states that – as a guide to the limits of acceptability – the sound level should not exceed (at any residential site and at any of the nominated wind speeds) the background sound level by more than 5 dB or a level of 40 dB, whichever is greater (Auswind, 2006).

[10] www.casa.gov.au/rules/1998casr/139/139c18.pdf; www.innescorp.com.au/Uploads/Downloads/Manuals/CASA-139_Standard.pdf

4. THE MCHARG RANGES REGION

The McHarg Ranges are located on the northern slopes of the Great Dividing Range, approximately 85 kms north - north west of Melbourne (just over 100 kms by road) and approximately 65 kms from Melbourne airport.

The Ranges themselves sit on the statistical boundary of two quite different regions: the "Macedon Ranges – Kyneton" Statistical Local Area (SLA) to the south and southwest, and the "Mitchell – North" SLA to the north and east. The Macedon Ranges – Kyneton SLA has been characterised over recent years by a rapidly growing population. According to a range of data sources from both the Australian Bureau of Statistics and the Australian Taxation Office, its economy has grown rapidly, significantly faster than both regional Victoria and Victoria as a whole. By comparison, the Mitchell – North SLA has declined in population over recent years, though its economy has continued to grow at a pace comparable to that of regional Victoria as a whole.

TABLE 4-1: ECONOMIC CHANGE IN THE MCHARG RANGES REGION

	Time Period	Macedon Ranges - Kyneton	Mitchell - North	Regional Vic	Victoria
Population	1996 to 2006	10.3%	-3.8%	7.1%	12.4%
Employment	1996 to 2006	22.3%	4.2%	18.7%	20.1%
Agricultural employment	1996 to 2006	10.1%	-7.1%	-12.9%	-14.1%
Non agricultural employment	1996 to 2006	23.0%	5.2%	23.1%	21.4%
Business Numbers	2002 to 2006	7.8%	-8.3%	4.3%	5.7%
Total taxable income	2002 to 2005	22.9%	17.1%	19.4%	21.9%
Mean taxable income	2002 to 2005	15.1%	14.7%	12.2%	13.7%
W & S mean income	2002 to 2005	16.1%	13.5%	12.1%	12.0%

Note: W & S: wages and salaries

Data source: ABS Census of Population and Housing, Time Series Profile; ABS National Regional Profile

In terms of future growth, the Victorian Government's` *Victoria in Future* publication has forecast that the Macedon Ranges – Kyneton SLA will be one of the faster growing areas of regional Victoria, with the population expected to increase by almost 22% between 2008 and 2030. This represents faster growth than that forecast for both Melbourne and for Victoria as a whole. By comparison, growth in the Mitchell – North SLA is only expected to be modest (just under 5%).

A key difference between the SLAs surrounding the McHarg Ranges and other non-metropolitan LGAs is the low dependency on agriculture as an employment base, as evident in the results from the 2006 Census. Only 5.12% of the employed population within the Macedon Ranges – Kyneton SLA and 6.37 % within the Mitchell – North are employed in the agriculture sector. This compares with over 9% for all of regional Victoria. Many regional Victoria SLAs that do not contain major regional cities have an equivalent proportion over 30%. **It is clear that the broader McHarg Ranges region is not a typical agricultural-based economy.**

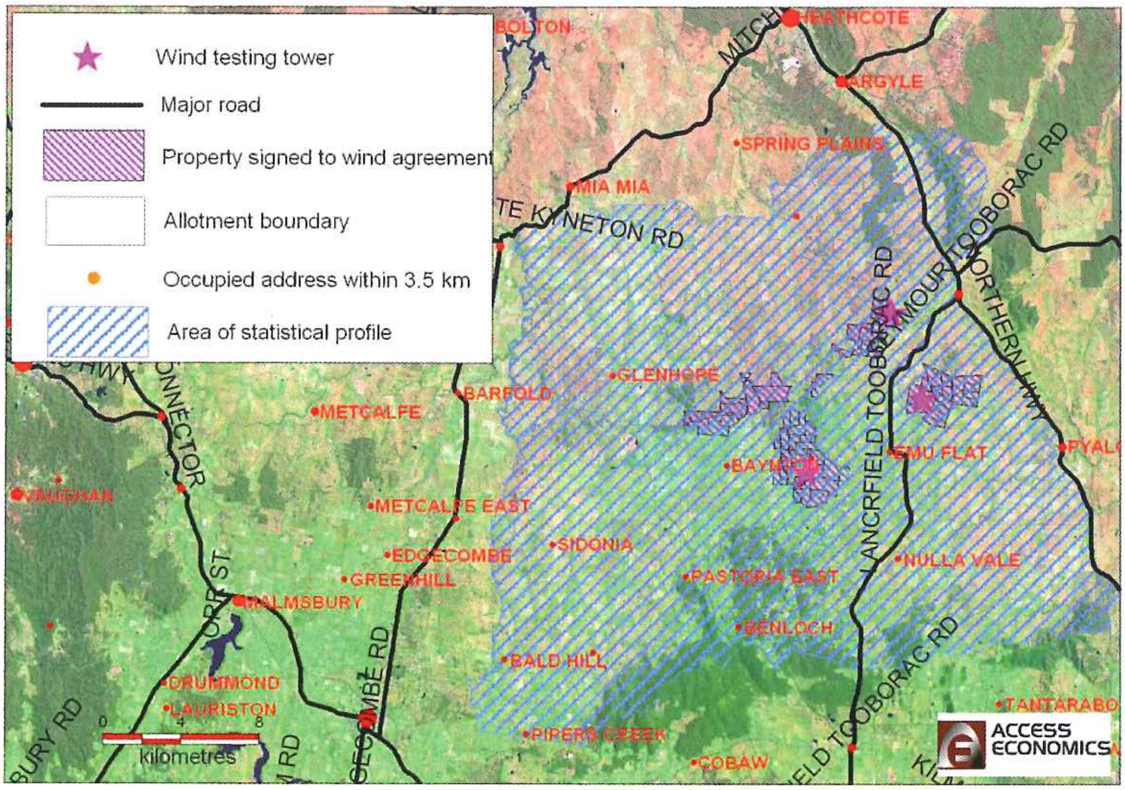
There is diversity even within the agricultural sector, as evident in the latest ABARE Agricultural Census. There is virtually no broadacre cropping in the area, with grazing of beef, sheep and goats the dominant mainstream land use. There are also a number of niche farming enterprises in the area. Despite only containing approximately 1% of Victorian agricultural land, the area produces over 20% of Victoria's cultivated turf. It is also the source of over 12% of horses sold from Victorian farms and 4% of stud horses, over 7% of undercover tomato production, and over 7% of Victoria's goats.

From the same Agricultural Census, environmental protection is also occurring on farms in the region, with large areas of previously agricultural land being set aside for environmental purposes. For example, over 8% of the fencing that occurred in Victoria in 2005/2006 to protect and rehabilitate degraded areas from grazing occurred within this area, as did over 3% of all trees planted for the purposes of protection of land and water.

REGIONAL PROFILE IN MORE DETAIL

Thus far this regional profile has been as the broad level of the SLA. Although this is important to understand the broader context of the McHarg Ranges area, it is also useful to specifically focus on the McHarg Ranges area. A lack of small area data means that this analysis cannot go into as great a depth as an analysis at a larger spatial unit, such as an SLA. Nevertheless, some Census data is available at the level of the smallest spatial unit used in Australian statistical geography: the Census Collector District (CCD). At this more local level, the Ranges themselves can be statistically analysed by a combination of CCDs. The combination of CCDs that best captures the location of the proposed wind farm, and the local affected community, is hereafter called the 'McHarg Ranges' and is illustrated in Figure 4-1. This area captures not just the properties that have signed wind agreements, but also the surrounding areas most likely to be impacted by the proposed wind farm.

FIGURE 4-1: MCHARG RANGES STATISTICAL PROFILE AREA



Source: Base data and digital boundaries © Commonwealth of Australia

As of the 2006 census, the McHarg Ranges (the area shaded blue in the map above) had a population of 1,113. Some of the key socio-economic variables specific to this area are identified in Table 4-2. The variables where the McHarg Ranges is significantly different to elsewhere in regional Victoria include older median age (43 versus 39), higher median household income ($966 versus $821), and lower unemployment rate (3.08% versus 5.61%).

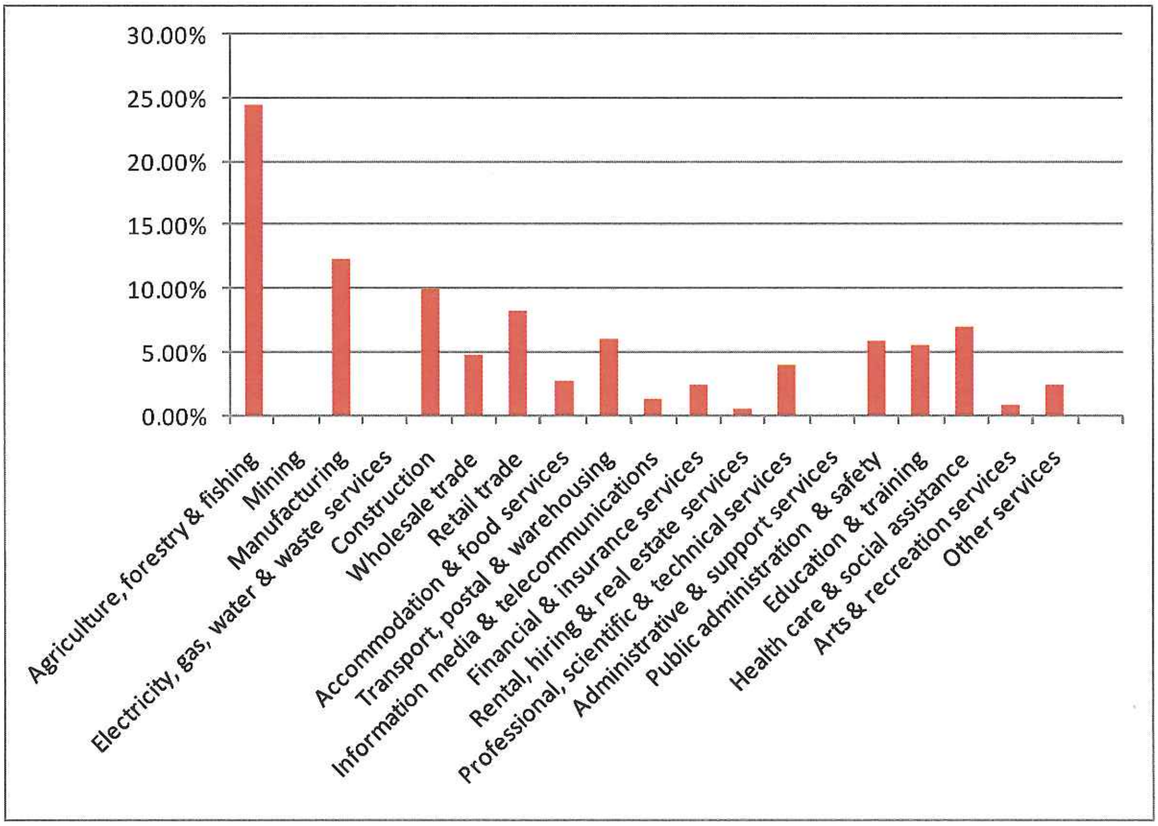
TABLE 4-2: MCHARG RANGES PROFILE

Variable	McHarg Ranges
Population	1113
Lived at same address 1 year ago	973
Lived at same address 5 years ago	710
Population over 15	908
Median Age	43
Unemployment rate (%)	3.08
Median individual income ($/weekly)	394.32
Median household income ($/weekly)	966.27

Data source: ABS Census of Population and Housing, Basic Community Profile

As the labour force breakdown in Figure 4-2 shows, while this local economy is heavily dependant on agriculture, unlike many other rural economies, residents of the region have a broad diversity of employment base. Compared to most other rural areas that do not contain any sizeable towns, a high proportion of workers in the area are employed in manufacturing, construction, retail trade, transport, health, public administration and education.

FIGURE 4-2: LABOUR FORCE OF THE MCHARG RANGES



Relative to non metropolitan Victoria as a whole, an area that encompasses all rural and regional areas as well as major provincial cities (including Geelong), the McHarg Ranges has a proportionally higher employment base in financial and insurance services, transport, wholesale trade, construction, manufacturing, public administration and professional, scientific and technical services. In fact, almost 25% of the workforce in the area are employed in either financial and insurance services, public administration and professional, scientific and technical services, education and health. For an area with no large towns or cities, this is a very high proportion and evidence of an area that is not a typical agriculture based community.

Many of the residents of the area surrounding the proposed development are new to the area. Almost 32% of the region's residents have moved into the area in the 5 years between 2001 and 2006, with the vast majority of these (24%) coming from another SLA within Victoria. The high median age of the population (43 years), and the increase in that median age of 4 years over a 4 year period, strongly suggests that many of the arrivals into the region have been mature age.

We explore more into the characteristics of the local region in Chapter 4, especially how this particular area differs from other areas of regional Victoria (principally those areas where wind farms have already been located or approved).

5. THE WIND FARM PROPOSAL

The proposed Baynton/Tooborac wind farm is a proposed anticipated joint venture between Transfield Services Infrastructure Fund (TSIF), a publicly listed company owning assets including power stations, water filtration plants and wind farms, and Windlab Systems, an ACT-based firm specialising in the development and application of atmospheric modelling systems.

The project was initially developed by Stanwell Corporation Limited, a Queensland Government Corporation; however the Baynton/Tooborac wind farm project, together with a basket of other energy infrastructure projects, was sold to TSIF in late 2007.

TSIF have considerable involvement in Australia's wind power industry, with current operational wind facilities including Windy Hill wind farm in northern Queensland (20 turbines; 60MW), Toora wind farm in south-east Victoria (12 turbines; 21MW), Mt Millar wind farm on South Australia's Eyre Peninsula (35 turbines; 70MW), and Star Fish Hill wind farm in south-east South Australia (23 turbines; 34.5 MW).

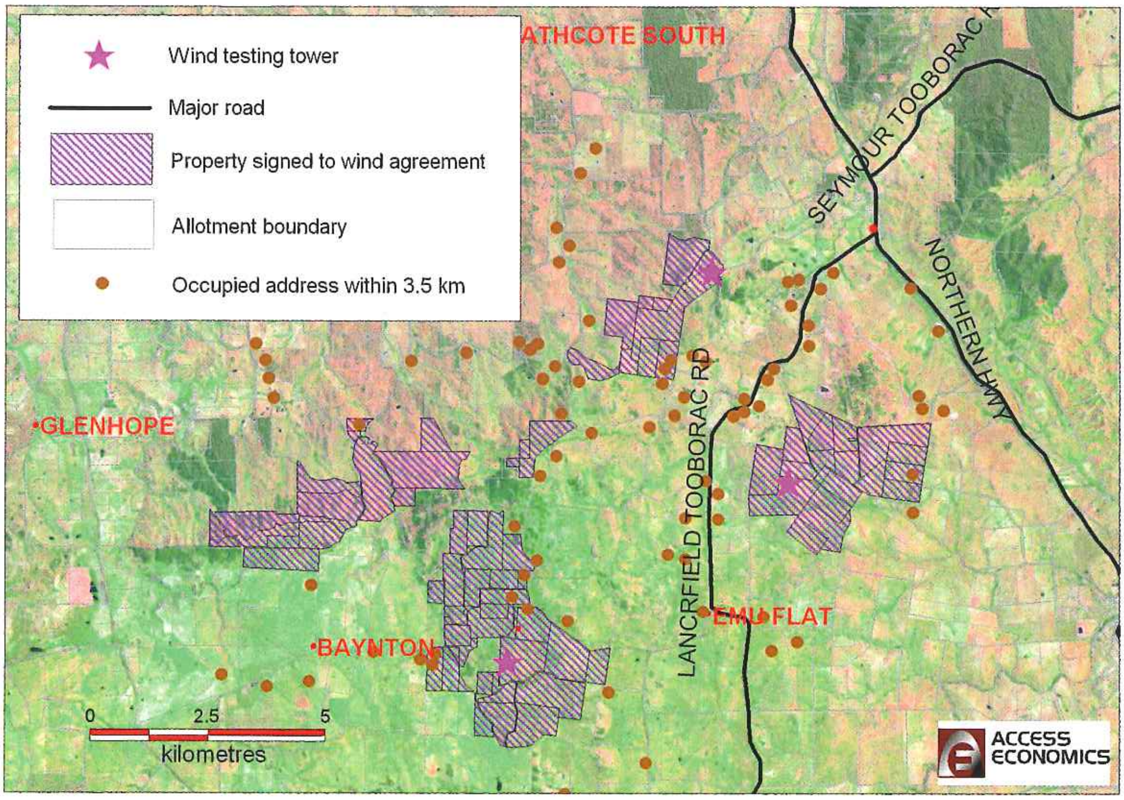
Publicly released information on the proposed Baynton/Tooborac wind farm is limited. As the project remains in the 'pre-feasibility' stage – as it has since mid-2004 – the information disclosure requirements imposed on the developers remain minimal. A 2004 press release by Windlab Systems reported the signing of a memorandum of understanding between Windlab and Stanwell, relating to their interest in developing a wind farm in the Baynton area. It was suggested that the estimated potential installed capacity of the project would be in excess of 200 MW, provided by approximately 100 turbines. Recent suggestions in the local media have indicated the project may be more in the 70 turbine stage, however there has been no formal announcement from the developer.

After four years on the table, the project remains in the 'pre-feasibility' stage, having not progressed to any formal State Government planning or approval processes. From publicly available information, it is not evident how far the developers have progressed with the proposal, however we understand that several land owners have been approached and potentially signed up to host turbines. Despite this, the wider local community is yet to be consulted on the project. Discussions with the developers, Transfield, yielded little additional information to that available in the public domain. Indications were that the project remained in the very early stages of consideration, with no decision yet made as to whether it would proceed to the planning process.

The only clear evidence that the project is under consideration is the erection and maintenance of several monitoring towers in the region. A single tower was put in place in September 2004, and this was followed by several more over the following years. Three monitoring towers remain in place at the time of writing. Guidelines specify a three year limit on the duration which a monitoring tower can be erected, however an extension was recently sought to allow monitoring to continue.

While there is no formal information on specific location and nature of the proposal in the public domain, a broad understanding of the possible turbine locations has been developed through the collective area of property belonging to all those whom, we understand, have signed wind farm agreements. Our understanding of the location of the development is illustrated in Figure 5-1 below. Rather than being a precise plan of wind turbine sites, this represents all potential sites that turbines could be located. The map also shows occupied addresses within 3.5 km of such properties, as well as the location of the three wind speed testing stations that have been erected in the area.

FIGURE 5-1: INDICATIVE WIND FARM LOCATION



Source: Access Economics

6. THE ECONOMICS OF WIND FARMS

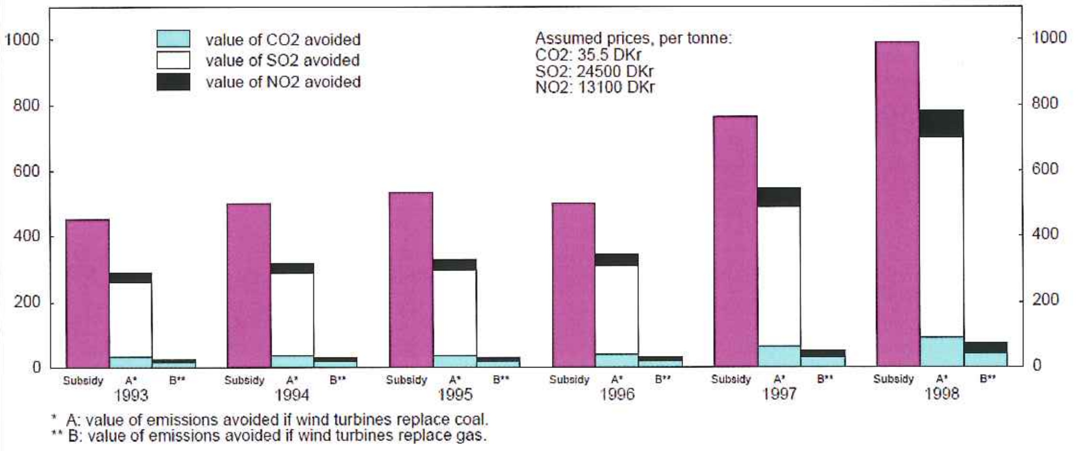
This section presents the key results of economic analysis of wind farms. It proceeds with a general review of the broad impacts of the proposed wind farm at the national and international levels, followed by analysis at the State and national economy levels, in particular in terms of energy supply and greenhouse gas reductions.

6.1 NATIONAL AND INTERNATIONAL WIND FARM ANALYSES

Despite the intense national and international debate about the actual impacts of wind farms, examples of thorough cost benefit analyses of wind energy facilities are still rare, both locally, and internationally.

The OECD (2000) estimated the costs and benefits of the Danish wind turbine program between 1993 and 1998, comparing the expenditure on subsidies for wind farms with the (approximate) value of greenhouse gas and other emissions avoided. The analysis (undertaken for illustrative purposes only) shows that wind energy seems to have incurred costs higher than the environmental benefits achieved (Figure 6-1). The analysis also distinguishes the benefit from the replacement of coal (column two) and the benefit from the replacement of gas (column three), showing that the costs of subsidies far exceed environmental benefits when gas is replaced, while subsidies align more closely with environmental benefits when coal is replaced. This does not necessarily infer that subsidies are excessive in Denmark, as (i) wind typically replaces coal rather than gas and (ii) Denmark is a leader in the development and deployment of wind technology, and subsidies may have acted as technology stimulation.

FIGURE 6-1: COSTS AND BENEFITS OF THE DANISH WIND TURBINE PROGRAM (DKR MILLION)



Note: The prices used here are illustrative, not intended as an explicit estimate of the environmental costs of emissions. They correspond to those used for the "green adjustment" shown in Figure 24.
For each year the second and third columns represent the value (see footnote 32) of the emissions that would have occurred if, respectively, coal or gas fired power stations had been used to generate the electricity that was produced in that year by wind turbines.

Source: OECD 2000

One of the more comprehensive cost benefit analyses comes from the US. Haughton et al (2004) assessed the economic and financial costs and benefits as well as local effects of America's first offshore wind farm in Nantucket Sound (Massachusetts). The wind farm proposal was for 130 3.6 MW wind turbines over a 24 square mile area, five miles off the coast in federal waters. The wind farm was estimated to generate 1.4 million MWh of electricity per annum.

The economic benefits included a reduction in fossil fuel consumption (valued at $522 million), capital and operating cost savings (valued at $104 million), emission reductions (valued at $108 million) and greater energy independence (valued at $11 million). The economic costs included those of installing and operating the wind farm (estimated to be $888 million), integration into the power grid (estimated to be $26 million) and 'external' costs the project might impose on the environment (estimated to be $39 million). The economic costs (amounting to $952 million) exceeded economic benefits (amounting to $744 million) by $208 million, which indicated that – from a socio-economic point of view – the project could not be justified.

Moreover, the wind farm was expected to have a number of local effects. In particular, it was estimated to reduce tourist spending by between $57 million and $123 million and reduce property values by around 4.0% (amounting to a total loss in property value of over $1.3 billion and a loss in property tax revenue of $8.0 million), but create 135 direct jobs (and up to 875 indirect jobs) during construction and 45 direct jobs (and up to 90 indirect jobs) during operation.

From the developer's perspective (i.e. looking at financial costs and benefits), the project was much more appealing, as it was estimated to be privately profitable because government subsidies increase the real return. Although electricity from this wind farm was estimated to cost 8.17 cents/kWh when the market value of electricity was only 4.68 cents/kWh, subsidies increased the return to the wind farm operator to 8.20 cents/kWh. The Massachusetts 'green credits' scheme, for instance, which requires consumers to purchase a growing proportion of electricity from 'new renewable' sources and thereby cause electricity prices to rise, was estimated to cost ratepayers $267 million (NPV). A Federal Renewable Electricity Production Credit was estimated to represent a subsidy of $98 million, while accelerated tax depreciation was estimated to be equivalent of a further $58 million. After making an allowance for taxes and royalties paid, the net subsidy was estimated to be $382 million over the life of the project. This subsidy was seen as excessive, as external benefits (cleaner air, greater energy independence, etc) were only valued at $268 million, hence government regulations provided an excess subsidy of $114 million (see Table 6-1).

TABLE 6-1: PRIVATE AND ECONOMIC RETURNS, NANTUCKET SOUND WIND FARM

	Cents/kWh	*PV, $ millions*
Private return on equity (from Table 3)	**0.29**	**30**
Plus external benefits:		
+ Capital and operating expenditures saved	0.99	104
+ Value of emissions abated	1.03	108
+ Value of greater energy independence	0.10	11
+ Taxes paid to Federal, State and Local governments, and royalties	0.39	41
Less external costs:		
– Cost of integrating wind power with New England grid	0.24	26
– Environmental/aesthetic costs	0.37	39
– Federal production tax credit	0.94	98
– Massachusetts green credits	2.55	267
– Accelerated depreciation for tax purposes	0.55	58
And technical adjustments		
+ For value of output (economic valuation > market valuation)*	0.28	29
– For loan effect (developer can use optimal loan financing)**	0.41	43
= Net Economic Benefits (from Table 1; Benefits – Costs)	**(1.99)**	**(209)**
Memo items:		
Actual subsidy (net of taxes)	3.65	382
Optimal subsidy	2.56	268
Therefore: excess subsidy	**1.09**	**114**

Notes: * The market valuation measures what Cape Wind receives from selling the electricity from the project; the economic valuation measures this as the value of energy saved (which is slightly higher than the market valuation). ** The developer has recourse to loan financing, which raises the private return on equity since the interest rate on loans is lower than the discount rate of 10%.

Source: Haughton et al. (2004)

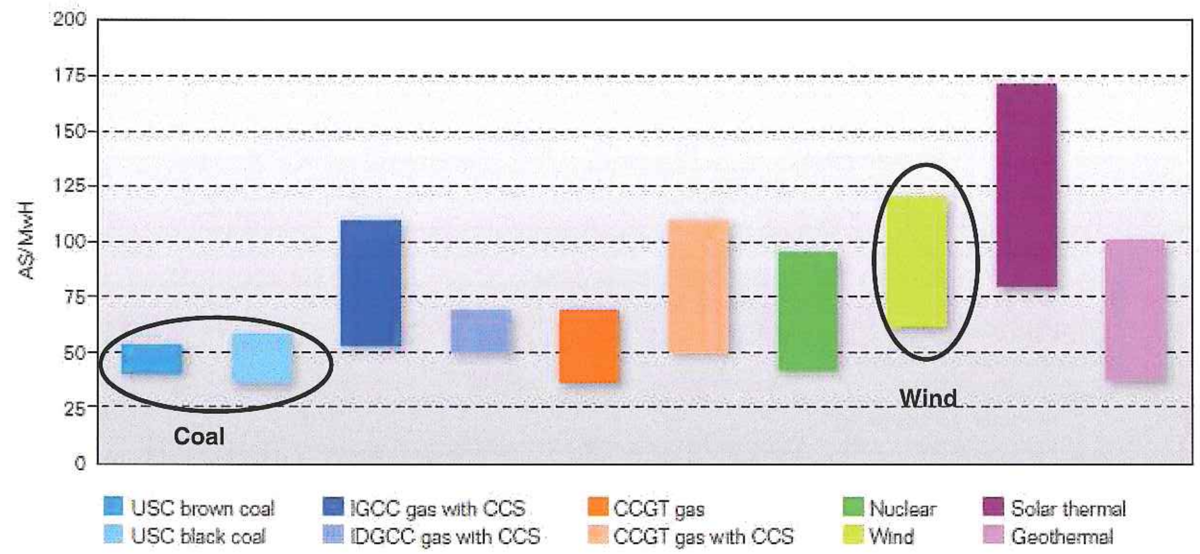
From the international literature reviewed therefore, there is no clear evidence that wind farms produce net economic benefits (including where broadly defined to include financial, social and environmental impacts). Even where the external benefits of wind energy are fully factored into the analysis, the magnitude of government assistance required to make this technology viable largely overshadows the benefits that accrue from greenhouse gas abatement.

6.2 THE DIRECT COST OF WIND POWER

The costs and economics of wind energy depend on a number of factors including capital costs (site preparation, acquisition and installation of wind turbines), operating costs (including system integration such as transmission, backup or – as a future possibility – storage, land rental as well as administration and general costs), maintenance and decommissioning costs, the wind energy market (including scale and associated learning curves, subsidies or other incentives and consumer behaviour (e.g. consumers may be willing to pay a premium for green power)). Of course this must be taken in the context of the total costs of other forms of electricity generation (e.g. the cost of coal will include the cost of carbon once an emissions trading scheme is in place) and thus the market price of electricity.

Currently (and excluding the cost of greenhouse gas emissions and other externalities), wind energy is not competitive with other technologies, as the financial cost of wind energy is estimated to be around twice as much as that of coal, the cheapest source of power (see analysis from the Garnaut Review in Figure 6-2, below). As long as the value of wind energy (electricity price) is below the financial cost of wind energy, the use of a market/regulatory premium is needed to ensure that wind energy is viable. Current estimates suggest that wind energy is not financially profitable without government assistance in any country where it is used. Although wind energy is widely believed to become increasingly cost-competitive over time, it is likely to continue to need government support beyond 2020, leading to financial uncertainty (Simpson, 2004). That said, in the case of Victoria, the VRET scheme ensures some certainty until 2030.

FIGURE 6-2: COST RANGES FOR VARIOUS TECHNOLOGIES



Notes: USC = ultra-supercritical; IGCC = integrated gasification combined cycle; IDGCC = integrated drying gasification combined cycle; CSS = carbon capture and storage; CCGT = combined cycle gas turbine.

Source: Garnaut Climate Change Review (2008)

6.2.1 CONSTRUCTION COST

Continuous improvements in technology, an increase in the size of wind turbines and increases in the cost of key inputs such as steel, mean that the price per wind turbines continues to rise. The size of wind energy facilities has also increased over time, while per MW project costs (rather than equipment costs) have dropped (ASTAE, 2000). On average, wind turbines represent around 75–80% of the capital costs of wind energy facilities (Productivity Commission, 2008).

Accurate determination of the costs of constructing the McHarg Ranges wind farm is hampered by a lack of data in two respects. First, the project has not proceeded to the point where an announcement has been made on the type of turbines that would be used and their source, meaning that costing the specific turbine to be used in this project is not possible. Even the *number* of turbines remains subject to some uncertainty. Second, more broadly, minimal information is available in the public domain on the costs of the turbines themselves, or the associated ancillary infrastructure. While several developers and turbine manufactures were approached for cost data, the commercially sensitive nature of this information meant these parties were not willing to provide it.

The reported cost of recent wind farm developments in Australia gives an indication of the total construction cost, although only at an aggregated level. Table 6-2 shows the details of recent projects in Victoria, South Australia and Queensland. Evidently, construction costs vary considerably depending on the turbines installed (as well of course as other factors).

Aside from this, it is also apparent that per-turbine construction costs have increased over time, even taking account of the increased capacity of newer turbines.

TABLE 6-2: ESTIMATED CONSTRUCTION COSTS OF RECENT WIND FARMS IN AUSTRALIA

Site	Energy produced	No. of turbines	Turbine type	Turbine capacity	Year of completion	Estimated const. cost	$m/ turbine	$m/ MW
Windy Hill, QLD	12 MW	20	Enercon E40	0.6 MW	2000	$20 m	$1.00	$1.67
Codrington, Vic	18.2 MW	14	AN Bonus	1.3 MW	2001	$30 m	$2.14	$1.64
Toora, Vic	21 MW	12	Vestas V66	1.75 MW	2002	$38 m	$3.17	$1.81
Challicum Hills, Vic	52.5 MW	35	NEG Micon	1.5 MW	2003	$76 m	$2.17	$1.45
Starfish hill, SA	34.5 MW	23	Vestas NM64C	1.5 MW	2003	$65 m	$2.83	$1.88
Wonthaggi, Vic	122 MW	6	REpower MM82	2 MW	2005	$20 m	$3.33	$1.67
Mt Millar, SA	70 MW	35	Enercon E70	2 MW	2006	$138 m	$3.94	$1.97
Yambuk, Vic	30 MW	20	NEG Micon	1.5 MW	2007	$50 m	$2.50	$1.67
Portland, Vic	58 MW	29	REpower	2 MW	2008	$130 m	$4.48	$2.24

Source: Transfield infrastructure fund, Wind Power Pty Ltd, Pacific Hydro, Acciona Energy

As noted above, no announcement has been made on the type of turbine to be used in the McHarg Ranges project. It has been suggested that the project will produce 200 MW of energy from circa 100 turbines, hence the assumption that the turbines will be 2MW is adopted in the analysis. Based on the recent Mt Millar project in South Australia, and incorporating the likely cost savings through economies of scale, coupled with the likely cost increases due to commodity-price fuelled increases in construction costs, it is estimated that the construction cost of the McHarg Ranges wind farm, in 2010 dollars, is in the vicinity of $440 million

6.2.2 OPERATING COSTS

Little data is published on the maintenance costs of turbines – the main operating cost associated with wind farms – as again, such data is generally commercially sensitive, with developers and operators having minimal interest in publicising such information. Estimates from the overseas literature suggest that for newer turbines, operation and maintenance costs average around 1.5-2% of the original turbine investment, per year[11].

6.2.3 DECOMMISSIONING COSTS

The costs of decommissioning wind farms can be significant, however as there is little experience with decommissioning in Australia, it is not certain how decommissioning will be

[11] www.windpower.org

undertaken, and what the likely cost will be. For example, one of the greatest costs of decommissioning would be the removal of the concrete base. However, it would be both feasible and possible for the base to be reused and for the turbine to simply be replaced with another at the end of its lifespan. While European estimates put the cost as high as $1 million Euros ($1.65 million AUD)[12], there is no evidence in Australia as to what the cost might be. The potential for the turbine to be sold to recyclers is likely to partially offset the costs of decommissioning; however this will of course depend on the market for scrap metal 20-25 years from now.

An additional issue related to decommissioning is who bears the cost. In a cost benefit framework, who bears the cost is less significant than its absolute magnitude; however, in assessing the benefits to the local region, it has a considerable impact on the outcomes (i.e. whether it is the developer, the wind farmer owner or the landholder who bears the costs). Some developers have been quite clear in their assertions that they will not bear the cost of decommissioning[13], leaving concerns that it may be the landholder who ultimately bears the cost. In general however, it is not clear how this would unfold.

By way of illustration, if the return to the landholder were to be indexed at $8,000 per turbine per year (see discussion below on returns to land holders), then at a real discount rate of 5%, the NPV of 25 years' income would be $113,000 per turbine. Precluding any other benefits, if the NPV cost of decommissioning were to exceed this, on net, the landholder would be worse off. To reverse this calculation, and given a NPV per turbine of $113,000 at a 5% discount rate, the decommissioning cost per turbine in 25 years time would have to exceed $362,258 per turbine for the landholder to be worse off (in real 2008 dollar terms, meaning not adjusted for inflation - the figure in 2033 dollar terms would be higher).

6.3 THE MARGINAL COST OF WIND POWER OVER NON-RENEWABLE ENERGY

When all of these construction, operating and decommissioning costs are combined, a picture of the total direct cost of the wind power project (from a financial perspective) emerges. When this dollar figure is divided by the total energy generated over the life of the project (measured in MWh), the long run marginal cost (LRMC) of wind power can be calculated. It is possible to estimate this cost of wind-generated electricity from information on capital cost and nominal generating capacity, which is usually provided in a wind farm's planning permit application. Applying discounted cash flow analysis and a range of input assumptions to past applications, it is evident that the LRMC of electricity generated by wind farms in Victoria will generally be in the range of $68 to $82 per MWh. This compares with an average price on the NEM of around $40 per MWh, suggesting that the additional incremental cost of wind power compared to the NEM average is between $28 and $42 per MWh. Note that this figure is the *marginal* difference between the direct cost of wind power over the direct cost of other power sources into the NEM. To the extent that wind power requires additional backup above and beyond what already exists in the NEM, to compensate for times when wind resources is not available, the cost of wind will be higher. This will become a greater issue if and when the share of wind power as a proportion of total

[12] http://environnementdurable.net/documents/html/demantelement1.htm

[13] See for example Wind Power Australia Director Steve Buckle's comments in the Sydney Morning Herald, September 4, 2004.

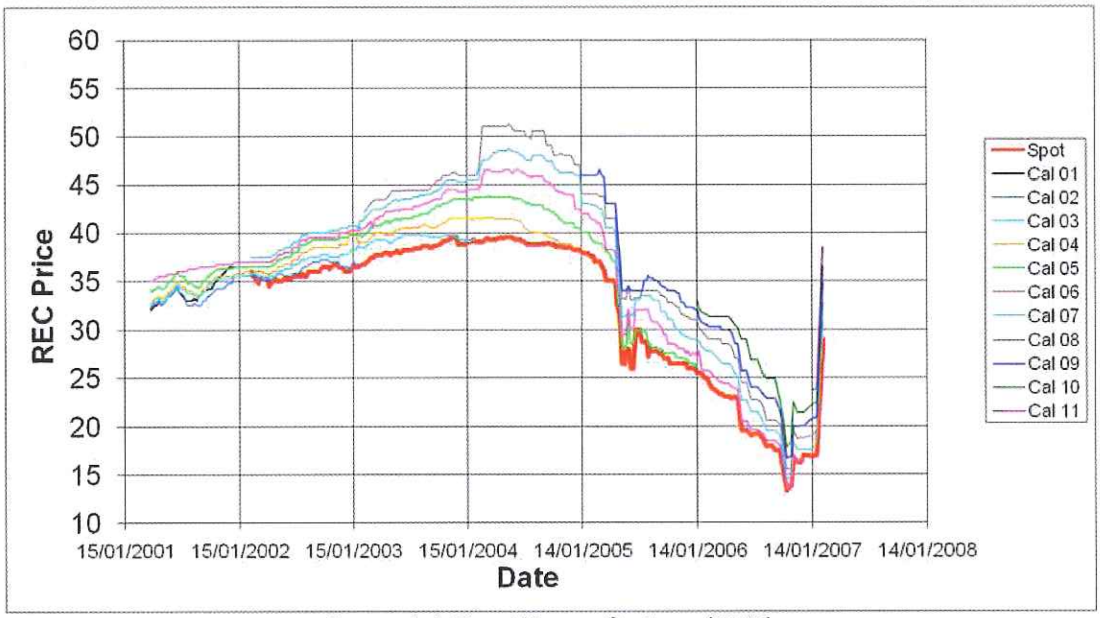
power increases in the future, more so than a direct additional cost attributable to current wind farms in the State.

If significant amounts of wind energy are generated at times of peak electricity demand, it is possible that electricity from wind farms might yield a higher price than the NEM average. Though wind energy cannot be produced specifically in response to peak demands, the operation of the NEM means that all wind energy is accepted into the grid at all times, and hence wind farms could make high short run returns in the situation where the wind happens to blow when electricity prices peak. However, and in practice, most wind farms have a supply contract with a single buyer taking all the output at an agreed price which reflects longer term averages, so anomalies in the NEM may not add greatly to the economic viability of the wind energy sector. On the other hand, the ability to cash in on very high spot prices for electricity is the key to the profitability of hydro-electricity generators, who can adjust their supply precisely to meet periods of highest price.

In any case, electricity from wind farms is much more expensive to generate than electricity from other sources in Victoria, and wind farms are viable (in a financial sense) largely because of a government-mandated, consumer-paid subsidy under the Commonwealth MRET scheme and the new Victorian Government VRET scheme (discussed in Section 3). Indeed, another way of estimating the marginal cost of wind power over the non renewable sector (and hence the extent of the subsidy afforded by MRET and VRET) is to explore the price history of the renewable energy certificates (RECs).

In the past, the price for RECs has been very volatile (Figure 6-3). While RECs sold for close to $40 (the penalty rate per MWh short under the MRET system) during 2004, spot prices dropped below $15 in late 2006 due to an oversupply of renewable energy (i.e. there was enough plant to supply the MRET and there was a very large inventory of RECs) before recovering again when VRET and other state schemes were introduced.

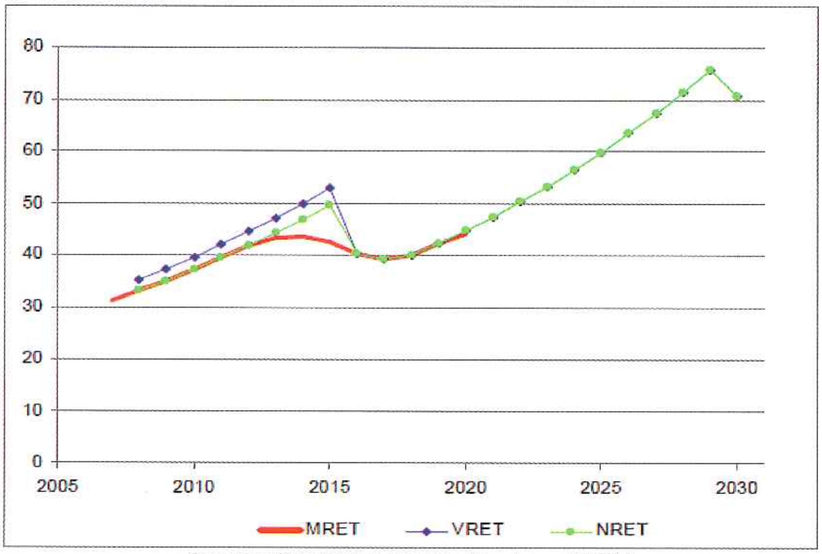
FIGURE 6-3: HISTORICAL REC PRICES (SPOT AND FORWARD)



Source: Intelligent Energy Systems (2007)

Figure 6-4 illustrates the potential development of REC prices based on an 'Emissions Trading' scheme scenario. REC prices are forecast to be between $30 and $40 initially, rising to $70 by 2030.

FIGURE 6-4: PROJECTED REC PRICES – EMISSIONS TRADING SCENARIO



Source: Intelligent Energy Systems (2007)
NRET = NSW Renewable Energy Target

The long run average price of the RECs of between $30 and $45 is consistent with the marginal cost of wind power over fossil fuel-based power generation noted previously (between $28 and $40). This estimate of the marginal cost of wind power over non-renewables is significant in our subsequent calculations on the cost of abatement through wind power.

6.4 SUMMARY

Based on the international literature reviewed here, there is no clear evidence that wind farms produce net economic benefits, from their energy production alone. In relation to the economics of wind power in Australia, the findings of this Section suggest the following key conclusions:

- Increasing turbine manufacturing costs continue to inflate wind farm construction costs, with recent projects estimated to cost as much as $2.2m/MW.
- While there is minimal experience with wind farm decommissioning in Australia, overseas evidence suggests the costs associated with this can be significant. Marked uncertainty currently surrounds who would bear this cost – land owners, developers or wind farm owners.
- The long-run marginal cost of wind energy generated by wind farms in Victoria is estimated to be in the range of $68 to $82/MWh, suggesting an incremental cost, relative to the NEM average, of between $28-$42/MWh – a figure consistent with the long run average price of RECs.

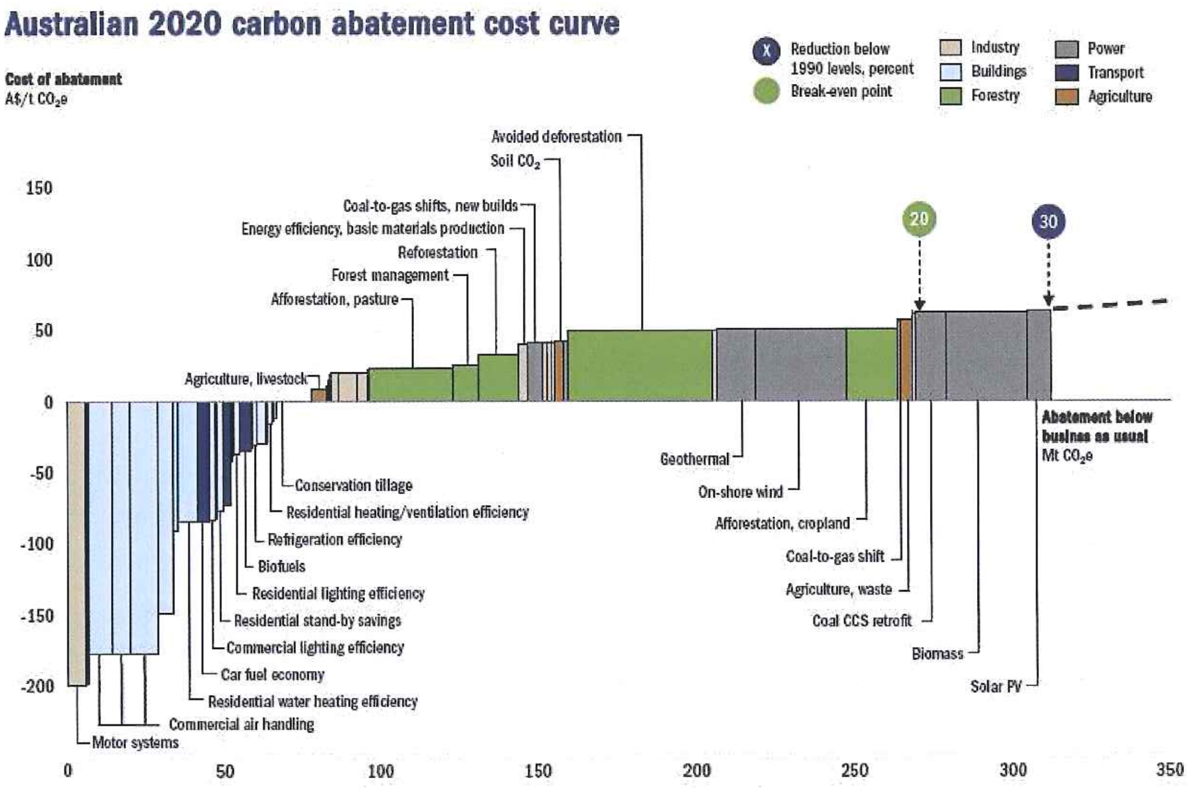
Overall, the direct costs of wind energy (in $/MWh) suggest that at present (and excluding the cost of greenhouse gas emissions and other externalities), wind energy is not competitive with other technologies.

7. THE COST OF GREENHOUSE GAS ABATEMENT THROUGH WIND POWER

One of the key concepts in the economics of climate change policy is the concept of a cost of abatement of different policy and investment options. It is a commonly quantified figure for different policy and investment options, and hence it is a fundamental unit of measurement in any cost effectiveness review, especially when the primary aim of a type of investment in a state is to "deliver cost effective greenhouse abatement in the long term" (as it is in Victoria).

The comparison of different cost of abatement figures for different climate change responses is often presented as a marginal abatement cost curve, an example of which is given as Figure 7-1. This (stylised) curve shows the cost (say in dollars per tonne of CO_2) of reducing greenhouse gas emissions for a particular economy. At low levels of abatement, emission abatement may actually provide benefits (so-called 'no regrets' policies). Curves such as this allow assessment of the cost of one option to reduce emissions against other options. This comparison is important in the context of a cost effectiveness study, such as the one being undertaken here.

FIGURE 7-1: ABATEMENT COST CURVE



Note: Abatement opportunities are not additive to those of previous years

Source: McKinsey Australia Climate Change Initiative (2008)

In this case, we are most interested not in the cost of wind power in general, but the cost of wind power in the McHarg Ranges. In other words, where does the specific McHarg Ranges wind farm sit in relation to other options in Figure 7-1, and compared to other locations where wind farms are either operating or have been approved.

For a given level of CO_2 savings per MWh of wind energy produced, and a given marginal cost of wind power in excess of other energy sources, it is possible to calculate the cost of each tonne of CO_2 saved through the generation of wind power. Using the figures identified in the literature as a starting point, the following implied cost of CO_2 abatement is evident:

- The lowest cost is found through the 1.3 tonnes displaced (as identified in the Victorian Government's Policy and Planning Guidelines for the development of wind energy facilities in Victoria), combined with an additional cost of wind power of $28 per MWh implies a figure of A$21.54 per tCO_2e. Using an additional cost of wind power of $34 per MWh, the cost of abatement is $26.16. This cost is competitive with some of the widely quoted 'prices' of carbon figures being used in carbon offset programs and early carbon trading markets and below that of several other mitigation options, and would suggest wind power in Victoria may have economic merit.
- The highest cost is found through the 0.33 tonnes displaced (as identified by the lower range of the South Australian Wind Power Study) combined with an additional cost of wind power of $42 per MWh, which implies a figure of $127.27 per tCO_2e. This would make wind power an extremely expensive CO_2 abatement option, well in excess of other options. However, this is an unrealistic emissions factor to use in Victoria. Hence, the abatement cost from a wind farm in Victoria will be lower than this.

Applying the same calculations to our estimate of the abatement potential of the McHarg Ranges wind farm (0.85 to 0.90 tCO_2e/MWh) and the marginal cost estimates ($28 to $40), we arrive at a cost of abatement for the McHarg Ranges wind farm of between $31 to $47 per tCO_2e, giving a midpoint of $39 per tCO_2e.

To the extent that our estimate of the abatement potential of wind power in the Victoria grid (0.85 to 0.9 tCO_2e/MWh) is an upper bound estimate (for reasons explained earlier), our estimate as to cost of abatement through the project ($31 to $47 per tCO_2e) is very much a lower bound estimate. Nevertheless, it sits comfortably higher than many other abatement opportunities available, even before we have considered another potentially significant category of costs; those imposed on the local community.

7.1 IMPACTS ON THE STATE: A COST EFFECTIVENESS REVIEW OF THE MCHARG RANGES WIND FARM

As discussed previously, the three main State objectives driving investment in renewables are to deliver cost effective greenhouse abatement in the long term, drive regional investment, and contribute to the diversity and security of energy supply.

The latter two objectives are somewhat problematic when it comes to assessing the merits of any one wind farm in any one region. In an absolute sense, any investment in energy supply will tend to drive regional investment (for few power stations of any sort are located in metropolitan areas), any investment in energy will enhance the security of energy supply relative to a situation if that investment did not occur, and any investment in a new or minority energy generation technology will enhance energy diversity. Without assessing whether these objectives are sound and, for example, why the concept of energy diversity matters or what is 'optimal' energy diversity, it is clear those two objectives are not particularly useful in enlightening answers to the pragmatic questions of what and where: what technology, and where should it be located.

Because so many investments in energy generation will pass the latter two tests, we are left with the first objective of renewables – to deliver cost effective greenhouse abatement in the long term – to best assess the relative merits of different options. Indeed, this objective articulates the single main argument in support of wind energy generation despite its higher direct costs; that it reduces the need to operate fossil fuel burning power stations, and thereby reduce CO_2 emissions. Wind farms are therefore seen as beneficial because, across the grid, they lower emissions. Once those emissions are appropriately costed, the argument follows that wind farms can be shown to be economic, despite their greater direct costs (largely upfront capital) per unit of energy produced. The abatement potential of wind combined with its additional cost can be combined to calculate a dollars per tonne of CO_2 abated that wind power in Victoria allows for. This can then be compared against other ways that CO_2 can be saved.

In this way, the concept of 'cost-effectiveness' of any one investment can be objectively measured.

7.1.1 WIND POWER AND GREENHOUSE GAS ABATEMENT

Although it is also clear that wind energy can displace some fossil fuel-based generation, reducing both fuel use and carbon dioxide emissions, it is also clear that wind turbines do not displace fossil generating capacity on a one-for-one basis (where one unit of power generated by wind power means one less unit of power generated by fossil fuels). Indeed, there is a great deal of debate about the actual CO_2 abatement potential of wind power, especially as it relates to different electricity markets around the world.

To properly assess the merit of this argument in a Victorian context, we need to consider how the Victorian electricity market works as part of a broader national electricity market (NEM), what power source will the wind farms substitute for and what emission savings will this substitution allow for.

In Victoria, the Policy and Planning Guidelines for the development of wind energy facilities (Sustainable Energy Authority Victoria, 2003) contain an explicit assumption that for every megawatt hour (MWh) of renewable energy generated, the emission of approximately 1.3 tonnes of CO_2 would be displaced. This is derived directly from the electricity pool coefficient, which is essentially the average of the greenhouse emissions per unit of electricity generated from the mix of generators contributing to Victoria's electricity supply. In Victoria, such an average is overwhelmingly influenced by the coefficient factor (the emissions per unit energy produced) of brown coal, our most polluting energy source.

The use of the electricity pool coefficient in this context is highly problematic. The greenhouse gas abatement impact of wind power depends on *which* other energy sources in the NEM are displaced when wind farms come online, not on any market-wide average. Due to the intermittent nature of wind farm energy creation, it is likely that additional wind farm inputs to the system will tend to displace the most flexible generators in the grid first, notably hydro and fast-start gas generators (see modelling results below). As these, on average, tend to produce less tonnes of CO_2 per MWh produced than the market average (a market dominated by brown coal), the greenhouse gas abatement due to the addition of wind energy to the power grid will tend to be lower.

The complexity of the role of wind energy in the Victorian market does not end there. Even when coal-fired power stations are displaced as the power source, as additional wind turbines come onto the market, a market wide average abatement calculation is still likely to overstate the savings. This is because it is likely that the generators will reduce their output rather than shut down, and may have to run in a standby mode at less than maximum efficiency (to accommodate for the times when wind energy is not available). This will tend to further reduce any savings in greenhouse gas emissions attributable to the input of wind power as well as reducing the efficiency of coal-fired generation.

Rather than use the electricity pool coefficient from the Victorian Government's Policy and Planning Guidelines, there have been several more sophisticated attempts to estimate the effect that a marginal MWh of wind energy will have on greenhouse gas emissions from the NEM as a whole. These lead to far lower greenhouse gas abatement savings per MWh than the 1.3 tonnes of the Policy and Planning Guidelines. For example:

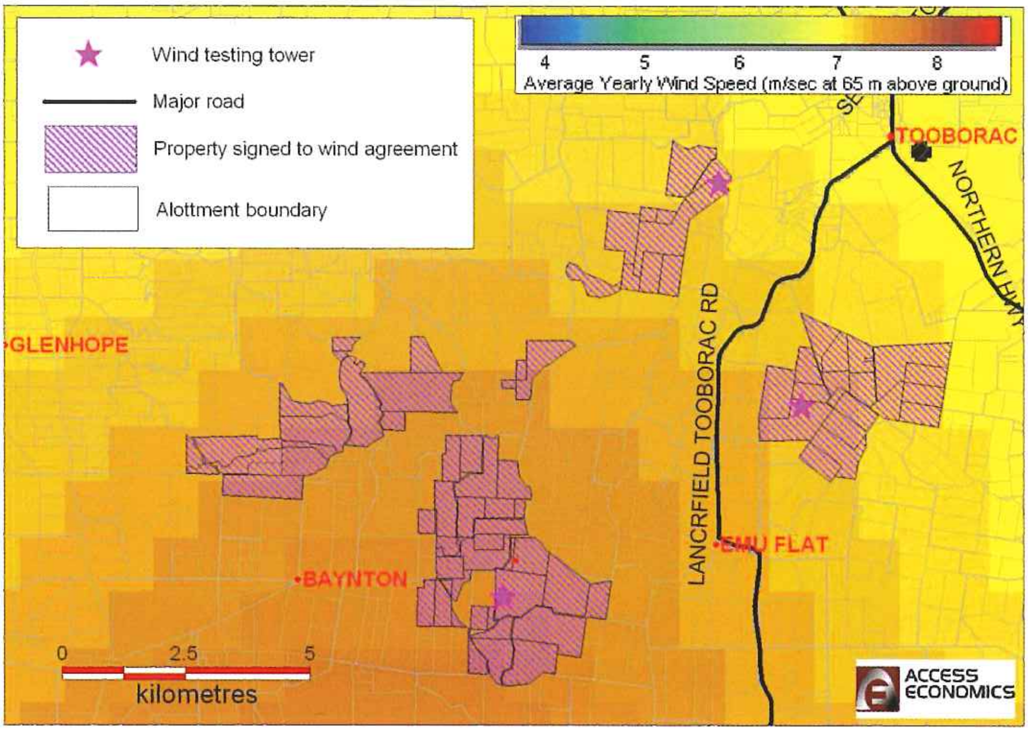
- The South Australian Wind Power Study (ESIPC 2003, using a PLEXOS simulation model of the national grid) found that, for each MWh of wind generation in South Australia produced, national CO_2 emissions were reduced by 0.49 to 0.52 tonnes.
- ESB National Grid (2004), the independent Transmission System Operator of Ireland, used an analytic program combined with an hourly Monte Carlo generation to find that the reduction in CO_2 emissions varied from 0.33 to 0.59 tonnes per MWh of wind power generated, depending on the level of wind generation in the system.
- A study for the Victorian Government by McLennan Magasanik Associates (MMA, 2008) found that the greenhouse gas abatement effect varied from 0.88 to 1.01 tonnes per MWh. The study noted that its findings regarding displacement of coal-fired generators needed to be viewed 'with caution'. The study found that the most significant component of greenhouse gas reduction was due to reduced imports of black-coal generated power from NSW, and associated transmission losses.

7.1.2 ESTIMATING THE WIND RESOURCES OF THE MCHARG RANGES REGION

To estimate the effect of a 200MW wind farm in the McHarg Ranges, it is first necessary to estimate the magnitude and variability of the wind resource available. In the course of this project the actual wind speed data from the three wind testing facilities currently located in the region was sought from the developer, Transfield. These attempts were unsuccessful. Understandably, the data is commercially sensitive, or the results are not yet complete.

As an alternative, wind data from the Victoria Wind Atlas has been combined with variability data from the Bureau of Meteorology to arrive at our own estimates. To estimate wind speed, we have used data from the Victorian wind atlas as a map overlay to the area (see Figure 7-2 below). Based on the modelling assumptions and methodology behind the Wind Atlas (the most significant of which is that wind speed is modelled to a 3km grid, meaning smaller hills and valleys are not captured), the average wind speed in the areas of the three testing sites is between 7.1 and 7.4 metres per second. According to the wind atlas, the site of the proposed wind farms, including the three existing wind testing towers, is five to ten kilometres to the north of the strongest winds in the region.

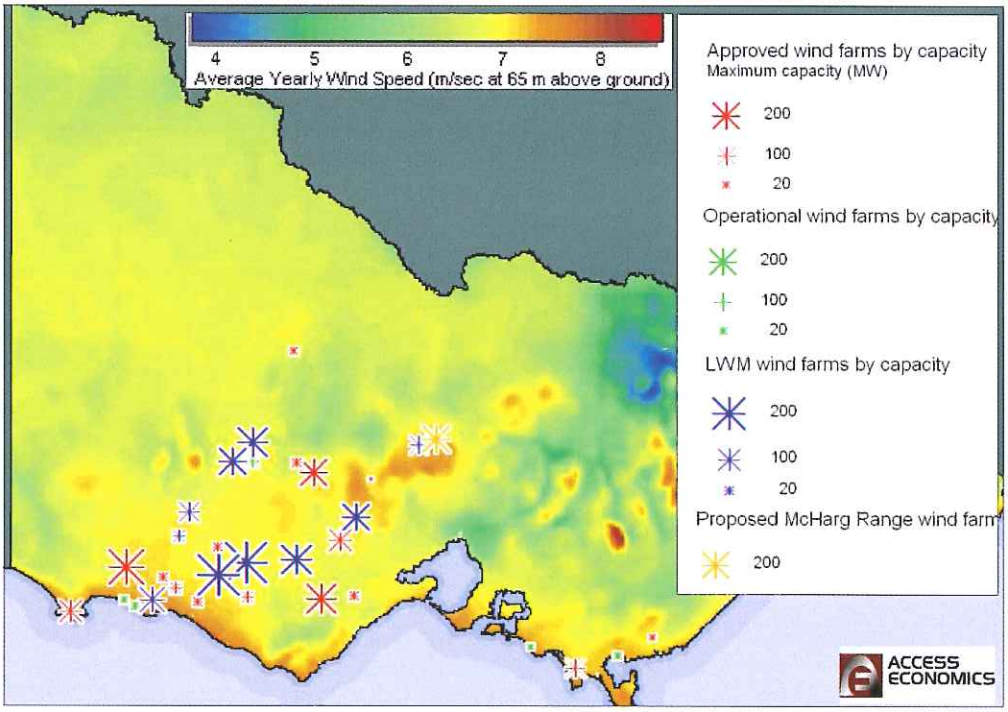
FIGURE 7-2: AVERAGE WIND SPEED AND WIND VARIABILITY IN THE MCHARG RANGES



Source: Access Economics based on the Victorian Wind Atlas

By comparison, the wind speed in the area is above the Victorian state-wide average of 6.5 metres per second, but slightly less than that for most other areas where wind farms have been located and about to be located within the State of 7.4 metres per second. This latter figure is Access Economics' calculation using the wind atlas data overlaid with the known location of Victoria's five existing facilities, and the 17 (at the time of writing) that have been approved but are not yet operational.

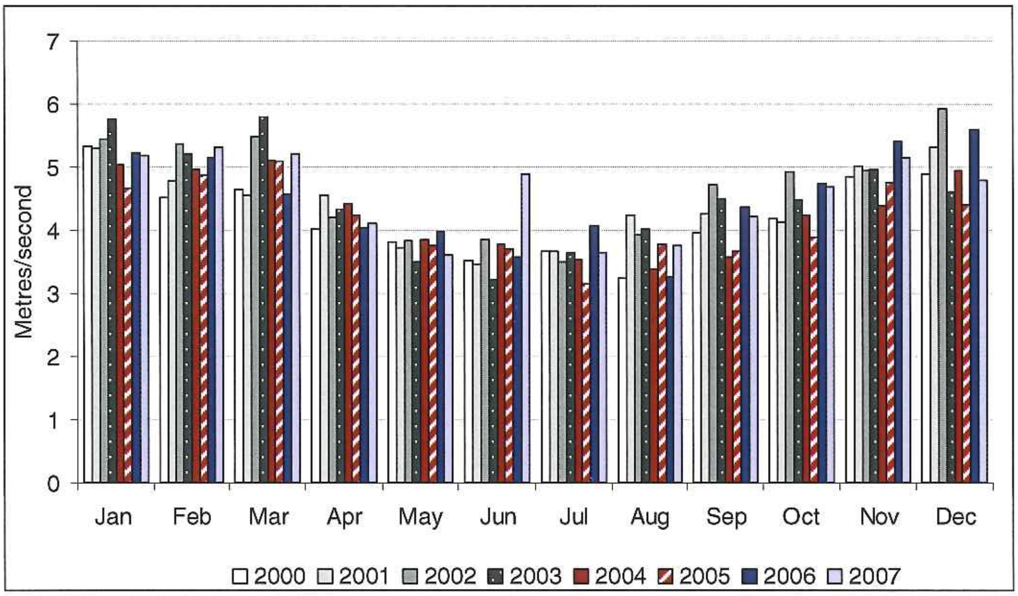
FIGURE 7-3: AVERAGE WIND SPEED ACROSS VICTORIA



Source: Access Economics based on Victorian Wind Atlas

The energy generation capacity and the CO_2 abatement potential of any facility is not just a function of the average wind speed - the wind *variability* is also important. To understand the likely variability of wind in the McHarg Ranges, detailed hourly wind data was sourced from the nearest Bureau of Meteorology weather station; that of Redesdale, approximately 20 km to the west of Tooborac (it is identified in Figure 7-4). The data we sourced covered eight years, however the overall pattern was relatively stable across years (Figure 7-4).

FIGURE 7-4: AVERAGE MONTHLY WIND SPEED, REDESDALE WEATHER STATION, 2000 TO 2007

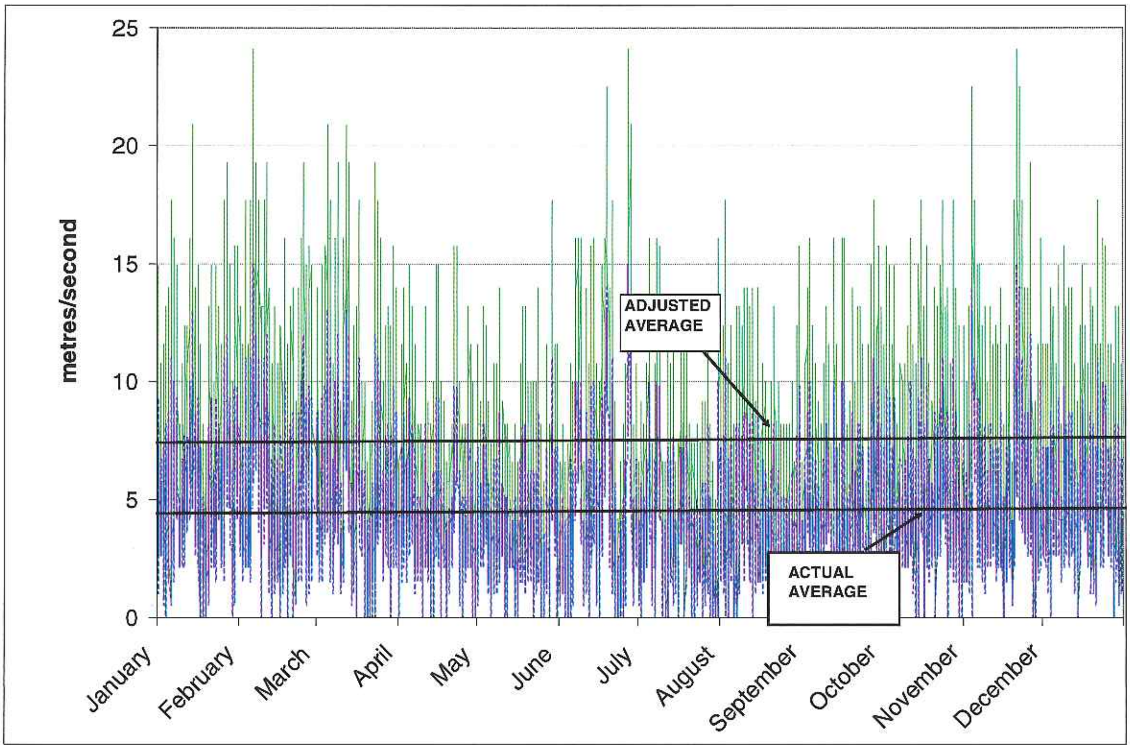


Source: Access Economics based on BOM data

The Redesdale weather station sits at 290 metres elevation in a more protected location, compared to the 400 to 500 metres of the McHarg Ranges. Consequently it has a lower average wind speed (4.5 meters per second (m/s) in 2007, for example). However, a reasonable assumption is that, though the peaks may be lower, the pattern of wind speed variability will be similar at Redesdale to that which is found on the McHarg Ranges. To reflect the higher wind speed in the McHarg Ranges, we have applied a consistent multiplier to the Redesdale data to yield an average wind speed across the year of 7.4 m/s. This effectively retains the variability of the Redesdale data, but yields an average wind speed of 7.4 metres per second equivalent to the McHarg Ranges.

The Redesdale data inflated in this way yields the yearly pattern shown in Figure 7-5, below. The blue line depicts the actual wind pattern at the Redesdale weather station, based on hourly observations, while the green line shows the Redesdale data factored up by a constant multiplier to achieve an average wind speed of 7.4 m/s.

FIGURE 7-5: ACTUAL AND ADJUSTED WIND VARIABILITY, REDESDALE WEATHER STATION



Source: Access Economics based on BOM data

Given this wind pattern, the actual hourly MW yield achieved through a 200MW wind power station in the area is calculated. Absent a greater level of detail about the project specifications, it is not possible to model the precise capacity factor implied by this wind profile. Instead, a range of capacity factors is modelled - from 20% to 35% - encompassing the likely actual capacity factor of the McHarg Ranges project.

This profile of useable power (hourly observations over a 12-month period) has then been modelled using our in-house energy market dispatch model (see Box 7-1 below) taking into account potential for the intermittent wind capacity to displace base load brown coal generation, hydro and peaking gas capacity with the current generation mix in Victoria. Results of the modelling indicated that in 2007, the introduction of this profile of wind energy to the Victorian grid would result in the displacement of 42% coal, 51% gas, and 6% hydro.

As such, reflecting the carbon-intensity of these energy sources, modelling undertaken by Access Economics suggests that the upper bound of the abatement achieved by wind generation would fall in the range 0.85-0.90 tCO2e/MWh for a 200 MW wind farm in the McHarg Ranges - significantly lower than the 1.3 tonnes adopted in the Policy and Planning Guidelines.

The tight range around the abatement factor suggests the modelling is not particularly sensitive to the assumed capacity factor. That is, given a capacity factor range of 20-35%, the abatement factor varies only from 0.85-0.90 tCO2e/MWh. Other factors, such as the pattern and the time of day the wind energy is generated, are evidently more important to the outcome.

This result is considered an upper limit as it is expected that as a series of proposed combined cycle gas plants come into production in Victoria over the next decade, this figure would fall. The lower emissions-intensity of these energy sources suggests that the abatement achieved over time through the introduction of wind energy to the grid would fall significantly – to the point where within 10 years, the vast majority of power displaced is that generated by gas. In addition, taking into account imports of electricity from NSW (predominantly black coal), Tasmania (hydro) and South Australia (predominantly gas) (which has not been undertaken here), further reinforces this result as an upper bound. It should also be noted that this analysis does not take into account any loss of efficiency that occurs when other generators have to reduce their output rather than shut down. This will further tend to reduce any savings in greenhouse gas emissions attributable to the input of wind power.

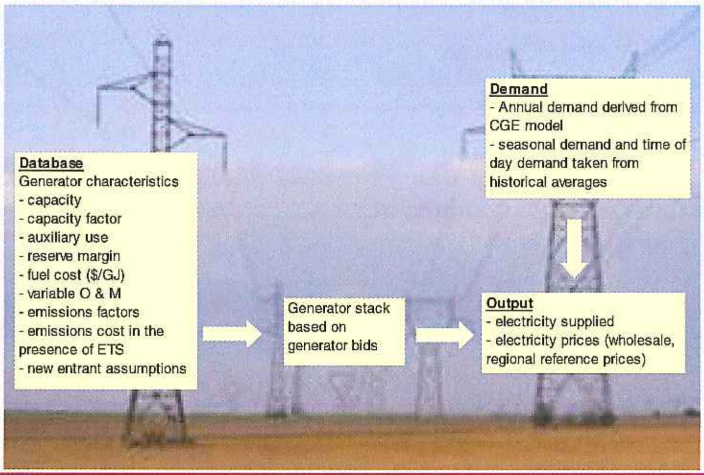
Countering some of this however, is the possibility, in theory at least, that sufficient wind energy comes online across enough geographical diversity to delay, or displace altogether, the construction of an additional coal-fired power plant. That is, over time, the development of a sufficiently large and sufficiently reliable wind energy sector in the State may produce benefits greater than the incremental changes modelled, through preventing the need for additional emissions-intensive generation capacity. Of course, this depends on a wide enough geographical spread of wind farms serving the one energy market, and it is highly debatable the extent to which this is possible in the context of the Australian NEM. Such spread is not likely to be possible for a lot of the time in a small State such as Victoria, where dominant high or low pressure systems will sometimes affect the whole state at the same time, and where microclimatic wind events caused by local area affects, such as a sea breeze by a coastal location, tend to occur at similar times of the day. The increasing potential of interstate trade may go some way to enhancing the geographical spread of connected wind farms over time, though, at best, this may only reduce the need for base load backup to wind power, rather than eliminate the need altogether.

Box 7-1: Access Economics' electricity dispatch model

To undertake the detailed electricity sector analysis required to capture the impacts of wind energy on the national electricity market, an electricity market dispatch model was used. The model builds on a database of information relating to electricity generation performance and input characteristics, such as fuel costs and variable operation and maintenance costs, and additions to and withdrawals from capacity. As shown in Figure A below, the model is comprised of:

- A generator database, including assumptions about new entrants;
- A ranking and dispatch mechanism;
- Periodic (seasonal and time of day) electricity demand compilation and reconciliation with dispatch; and
- Output (wholesale average prices and dispatch by generator).

FIGURE A: SUMMARY OF ACCESS ECONOMICS ELECTRICITY DISPATCH MODEL



The dispatch model calculates generator bids, based on each generator's short run marginal cost and then ranks these bids in a merit order for dispatch from least costly to most costly. The resultant stack of generator capacity is then reconciled with periodic demand, with the regional reference price being the bid of the last generator dispatched to meet demand. Peak load, seasonal and time of day demand patterns are derived from the NEMMCO *Statement of Opportunities.*^

The model database contains assumptions about potential new entrant generators, including renewables. The new entry prices for a range of technologies are calculated using a levelised pricing model that estimates the levelised price (over the lifetime of the new entrant) required for the new entrant to recover its costs, including emissions costs in the presence of any policy change. The scheduling of new entrants in the future is based on the respective new entrant levelised price relative to the projected wholesale regional pool price at the time. Through this analysis, the impacts of a policy on the relative cost competitiveness of prospective new entrants can be quantified. This model has been used to estimate the impacts of a carbon price on the value of Queensland Government-owned power generation assets, impacts of energy efficiency programs in New South Wales, and modeling of the power generation assets in Victoria partly owned by the MTAA superannuation fund.

^ National Electricity Market Management Corporation (2007) "Statement of Opportunities 2007"

7.2 LOCAL AREA IMPACTS

Local area effects fall into two broad categories: those experienced by the decision makers (in this case Transfield and the landholder signing the lease agreement), and those experienced by others in the community.

As with any cost benefit analysis (as distinct from a pure financial analysis), the focus is not purely on impacts that are internal to the market transaction – the lease arrangement between the wind farm developer (Transfield) and the local farmer, and the consequential costs and benefits to both parties. Costs to Transfield include the lease payment to the farmer and capital and maintenance expenses, while costs to the farmer include loss of agricultural land and potential decommissioning costs at the end of the generator's life. Benefits to Transfield include income from the wind power (including a large component that we would consider a subsidy from the people of Victoria), while benefits to the farmer include upfront and lease payments and income stream certainty.

These impacts are not the focus of this study as there is little merit in analysing whether the costs outweigh the benefits to the two parties involved. As long as the transaction is voluntary, the benefits must be assumed to outweigh the costs from the mutual perspectives of the two parties, otherwise the parties would not have freely entered the transaction.

However, it is not just the financial costs and benefits to the wind farm operators and the landholders that are important here. For reasons previously discussed, the Government has an interest, for it is their subsidies and mandatory renewable energy targets, ultimately paid by taxpayers and power users, that makes such wind farms financially viable. Additionally, there is another larger group who is impacted, but because they are not part of the economic transaction which takes place, the costs and benefits that they experience are not directly considered in normal market transactions. In economic terms, these are known as third party impacts or externalities; externalities because they are external to decision makers and outside of a normal market transaction.

In particular, wind farms in some situations can often illustrate an example of where the benefits of a project are few and easily measured, but the costs are dispersed and more difficult to measure.

Desktop research and local consultation revealed a raft of potential local area impacts associated with a wind farm in McHarg Ranges. While these impacts are discussed qualitatively in the subsections that follow, in the end we focus on the impacts on land value, as this is the most objectively quantifiable measure and it tends to capture many of the other impacts. Due to the lack of site-specific information on the project at this 'pre-feasibility' stage, the local area impacts are discussed in terms of likely impacts, rather than through a definitive quantitative assessment. Where local experience or overseas literature can be drawn on to sufficiently rigorously quantify the impacts, this has been done. In other instances, the analysis is purely qualitative.

7.2.1 Revenue to landholders

Wind farms have the potential to inject resources into the local economies where they are hosted, through the rental returns accruing to farmers who lease their land to developers. To the extent that the local landholder gains, there is likely to be some level of flow-on benefits to the local community.

Agreements between developers and landholders generally involve the landholder receiving a revenue stream either through an annual per-turbine payment, or through a share of the energy generated by the turbine.

While such information is protected by commercial sensitivities and hence not readily accessible for a project of this nature, anecdotal reports suggest farmers have been paid between $4,000 and $8,000 per turbine per year. For a project of 100 turbines therefore, $400,000 to $800,000 annually could potentially be injected into the region. Of course the *real* value of this over time will depend on indexing provisions in the lease agreement.

Not all of this income is a net benefit to the landholder. Although small, there may be a loss of agricultural productivity on and surrounding the area where the turbines are located. There will also be a loss of land use options (for example, trees around turbines or under power lines will not be an option). As discussed above, depending on the nature of the contract, the landholder may eventually have to meet any decommissioning costs of the turbine, potentially significantly undermining the return generated.

Nonetheless, and for the reasons discussed earlier, we can safely assume that, from the landholder's perspective, provided their decision was a sufficiently informed one, there is a net gain. Otherwise they would not have voluntarily entered into the transaction.

7.2.2 ATMOSPHERIC IMPACTS

Atmospheric impacts encompass the effects of noise and vibration associated with turbine operation. While low-frequency noise was a significant concern with early turbine models adopted in Australia, technological advancements have meant wind turbines are now considerably quieter than in the past (Stewart, 2006). The main source of noise from wind turbines is the sound of the blades rotating – so called 'aerodynamic noise'. As wind passes over the blades, it creates fluctuations in air pressure that are detectable by the human ear. Other sources of noise can include the generator and the gearbox – so called 'mechanical noise'.

Robustly quantifying the noise impacts of the McHarg Ranges proposal is hampered by the fact that no formal plans of the turbine locations have been released by developer. Indeed it may be the case that formal plans are yet to be finalised. Absent knowledge of precise location of each turbine, it is not possible to model the number of residents likely to be affected and the likely magnitude of these effects (i.e how close to the turbines they will actually be).

Anecdotally there have been reports of significant adverse impacts from the noise associated with wind turbines (loss of sleep, deterioration of health), and some formal noise level studies have supported this. Phipps (2007), for example, presents evidence of the detrimental impacts of low-frequency noise on health and wellbeing, citing a range of studies from the international literature that highlight the potential adverse impacts of low-frequency noise.

The UK Sustainable Development Commission (2005), estimate the indicative noise level of a ten-turbine wind farm at 350m as being within the estimated range of rural night-time background noise (Table 7-1). While noise levels increase with increasing wind speed, as the background noise also increases, it is difficult to detect any increase in turbine sound above the increase in normal background noise levels caused by the wind (SDC, 2005).

TABLE 7-1: INDICATIVE NOISE LEVELS FROM COMMON SOURCES AND ACTIVITIES

Source/Activity	Indicative noise level (db[A])^
Threshold of hearing	0
Rural night-time background	20-50
Quiet bedroom	35
Wind farm (10 turbines) at 350m	35-45
Busy road at 5km	35-45
Car travelling 65km/h at 100m	55
Busy general office	60
Conversation	60
Truck travelling 50 km/h at 100m	65
City traffic	90
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

Source: AusWEA, SDC (2005)

^The [A] represents a weighting of the measured sound to mimic that discernable by the human ear.

While there is an element of subjectivity to the impacts of noise, provided appropriate guidelines are followed regarding sufficient buffers between turbines and residencies, the aggregate costs associated with noise impacts do not appear to be substantial, though for those directly impacted, they are potentially more significant.

7.2.3 VISUAL AMENITY

Because wind energy facilities are sited to take advantage of the available wind resource, as a general rule, they tend to be located in areas exposed most to prevailing winds. As discussed by the Australian Wind Energy Association and Australian Council of National Trusts (2004) this typically means coastal, open, elevated and/or elevated locations. Existing and approved wind facilities in Victoria to date (as illustrated in Figure 7-3) highlight this in a Victorian context, where facilities have been developed or approved either near the coast, in open inland areas, or on ridgelines. As well as being areas of high wind, they also tend to be highly visible and/or prominent locations, with high aesthetic values. The natural environment of the McHarg Ranges, in particular the dramatic topography and granite outcrops discussed in Section 3, is no exception.

Attempts have been made to objectively quantify the amenity value of different areas. For example, scales have been developed where attributes such as proximity to a coastline, a forest, a watercourse, a wetland, a natural area, or an area of topographical variation are quantified. The Australian Wind Energy Association and Australian Council of National Trusts (2004) identify some examples of criteria for significance used in existing studies. These include:

- scenic quality (either professionally determined, or though community perceptions studies, or both);
- scarcity (the relative uniqueness of a landscape type or feature);

- visitation/recognition (the level to which people are drawn to a landscape, and broadly the catchment from which they are drawn);
- visibility (the number of people who view a landscape, and from where they view it); and
- occurrence in the arts (including the documentation of landscapes in visual or written artwork, the level of recognition of the artwork, and length of association of an artist with a place).

Given that wind farms tend to be located in areas of high scenic values, there is a polarisation of opinions over the extent to which they detract from those values. According to overseas studies, based on earlier and less efficient types of wind turbines that required large clusters of turbines, the number of turbines was found to have a bigger impact on landscape values than their size (Ibid, 2004). The visual amenity issue, as it relates specifically to the McHarg Ranges is explored further in Section 7.3 in the context of land values.

7.2.4 IMPACTS ON LOCAL INFRASTRUCTURE

Consultation with local residents in the Tooborac area – in particular, former Local Government members – raised concerns regarding the impact of the potential wind farm on local infrastructure. It was pointed out that many of the local roads and bridges in the region were considerably outdated and would be put under significant pressure by a industrial construction vehicles which would frequent the region throughout the project's development.

While it is likely that the developer would make a financial contribution towards the cost of local infrastructure maintenance and upgrades, the possibility of under-provision means that Local Government – ultimately local residents – may bear additional costs as a result of the development. While this would be something to be negotiated in the course of the development's approval process, it is a possible additional cost on local residents that should be taken into account.

7.2.5 BIODIVERSITY – LOCAL BIRD SPECIES

Operating wind turbines have the potential to harm or kill birds that inadvertently fly through their rotors. While in general, the risks appear low – for example the rate of bird mortality at the Codrington, Woolnorth and King Island wind farms has been reported to range between 0.23 and 2.7 birds per turbine per year (AusWEA) – the risks may be higher where turbines are located in regular flight paths or adjacent to major food resources.

The presence of a significant or sensitive species is also a consideration in biodiversity analysis, with risks to endangered or threatened species carrying significant weight. The Bald Hills wind farm in Gippsland for example, was almost blocked by the Federal Government when it was discovered that the development may interfere with the environment of the endangered Orange-bellied Parrot.

In the McHarg Ranges, concerns have been raised about the potential impacts of a wind farm development on the Swift Parrot and the Wedge Tailed Eagle. The endangered Swift Parrot breeds in Tasmania and spends winter predominantly in the Box-Iron Bark Forests of the Heathcote, Bendigo and Castlemaine area, potentially passing over the proposed wind farm development in the process (McHarg Ranges Landscape Guardians, 2006). There have been regular sightings of the species in the McHarg Ranges. The McHarg Ranges are also a noted breeding ground for the Wedge Tailed Eagle, also an endangered species. Given overseas observations that larger birds of prey are among those species which appear more prone to fatal collisions, there may be some concern to Wedge Tailed Eagles in the region. This, of course, should become the subject an EES if the project proceeds, and hence detailed analysis is beyond the scope of this report.

7.2.6 WILDFIRE

Wind turbines can potentially increase the risk of wildfire through both mechanical failure and increased risk of lightning strike, and impede fire-fighting capability, particularly aerially.

Assessing the risks

The risk of fire associated with mechanical failure in modern wind turbines is low (MacIntosh and Downie, 2006). Though the combination of electricity and oil is perceived as something of a recipe for disaster, modern technology has largely ameliorated any concomitant risks. Similarly, although lightning strike was initially a concern with early turbine models, lightning strike protection devices have substantially reduced the risks.

Indeed, evidence in Australia indicates few instances of fire due to wind turbines. A survey by the Australia Institute of 40 of Australia's 41 wind farm operators in 2006, reported only two fires – one at Ten Mile Lagoon in Western Australian in the mid-1990's and one at Lake Bonney in South Australia in 2006 – neither of which spread beyond the relevant turbine (Macintosh and Downie, 2006).

Fire risk mitigation

In accordance with the *Electricity Safety Act*, wind farm operators must develop a Bushfire Mitigation Plan (BMP) for approval by Energy Safe Victoria. The BMP must take account of factors such as location (i.e. bushland vs grassland), accessibility, water supply, fuel/vegetation management, infrastructure and consultation (principally, with local fire authorities). Through appropriately regulated development, the risk of wildfire from air turbine fire could be significantly mitigated.

While the nature of the terrain in the McHarg Ranges would pose challenges to fire fighting, provided sufficiently robust access tracks were constructed as part of the plant maintenance infrastructure, fire-fighting ability need not be overly impeded, and may potentially be enhanced. Concerns were also raised by local authorities that wind turbines in the region may hamper aerial fire fighting efforts. In this regard, the Country Fire Authority, in their *Emergency Management Guidelines for Wind Farms*[14] notes that:

> *Fire suppression aircraft operate under "Visual Flight Rules". As such, fire suppression aircraft only operate in areas where there is no smoke and during daylight hours. The standard distance of 300 metres between wind turbines would allow aircraft to operate around a wind farm given the appropriate weather and terrain conditions.*
>
> *Wind turbines, similar to high voltage transmission lines, are part of the landscape and would be considered in the incident action plan.*

[14] Emergency Management Guidelines for Wind Farms, *Version 3; April 2007,* Country Fire Authority

Fire risks in the McHarg Ranges region

The McHarg Ranges region, while not dense bushland, is prone to wildfire due to its low, infrequent summer rainfall (the average annual rainfall is approximately 700 mm) and strong winds (ironically, the very thing that attracts the development). Fire risk is also increased by the fact that widespread granite on and around the McHarg Ranges attracts lightning strikes, which have been a common source of fire in the past. Much of the region is in fact subject to wildfire overlay from the Mitchell Planning scheme, indicating the level of wildfire risk.

Though the risks of wildfire should not be understated, provided the development is appropriately regulated to mitigate the risk of fire and provision for precautionary fire-fighting services, the risk of wildfire would not appear significantly increased.

7.2.7 SALINITY AND EROSION

Being part of the Great Dividing Range, the McHarg Ranges sit on the southern edge of the Murray-Darling Basin. The ranges comprise part of the catchment of the Wild Duck Creek, Lake Eppalock and, eventually the Campaspe and Murray Rivers. The Ranges are a recharge area, where surface water infiltrates to the groundwater table. In discharge areas further down the catchment the watertable comes to, or close to, the surface, often bearing the salt that causes dryland salinity problems. Vegetation, in particular trees, in recharge areas such as the McHarg Ranges are important as they draw moisture out of the soil profile, reducing infiltration to the groundwater table. The Mitchell Planning Scheme has a salinity overlay on much of the area, including many of the properties that are understood to be signatories to the wind farm agreements. Significant grants have already been made to landholders to plant out recharge areas.

The specific concern of this wind farm proposal is not one of wind farm construction requiring the clearing of existing vegetation. Rather, it is the inability to revegetate the recharge areas in the vicinity of the wind turbines in the future as a salinity control option. In the context of the entire recharge areas feeding the downstream discharge areas, the land areas affected by the wind turbines and the extent that landholders would actually revegetate those areas in the future if the wind farm does not go ahead is small. This suggests that the salinity risk, although present, in not likely to be a significant cost to the project.

The issue of erosion – a concern raised by several residents throughout local consultation – and consequential impacts on water quality further down in the catchment, is an important issue in the McHarg Ranges. Due to the unstable granite soils, almost the entire region is under an erosion overlay in the Mitchell Planning Scheme, particularly the ridge top areas likely to be sites for the wind farm development. The specific erosion concern regarding the wind farm relates to two possible hazards:

- The construction phase requiring new roads and earthmoving, greatly increases the susceptibility of the landscape to erosion unless preventative measures are adequately employed.
- The loss of the revegetation option, as discussed previously in relation to salinity. Revegetation of unstable soils, through either trees or perennial pastures, is one of the most cost-effective soil stabilisation techniques available.

To the extent that erosion occurs on or around the site of the turbines, some of the cost is ultimately met by the landholder as either preventative expenditure or loss of productivity. Only when the eroded material is carried into the local watercourses and further down into the creeks and rivers of the region, increasing turbidity or resulting in stream deposition, does the cost become a true externality, either to other water users or as an environmental cost.

7.2.8 IMPACT ON SOCIAL COHESION

Wind farms, like many forms of industrial development, tend to evoke a polarisation of views and opinions within affected communities. While landholders' decisions to lease their land to developers is a private market transaction, the potential for considerable external impacts on other local residents means that communities can become highly divided by such developments. Such considerations are acknowledged by both industry and government as important considerations in the planning process (see discussion above). Some communities have been relatively welcoming of wind farms, however in other areas there is anecdotal evidence of landholders who lease their farms to developers being isolated from the local community. Given the significance of social cohesion to communities in rural areas, the ability for wind farms to create social division, while inherently difficult to quantify, is nonetheless an important consideration in the broader socio-economic analysis.

7.3 IMPACT ON LAND VALUES

The variable of land value impacts tends to capture many of the other impacts previously discussed. Put simply, land values tend to encompass people's perceptions of many of those previously discussed issues, and others, into the one unit – willingness to pay for land.

A review of the literature on the impact of wind farms on land values reveals no consistent conclusions. Some (e.g. Sterzinger, Beck, Kostiuk, 2003) argue that a wind farm has no impact and can, in some circumstances, enhance property values. This conclusion is based on an active wind farm in the area opening up another source of (non-agricultural) revenue to the farmer, creating an additional income stream from the land. Other studies (e.g. Inspiring Place Pty Ltd, 2002; Bunyan and Beckford, 2008) claim that wind farms do indeed have a detrimental impact.

The methodology and local area data used to support these conclusions across the various areas is unable to be verified, however one conclusion from the international and Australian evidence is clear: there is no universally agreed and applicable relationship between proximity to wind farms and land values. Critically, what matters is the specific characteristics of the region in which the wind farm is being located.

What can be concluded, and what is certainly consistent with land valuation theory, is that in areas where agricultural productivity is the dominant driver of land value, wind farms will have negligible effect. This is understandable, for there is little evidence that wind turbines undermine agricultural productivity and, as discussed, the presence of a wind operator in the region can open up another revenue stream to the land owner and enhance their overall revenue. This is not only beneficial as an additional revenue stream, but also minimises agricultural and seasonal risk to the farmer's income. Any loss of amenity due to the wind farm (such as noise or aesthetic impacts) will have minimal, if any, impact upon land values when amenity is not driving the land value. If the value of the land is tied to its income earning potential, then an additional income earning option is, all other variables remaining the same, likely to enhance property values or at least ensure that any impact is negligible.

However, there is a great deal of anecdotal evidence, often backed with the conclusions of real estate agents, that wind farms in some areas would and do undermine land values. This has been highlighted recently in Victoria, with one estimate placing the decline in land values as high as one third, in the lifestyle coastal areas of Gippsland (Cuming and Skuthorp, 2008). The argument is generally based on the loss of amenity value, rather than any cost to agricultural productivity or revenue earning potential per se. Once again, these studies and their impacts on the local area property markets cannot be verified, however the perception that, in areas where amenity value is driving property prices, wind farms are not a desirable attribute of an area, can be confirmed.

Of course, some will argue against these perceptions, and passionately believe that wind farms do not detract from landscape values or cause local area nuisance issues such as noise pollution. Research by the Australian Wind Energy Association and Australian Council of National Trusts (2004) highlight the diversity of opinions on this. However, the important economic principle here is that, for a wind farm development to impact upon price by reducing demand for the land, not everyone has to share the view that the development is undesirable. Only some do.

This is because a property market, and the eventual price at which a buyer's willingness to pay meets a seller's willingness to sell, reflects the aggregated preferences of *all* potential buyers and sellers. Just because *some* do not feel that wind farms reduce amenity does not mean that the price will not be lower, even if the eventual buyer is one of them. So long as some potential buyers share the concern that a wind farm is not a positive asset to have nearby, the wind farm will be affecting price. Once again, we stress that the validity of people's concerns over issues such as noise, aesthetic impacts and impact of local roads, to the extent that they can be objectively assessed, is not relevant to the market price. These are often subjective opinions that cannot be proven or disproven. Their validity does not matter to the market price; the market responds to peoples' preferences, regardless of whether that preference is logical or rational in the eyes of others.

Hence, the distinction between an area where land value is predominantly driven by agricultural productivity versus one where it is driven more by amenity value becomes an important local area characteristic.

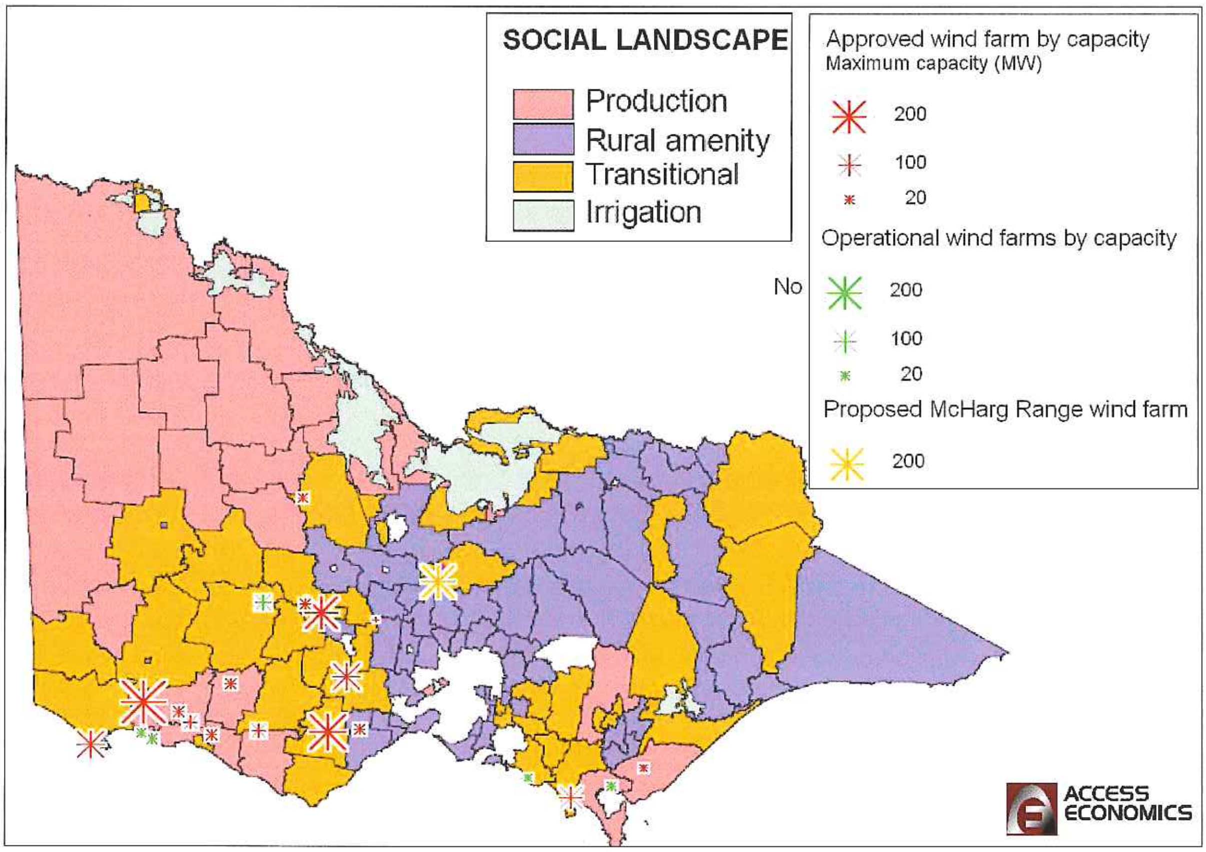
7.3.1 WIND FARMS IN RELATION TO LANDSCAPE ZONES OF VICTORIA

There are various ways to quantify the amenity value of an area. The Victorian Government publication *Understanding Rural Victoria* (Barr, 2005) disaggregates rural Victoria into four distinct zones:

- the agricultural production landscape;
- the rural amenity landscape;
- the rural transitional landscape; and
- the irrigation landscape.

These regions are illustrated in Figure 7-6. Figure 7-6 also shows the location of Victoria's operational wind farms, and those that have been approved but are not yet operational.

FIGURE 7-6: STYLIZED SOCIAL LANDSCAPES OF RURAL VICTORIA WITH WIND FARM OVERLAY



SOURCE: Base map modified from Barr (2005), wind farm data from DPI (2008)

This figure highlights a key difference between a wind farm in the McHarg Ranges and almost all other approved wind farms. With the exception of two small facilities at Winchelsea (28 MW capacity) and at Leonard's Hill (4 MW capacity), all Victorian wind farms are located in either 'production' or 'transitional' landscapes. **However, the site of the McHarg Ranges proposal sits on the edge of a 'rural amenity' zone.**

Barr (2005) define a rural amenity zone as one where demand for land has been driven by amenity rather than production purposes. Such purposes include hobby farms, rural residential properties, weekenders or bush retreats. According to Barr (2005) these areas have a "more secure future ... the diminished capacity to maintain population through natural increase is more than offset by migration from Melbourne". However, they warn that "this bright future depends on protection of the amenity features and landscapes that attract migrants" and that the management of "planning schemes that enhance amenity values will be crucial for the future, lest the migrants it attracts help destroy the very features that draw them".

A further indication of the area's amenity value came recently through a review of the quality of life afforded by each of Australia's Local Government Areas (LGAs) by Bankwest (2008). This review, bringing together indicators comprising of income, employment levels, crime rates, internet access, health, education levels, home ownership, house size, proportion of empty homes and community involvement, found that Macedon Ranges had the highest ranking of all non-metropolitan LGAs in Australia. Of all 590 LGAs in Australia, it was ranked

13th, making it the fifth highest in Victoria and higher than any other LGA outside of the capital cities in Australia.

Of course, the four landscape zones are broad categories, and to explore the extent to which amenity value is driving land values in the McHarg Ranges region compared to agricultural productivity, we have independently calculated the ratio of land values to agricultural productivity around the state, using a variety of measures of 'agricultural productivity'. Firstly, an analysis of the agricultural productivity of the McHarg Ranges region reveals that it is significantly less than the agricultural productivity of the areas where operational wind farms are located (Table 7-2), or areas where wind farms have been approved but are not yet operational. We have quantified three measures of agricultural productivity, explained in the footnote below, and in all cases the McHarg Ranges is less productive than other wind farm (both operational and approved) areas.

TABLE 7-2: AGRICULTURAL PRODUCTIVITY MEASURES, MCHARG RANGES COMPARED WITH OTHER PROPOSED AND OPERATIONAL WIND FARMS[15]

	NPP	YPP	Grazing $ per ha
McHarg Ranges	3.19	4.85	241.20
All Operational	4.41	8.69	969.27
All approved but not operational	4.05	8.30	693.78
Lodged with Minister	3.71	8.44	487.52

Source: Access Economics calculations, using gridded GIS data from CSIRO land and water (Profit Function Surfaces for Five Year Mean and Mean annual and monthly Net Primary Production (tC ha-1) in the "Agric" (present day)and 2005/06 ABARE agricultural census data.

Despite the lower agricultural productivity of the McHarg Ranges region compared to other wind farm locations across the State, the rural land is considerably more expensive, almost double the value on a per hectare basis than regions where other Victorian wind farms have either been located or approved (Table 7-3).

15 Based on SLA level calculations. McHarg Ranges is the weighted average of the 'Macedon Ranges – Kyneton' and the 'Mitchell – North' SLAs.
NPP = Net Primary Productivity, a measure of the biomass growing potential of the area, reflecting soil, climatic and aspect variables.
YPP = Yield of Primary Production at full profit equity. Conceptually, this is a similar concept to the carrying capacity of the land as measures by units such as the dry sheep equivalent (DSE) per hectare for grazing land.
Grazing yield calculations based on data from the 2006 ABARE Agricultural Census.

TABLE 7-3: RURAL LAND VALUE ($ PER HA)[16]

Land Values	All rural land	Land wo buildings*
McHarg Ranges	$15,311.81	$15,470.08
Areas of operational wind farms	$8,287.24	$10,125.35
Areas of approved wind farms	$8,234.87	$9,029.64
Areas of wind farms lodged with minister	$7,284.85	$7,420.17

Source: Access Economics calculations using LGA level data from Land Victoria, 2008, A Guide to property values, Data and analysis from the Valuer-General Victoria using 2007 property sales information for residential, commercial, industrial and rural property, Melbourne.

In terms of quantifying the extent to which amenity value, rather than agricultural productivity, is land value in an area, it is the ratio between land value and agricultural productivity that is most important. No single measure of this is conceptually perfect but, as revealed in Table 7-4, all ratio measures used show the same consistent trend; **that land in the McHarg Ranges is valued well above what it would be valued purely on the basis of agricultural productivity. This is strong evidence of a region of high amenity value, and confirms the findings from the Victorian Government report (Barr, 2005).**

TABLE 7-4: RATIO MEASURES OF LAND VALUE COMPARED TO AGRICULTURAL PRODUCTIVITY

	All rural land value/NPP	Land value wo buildings/YPP
McHarg Ranges	$4,798.86	$3,192.98
Areas of operational wind farms	$1,878.86	$1,164.50
Areas of approved wind farms	$2,035.46	$1,087.44
Areas of wind farms lodged with minister	$1,965.21	$879.32

Source: Access Economics calculations

On a more local area level, the McHarg Ranges region has a consistently higher ratio than all other wind farm regions in Victoria, including areas that are operational, approved or have been lodged before the Minister.

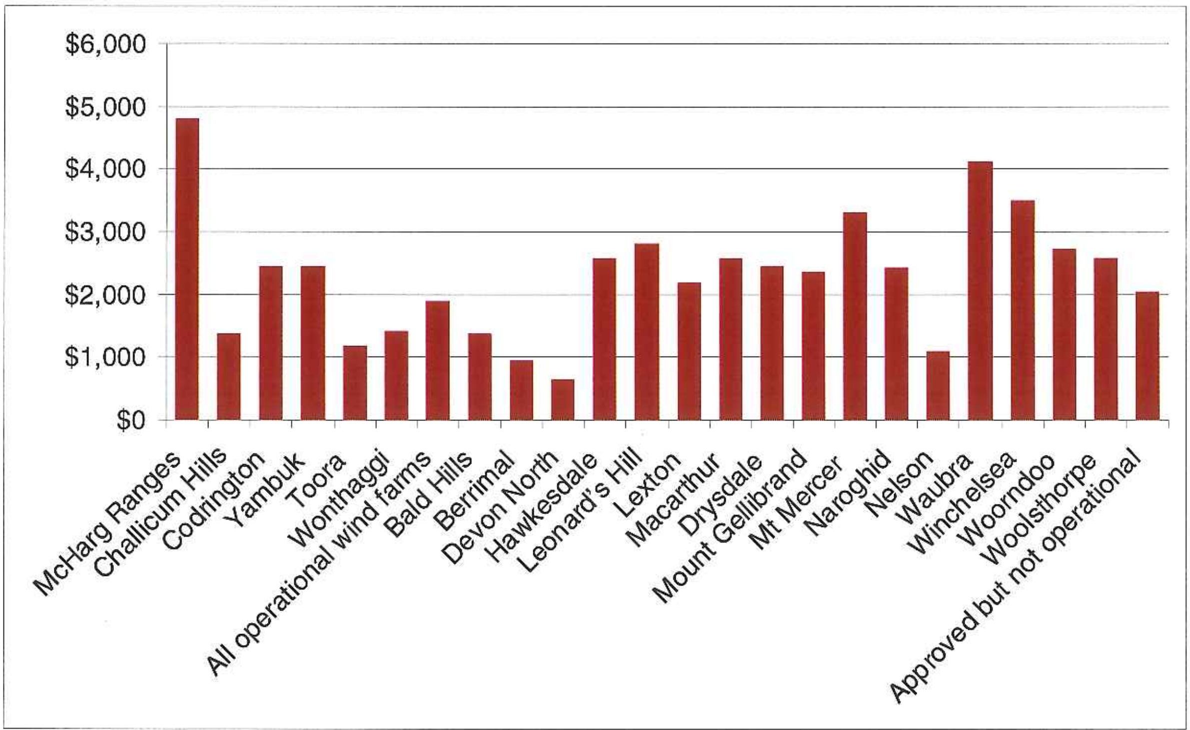
[16] NOTE: "Land wo buildings" refers to those categories of land for which there were no buildings involved, a more pure measure of the underlying unimproved value of the land. These categories are "Farm land (without buildings)" and "hobby farm land (vacant)". Such land may be more expensive, on an average per hectare basis, than other land which may have buildings (or other improvements such as vineyards or orchards), because they will typically be smaller allotments and, even though they may have no building, they may have building permits (or at least be large enough such that a planning permit would be provided).

TABLE 7-5: ALL VICTORIAN WIND FARM RATIOS

	All rural land value/NPP	Land value wo buildings/DSE	Grazing income/DSE
McHarg Ranges	$4,798.9	$3,193.0	$64.1
Challicum Hills	$1,363.0	$484.2	$16.2
Codrington	$2,446.2	$1,353.1	$7.2
Yambuk	$2,446.2	$1,353.1	$7.2
Toora	$1,179.8	$1,145.4	$8.0
Wonthaggi	$1,404.5	$4,173.5	$28.4
All operational wind farms	$1,878.9	$1,164.5	$10.4
Bald Hills	$1,363.5	$1,144.7	$8.6
Berrimal	$946.1	$463.3	$12.0
Devon North	$648.1	$1,089.5	$9.1
Hawkesdale	$2,566.6	$1,114.3	$18.3
Leonard's Hill	$2,806.2	$4,034.1	$49.6
Lexton	$2,180.9	$1,225.9	$38.7
Macarthur	$2,566.6	$1,114.3	$18.3
Drysdale	$2,446.2	$1,353.1	$7.2
Mount Gellibrand	$2,348.8	$909.2	$7.5
Mt Mercer	$3,308.9	$893.5	$23.6
Naroghid	$2,427.7	$751.8	$8.6
Nelson	$1,086.5	$906.7	$9.7
Waubra	$4,104.5	$957.6	$17.0
Winchelsea	$3,487.7	$2,020.3	$24.8
Woorndoo	$2,723.0	$1,327.5	$19.5
Woolsthorpe	$2,566.6	$1,114.3	$18.3
Approved but not operational	$2,035.5	$1,087.4	$13.0
Ararat	$1,363.0	$484.2	$16.2
Berrybank	$2,427.7	$751.8	$8.6
Crowlands	$2,180.9	$1,225.9	$38.7
Darlington	$2,427.7	$751.8	$8.6
Glenthompson	$871.9	$517.3	$15.1
LaL LaL	$2,987.9	$1,328.9	$23.8
Mortlake	$2,723.0	$1,327.5	$19.5
Morton's Lane	$871.9	$517.3	$15.1
Ryan Corner	$2,446.2	$1,353.1	$7.2
Sidonia Hills	$3,492.8	$5,029.9	$86.4
All wind farms lodged with minister	$1,965.2	$879.3	$15.2

Source: Access Economics calculations

FIGURE 7-7: RURAL LAND VALUE/NPP FOR WIND FARM AREAS OF VICTORIA



Source: Access Economics

To appreciate how the specific McHarg Ranges area is different to either the Macedon Ranges – Kyneton or the Mitchell North SLAs[17], examples of recent property sales in the area have been sourced. The average rural land sales (without buildings) within a 5 km area of a signed wind farm property was approximately $11,000 a hectare, similar to the equivalent figure in the Mitchell North SLA but only about half of that of the Macedon Ranges – Kyneton SLA.

However, analysis of the gridded GIS data on net primary productivity reveals that agricultural productivity within the McHarg Ranges itself is lower than that of both the Macedon Ranges – Kyneton and the Mitchell North SLAs. This means the ratio between property prices and agricultural productivity is therefore broadly similar to that calculated for the Macedon Ranges – Kyneton and the Mitchell North SLAs as a whole.

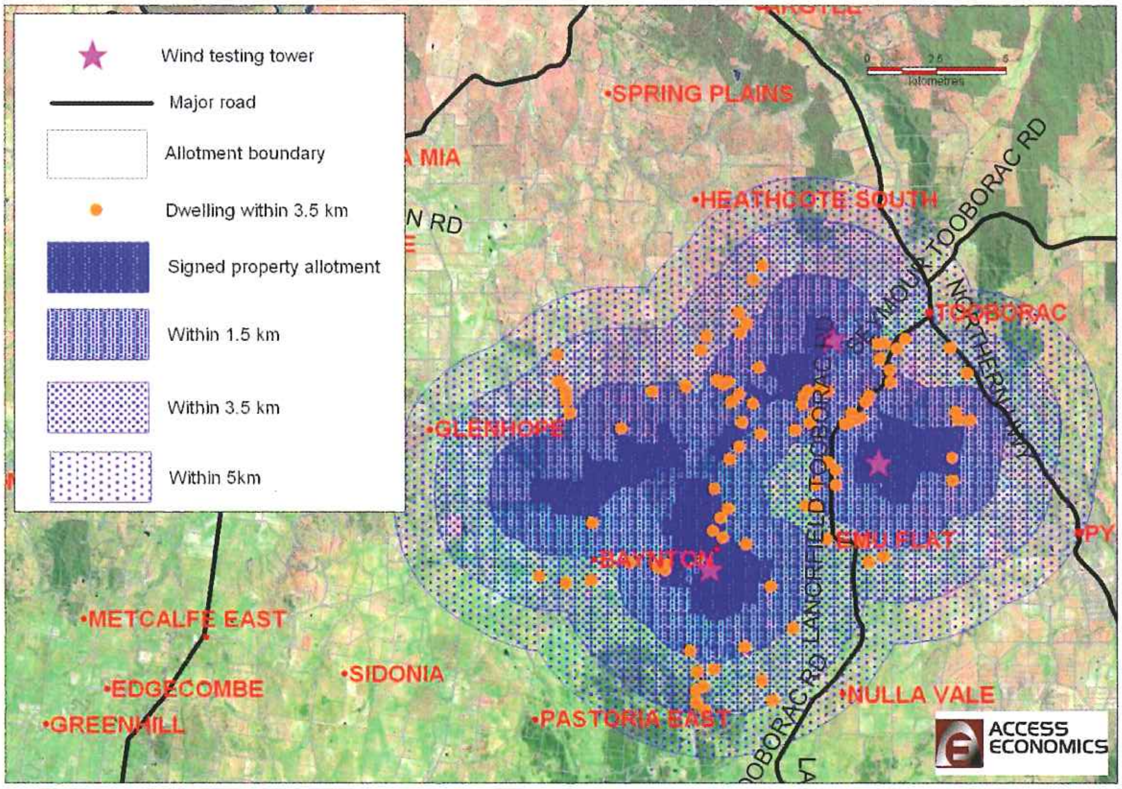
7.3.2 AREA AND PROPERTIES AFFECTED

As discussed, there is a lack of information available on the precise location and nature of the wind farm development and the turbines it will comprise. Nevertheless, some calculations on the areas and dwellings affected are possible based on the location of the properties who are understood to have signed to the wind farm agreements. As identified by Australian Wind Energy Association and Australian Council of National Trusts (2004), the scale of wind turbines and their contrasts to landscape character means that their impacts on scenic

[17] These figures are based on Statistical Local Area calculation. SLAs are not homogenous landscapes. One SLA may encompass a number of landscapes, but this will be hidden by aggregation of data whereby one average for each SLA is presented.

character extend well beyond the site of the turbines themselves. Figure 7-8 illustrates the area likely to be most affected within 1.5 kilometre, 3.5 kilometre and 5 kilometre buffers around the properties that have signed wind agreements.

FIGURE 7-8: AREAS MOST LIKELY TO BE IMPACTED



The collective area of the properties for which wind agreements have been signed comprises 79 individual allotments and a land area of 2,987.8 hectares.

Not including area within the signed properties, within a 1.5 km radius of a signed property, there are:

- 313 individual title allotments
- 46 occupied addresses, mostly dwellings
- 10,276 hectares of land

Within a 3.5 km radius of a signed property there are:

- 887 individual title allotments
- 81 occupied addresses, mostly dwellings
- 22,635 hectares of land

To illustrate how declining property values can undermine the economics of the project as a whole, particularly the cost-effectiveness of the wind farm as a greenhouse abatement option, the following indicative examples are provided. In all cases we assume that land values decline only on land surrounding the signed properties, not on the signed properties themselves. We also assume that the costs of the wind farm do not change with different capacity factor assumptions:

- If land values within 1.5 km of the signed areas (not including the signed areas themselves) were to drop by 10%, the total cost to affected properties is approximately \$15.7 million, increasing the cost of abatement over the project lifetime by \$1.17 per tCO2e assuming a 35%capacity factor for the wind farm, and \$1.37 with a capacity factor of 30%.
- If the land values within 1.5 km were to drop by 10%, areas within 3.5 km by 5%, within 5 km by 3%, and within 10 km by 1.5%, the total cost to affected properties is approximately \$40.5 million, increasing the cost of abatement for the project by \$3.02 per tCO2e assuming a 35% capacity factor for the wind farm, and \$3.52 with a capacity factor of 30%.
- If land values within 10 km, in general, were to drop by 10%, the total cost to affected properties is \$121.2 million, increasing the cost of abatement by approximately \$9.04 per tCO2e assuming a 35% capacity factor, and \$10.53 assuming a capacity factor of 30%.
- If land values within 5 km were to drop by 25%, and areas within 10 km by 10%, the total cost to affected properties is \$196.5 million, increasing the cost of abatement by approximately \$14.65 per tCO2e assuming a 35% capacity factor, and \$17.07 assuming a 30% capacity factor.

An equivalent study into the areas of land affected by nearby non-renewable power plants, such as coal plant, would be less, simply because many hundreds of wind turbines are required to replace the power output of just one fossil-fuel fired facility. In any case, the addition of a 200 MW wind power facility is unlikely to, alone, result in any less fossil fuel powered facility. Indeed, the ability of many wind farms in aggregate to allow for a substitution of a fossil fuel power facility is limited, unless the spread of those wind farms allows for access to broadly different weather systems at any one time.

A fall of 25% in property values is high, and indeed the perception of wind farms as highly destructive features to a landscape must be very widespread and strong for this occur. However, our previous analysis of the ratio of land values to agricultural productivity, as a way of inferring the role of amenity value in driving land values, suggests that a premium of up to 200% is being paid in the McHarg Ranges region. Of course, this premium would also be a function of accessibility (especially to Melbourne) as well as amenity. In effect, the land value premium in the McHarg Ranges is likely due to *accessible* amenity, as distinct from attractive landscapes more distant from the capital cities.

As a guide to the potential role of amenity per se, rather than accessibility, we can look at land values at other inland SLAs an equivalent distance from Melbourne as the McHarg Ranges. Some of these areas, such as Murrundindi, Strathbogie, Golden Plains and Baw Baw have unimproved rural land values of less than half of those of the McHarg Ranges area despite comparable or higher agricultural productivity. If neither agricultural productivity nor accessibility to Melbourne (or a major provincial city) can explain the difference in land values between these areas and the McHarg Ranges, only amenity value is left of the key drivers of rural land values[18].

[18] Quality of local infrastructure and other local area variables can also, of course, influence local area property prices, but these would have to be vastly different in those areas compared to the McHarg Ranges to explain such a large difference in price.

A doubling of land value due to the premium paid for amenity value places an upper bound on the possible land value impacts due to a wind farm, to the extent that wind farms only undermine amenity value of land. This means, for example, a total loss of the amenity value would have the effect of lowering land values by 50%. A loss of half of the amenity value would lead to a 25% decline in land values. Of course, this is a simplistic approach to what are vastly more complex land valuation issues, but it is one way of conceptualising the range of possible land value impacts from a wind farm development.

Although the aggregate land value costs under these scenarios run into the tens of millions of dollars, and over a hundred million under the most severe land value impact scenarios, it is clear that unless some highly speculative assumptions are made regarding land value impacts (themselves an aggregate of many of the local area impacts of wind farm developments), in aggregate the cost of declining land values will be small relative to the generic marginal cost of wind power over non renewables. In other words, the majority of the additional cost of wind power comes through its direct costs of construction, operation and decommissioning (specifically how much more expensive on a per MWh basis than the equivalents costs of non renewable options), rather than externality impacts on neighbouring properties. Specifically, it that the marginal direct cost of wind power over non renewables, the same cost that is met by Victorian power users or taxpayers, that is the major component of the cost. However, distributional issues and the burden of who pays is relevant here; whereas the marginal direct cost of wind power is met through millions of power users, the cost of declining land values on properties surrounding wind farms is met by the relatively few surrounding property owners. From their perspective, the impacts on land values only have to be proportionally very small for the absolute impact on them to be very large. From a policy perceptive, it is debatable whether the burden of paying for what is a genuine public good – greenhouse gas abatement – should fall so disproportionately on so few.

There is no legal precedent for compensation for declining land values as a result of a wind farm development in Victoria. Indeed, private property rights in Victoria do not extend to a right to protection from declining land values because of the activities on adjoining properties. Rather, the reverse is true; private property rights *protect* the right of the landholder to use their land as they see fit, within the existing legal and planning framework.

The Victorian planning process itself does not consider land value impacts. A recent Victoria wind farm panel report (Oakland Hill Wind Farm, Panel Report, 2008) highlights this.

> *Mr Power argued that effects on land values were not something that could be taken into account and drew our attention to the approach taken in previous panel reports. Some of the panel reports which address this matter are the Bald Hills Wind Farm, Waubra Wind Farm, Mt Gellibrand Wind Farm and Mt Mercer Wind Farm Panel Reports. Those reports adopt the view urged by Mr Power that land valuations are not a relevant matter in planning decisions and the Bald Hills report lists a number of legal cases in support of the proposition.*

The legal and planning case for consideration of land value impacts is unambiguous. Certainly from a planning perspective, it is generally the primary *drivers* of any impact on land values that are the focus, such as noise and aesthetic impacts, rather than the land value impacts themselves. To count these other impacts and land value impacts simultaneously would risk double counting the same impact.

However, from an overall economic welfare and public policy perspective, impacts on land values certainly should be considered so long as the broader public interest remains the standard of policy. There is no universally agreed measure of 'the public interest', indeed strict definition of the term has proven elusive for centuries. One widely held 'test' of whether a policy or project is in the public interest or not is found in the concept of the Pareto efficiency or the related Kaldor-Hicks efficiency. In summary, as a widely used criterion for evaluating whether a change is in the public interest, this states that some change is in the public interest if the winners from the change could fully compensate the losers, and still be better off. The question of whether the compensation actually has to take place or not is debatable; what matters most from the public interest is that the compensation is at least hypothetically possible. This underlying concept that the sum of the benefits must outweigh (or be more than) the sum of the costs is also central to cost benefit analysis.

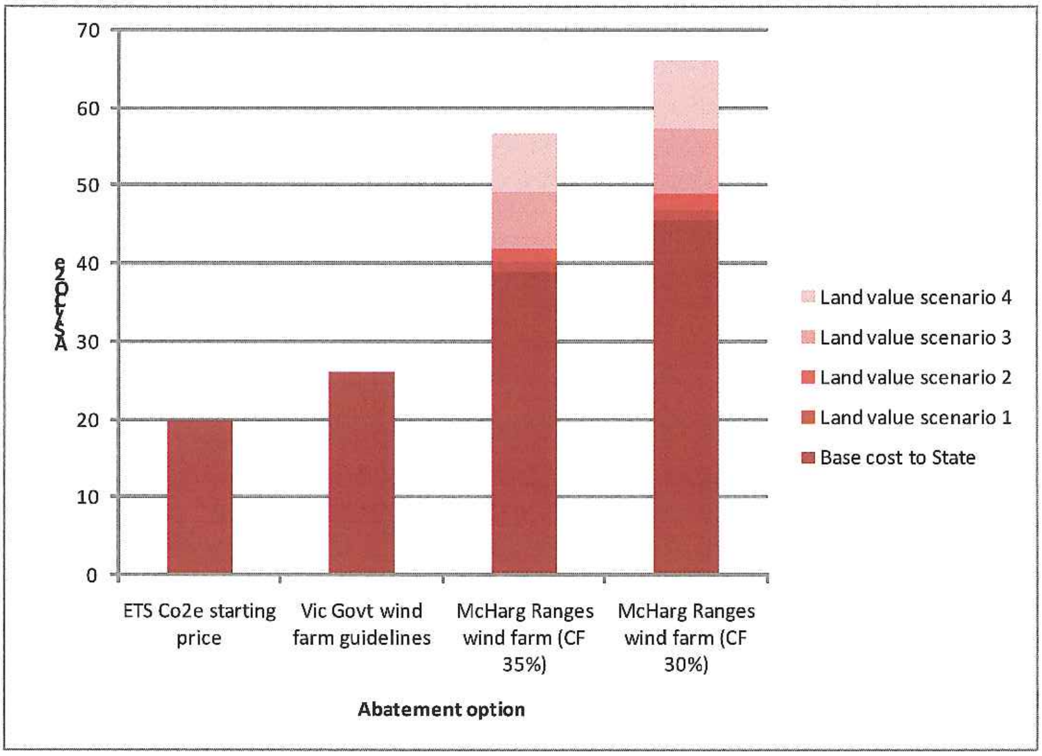
A failure to accommodate declining land values from a wind farm development is excluding the losers from the equation. From that flawed base, and by failing to accommodate impacts on one section of the 'public', one is in no position to determine whether a wind farm is enhancing the overall public interest or not.

8. SUMMARY AND CONCLUSIONS

From the State perspective and overall cost, any cost from declining land value makes an already expensive exercise more costly. With the cost of abatement due to the direct marginal cost of wind power in the McHarg Ranges already high ($31 to $47 per tCO2e), any further increase in those costs due to local area impacts acts to further undermine the cost effectiveness of the project. This is highlighted in the Chart below, illustrating the costs involved in various McHarg Ranges wind farm scenarios versus other pertinent cost of abatement measures. The chart illustrates the cost comparison of the McHarg Ranges wind farm (under several land value scenarios drawn from the report) versus other key abatement costs (in terms of $ per tonne of CO2e). The four cost scenarios are:

- The starting price of an emissions trading scheme of $20 per tCO2e.
- The cost of abatement through wind power using the 1.3 tonnes of CO2e displaced and a capacity factor (CF) of 35% (as identified in the Victorian Government's Policy and Planning Guidelines for the development of wind energy facilities in Victoria), combined with an additional cost of wind power of $34 per MWh = A$26.2 per tCO2e.
- The cost of the McHarg Ranges wind farm with an assumed CF of 35% using Access Economics calculations, combined with an additional cost of wind power of $35 per MWh = $38.9 tCO2e. On top of that cost, we have calculated the cost of declining land values under four different land value decline scenarios hypothesized in the previous section.
- The cost of the McHarg Ranges wind farm with an assumed CF of 30% using Access Economics calculations, combined with an additional cost of wind power of $35 per MWh = $45.5 tCO2e. On top of that cost, we have calculated the cost of declining land values under four different land value decline scenarios hypothesized in the previous section.

CHART 8-1: COST OF ABATEMENT OPTIONS



Land value scenario 1: 10 percent drop in land values within 1.5km

Land value scenario 2: 10 percent drop within 1.5 km, 5 percent within 3.5 km, 3 percent within 5 km and 1.5 percent within 10 km

Land value scenario 3: 10 percent drop within 10 km

Land value scenario 4: 25 percent drop within 5km, 10 percent within 10 km.

Although we do not believe that the higher level land value impacts (land value scenario 4 on the above chart) are the most likely scenario, the key point from this is that detrimental land value impacts (themselves a function of several local area impacts) are likely, and they do not have to be high to make the project non-cost effective. At a cost of upwards of $40 per tCO_2e, above $50 given moderate land value impacts, a 200 MW wind farm in the McHarg Ranges is an expensive way to approach greenhouse gas abatement, with a cost of abatement not only significantly higher than the starting cost from the proposed ETS but also significantly higher than the cost of abatement from wind power using assumptions with the Victorian Government's guidelines for wind development within the State.

The conclusion that the proposal is not a cost effective approach to greenhouse gas mitigation is further strengthened by the probability that the calculated emissions savings from the wind farm are likely to be too high, meaning the calculated cost of abatement from the project is too low (as discussed in Section 4.1).

Hence, to the extent that the main objective of wind farm developments in the State is to "deliver cost-effective greenhouse abatement in the long term", this project fails against that main objective.

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APPENDIX A: COST BENEFIT ANALYSIS METHODOLOGY

Cost Benefit Analysis is a tool used to determine whether or not the socioeconomic benefits of a policy change are outweighed by its socioeconomic costs. When done properly, a CBA examines all the monetary and non-monetary/intangible costs and benefits of a policy to society, including economic, social, environmental and other concerns.

CBA requires the 'policy change' scenario to be compared against a 'do nothing' scenario (also called the 'business as usual' scenario). It is only the incremental benefits and costs of the 'policy change' scenario over and above those that would have occurred in the 'do nothing' scenario that are measured. As such, it is important to identify which costs or benefits are common to both scenarios, and behavioural change that might occur in moving from one scenario to another.

CBA is forward looking – it assesses the policy against a baseline of what the world might be reasonably expected to look like over the life of the project in place. As such, the time frame of the analysis depends on the nature of the project and the asset lives; in this case approximately 25 years.

Some of the impacts of an infrastructure project are often more immediate, such as the upfront capital expenditure costs, while others will tend to occur over a long timeframe (such as CO_2 abatement and resulting climate change mitigation) or loss of visual amenity and resulting impact on land values. Comparing the impacts that occur at different time periods within the project's existence, to arrive an overall project evaluation, therefore requires a method of comparing impacts in the present versus those in the future. To do this, a discount rate is applied to future impacts (either costs or benefits), to reduce the impacts to their present value.

The conceptual approach adopted in this project follows, as much as appropriate, standard CBA procedures, such as those outlined in the Australian Commonwealth Government publications Introduction to Cost-Benefit Analysis and Alternative Evaluation Methodologies (2006) and the Handbook of Cost-Benefit Analysis (2006). The broad steps taken have been to:

1. Define the scope and objectives.
2. Define the baseline scenario (where the wind farm is built and operates) and counterfactual case (where the wind farm is not built).
3. Research and specify the various costs and benefits of the different scenarios.
4. Quantify the various costs and benefits, where possible.
5. Discount past and future costs and benefits to New Present Values.
6. Sensitivity tests for uncertainties.
7. Consider distributional and regional issues.

The major challenge of a study such as this is generally found at step four, and the challenge of quantifying the various costs and benefits. Unlike a more narrow financial evaluation, cost benefit studies cover a much wider range of impacts. Quantification of some of those impacts can be difficult, especially where they relate to indirect environmental and social impacts. Additionally, the required data in order to properly undertake a quantification exercise for some of the impacts may not exist or can be elusive. The impacts quantified in this study are limited only to those where there is a reasonable level of confidence in the data and the valuation techniques. Where there was less confidence, the impact is discussed in qualitative terms, with a specific focus on relevance of the impact to the specific McHarg Ranges environment and the wind farm proposal.

APPENDIX B: INTERNATIONAL BEST PRACTICE GUIDELINES

The European best practice guidelines (EWEA, 1999), for instance, also emphasise the need for consultation and specify more detail in relation to wind resource (specifying that promising values are average wind speeds above 6 m/s), tourism and recreational effects (i.e. they should be identified) and decommissioning (stating that developers, owners and operators of wind energy projects should accept that their responsibility for satisfactory operation of the project carries on throughout its lifetime until it is replaced or removed (noting that the scrap value of the turbines themselves will usually be sufficient to cover the costs of their dismantling or – where this is not the case – funds should be set aside over the life of the project to ensure there will be enough money available at the end of the project's life to pay for decommissioning) and that consideration should be given to restoration measures including the removal of group equipment, landscaping of foundations and as to whether roads or tracks will re-seed naturally or will require additional treatment).

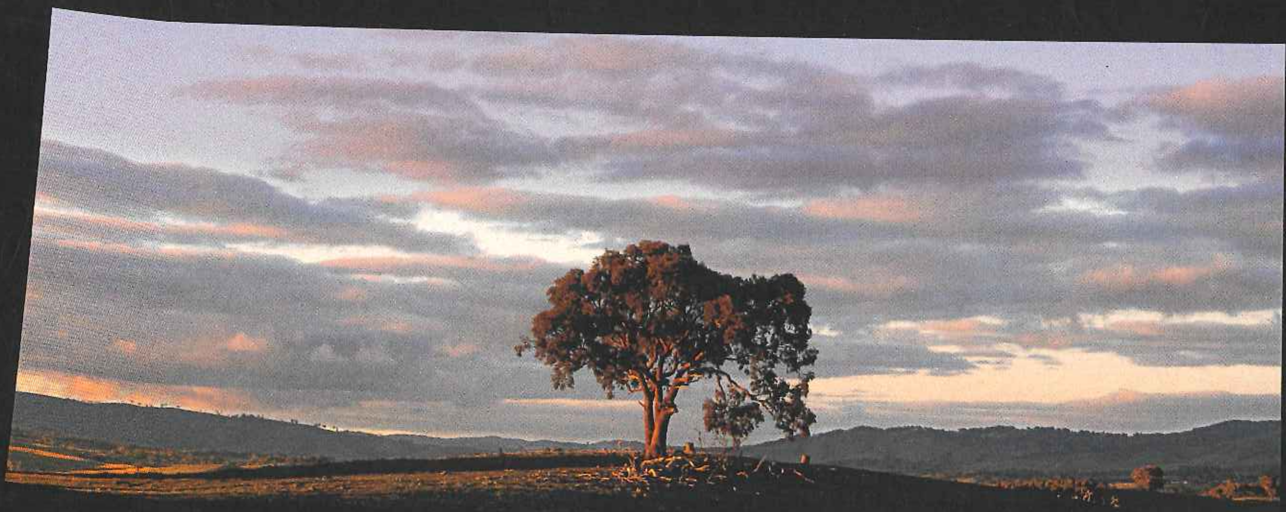
The latest Irish best practice guidelines (IWEA, 2008) explicitly discourage insensitive wind farm developments, stress the importance of early consultations, community involvement and public exhibition of the plans and highlight separation distance as an important constraint for the layout of wind farms. It is also noted that in Ireland environmental impact statements are mandatory for any proposed wind farm with more than five turbines or a total output of more than 5 MW. Hence, lease agreements with landholders should remain flexible in order to incorporate changes in the layout throughout the planning stage. The guidelines also recommend that funds should be set aside for decommissioning over the life of the project. The Irish guidelines are complemented by wind farm planning guidelines developed by the Irish Department of Environment, Heritage and Local Government (2004) which give detailed advice to planning authorities on planning for wind farms, discussing in aesthetic considerations, environmental impact statements as well as noise, decommissioning and maintenance issues.

The Western Australian best practice guidelines (WAPC, 2004) state that sites with a mean wind speed above 7.5 m/s are favoured in Western Australia. The guidelines also note that the price paid for wind-generated electricity can determine the location of wind farms, as legislation that makes extra subsidies available for renewable energy makes inland sites with lower output more attractive to proponents. Furthermore, local government (rather than developers) may consider appropriate locations for wind farms as part of the local planning strategy. In regards to noise, the WAPC recommends that 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. This is significantly more than the Victorian Planning guidelines which, based on New Zealand guidelines, is only 400 meters.

Sustainability and due diligence guidelines developed by the World Wind Energy Association (WWEA, 2005) are aimed at promoting best practice by governments, developers and local cooperatives when planning, constructing, operating and decommissioning large commercial wind farms. The guidelines recommend the application of sustainability criteria when comparing project alternatives. When developing a wind farm, it should be demonstrated that there is a need for the project (and that the project is the best option to meet the need – for instance, for future energy requirements of alternative energy), that it is economically viable, uses appropriate technology, is safe and minimises waste products and the environmental footprint, has a high energy payback ratio, provides economic benefits across the local affected community and broader region, maximises opportunities for local involvement and does not present a significant threat to vulnerable social groups.

An environmental impact statement is recommended for wind farms that are likely to have significant impacts on the environment. Community acceptance is seen as important and should be gained through adequate consultation, education and informed input in the decision making process (especially by making use of local knowledge) and the development of mitigation options as well as through providing affected communities with identifiable benefits (such as cooperative ownership, self funding solutions and other types of investment opportunities, support of additional community infrastructure, utilisation of local and regional resources (labour) or compensation in the case of displacement or loss of livelihood).

Economic sustainability decisions should be based on comprehensive evaluation of affected resources and project costs and benefits, taking into account construction, operations and maintenance costs, full environmental and social costs, full capital and recurrent costs of environmental and social mitigation plans, benefits at a national and regional level (such as additional taxes, industrial development, improved infrastructure or multiple use benefits), recognition of savings on greenhouse gas emission and benefits that accrue to local communities (such as integrated local renewable energy supply systems and ownership, job creation, local industry, investment opportunities and tourism). Once estimated, the economic performance and projected benefits should be monitored on an ongoing basis.



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