Senate Inquiry into The Social and Economic Impact of Rural Wind Farms

Submission from Pacific Hydro Pty Ltd

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Introduction

Pacific Hydro is Australia's leading renewable energy company with significant local and international renewable energy development and operational experience. The company is 100% owned by Industry Super Funds which presides over the superannuation of around five million Australians.

In Australia, the company has been at the forefront of the renewable energy industry over the last decade and has a substantial portfolio of hydro and wind assets, both operating and at an advanced stage of development. The company also maintains a watching brief on geothermal, wave and large-scale solar opportunities.

Our six operating wind farms in Australia are already meeting the annual power needs of 136,000 homes while avoiding the emission of up to 670,000 tonnes of greenhouse emissions each year.

In addition to the existing operating portfolio, Pacific Hydro has more than 600MW of wind energy projects in the development pipeline, mostly in rural and regional areas, totalling approximately two billion dollars of future investment. These projects, if built will increase total abatement from our wind farms by up to two million tonnes per annum.

Pacific Hydro's operating wind farms play an important role in the regional economies in which they are located. On a capital investment basis, all of these projects have a minimum 40% local content involving substantial civil construction activities, tower fabrication, transportation and turbine erection. To date, Pacific Hydro has established wind farms with a total capital value of $650 million of which $300 million has been spent directly in regional Australia.

On an ongoing basis direct regional economic benefits are primarily derived from lease payments to local farmers, annual operations and maintenance spend (including employment of local contractors), payment of local council rates and annual community fund payments.

Pacific Hydro currently operates 147 wind turbines with a combined generating capacity of 259.4MW. Given the average operational life of a wind farm is 20 years, the total estimated direct regional economic benefit of these six wind farms, in today's dollars, will be $215.7 million.

It is estimated that up to $25 billion of new capital investment will come about due to the Federal Governments Large Scale Renewable Energy Target (LRET) legislation, much of which is expected to be invested in new wind energy developments. In addition to this significant regional investment, assuming 4,000 wind turbines are constructed in Australia as a result of the LRET and they all operate for a period of 20 years the additional direct regional economic benefit in today's dollars will be $5.9 billion.

Australia will need to affect a transformation of our energy system in the coming decades to meet national emissions reduction targets and to ensure the Australian economy remains competitive in a low carbon future. Achieving this will require a plan of action that encompasses how we produce and consume energy to ensure continued growth and prosperity while delivering deep cuts in greenhouse gas emissions.

To achieve this, a coordinated set of policies and measures that drive investment and action towards a lower emissions profile will be required. Chief in the policy response is a price on carbon and continued industry development and transformation support through a specific target to deploy renewable energy.

The expanded renewable energy target (LRET) is a key policy measure and will complement broader action which will come from an economy wide price on carbon. The LRET is expected to drive investment of some $25 billion in Australia's emerging clean energy industry and deliver more than 12 GW of new renewable energy capacity by 2020. Some six-eight GW is expected to come from wind power, which will be built in regional and rural areas of Australia.

Onshore, utility-scale wind farms are highly economic and reliable. Development, deployment and operation of wind energy facilities is very closely scrutinised through local and state development and planning requirements. Community liaison and the ongoing relationship we have with local communities, is taken extremely seriously from the early stages of proposal development through construction, commissioning and operation.

While all major infrastructure projects incorporate a period of uncertainty, especially prior to commitment and construction as surrounding communities and businesses come to terms with the development, the projects and their operation are vital to job creation, establishment of new industries and, in the case of renewable energy generation, supply of zero emission electricity.

Wind farms create jobs and bring investment into regional and rural areas, increase sustainable farm income and sustainability (regardless of seasonal fluctuations), provide clean power to the local grid and reduce emissions.

Pacific Hydro is pleased to provide a response to this Inquiry regarding the significant role played by wind energy in Australia's energy supply system, emissions reduction, jobs and investment. We also outline results of independent research on infrasound and other issues raised by the Terms of Reference for the Committee.

Please note that Pacific Hydro would welcome the opportunity to engage in further stages of this Inquiry, including formal hearings and site visits to wind farm facilities.

Response to the Senate Inquiry Terms of Reference

1. Community Support for Wind Farms

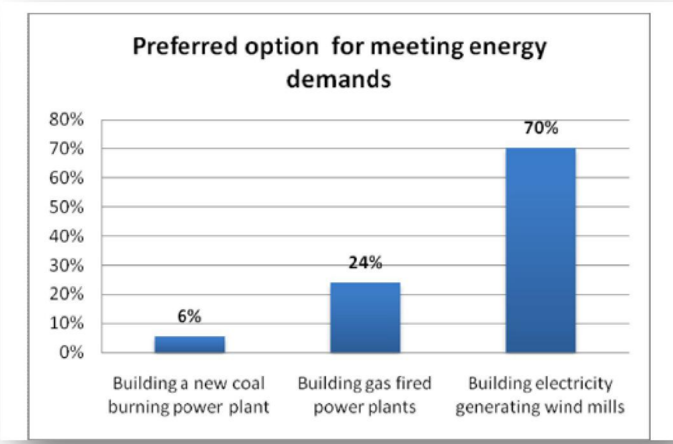
Community attitudes research conducted in Australia and internationally continues to find there is overwhelming support for wind energy facilities, including among residents living close to wind farms. Australian research including independent[1] and Government surveys found support for wind farms of between 80 and 90 per cent.

Recent polling conducted by QDOS for Pacific Hydro in mid 2010 (refer Appendix A) endorsed the findings of those earlier polls.[2] The Victorian polling emphatically showed strong support for wind farms across a number of Victorian electorates, many of which have operating or proposed wind farms in the area. Most notably, the report found that *"people living in areas where there are, or are likely to be, wind farms share positive perceptions"* about wind farms. Overall, over 80 per cent of those polled were supportive or strongly supportive of more wind farms in Victoria.

Table 1: Level of support for electricity supply options (QDOS Victorian Polling Results, 2010)

	Strongly Oppose	Oppose	Support	Strongly Support	Don't Know	MEAN
	%	%	%	%	%	
Building a new coal burning power plant	22	43	21	3	12	2.1
Building gas fired power plants	6	23	44	10	17	2.8
Building electricity generating wind mills	3	9	44	37	8	3.2

Figure 1: Responses to the question "if you had to pick one of these as your preferred option, which would it be? (QDOS, 2010)



When respondents were required to choose only one preferred option for meeting increasing energy demands, 70 per cent choose *"building electricity generating wind mills"*. Almost a quarter chose *"building gas fired power plants"*. Just six per cent of voters select *"building a new coal burning power plant"*.

Project developers, including ourselves, work very hard through all stages of project development to build and maintain relationships with the local community and to ensure that concerns are addressed to the benefit of the project and community.

[1] Clean Energy Council (2009) Newspoll Survey and the NSW Government (2010) AMR Interactive Survey.
[2] See for example Clean Energy Council (2009) Newspoll survey and the NSW Government commissioned survey from mid-2010.

As reflected in the following community comments, local support in the regions where Pacific Hydro has operating wind farms continues to be very strong.

"When the proposal was put before my Council to build these Wind Farm there was not one objection from anyone received from the local community. The farms that the towers stand on have a steady income each year which is wonderful when farmers are under stress from droughts and now floods. The people of Ararat have not experienced any side effects from the Wind Towers and warmly embrace the important contribution we can all make to the environment.
Pacific Hydro also contributes to a Community Fund of $50,000 [per year for the life of the wind farm] which has seen so many community groups and charities benefit from this fund."

Glenda Allgood. JP. Former Mayor and Councillor, Ararat Rural City

"At Ararat there is an operating wind farm (Challicum Hills owned by Pacific Hydro) and several other proposals which are at an advanced stage of planning. There has been almost no opposition to these projects. The proponents of the Challicum Hills Project consulted local communities and community groups extensively before progressing and there was no opposition to this project. There have been no significant complaints of any description since the Challicum Hills project began operation."

Peter Forster, Secretary, Environmental Farmers Network

Also included as part of Appendix A is a small sample of positive community comments regarding wind farms operated by Pacific Hydro.

2. Health Research

Pacific Hydro acknowledges there has been significant media attention in recent times regarding claims that wind farms are responsible for a range of health impacts. Despite this media attention, we point Members of the Committee to the numerous independent reviews from peak medical and scientific bodies such as the National Health and Medical Research Council (NHMRC), the Victorian Chief Medical Officer and the South Australian Environmental Protection Agency along with peer-reviewed research from around the world that has consistently found there is no bona fide, scientific or medical evidence that wind farms lead to adverse health impacts.[3]

Pacific Hydro would like to draw the Committee's attention to the conclusions drawn in recent development panel hearings in which the arguments put forward by Dr Sarah Laurie (referring particularly to work by Dr Nina Pierpoint) were found to be *"unconvincing"* by Dr Gary Wittert, Professor of Medicine at Adelaide University (Senior Consultant Endocrinologist, Royal Adelaide Hospital).

At seven recent Planning Panel Hearings in Victoria (held in Mortlake, Moorabool, Yaloak South, Lal Lal, Berrybank, Ararat and Stockyard Hill), the Planning Panels heard arguments about the existence of "wind turbine syndrome" and related concerns over noise and vibrations. The Panels generally concurred with, and/or accepted the position of the NHMRC (noted below) that wind turbines do not pose a threat to human health. Further, at the Stockyard Hill Hearing, the Planning Panel concluded that they were: *"...not able to conclude from Dr Pierpoint's work that there will be, or are likely to be, health problems among the general population living near [the] proposed wind farm which can be attributed to the wind farm and in particular its noise emissions".* Further, many of the Planning Panels noted that achievement of compliance with the existing standard NZS6808:1998 provides protection against "*sleep disturbance", "noise levels",* and *"health and amenity"*.[4]

Australia's National Health and Medical Research Council (NHMRC) published a statement in July 2010 that emphasised that while anecdotal cases of annoyance and anxiety may adversely affect the health of individuals in close proximity to a wind farm, it is the worry and stress – not the wind turbine itself – that may lead to the health concern.[5] A concerning development is that agitation about health impacts may (directly) lead to increased stress and worry among members of the community. The Victorian Department of Health also endorsed the conclusion of the NHMRC, noting that following an examination of available scientific literature on wind farms, they concluded that *"there are no direct health effects that can be attributed to modern wind turbines"*.[6]

Further emphasising the relative nature of these issues, the Royal Australasian College of Physicians and the Public Health Association of Australia note that *"the impact of climate change on human health should be addressed as a matter of serious concern"*[7] and specifically identify the importance of supporting clean energy sources like wind and solar and *"recognizing coal as a health hazard".*[8]

Coal combustion produces particulates which enter the air stream and leaves behind coal ash (this is usually 'stored' in ash dams or piles close to coal mines). A US Study from the Physicians for Social Responsibility found that coal ash deposits in the US contain *"a dangerous mix of arsenic, lead, mercury, cadmium, chromium and selenium".* These and other chemicals in coal can, according to the US EPA, *"cause cancer and neurological damage in humans".*[9] While we

[3] See for example Colby, W.D., Dobie, R., Leventhall, G., Lipscomb. D.M et al (2009). Wind Turbine Sound and Health Effects – an expert panel review. Especially sections 3.4, 4.3 and 4.6. (This report was prepared for the American Wind Energy Association and Canadian Wind Energy Association).
[4] Freehills (2011). Summary of Wind farm health effect issues raised at Panel Hearings.
[5] NHMRC (2010). Wind Turbines and Health – Public Statement.
[6] Victorian Department of Health (2010). In the Community – Wind farms.
[7] RACP and PHAA. Call for Health and Climate Change Action Now.
[8] Ibid.
[9] Physicians for Social Responsibility (2010). Coal Ash, the toxic threat to our health and environment.

acknowledge Australia's coals do not contain the same mix of substances as the US and the Australian Coal Association considers that the levels of toxicity are "*low by world standards*", combustion of coal is *"the single biggest source of mercury emissions, according to the National Pollutant Inventory".*[10]

Further, epidemiological research in Australia suggests that air pollution – caused by (in order of merit) *"motor vehicle emissions, wood smoke from home heating, industrial pollution and [in some years] major bushfires – has... demonstrable cardio-respiratory health effects ranging from minor respiratory symptoms to increased hospital admissions and mortality".*[11]

In an ABC TV Four Corners story last year, coal dust emissions in the NSW Hunter Valley were identified as leading to the toxic inhalation of nitrous oxide by a truck driver. The program notes that residents in the Hunter Valley report significant instances of *"asthma, coughs and skin disorders among local children"* and seen repeated requests for studies ignored by the NSW health department.[12]

In contrast, as demonstrated in this submission numerous studies have been undertaken by Australian health authorities who have weighed the evidence and concluded that there is no verifiable evidence of direct links between wind farms and claimed "health impacts".

The reason for bringing these issues to the attention of the Committee is to help provide some perspective. All forms of energy generation will have an impact on the surrounding environment. While some impacts may be significant we contend that well designed wind energy facilities have a very low impact on the immediate environment. In our 12 years of experience in developing and operating wind farms in Australia, the genesis of most objections is that of visual amenity.

Further, in our experience a vast majority of residents' concerns can be dealt with or disappear once the wind farm is operating. In all circumstances, significant studies are undertaken (as part of the standard planning and compliance procedures) to ensure proposals are in compliance with current standards and where possible are aligned with community expectations.

The following comments of local residents near Pacific Hydro's Codrington Wind Farm in Victoria are, in our experience, typical of the responses from people who have lived near wind farms for any length of time. Codrington has been operating for over 10 years, during which time there has been no complaints regarding health impacts.

"*We've been here 2.5 years now, and we've noticed no ill affects [sic] from the wind farm, either health wise or with issues such as noise, vibrations or disruptions of any sort.*
Thousands of guests pass through our business each year, we've just had about 2,000 guests over the Xmas break...We have very many conversations with guests about the wind farm, or wind farms in general. Our impression is that the public in general are very poorly informed, and the information they have is most often based on bad press, things they've read or heard at some time in the past, but mainly based on reports of communities opposing the installation of wind farms in their area and the issues they've used to oppose the establishment of a wind farm in their region.
... Some say they have found the turbines relaxing to watch since they've been staying here and had the time to sit and watch them",

Geoffrey Tonks, Codrington Settlement & Gardens (B&B), Codrington, Vic.

10 Shearman. D and Lloyd-Smith. M (2010). Coal Ash and Mercury: why coal is a health hazard.
11 Kjellstrom. T.E, Neller. A et al (2002). Air pollution and its health impacts: the changing paranormal.
12 ABC Four Corners (2010). A Dirty Business. Reporter Andrew Fowler, broadcast on 12 April, 2010.

3. Noise, Vibrations ("infrasound") and Proximity

Far from being "excessively noisy" as suggested by the Terms of Reference, wind farms in Australia are subject to jurisdictional planning laws which require developers to meet rigorous standards with regard to environmental (including flora and fauna), visual, noise, cultural heritage and residential impact.

Noise is often the most important factor in determining the separation distance between wind turbines and sensitive receivers. The assessment of noise, therefore, plays a significant role in determining the viability and size of wind farms. This is conducted in accordance with existing Standards and Guidelines in each State.

For example, the South Australian Government guidance on noise impact from wind farms can be found in *Wind Farms: Environmental Noise Guidelines 2009*. Following a review of the suitability of the guidelines and wind farm developments, the South Australian Environmental Protection Authority (SA EPA) concluded that *"the operation of a wind farm does not cause an adverse impact on the resident's amenity if noise levels are below limits set up in [the Guidelines]"*. Further, the SA EPA noted that in relation to health effects from inaudible infrasound; *"the emission levels from modern wind turbine generators are significantly below the perception threshold".*[13]

Notwithstanding the above, current guidelines do not cover the testing of infrasound which is generated by wind farms or any other industrial [infrastructure] source. We note that infrasound is associated with so many activities that the specific association with wind turbines is anomalous.

Infrasound is emitted naturally by waves on a beach and against the coastline, by waterfalls and by wind. Infrasound is also emitted from many non-natural sources including industrial processes, vehicles, air conditioning, ventilation systems and wind farms.

In the interests of informing the debate which has emerged regarding infrasound from wind farms, Pacific Hydro commissioned research to measure and compare infrasound levels from wind farms and some common environment infrasound sources, both natural and man-made.

The research and analysis was conducted by independent acoustic consulting firm, Sonus, and has assisted us to better understand the levels of infrasound that exist in the environment from a range of sources. The research, attached at Appendix B, included:

- Developing a methodology to measure infrasound to minimise the influence of wind on the microphone;
- Measuring the level of infrasound at a range of distances from Pacific Hydro's wind farms at Clement's Gap in South Australia (CGWF) and at Cape Bridgewater in Victoria (CBWF);
- Comparing these results with previous wind farm infrasound measurements made in a range of other studies;
- Comparing the results with infrasound measurements made of natural sources, such as beaches, and man-made sources, such as a power station and general activity within Adelaide's CBD.

Infrasound was measured at two of Pacific Hydro's Australian wind farms, Clements Gap in South Australia and Cape Bridgewater in Victoria (while operating and while off). Measurements were also taken at a beach, a cliff top along the coastline, in the Adelaide CBD close to two busy roads, in an Adelaide suburb, and near a gas-fired power station.

The results show that infrasound is not unique to wind farms. The levels of infrasound produced by wind turbines is well below established perception thresholds and, importantly, is also below levels produced by other natural and man-made sources.

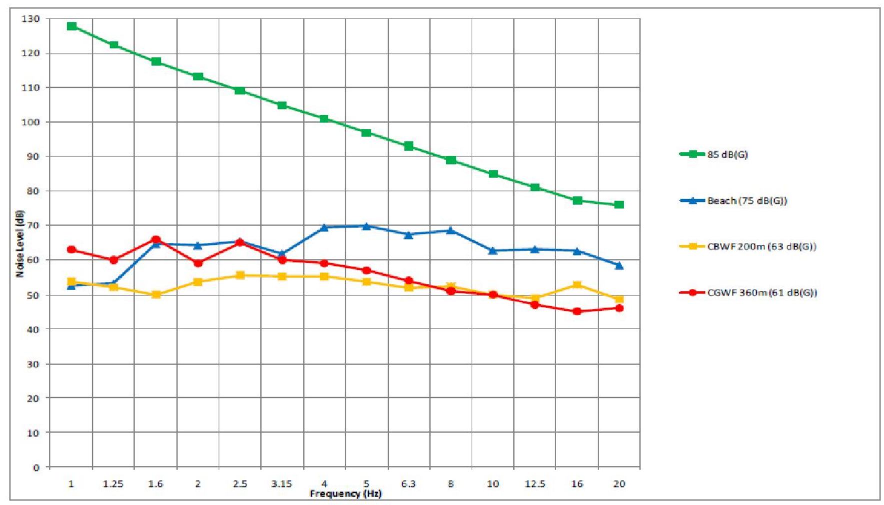
[13] SA Government (2010).

While this report is by no means exhaustive it does provide further support to existing overseas data which shows that infrasound emissions from operational wind farms is significantly below recognised perception thresholds of 85dB(G). It also re-affirms that infrasound is not unique to wind farms and is produced by many sources.

Table 2: Summary of Pacific Hydro Infrasound Report Findings. Sonus (2010).

Source	Measurement level dB(G)
Adelaide CBD - 70m and 200m from two main roads	76
Cape Bridgewater beach - 25m from high water mark	75
Gas fired power station - 350m	74
Cliff face (Cape Bridgewater) 250m (approx) from the coastline	69
Clements Gap wind farm 185m downwind of the closest operating turbine	67
Cape Bridgewater wind farm 200m downwind of the closest operating turbine	63
Ambient infrasound measurement at Cape Bridgewater wind farm (wind farm not operating). Recording taken 100m downwind from turbine but with turbines not operating.	62
8km inland from the coast - Victoria	57
Adelaide suburb (Blackwood) at 10m with no wind	51

The Sonus measurements found that both these Pacific Hydro wind farms are significantly below the internationally recognised Audibility Threshold of 85 dB.[14]



Summary Graph – Infrasound measurement results from two Australian wind farms (Clements Gap at 61 dB(G) and Cape Bridgewater at 63 dB(G)) compared against measurement results at a beach (measured at 75 dB(G)) and the internationally recognised Audibility Threshold (85 dB(G))

[14] Sonus (2010). Infrasound Measurements from Wind Farms and Other Sources. P.4.

In support of the findings of the Sonus measurements we draw the attention of the Committee to the following comments from residents living in close proximity to wind farms operated by Pacific Hydro:

> *In relation to nausea and dizziness I am more than certain it`s a fear of the unknown influencing people's health rather than wind. Issues that are taken into account before a Wind Farm is developed are wind availability, suitability of roads to transport components, environment and flora and fauna.*
>
> *Daryl O'Flaherty, Strathkellar Victoria.*

> *I have stood beneath towers in Western Australia, New South Wales, South Australia and in our locality of Codrington and Bridgewater and the only noise is a gentle "swoosh" as the blades turn.*
>
> *Ann Parry, Narrawong. Victoria*

4. Employment and Income

To meet the expanded Renewable Energy Target, a significant expansion in investment in wind farms and other renewable energy technologies is necessary. Rural and regional communities stand to benefit significantly from these projects in terms of regional energy security, regional investment, direct and indirect job creation.

While some organisations will argue that renewable energy creates few "real" or "ongoing" jobs, we believe this view is both erroneous and misleading. A recent study undertaken for the Clean Energy Council (CEC) found that the 20 per cent Renewable Energy Target (RET) will unlock over $20 billion in investment and create over 55,000 jobs (over and above the existing 8,000 jobs in the sector) – mostly in rural and regional areas.

The CEC study is broadly supported by recent work from Zero Carbon Australia which emphasised that substantially increasing the deployment of renewable energy would lead to around 30,000 new jobs in manufacturing and deliver a net increase in energy sector jobs.[15]

Earlier studies in Australia have also shown that increasing the deployment of clean energy will drive significant job growth, particularly in regional and rural areas.[16] Research from the Australian Conservation Foundation (ACF) and the Australian Council of Trade Unions (ACTU) showed that driving increased deployment of renewable energy would lead to employment growth of around 1.5 per cent higher than would otherwise occur by 2030.

Pacific Hydro presently employs over 110 people in Australia. When we develop a wind farm site, we always ensure that – as far as is possible – we source services and contractors from the local area. For example, we purchased towers from an Adelaide based tower manufacturer for the 56.7 MW Clements Gap wind farm in SA and employed 425 people on site.

The 44 MW Cape Nelson South wind farm and the 58 MW Cape Bridgewater wind farm each employed nearly 400 people on site. In constructing the last two projects, Pacific Hydro was able to source towers and most contractors from Portland and surrounding towns. Externally (internationally) sourced materials include the turbines, specialist advisors and some large transport equipment.

In addition to the existing operating portfolio, Pacific Hydro has more than 600MW of wind energy projects in the development pipeline, mostly in rural and regional areas, totalling approximately two billion dollars of investment. These projects would increase total abatement from our wind farms by up to two million tonnes per annum.

Pacific Hydro's operating wind farms play an important role in the regional economies in which they are located. On a capital investment basis, all of these projects have a minimum 40% local content involving substantial civil construction activities, tower fabrication, transportation and turbine erection. To date Pacific Hydro has established wind farms with a total capital value of $650 million of which $300 million has been spent directly in regional Australia.

On an ongoing basis direct regional economic benefits are primarily derived from lease payments to local farmers, annual operations and maintenance spend (including employment of local contractors), payment of local council rates and annual community fund payments.

Pacific Hydro currently operates 147 wind turbines with a combined generating capacity of 259.4MW. Given the average operational life of a wind farm is 20 years, the total estimated direct regional economic benefit of these 6 wind farms, in today's dollars will be $216 million.

It is estimated that up to $25 billion of new capital investment will come about due to the Federal Governments LRET legislation, much of which is expected to be invested in new wind energy developments. In addition to this significant

[15] Beyond Zero Emissions (2010). Zero Carbon Australia Stationary Energy Plan. p. xix

[16] For example: ACTU/ACF (20XX). Creating Jobs – Cutting Pollution: the roadmap for a cleaner, stronger economy. Also see: Hatfield-Dodds, S., Turner, G. Et al (2008). Growing the Green Collar Economy: skills and labour challenges in reducing our greenhouse emissions and national environmental footprint.

regional investment, assuming 4,000 wind turbines are constructed in Australia as a result of LRET and they all operate for a period of 20 years the additional direct regional economic benefit in today's dollars would be $5.9 billion.

4.1 Supporting Sustainable Communities

Sustainability is at the heart of everything Pacific Hydro does as a business and we strive to ensure that our operations ensure that communities in which we operate benefit from our wind farms. To this end, we provide support to local communities through our Sustainable Communities Fund. This Fund provides a portion of revenue from each of our operational wind farms back into local communities through local community groups. The Fund opens annually at each project site and is available for the life of the wind farms operation.

The Sustainable Communities Fund has provided $952,172 to 267 projects since 2005 including equipment for the Crystal Brook History Group, shade sails for the Ararat VRI Bowls Club, funding for the Portland Police community liaison project "Aquaplay" and equipment for various sporting clubs.

Further in-kind support has included sponsoring a Portland student to attend an international science symposium, hosting activities and tours around our sites, administration assistance to community organisations, educational information, support to schools taking part in the Future Shots Sustainable Film challenge, assisting small organisations to expand their support base, attending community events and coordinating activities around International Women's Day and World Environment Day at operating locations and volunteering activities such as tree-planting. We also provided IT equipment to the Point Danger Committee of Management to assist in remote viewing of a unique gannet colony as well as donating unneeded computers to 17 other regional community groups.

5. Wind Energy Reduces Emissions and Lowers Wholesale Prices

While wind is a naturally variable technology, it remains true that for every unit of zero-emissions energy generated by a wind farm, a unit of energy from other sources (typically coal or gas generation) is displaced, thereby abating greenhouse emissions from energy production. We note, however, that the exact level of abatement will depend on the energy sources in the supply mix at the time of generation.

Pacific Hydro's current operating wind farms in Australia abate up to 670,000 tonnes of greenhouse emissions every year. Projects in our development pipeline would increase this figure by up to two million tonnes per annum.

A report by MMA undertaken for the Victorian energy market found that for every 100MW of wind energy installed, between 0.23 and 0.31 million tonnes of greenhouse gas emissions were abated per annum.[17] Over the 20-25 year life of a wind farm, this would equate to approximately two million tonnes of greenhouse gas abated.

A further study by MMA in NSW found that due to the way the National Electricity Market bids generation into the market, wind generation is generally fully dispatched. In this way, wind generation usually displaces generation from the top of the 'bid-stack' and has the effect of reducing (or suppressing) pool prices, keeping the wholesale price of electricity down.[18]

The MMA study is also reinforced by a study conducted for the South Australian Government which found that the wholesale price of electricity can drop "*by as much as 75 per cent on high wind days".* The study (from ROAM Consulting) found that *"in summer, when the daily price peaked at an average of $100/MWh at 4pm on low wind days, it dropped to $25/MWh on high wind days".*[19]

A recent example of this was seen on Tuesday 1 February 2011 where temperatures in South Australia and Victoria hit 40 degrees. Both states experienced high winds with wind farm capacity reaching 80% to 90% for much of the peak period. During this time energy prices in Victoria reached $12,000/MWh while in South Australia, where wind farms play a much greater role in energy generation, peak pool prices hovered around $50/MWh.

South Australia's experience also shows that increasing wind generation, combined with enhanced forecasting capacities, has not lead to a significant increase in fossil fuel generation to "back-up" wind farms. The experience has, in fact, been the opposite. As noted by an annual indicator report from The Climate Group *"unlike all the other states [in the NEM], South Australia has begun to approach its 1990 levels of emissions"* (see Figure 5).[20]

In fact, while electricity demand in South Australia increased by 0.1 per cent in 2009, growth in Gross State Product of 1.4 per cent and positive population growth of 1.2 per cent, generation from coal-fired generators fell by 2.8 per cent and that from gas-fired generation fell by 11.5 per cent in the 2009 year.[21]

Thus, although the state imported some electricity in 2009, it appears to have been (largely) self sufficient and did not need to rely on Victorian brown coal generation for support.

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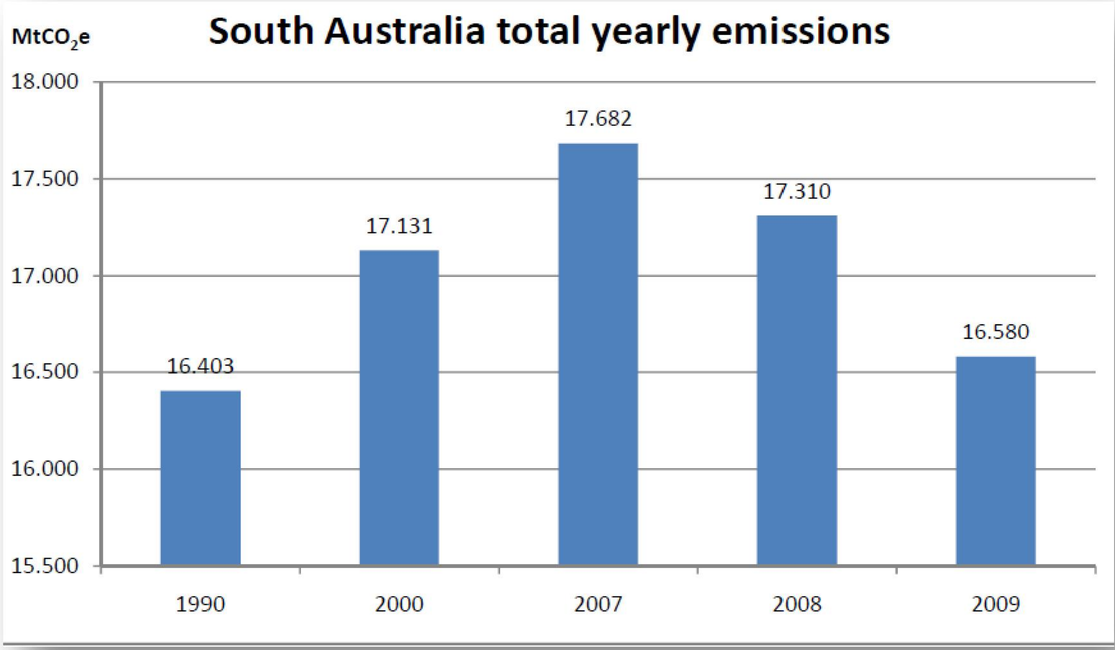
[17] MMA (2006). Assessment of Greenhouse Gas Abatement from Wind Farms in Victoria.
[18] See MMA (2009). Estimating Greenhouse Gas Emissions Abatement from Wind Farms in NSW. See also the CEC submission to this Inquiry.
[19] SA Premier (2010). SA Wind Power Driving Electricity Prices Down. Media Release, 7 October 2010.
[20] The Climate Group (2010). Greenhouse Indicator Annual Report 2009: Victoria, New South Wales, Queensland and South Australia. p. 16
[21] The Climate Group (2010). Greenhouse Indicator Annual Report 2009: Victoria, New South Wales, Queensland and South Australia.

Figure 2: South Australia's total annual emissions 1990-2009 data. The Climate Group, 2010.



These findings are consistent with those of studies conducted in other energy markets around the world. In 2008 a report from the US Department of Energy said the following[22]:

Wind Energy Displaces Emissions from Fossil Fuel-Fired Power Plants: Wind energy generation results in reductions in air emissions because of the way the electric power system works. Wind energy is a preferred power source on an economic basis because the operating costs to run the turbines are very low and there are no fuel costs. Thus, when the wind turbines produce power, this power source will displace generation at fossil fuelled plants, which have higher operating and fuel costs.

The specific types of fossil fuel-fired power units that will be displaced by wind generation vary significantly among states and regions. Some states and regions rely on coal plants for a majority of their generation (e.g., West Virginia), whereas other regions and states rely heavily on natural gas-fired units (e.g., most of New England). The displaced emissions of CO2, NOx, SO2, and mercury generally will be greater in areas with large amounts of coal-fired generation and lower in areas where natural gas is the dominant fuel. The emissions level is also influenced by the age of the fossil fuel-fired units, as well as their relative levels of efficiency and pollution control.

[22] US Department of Energy (2008) Wind Energy and Air Emission Reduction Benefits: A Primer

6. Network Operation and Reliability

Wind farms are a growing, core component of the electricity generation infrastructure kit in Australia, taking advantage of our natural (renewable) resources. While wind is a naturally variable technology, this does not limit the value of its contribution to meeting consumer demand in a cleaner energy system. Even in the current energy system, wind penetration could reach up to 20 per cent without causing issues for network operators.

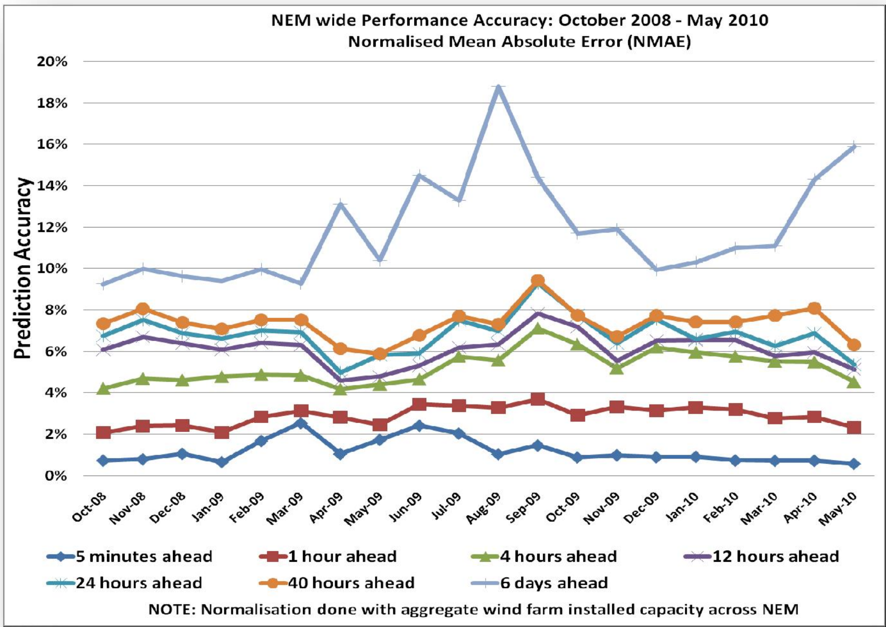
For example, wind currently provides about 20 per cent of South Australia's power and is producing *"enough reserve power into the grid to safeguard Adelaide's supply...for this and the following summer despite an increase in consumer demand."*[23] This view, from Australian Energy Market Operator (AEMO), clearly shows that wind energy has the capacity to shore up supply, rather than being a 'draw' on the network.

Indeed, in the National Electricity Market (NEM), there are a number of market management arrangements in place to ensure that over time, the network adapts to increasing levels of wind generation.

The AEMO – which manages the inter-connected eastern sea-board NEM – has worked with the wind industry for many years to develop and make improvements to the Australian Wind Energy Forecasting System (AWEFS).

This system has been operating since 2008 and AEMO continue to work through a program of enhancements to improve market operator capacity to forecast, schedule and manage wind generation.

Operational performance of the system from October 2008-May 2010 is shown below.



The AEMO have integrated the AWEFS with market systems such that:

- Wind generation forecasts are used for load forecasting and adjustment of native demand.
- Significant wind generation (>= 30 MW) is semi-dispatched when required to manage network volatility.

[23] Adelaide Advertiser (2010). Powered Up For Next Two Years. 20 November, 2010.

- Semi-scheduled wind farms submit dispatch offers and plant availability within the existing economic dispatch (bid-stack) model. The semi-scheduled plant receives (and must comply with) loading (dispatch) instructions from AEMO based on wind generation forecasts from the AWEF system modelling.[24]

Pacific Hydro's experience in working with this system belies the arguments that wind is "difficult to manage". Our view is also supported by the considerable operating experience with wind farms in the NEM that now exists.

Energy market expert and AEMO's Senior Manager Strategy & Economics, Mr Craig Oakshott wrote in response to a report from Peter Lang entitled 'Cost and quantity of greenhouse gas emissions avoided by wind generation':

> *With respect to the conclusions in the [Peter Lang] paper, the assertions of very limited greenhouse gas abatement from wind turbines is based on a limited analysis of the behaviour of the overall generation supply portfolio to match demand and the false assumption about coal consumption not varying with generation output. Overall it is recognised that wind power is more expensive than conventional forms of generation and that the output of wind generation is volatile. However, through its forecasting system, AEMO is demonstrating that wind generation is reasonably predictable and can be securely managed within the generation mix. Importantly wind offers some of the lowest cost, low emissions energy available with current technology and it is offsetting production from fossil fuel generation.* [25]

Regarding the capacity to forecast wind generation, Mr Oakshott wrote:

> *While variable, wind generation is able to be forecast. AEMO has been operating the Australian Wind Energy Forecasting System for some time now. Over the critical time period from 4 to 12 hours out, this system has forecast the wind generation with an average error of approximately 6%.*

With regard to the South Australian market specifically, Mr Oakshott wrote:

> *The historical record of South Australia's emissions over recent years clearly demonstrates the contribution wind can make to supplying customer demand and reducing emissions.*

On the economics of renewable energy generally and wind farms specifically, Mr Oakshott said:

> *That wind generation costs more than fossil fuel powered generation in Australia is unarguable. That matter was well understood by Governments in providing the renewable generation with an additional source of revenue through the MRET and now expanded RET schemes. While the [Peter Lang] report argues that wind has other impacts, lower value and the like, retailers will incorporate most of those costs in their purchasing decisions. The growth of wind generation in the market confirms that it remains one of the cheapest renewable energy sources, in some cases by a considerable margin.*

In 2008 a report from the US Department of Energy had this to say about back-up generation and wind energy[26]:

> *One of the misperceptions about wind power generation is that the air emission reduction benefits are extremely limited because of the need to construct significant additional backup fossil fuel generation. With increased experience in integrating wind generation and balancing various sources of electric power over a large power control area, utility grid operators have learned how to reduce variability and limit reserve additions to modest requirements when wind generation is brought online. This operational experience has been demonstrated most clearly at moderate levels of wind penetration of up to 10% to 20%.*[27]

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[24] AEMO (2011). Australian Wind Energy Forecasting System overview.
[25] Oakshott, C. Response to the report: Cost and Quantity of Greenhouse Gas Emissions Avoided by Wind Generation by Peter Lang
[26] US Department of Energy (2008) Wind Energy and Air Emission Reduction Benefits: A Primer
[27] US Department of Energy (2008) Wind Energy and Air Emission Reduction Benefits: A Primer

To further illustrate the potential benefits of wind energy and to provide further insight into grid integration and management of wind energy we point Senators to a recent article in Science Insider[28] (http://news.sciencemag.org/scienceinsider).

On one of the coldest days in recent history there, after 4 days of subzero weather temperatures dipped to -11°C in some areas, wind turbines played a key role in maintaining power for millions of homes. "We put out a special word of thanks to the wind community because they did contribute significantly through this time frame," said the head of Texas's electrical grid. "We had often 3500 megawatts of wind generation during that morning peak, which certainly helped us."

The events of last Wednesday, detailed here, began when cold air burst pipes, caused low pressure in natural gas lines, and damaged equipment in facilities, including some large coal plants. The grid operator, Electric Reliability Council of Texas, told ScienceInsider that the actual load on the system between 5 and 6 a.m. on 2 February was 52,556 MW. The 50 plants that went down should have been providing some 7000 MW of power; another 12,000 MW in generating capacity was down due to scheduled maintenance.

But the unusually low temperatures didn't prevent the windmills from operating. Between 3500 and 4000 MW was provided by wind turbines in the state, roughly 7% of the demand (wind power makes up about 10% of the state's installed capacity, although at any one time not all of it is working.) Energy economist Ryan Wiser of Lawrence Berkeley National Laboratory in California says that any one wind turbine can fail and that in general the power source "has a level of unpredictability" greater than for most traditional sources. But, he says, "When a 2000MW [power] plant goes offline, that's a big intermittency."

There's also a cost issue there: wind variability is generally fairly predictable, so so-called nonspinning reserves can be deployed to react when wind power resources are expected to produce less. (For example, a small gas plant can start up in 10 to15 minutes if wind capacity is dropping.) By contrast, power operators must maintain more expensive "spinning reserves" at power plants to be able to respond to big, unexpected shutdowns of coal, gas, or nuclear plants. That's energy that plants could be selling, but has to be held in reserve just in case.

"I think the broad message is that all types of generators have different characteristics and that they all work together to try and provide a reliable system," engineer Brian Parsons of the National Renewable Energy Laboratory in Golden, Colorado, wrote in an e-mail to Insider. "That said, it is a good thing that wind was able to contribute during a time of grid stress. ... So often we see (possibly overblown) concerns raised regarding wind's negative impact on the grid."

[28] Eli Kintisch (8 February 2011) When Wind Is Reliable: Turbines Help Texans Avoid the Dark

7. Property Values Show Little Impact from Wind Farms

There has long been debate about the effect of wind farms on property values, with the perception that "industrial" development in otherwise "pristine" rural landscapes may have an adverse impact on resale values. International studies undertaken to quantify the impact in a range of countries actively involved in wind energy development have found no conclusive evidence of a negative effect, and in the case of a study in the UK Kittas Valley, the proposed development had "*significant positive benefits for the community".*[29]

In Australia, studies undertaken by the Australian Wind Energy Association (now a part of the Clean Energy Council) revealed no evidence of change in property prices as a result of wind farms. At the Salmon Beach Wind Farm in Esperance, WA, of 15 properties evaluated, only one decreased in value after the construction of a wind farm, but this was related to subdivision activity rather than proximity to the wind development.[30] A recent assessment by the NSW Valuer General also found that *"wind farms do not appear to have negatively affected property values in most cases".* In the small number of cases where sales prices *correlate* with the construction of a wind farm, the direct impact is unclear. Further, the NSW report found that *"no reductions in sale price[s] were evident for rural properties located in nearby townships with views of the wind farm".*[31]

In Pacific Hydro's own experience, rather than having a negative impact on property values, wind farms provide rural communities and land holders with a mechanism to diversify their income base and drought proof agricultural tenements through lease agreements with wind developers.

Pacific Hydro's Portland Wind Energy Project (which includes the 58 MW and 44 MW wind farms at Cape Bridgewater and Cape Nelson South (commissioned in 2008 and 2009, respectively) appear to have had no discernible impact on property values in the area. This is supported by recent media articles noting that at Cape Bridgewater, property values have continued to rise in response to demand for properties in the area and surrounding Portland region.[32]

"*My family lives in Codrington on a property adjoining the existing wind farm run by Pacific Hydro. We have lived here for approximately ten years and the wind farm was in existence prior to our purchase….Over the last ten years property values in this area have more than doubled."*
Gordon Monsbourgh, Codrington

[29] See ECONorthwest (2006). The Economic Impacts of the Proposed Kittitas Valley Wind Power Project in Kittitas County, WA. See also, Renewable Energy Policy Project (2003), The Effect of Wind Development on Property Values.
[30] AusWEA (date unknown), Fact Sheet 12: Wind Farms and Land Values
[31] NSW Department of Lands (2009). Preliminary Assessment of the Impact of Wind Farms on Surrounding Land Values in Australia. p 2.
[32] Portland Observer (November 2010). Consistent high-end demand has realtors smiling.

8. Rationale for Action on Climate Change

Climate change is real and has significant consequences for Australia if we do not take action to reduce emissions and *at the same time* ensure that we adapt and increase our level of resilience to cope with increasing changes to our climate. There is broad community support for action on climate change[33] and increasing concern about how our infrastructure will cope with increasing extreme weather events.

Scientific evidence for climate change is strong. The World Meteorological Organisation's latest update notes that, based on observed data from NASA, the UK Meteorological Office Hadley Centre and the US National Climatic Data Center, *"the 2010 data confirm the Earth's significant long-term warming trend".* Further, last year showed that *"arctic sea-ice cover in December 2010 was the lowest on record, some 1.35 million km2 below the 1979-2000 average for December".*[34]

As noted in a recent Australian report from the Prime Minister's Science, Engineering and Innovation Council (PMSEIC), *"there [is] evidence that the earth has warmed by about 0.8 degrees since pre-industrial times, and that [...] emissions from human activities are a primary cause."* This evidence is based on robust, peer reviewed research over many decades and thousands of studies.[35]

PMSEIC's report warns that if humans continue to drive up greenhouse gas emissions following a business as usual approach (i.e. low or limited action), *"further warming of several degrees is expected to occur, accompanied by many other climate changes to rainfall patterns, sea levels, ocean currents, ice sheets, ecosystems, food production systems and much more".*[36] Climate change is evident in Australia, with the continent warming by about 0.7 degrees from 1960 to 2009 and *"increasing evidence that human-induced climate change"* is a clear contributor to ongoing change.[37]

Australia, says PMSIEC, is *"highly vulnerable to climate change".*[38] As such, the policy rationale for acting to reduce our exposure to current and future climate change is clear: To reduce that level of vulnerability and to increase our capacity to adapt across infrastructure, industries, communities and society to less emitting, more efficient technologies and practices. This includes shifting our energy supply system to low and zero emissions generation.

Reducing emissions from energy generation is vital to lowering greenhouse emissions as fossil fuel combustion is by far the largest contributor to global emissions. Renewable (zero carbon) energy generation has a very significant role to play in ensuring ongoing and reliable supplies of energy are maintained and emissions are reduced.

8.1 Australia's Renewable Resources in Context

As noted by Nobuo Tanaka, Executive Director of the International Energy Agency, 2010 saw renewables – across the world – become the second-largest source of electricity behind coal, reflecting *"government support* [across many countries], *prospects for higher fossil fuel prices and declining investment costs"* in renewable technology deployment.

Under the IEA's 2030 reference scenario, the World Energy Outlook predicts that the share of non-hydro renewables (much of which will be wind generation) will grow by a significant proportion.

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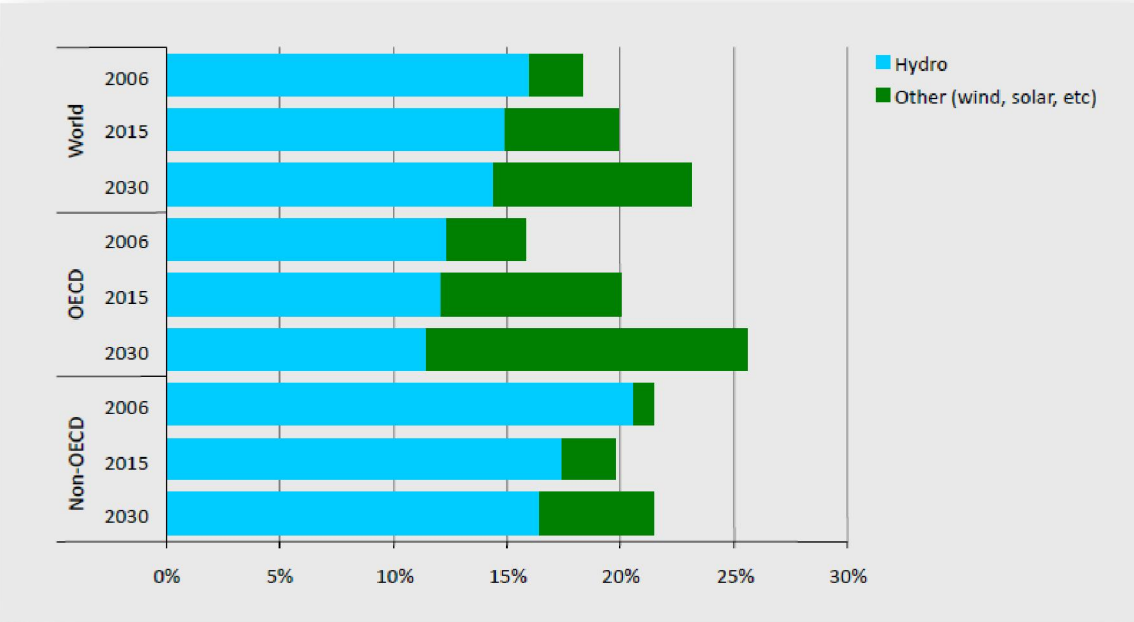
33 See for example, Ipsos Mackay (2010). Climate Change Report 2010.
34 WMO (2011). 2010 equals record for world's warmest year. Media Release # 906, 20 January, 2011
35 PMSEIC (2010). Challenges at Energy-Water-Carbon Intersections. Prime Minister's Science, Engineering and Innovation Council, Canberra, Australia. p. 13
36 Ibid
37 Ibid.
38 Ibid.

The IEA's scenario modelling shows that wind generation is likely to grow significantly and provide more generation capacity than nuclear by 2030, as shown in Figure 4 (below).

Figure 3: Share of renewable in electricity generation in the Reference Scenario (IEA World Energy Outlook, 2008). Presentation by N. Tanaka

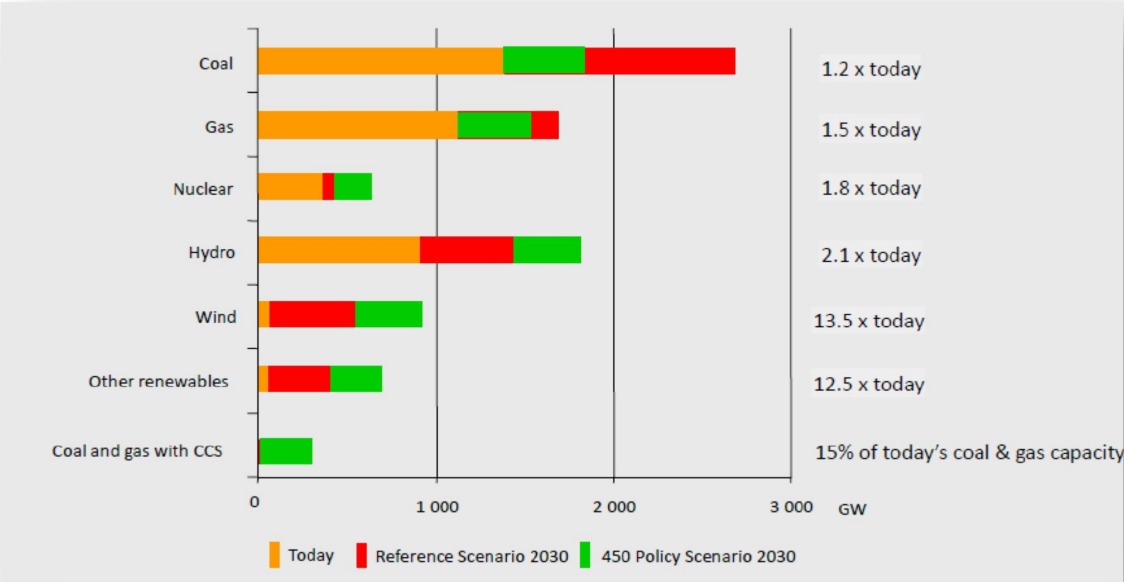


Australia is blessed with significant renewable resources that are distributed across the country.[39] As noted in the 2010 Australian Energy Resource Assessment, we have "*some of the best wind resources in the world, located in western, south-western and south eastern regions but extending hundreds of kilometres inland and including highland areas in south-eastern Australia*".[40]

To deliver on a global target to reduce CO2 emission levels to 550 parts per million, or even 450 ppm, the IEA's outlook shows that renewables and biofuels will play a very significant role alongside much increased levels of energy efficiency, as shown in Figure 5.

[39] Australian Government (2010). Australian Energy Resource Assessment. p.20
[40] Ibid.

Figure 4: Total power generation capacity today and in 2030 by scenario. IEA WEO, 2008.



Onshore wind generation is already a major contributor already to Australia's renewable generation portfolio and will continue grow in order to meet the 20 per cent renewable energy target for 2020, taking advantage of natural wind resources, project and development economics and increasing network management capabilities (outlined further in Section 4).

The importance of wind energy to the reduction of greenhouse gas emissions in Australia is further illustrated by a recent report produced by the Department of Climate Change and Energy Efficiency[41] which states the following:

While in previous decades, emissions from electricity generation have accounted for the majority of growth in emissions, from 2010 to 2020 they are projected to increase by only 6 per cent (or 12 Mt CO2-e), much lower than the historical growth rate. This is primarily due to the increased electricity generated by renewable technologies, promoted by the Renewable Energy Target.

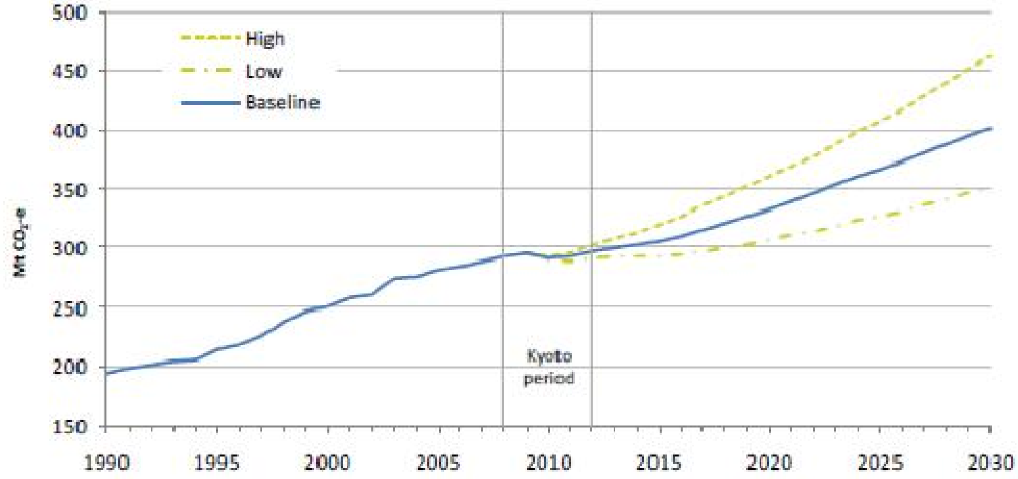
The impact of emissions abatement measures in the stationary energy sector is estimated to be 26 Mt CO2-e per year over the Kyoto period, increasing to 85 Mt CO2-e in 2020. Major emissions abatement measures in the Stationary Energy sector include the Large-scale Renewable Energy Target and the Small-scale Renewable Energy Scheme, energy efficiency measures and other State and Local Government measures.

These projections indicate that the Large-scale Renewable Energy Target will play a major role in reducing greenhouse gas emissions below a business as usual scenario over the coming decade. It is universally agreed that wind energy will play a lead role in achieving these targets.

The following figure, taken from the recent Department of Climate Change report, clearly demonstrates the impact of the Large-scale Renewable Energy Target

[41] Department of Climate Change (2011) Australia's Emissions Projections

Figure 8 Stationary energy emissions projection



Source: Department of Climate Change (2011) Australia's Emissions Projections

9. Industry Regulation and Compliance

The commercial viability of a wind farm relies on optimisation of wind turbines to maximise output and, consequently, to deliver the highest potential abatement. This assists in meeting the LRET, lowering actual emissions and – as noted earlier – suppressing the likelihood of high-priced events in the NEM.

Pacific Hydro believes that, consistent with other industrial [infrastructure] developments, each development should be addressed on a site-by-site basis to understand amenity impacts in terms of noise, visual impact, shadow flicker, local fauna and flora and to determine the acceptability of a particular project.

In Australia, regulation of wind farm developments is guided by strict state and federal planning and environmental laws providing one of the most rigorous assessment regimes in the world. Wind farm planning applications are required to be accompanied by comprehensive environmental impact assessments including flora and fauna impacts, noise assessments and visual amenity.

Historically, due to the new to market technology aspects of wind energy, the industry has typically adopted a far higher standard of rigour when carrying out assessments than other infrastructure developments. This assessment process commonly results in a raft of mitigation measures being embedded within the wind farm design or adopted during construction and operation. In addition, long-term monitoring of identified potential impacts is carried out at wind farm facilities in order to verify the accuracy of previous environmental assessments.

It is our experience that proponents of wind energy facilities take social and environmental compliance very seriously as to do otherwise is simply poor business practice. For example, we have in place management procedures that must be engaged in the unlikely event that the rare orange-bellied parrot is sighted close to our operational wind farms near Port Fairy. Through a monitoring program, established with the assistance of local bird watchers [ornithologists], we are able to shut down turbines if orange-bellied parrots are sighted within the vicinity of these wind farms.

This process was activated twice in 2008, when Pacific Hydro shut down the turbines at the Yambuk wind farm when alerted that a number of parrots were feeding in the vicinity. As part of our overall mitigation strategy we have also provided funding to Greening Australia to assist them expand salt-marsh habitat for the endangered parrot in the local area[42].

Given the comprehensive planning process already in place we consider that (arbitrary) measures such as set buffer distances are counter-productive as they are not based on scientific processes and can affect the project's capacity to deliver the highest possible abatement.

Pacific Hydro believes that wind farms should be subject to the same planning and development principles as other infrastructure and as a matter of fairness and competitive neutrality with other forms of energy generation should not be forced into a higher level of compliance.

Suggestions to establish mandated 'buffer zones' of two kilometres for wind farms would jeopardize many billions of investment dollars and could set a precedent for other infrastructure. In 2010, the NSW Land & Environment Court considered calls for such a zone in relation to the Gullen Range Wind Farm. The court refused to apply a blanket two kilometre setback, noting that was an *"unsubstantiated empirical standard"* and not founded on a proper basis. The court said assessments of impacts on properties should be done on an individual basis taking into account specific impact assessments, topography, orientation of houses, distances to visible turbines etc.

Wind farm developments are complex in nature with no two circumstances being the same and therefore we agree with the NSW Land & Environment courts view that each project should be dealt with on its merit.

[42] The Age (2009). Flying right for rare parrot. By John Elder, 6 September 2009.

In Conclusion,

- Pacific Hydro has shown there is strong community support for wind farms and many positive social, environmental and economic benefits especially in regional and rural communities.

- We submit that the health impacts associated directly with wind farms are tenuous and existing guidelines provide sufficient balance for both developers and communities.

- We submit that wind farms provide much needed economic stimulus in regional Australia creating job opportunities, driving regional and rural investment as well as providing support for social and community initiatives.

- We submit that wind generation is efficient and clean, delivering emissions abatement, contributes to lower wholesale energy prices and is by far the lowest cost, most deployable form of renewable energy available to meet the Renewable Energy Target.

- Finally, Australia's Network Operators are able to manage wind generation and forecast availability with good accuracy and do not consider wind to be an issue with regard to market or network stability.

Appendix A: Community Support for Wind farms

- QDOS Report
- Letter from former Ararat Mayor
- Selected letters to the editor

TIMELY, PROFESSIONAL & RELEVANT RESEARCH

Report

July 2010

QuickTime™ and a
decompressor
are needed to see this picture.

Prepared for

Pacific Hydro

Prepared by

Qdos Research
Timely, professional and relevant research

Contact

John Armitage
Research Director
Level 17 461 Bourke Street Melbourne, 3000

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1. RESEARCH PURPOSE AND OBJECTIVES

Background

Pacific Hydro currently operates five wind farms in Victoria and has two further projects awaiting planning approval.

The Victorian Government has recently undertaken a thorough review of the planning process for wind farms in Victoria seeking to remove barriers to investment.

The recent Victorian Opposition wind farm proposal puts doubt into billions of investment and jobs and seems to be at odds with rhetoric in support of new wind energy projects in the state.

Purpose and objectives

Pacific Hydro commissioned Qdos to undertake quantitative research to examine Victorian's attitudes to wind energy.

The survey was designed to:

- Measure the attitude of the general community to wind energy
- Measure the importance placed on Environmental issues compared to key Government service areas.
- Measure the support for building electricity generating wind mills compared to other energy generating sources.

2. METHODOLOGY AND SURVEY ACCURACY

Research

602 people were surveyed across Victoria for the research project. The survey was conducted across ten different state electorates to include:

- A range of respondents from city and country areas
- Seats where there is not high support for the Greens
- Respondents who are likely to have mixed (high and low) awareness of the issue

The overall margin of error for the survey is +/- 4%. In simple terms this means that if the survey found that say 50% of voters gave a particular answer to a question it is likely that between 46% and 54% of all voters would share that view.

However, some smaller subgroups have a higher margin of error for example voters in Mordialloc comprised 60 people. The margin of error for that group is about +/- 13%.

3. DEMOGRAPHICS

Respondent demographics

Overall, 602 respondents were surveyed across Victoria.

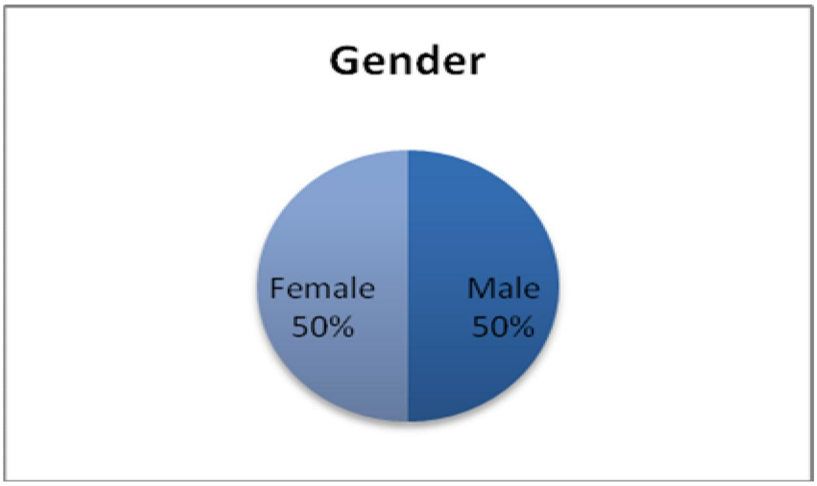

Figure 1: Gender

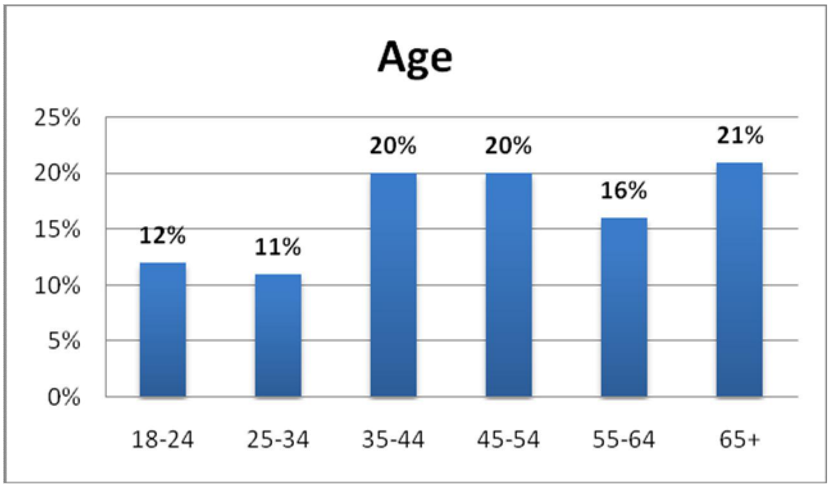

Figure 2: Age

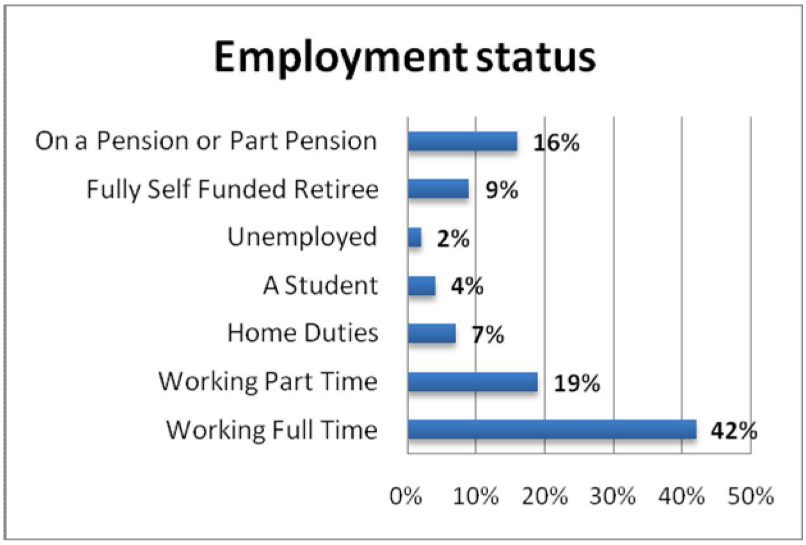

Figure 3: Employment status

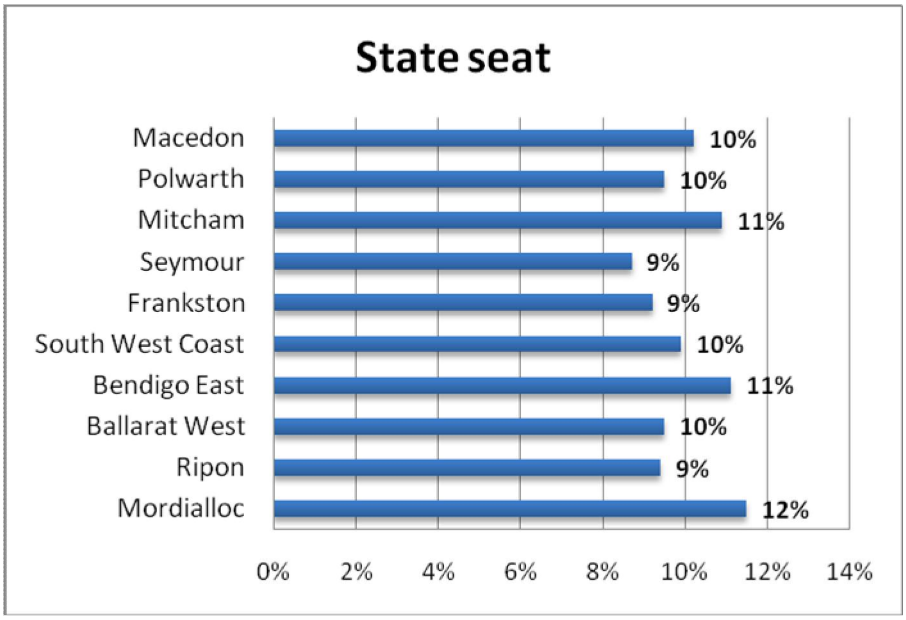

Figure 4: State seat

4. FINDINGS

Voters believe that health and education are most important areas of responsibility for government

Health and education were considered the most important things for a government to do well. The majority (92%) of voters said that rated the importance of government *providing quality health services* as high or very high and 89% gave the same importance rating to *Providing quality education services.*

These importance ratings are consistent with those founds in the 2002 survey where was again received a total of 92% who rated its importance as high or very high and 91% gave the same importance rating to education.

Protecting the environment was considered by respondents to be the most important environmental issue with over two thirds (70%) of people giving it a total high importance rating.

Ranking of the importance of government performance on key issues was consistent across all sub groups although the electorate of Seymour tended to rate environmental issues as being more important. For example those in Seymour gave a total importance ranking of 83% for *Protecting the environment* and 90% for *Preventing plants and animals becoming extinct* compared to 68% overall.

It should however be kept in mind that this group of respondents is small and subject to a higher margin of error (as are each of the electorates included in the survey).

Importance rating of government responsibilities							
	Very Low	Low	Moderate	High	Very High	Don't Know	MEAN
	%	%	%	%	%	%	
Providing quality health services	0*	1	7	41	51	1	4.4
Providing quality education services	0*	1	9	47	42	1	4.3
Reducing crime levels	1	2	15	45	36	0*	4.2
Creating employment	0*	2	16	52	29	1	4.1
Ensuring a reliable electricity supply	1	2	24	48	24	1	4.0
Preventing plants and animals becoming extinct	1	4	27	40	28	1	4.0
Protecting the environment	0*	3	26	44	26	1	3.9
Reducing air pollution and improving air quality	1	4	26	47	21	0*	3.8
Reducing greenhouse gas emissions such as carbon dioxide	1	6	24	42	25	2	3.8
Reducing logging in native forests	2	9	34	33	19	3	3.6

(Less than 0.5%)

Table 1: Thinking about the things that are important for a government to do well would you rate the importance of...?

Voters strongly support electricity generating wind mills

The majority of voters (81%) support building electricity generating wind mills. This level of support is consistent across the ten State electorates.

Just over half (54%) of those surveyed support building gas fired power plants.

Almost two thirds of voters (65%) oppose building a coal burning power plant while 24% support this proposition.

Level of support for electricity supply options						
	Strongly Oppose	Oppose	Support	Strongly Support	Don't Know	MEAN
	%	%	%	%	%	
Building a new coal burning power plant	22	43	21	3	12	2.1
Building gas fired power plants	6	23	44	10	17	2.8
Building electricity generating wind mills	3	9	44	37	8	3.2

Table 2: Do you support or oppose...?

When voters were required to choose only one preferred option for meeting increasing energy demands 7 in 10 (70%) chose *Building electricity generating wind mills.* Almost a quarter (24%) chose *Building gas fired power plants* and the remaining 6% of voters preferred *Building a new coal power plant.*

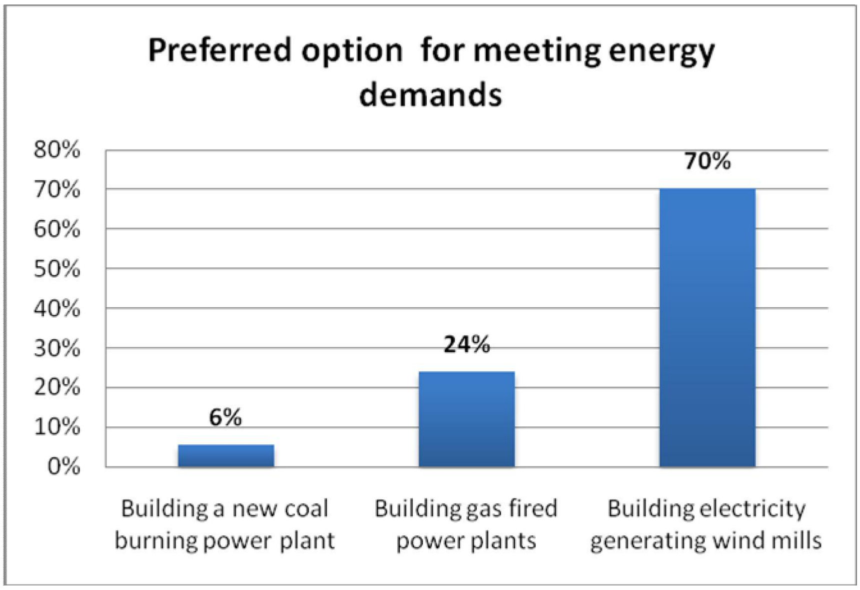

Figure 5: If you had to pick one of these as your preferred option which would it be?

As a Former Mayor [5 times] and Councillor of the Ararat Rural City I feel the concerns of the noise, vibrations and health effects suffered by people in close proximity to Wind Farms are imaginary.

Pacific Hydro is the company involved in this area with Wind Energy.

The Municipality of Ararat is so much more aware of the environment that we all live in and realize along with the children how important wind energy is to help protect the world environment...

When the proposal was put before my Council to build these Wind Farm there was not one objection from anyone received from the local community.

The local businesses and the population had the opportunity to comment on the proposal but in the years of towers being in this community there has not been one complaint about noise, health effects or any side effects.

The children make small models in kit form as a way of understanding the concept and how wind energy generates power.

The people of Ararat have not experienced any side effects from the Wind Towers and warmly embrace the important contribution we can all make to the environment.

The community attend a tour that the local Festival conducts each year and cannot understand how some people complain about the noise and vibrations that occur from Wind towers.

The farms that the towers stand on have a steady income each year which is wonderful when farmers are under stress from droughts and now floods.

Pacific Hydro also contributes to a Community Fund of $50,000.00 which has seen so many community groups and charities benefit from this fund.

This funding has allowed so many important projects receive funding with some projects that are vital for the survival of this community.

Yours Sincerely,

Gwenda Allgood J.P.

(Email to Pacific Hydro – 25 January 2011)

Letters to the editor

Preference will be given to typewritten letters of not more th
or not publish any letter. Letters must contain the writer's ful
circumstances only will a req
Send letters to PO Box 431, Portland VIC 3305; 1

Wind turbines

I WRITE in reply to "Wind turbine health warning" Observer 10/01/11.

I agree that everyone has the right to push a personal barrow for whatever cause may take their fancy, or to promote their ideological beliefs, but I draw the line at the person or persons using scare tactics to promote them.

Dr Sarah Laurie of the Waubra Foundation is a case to ponder, where her passion to make a point, leaves her common sense questionable.

Her assertion that people living in any proximity within five kilometres of wind turbines, should buy blood pressure monitors and take their blood pressures when they first woke up, is alarming to say the least.

It is a well-known medical fact that early morning blood pressures are higher than at other times through the day.

For untrained people to rush out and buy monitors is not the way to go, especially as there is much evidence to contradict what Dr. Laurie is espousing.

I suggest that people who want to know the other side of the story, go online. There is a wealth of information regarding Wind Turbines based on much scientific fact.

L.W.JOHN
Portland

IF wind towers are so detrimental to a person's health, how come they have been installed in so many countries throughout the world? Germany, Denmark, USA and China to name just a few. Surely the health experts of these countries would have thoroughly investigated each and every proponent of the make up of such towers. A wind turbine is a machine made up of two or three propeller blades called the rotor. The rotor is attached to the top of the tall tower. As the wind blows it spins the rotor, and as the rotor spins the energy of the movement of the propeller gives power to the generator. The electricity is made up of magnets and a lot of copper wire.

I don't have a tower near me, I wish that I did, all I have is an ugly power pole with lines stretched across the vista of overlooking the Portland harbour.

I have stood beneath towers in Western Australia, New South Wales, South Australia, and in our locality of Codrington and Bridgewater and the only noise is a gentle "swoosh" as the blades turn. We, in this area of Victoria live in a windy, but beautiful part of the countryside. We might have wind towers but we also have ugly power lines.

When the power line went in for Alcoa, nobody complained of getting sick, but stock wouldn't graze beneath the lines and the grass didn't grow, but that is all in the past, Those lines are a blot on our landscape, whereas a wind tower is like a fish in a bowl, mesmerising; you can stand watch them turn and wonder at what they are producing.

Maybe the cynics of the world would like us to go back to the days of tilley lamps, 32 volt plants and diesel plants all using fossil fuel, and where would industry be today and where would you be? You wouldn't have the power to use your computers, telephones and other technology that the world we live in now uses.

The energy that the wind towers generate is renewable, which means that as long as the wind blows there is power to turn the blades of the rotor and thus putting power into the grid. Using this type of energy means that there is less fossil fuel (coal and oil) used to make electricity. Burning fossil fuel pollutes the atmosphere and adds greenhouse gases to it, which in turn means that pollution could be a cause of global warming.

ANN PARRY
Narrawong

I WRITE in response to last Monday's front page article ("*Wind turbine health warning*" 10/1/11) in which the visit of full-time anti wind energy activist Sarah Laurie was reported.

It's not the first time that full-time political activists have visited Portland and done their best to hurt local businesses and threaten the jobs of people who rely on those businesses to build a future and support their families.

Ms Laurie's scaremongering visits to towns all across Australia in recent months are apparently funded by the highly secretive Waubra Foundation, which has consistently failed to disclose its own funding sources. People in Portland are entitled to ask which kind of shady interests would put big dollars behind a campaign against renewable energy and jobs.

For the record, wind energy is one of the safest ways of generating electricity. Unlike other forms of power generation, wind farms don't produce greenhouse gas emissions, or any other kind of air or water

IITORS

Portland Observer
14/01/2011
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By: Daryl O'Flaherty
Section: Letters
Region: Portland VIC Circulation: 3586
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Size: 158.00 sq.cms
Frequency: M-W-F--

Wind turbines

WHAT are these so-called 'Landscape Guardians' on about with regard to wind energy?

When you have independent scientific reports and analysis showing that the "so-called symptoms of nausea and dizziness" associated with wind turbines are clearly not a major health issue.

These reports and data are collected and analysed by independently scientific sources. These findings are not taken lightly by the wind energy developers. Can the Landscape Guardians bring up any evidence to show otherwise?

In relation to nausea and dizziness I am more than certain it's a fear of the unknown influencing people's health rather than wind. It has happened in the past with the motorcar, electric lighting and new medical techniques and drugs. It's human nature and one that will never change no matter what.

Another factor that has come to light is jealousy between landowners over the turbine sites and monies paid to the landowner. Recently one vocal opponent of wind energy came out in support of a new proposal where monies paid to one landowner would also be in a shared arrangement with all neighbouring landowners. Another element of human nature, jealousy.

One president of a Landscape Guardian Group in a recent newspaper article put forward statements that were just his opinion and I ask as to what expertise he has in the area of wind energy other than putting forward scare mongering arguments. Most of these people suffer from one problem; ignorance.

The map that was put forward is part of what is a major plus for this region in relation to creating employment in the manufacturing, transport, construction and maintenance of these wind energy developments.

In this creation of employment it has a flow on effect for the whole of the south west of Victoria as monies will be earned and spent in buying goods of a varying nature; fuel, tyres, food, clothing and family items. Taxes will be paid by the workers and the companies and this is added to the revenue of Australia for all people.

Also superannuation has to be paid and this flows on so as to allow workers to retire at a fair and just living standard as not all access to schemes available to some others.

I would call on the Landscape Guardians to view the Keppel Prince operation and the Port of Portland, when the ships are unloading components, and also the professional operation of transporting components to site and view the employment it creates and monies earned for this region.

Issues that are taken into account before a wind farm is developed are wind availability, suitability of roads to transport components, environment and flora and fauna.

Most importantly go to a wind farm and see for yourselves these magnificent structures and the potential they have for this region.

An industrial blight, what rubbish, could be nuclear or coal in our part of the state, some sea change that would be.

DARYL O'FLAHERTY
Strathkellar

Appendix B: Sonus Report

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INFRASOUND MEASUREMENTS FROM WIND FARMS AND OTHER SOURCES

Prepared for:

Pacific Hydro Pty Ltd
Level 11, 474 Flinders Street
Melbourne VIC 3000

November 2010

CONTENTS

EXECUTIVE SUMMARY

Infrasound is generated by a range of natural sources, including waves on a beach and against the coastline, waterfalls and wind. It is also generated by a wide range of man-made sources such as industrial processes, vehicles, air conditioning and ventilation systems and wind farms.

Specific International studies, which have measured the levels of infrasound in the vicinity of operational wind farms, indicate the levels are significantly below recognised perception thresholds and are therefore not detectable to humans.

The measurement of infrasound at low levels requires a specific methodology, as it is readily affected by wind on the microphone. Such a methodology has been developed for this study to measure infrasound from two Australian wind farms for the purposes of comparison against recognised perception thresholds. This study also measures the levels of infrasound from a range of natural and man made sources using the same methodology for the purposes of comparison against the wind farm results.

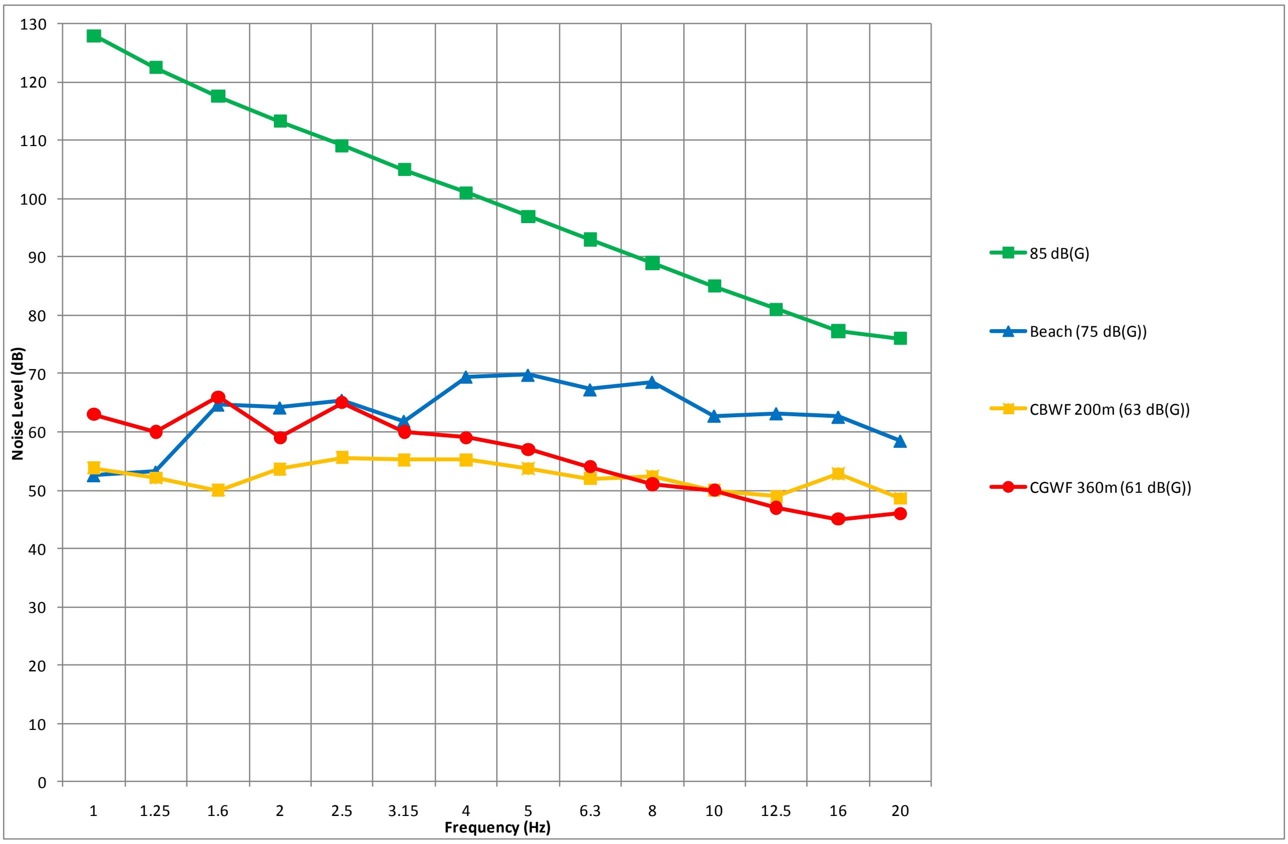
The specific methodology is based on measurements being conducted below the ground surface in a test chamber that is approximately 500mm square and 500mm deep to reduce the influence that even light surface breezes can have on the infrasound results.

The below ground methodology has been tested as part of this study and it has been confirmed that levels of infrasound above the ground and within the chamber are the same in the absence of surface winds when measuring a known and constant source of infrasound.

The methodology has also been tested on site, and it has been confirmed that the expected theoretical reduction in infrasound of 6 dB per doubling of distance can be measured from a wind turbine. This reduction cannot be measured above the ground surface due to wind on the microphone influencing the results. This result confirms that the below ground methodology is able to reduce the influence of wind on the microphone to identify the level of infrasound from a noise source.

Infrasound was measured at two Australian wind farms, Clements Gap in the mid-North of South Australia (CGWF) and Cape Bridgewater in the coastal region of south-western Victoria (CBWF), using the below ground methodology. Infrasound was also measured in the vicinity of a beach, the coastline, a central business area and a power station using the below ground methodology.

A summary graph of the results of the infrasound measurement results at the wind farms and at a beach are shown below against the perception threshold for infrasound established in international research as 85 dB(G).



Summary Graph – Infrasound measurement results from two Australian wind farms (Clements Gap at 61 dB(G) and Cape Bridgewater at 63 dB(G)) compared against measurement results at a beach (measured at 75 dB(G)) and the internationally recognised Audibility Threshold (85 dB(G))

The measurement results indicate that the levels of infrasound in the vicinity of the two Australian wind farms are:

- well below the perception threshold established in International research as 85 dB(G); and
- of the same order as other International infrasound measurement results (a table summarising the results of other measurements is provided in this study); and
- of the same order as that measured from a range of sources including the beach, the Adelaide Central Business District and a power station.

This Australian study therefore reinforces several international studies by government organisations that infrasound emissions from wind farms are well below the hearing threshold and are therefore not detectable to humans.

This study goes beyond the international studies by providing comparative measurements of natural and other human made sources. These sources, including waves on a beach and motor vehicles, have been found to generate infrasound of a similar order to that measured in close proximity to wind farms.

In addition, measurements of the transfer of infrasound from outside to inside a dwelling have been made in this study, to confirm that the levels of infrasound inside a dwelling will be lower than the levels of infrasound outside a dwelling for an external noise source. This information is important because there is limited research available on this transfer.

INTRODUCTION

Noise is often the most important factor in determining the separation distance between wind turbines and sensitive receivers. The assessment of noise therefore plays a significant role in determining the viability of and the size of wind farms.

Australian States presently assess the noise from wind farms under a range of Standards and Guidelines. These Standards and Guidelines do not provide prescriptive requirements for infrasound from wind farms due to the absence of evidence that infrasound should be assessed.

Notwithstanding, there have been concerns raised by the community regarding infrasound levels from wind farms.

Pacific Hydro has therefore engaged Sonus to make an independent assessment of the infrasound produced by wind farms.

To further investigate infrasound in the vicinity of Australian wind farms, this study:

- Develops a methodology to measure infrasound that minimises the influence of wind on the microphone;
- Measures the levels of infrasound at a range of distances from two wind farms;
- Compares the results against recognised audibility thresholds;
- Compares the results with previous wind farm infrasound measurements made in a range of other studies; and
- Compares the results with infrasound measurements made of natural sources, such as beaches, and man-made sources, such as a power station and general activity within the Central Business District of Adelaide.

INTERNATIONAL DESKTOP RESEARCH

Noise is inherently produced by movement. There are two main moving parts that generate the environmental noise from a wind turbine, being the external rotating blades and the internal mechanical components such as the gearbox and generator.

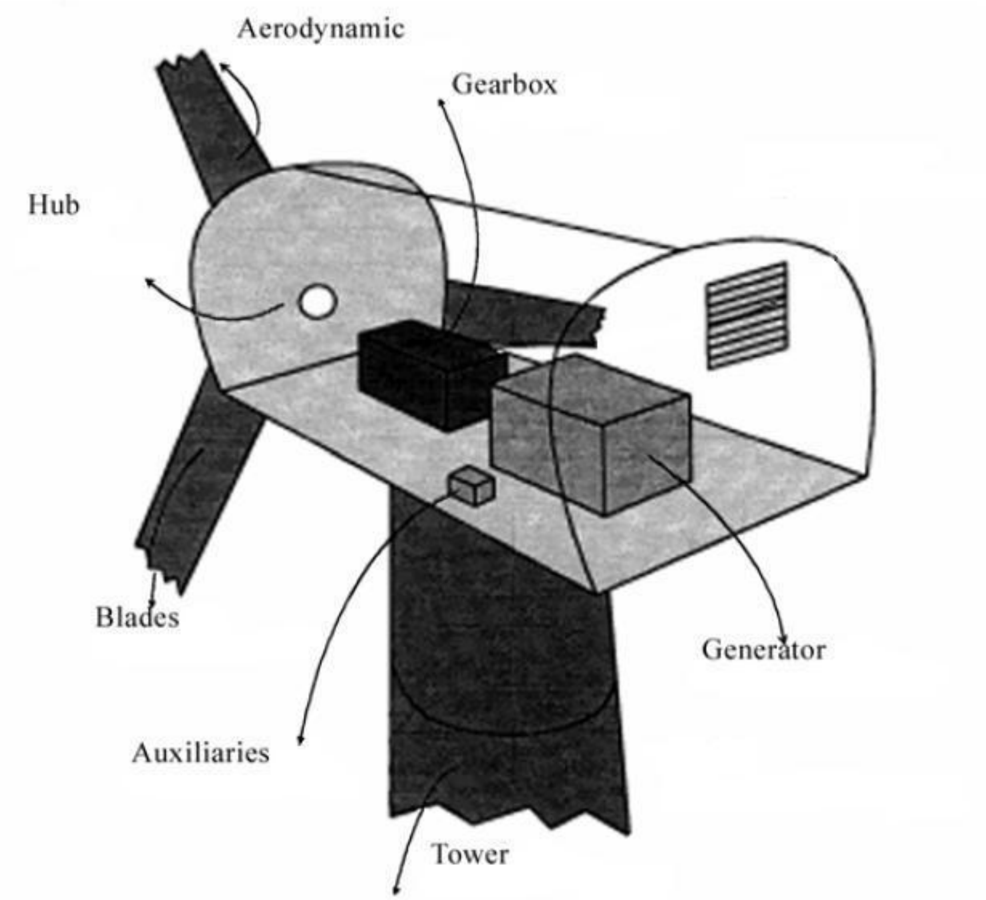


Figure 1 - (Modified from Wagner 1996)

The noise from the blades and the internal machinery are commonly categorised as mechanical and aerodynamic noise respectively.

Mechanical Noise

Mechanical noise sources are primarily associated with the electrical generation components of the turbine, typically emanating from the gear box and the generator. Mechanical noise was audible from early turbine designs, however, on modern designs, mechanical noise has been significantly reduced (Moorhouse et al., 2007).

Aerodynamic Noise

Aerodynamic noise typically dominates the noise emission of a wind turbine and is produced by the rotation of the turbine blades through the air.

Turbine blades employ an airfoil shape to generate a turning force. The shape of an airfoil causes air to travel more rapidly over the top of the airfoil than below it, producing a lift force as air passes over it. The nature of this air interaction produces noise through a variety of mechanisms (Brooks et al., 1989).

Aerodynamic noise is broadband in nature and includes acoustic energy in the infrasound, low, mid and high frequency ranges.

Whilst the aerodynamic noise from a rotating turbine blade produces energy in the infrasound range, there are natural sources of infrasound including wind and breaking waves, and a wide range of man-made sources such as industrial processes, vehicles and air conditioning and ventilation systems that make infrasound prevalent in the natural and urban environment (Howe, 2006).

Aerodynamic noise can be further separated into the following categories which are relevant to the infrasound study:

Amplitude Modulation

Amplitude modulation is most commonly described as a “swish” (Pedersen, 2005). “Swish” is a result of a rise and fall in the noise level from the moving blades. The noise level from a turbine rises during the downward motion of the blade. The effect of this is a rise in level of approximately once per second for a typical three-bladed turbine as each blade passes through its downward stroke.

It was previously thought that “swish” occurred as the blade passed the tower, travelling through disturbed airflow, however, a recent study indicates it is related to the difference in wind speed over the swept area of a blade (Oerlemans and Schepers, 2009).

Other explanations for the rise in noise level that occurs on the downward stroke relate to the slight tilt of the rotor-plane on most modern wind turbines to ensure that the blades do not hit the tower. An effect of the tilt is that when the blades are moving downwards they are moving against the wind. Conversely, when moving upwards they are moving in the same direction as the wind. Therefore, with the effective wind speed being higher on the downward stroke, it is suggested that a higher noise level is produced.

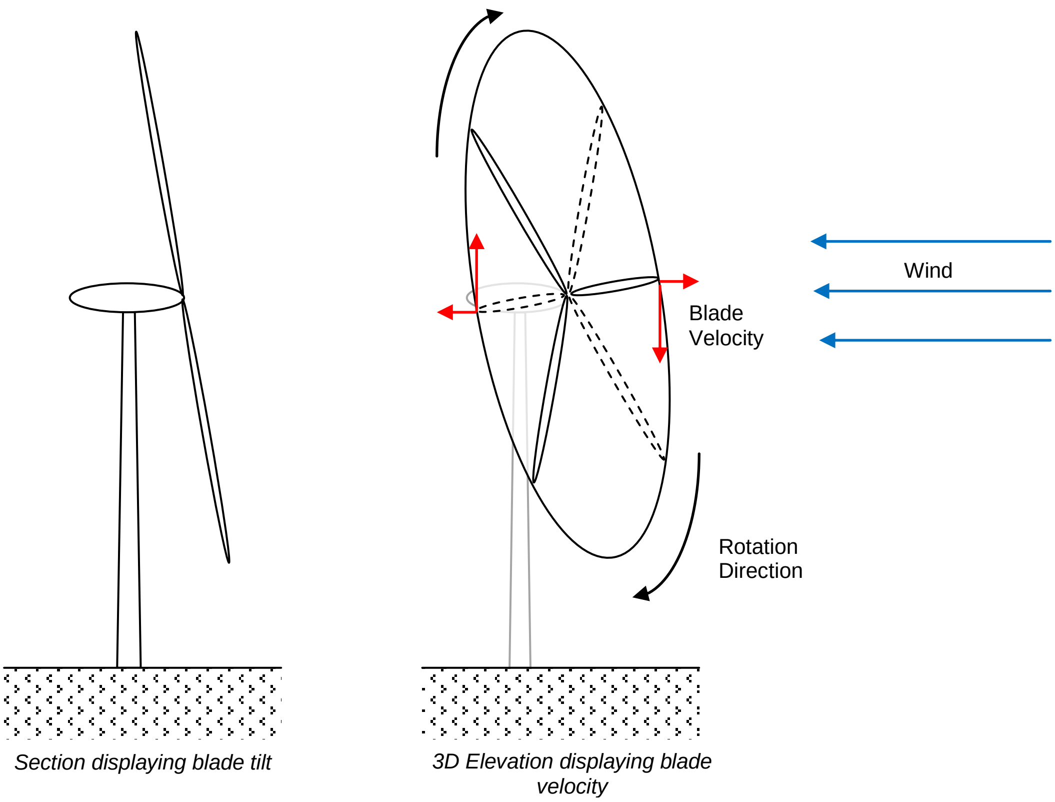


Figure 2 - Blade Velocity due to Tilt

Low Frequency Noise

Noise sources that produce low frequency content, such as a freight train locomotive or diesel engine have dominant noise content in the frequency range between 20 and 200 Hz (O'Neal et al, 2009). Low frequency noise is often described as a "rumble".

Aerodynamic noise from a wind turbine is not dominant in the low frequency range. The main content of aerodynamic noise generated by a wind turbine is often in the area known generically as the mid-frequencies, being between 200 and 1000Hz.

Noise reduces over distance due to a range of factors including atmospheric absorption. The mid and high frequencies are subject to a greater rate of atmospheric absorption compared to the low frequencies and therefore over large distances, whilst the absolute level of noise in all frequencies reduces, the relative level of low frequency noise compared to the mid and high frequency content increases. For example, when standing alongside a road corridor, the mid and high frequency noise from the tyre and road interaction is dominant, particularly if the road surface is wet. However, at large distances from a road corridor in a rural environment, the remaining audible content is the low frequency noise of the engine and exhaust.

This effect will be more prevalent in an environment that includes masking noise in the mid and high frequencies, such as that produced by wind in the trees.

Separation distances between wind farms and dwellings can be of the order of 800 to 1200m. At these distances, in an ambient environment where wind in the trees is present, it is possible that only low frequencies remain audible and detectable from a noise source that produces content across the full frequency range. This effect will become more prevalent for larger wind farms because the separation distances need to be greater in order to achieve the relevant noise standards. A greater separation distance changes the dominant frequency range from the mid frequencies at locations close to the wind farm to the low frequencies further away, due to the effects described above.

Low frequency sound produced by wind farms is not unique in overall level or content. Low frequency noise from other sources that is well in excess of that in the vicinity of a wind farm can be measured and heard at a range of suburban and rural locations.

The low frequency content of noise from a wind farm is inherently considered as part of its environmental noise assessment against relevant standards and guidelines.

Infrasound

Infrasound is generally considered to be noise at frequencies less than 20 Hz (O'Neal et al., 2009). The generation of infrasound was detected on early turbine designs, which incorporated the blades 'downwind' of the tower structure (Hubbard and Shepherd, 1990). The mechanism for the generation was that the blade passed through the wake caused by the presence of the tower.

Audible levels of infrasound have been measured from downwind blade wind turbines (Jakobsen, J., 2005). Modern turbines locate the blades upwind of the tower and it is found that turbines of contemporary design now produce much lower levels of infrasound (Jakobsen, J., 2005), (Hubbard and Shepherd 1990).

Infrasound is often described as inaudible, however, sound below 20 Hz remains audible provided that the sound level is sufficiently high (O'Neal et al., 2009). The thresholds of hearing for infrasound have been determined in a range of studies (Leventhall, 2003). These thresholds are depicted in graphical form below for frequencies less than 20 Hz (Figure 3).

Non-audible perception of infrasound through felt vibrations in various parts of the body is also possible, however, this is found to only occur at levels well above the audible threshold (Moeller and Pedersen, 2004).

Weighting networks are applied to measured sound pressure levels to adjust for certain characteristics. The A-weighting network (dB(A)) is the most common, and it is applied to simulate the human response for sound in the most common frequency range. The G-weighting has been standardised to determine the human perception and annoyance due to noise that lies within the infrasound frequency range (ISO 7196, 1995).

A common audibility threshold from the range of studies is an infrasound noise level of 85 dB(G) or greater. This is used by the Queensland Department of Environment and Resource Management's (DERM's) draft Guideline for the assessment of low frequency noise as the acceptable level of infrasound in the environment from a noise source to protect against the potential onset of annoyance.

The audibility threshold limit of 85 dB(G) is consistent with other European standards and studies, including the UK Department for Environment, Food and Rural Affairs threshold developed in 2003 (DEFRA., Leventhall, 2003), the UK Department of Trade and Industry study (DTI, Hayes McKenzie, 2006), the German Standard DIN 45680, the Denmark National Standard and independent research conducted by Watanabe and Moeller (Watanabe and Moeller, 1990).

The 85 dB(G) audibility threshold limit is shown in Figure 3 below. Other audibility thresholds have also been overlaid to provide a comparison.

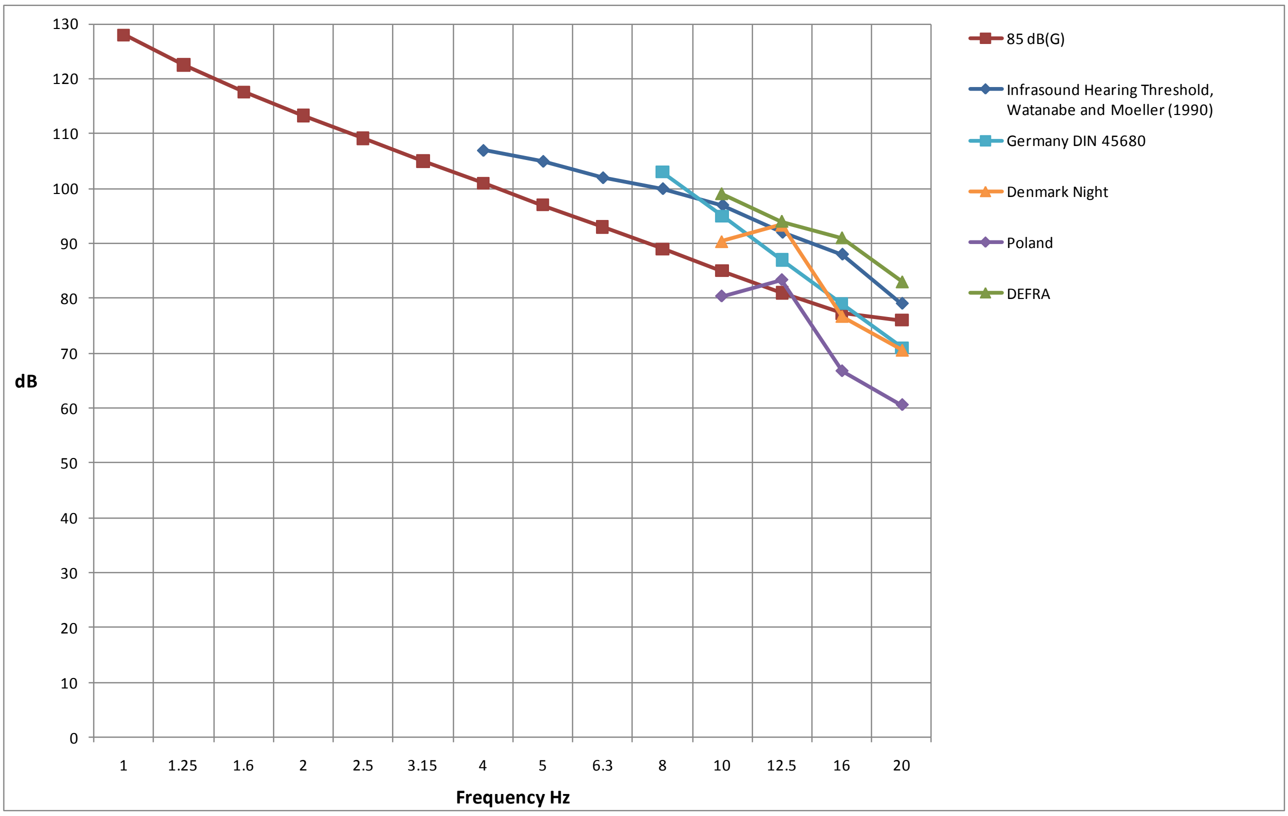


Figure 3 - Audibility Threshold Curves from the Listed Sources

DETERMINATION OF A MEASUREMENT METHODOLOGY

Microphone Mounting Method

A microphone mounting method is provided in IEC 61400-11 (IEC, 2002), as shown in Figure 4 below. The method was developed to minimise the influence of wind on the microphone for the measurement of noise in frequencies higher than those associated with infrasound. This is achieved by mounting the microphone at ground level on a reflecting surface and by protecting the microphone with two windshields constructed from open cell foam.

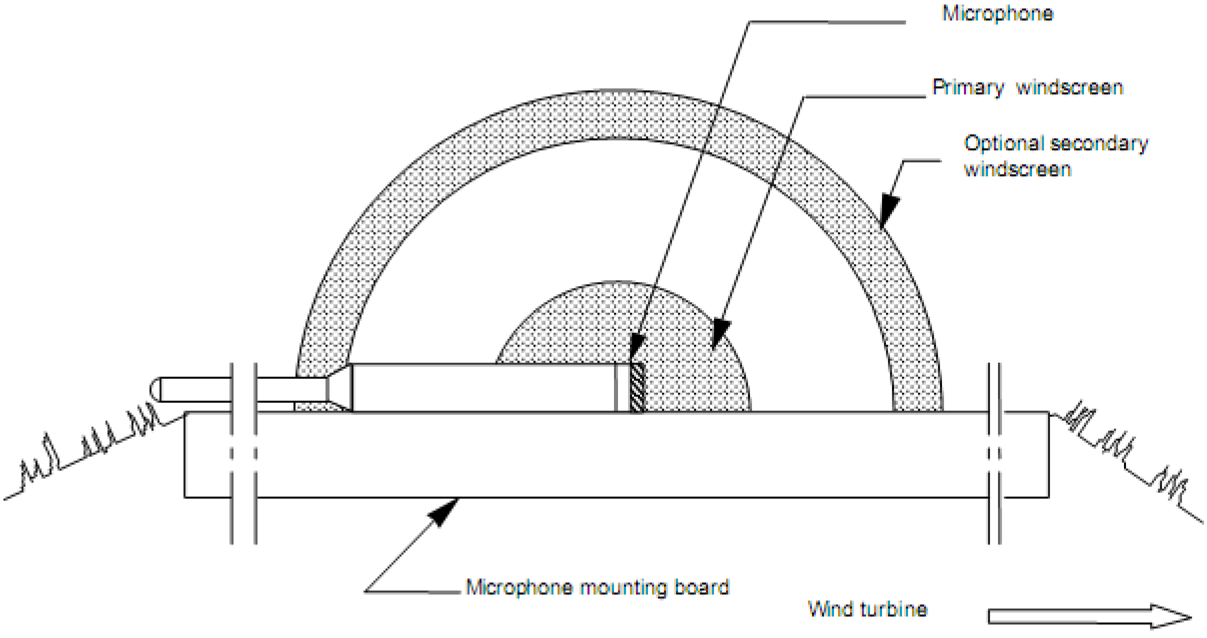


Figure 4 - Mounting of the microphone – vertical cross-section (Reproduced from Figure 1b, IEC 61400-11)

The above method was not developed specifically for the measurement of infrasound, and wind gusts can be clearly detected when measuring in the infrasound frequency range using the above method.

Therefore, this study has developed an alternative method to reduce the influence of wind on the microphone that would otherwise mask the infrasound from the turbine.

A below ground surface method was developed based on a similar methodology (Betke et al, 2002). This method has been adapted for this study, and includes a dual windshield arrangement, with a foam layer mounted over a test chamber, and a primary windshield used around the microphone.

The microphone mounting arrangement is depicted in the following schematic:

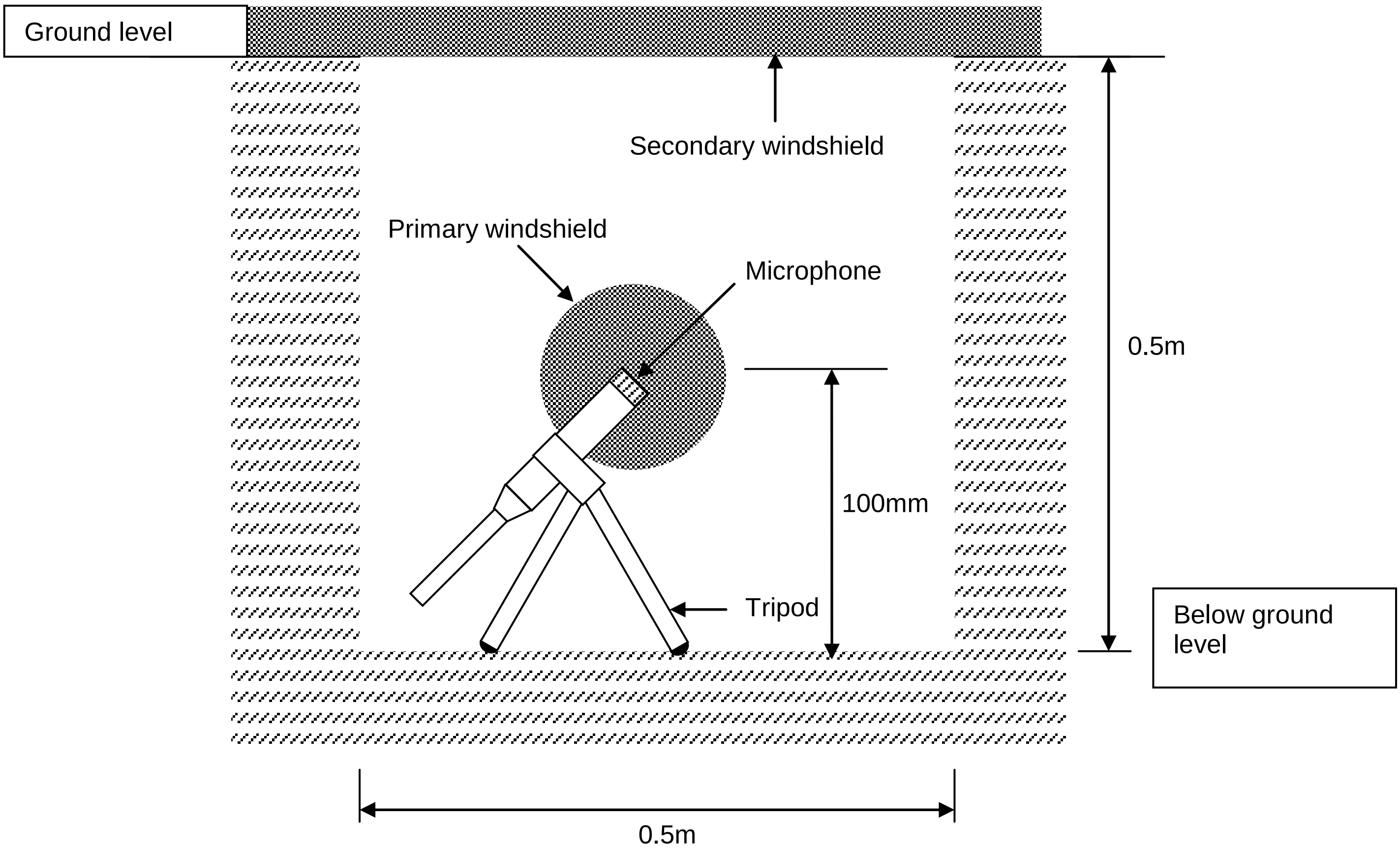


Figure 5 - Schematic of Microphone Position

Inputs

The measurement methodology was developed with the following inputs:

- Literature review related to wind turbine infrasound research;

- Measurements to determine the influence of wind on the microphone using different measurement techniques, including the IEC 61400-11 measurement procedure, placing the microphone in an enclosure above the ground, and placing the microphone in a 500mmx500mmx500mm deep (approximate) test chamber with an open cell foam (acoustically transparent) lid, based on the Betke et al method. The measurements were initially made at locations without any appreciable man made noise sources;

- Measurements to determine the level of transfer of infrasound at a range of different frequencies between 8Hz and 20Hz, from immediately outside a chamber to inside a chamber, under conditions of negligible wind and ambient noise influence. The infrasound noise source (bass speaker and tone signal generator) was placed 10m away from the chamber and 1m above the ground;

- Measurements to determine the level of transfer of infrasound at a range of different frequencies between 8Hz and 20Hz, from immediately outside a lightweight elevated dwelling with windows open, to inside a room within that dwelling, under conditions of negligible wind and ambient noise influence, comprising use of an infrasound noise source (bass speaker and tone signal generator) placed 10m from the dwelling and 1m above the ground;

- Discussions with Mr Andrew Roberts of REPower Australia Pty Ltd regarding the test measurement procedure and the preliminary results.

Based on the above, the important factors for an infrasound measurement methodology comprise:

- The ability to reduce the influence of wind on the microphone;
- Turning the noise source on and off to confirm infrasound from the source can be identified within the ambient environment;
- Measurement conditions that minimise the influence of the ambient environment whilst enabling the operation of a wind farm. This is expected to comprise a light breeze (similar to a Beaufort Scale 2 breeze of between 2 and 3 m/s at ground level) occurring on a night or early morning with a clear sky.

MEASUREMENTS

Equipment

All measurements were made with the SVANTEK 957 Type 1 NATA calibrated sound and vibration analyser. The SVANTEK 957 Type 1 meter has a measured frequency response to 0.5 Hz. A GRAS 40AZ ½" free field microphone with a frequency response of ±1dB to 1 Hz was also used. The meter and microphone arrangement is therefore suitable for measurement of noise levels in the infrasound range.

Controlled Verification

The below ground technique was analysed at a remote site away from a wind farm, transport corridor or other appreciable noise source and in very still conditions. The location was a suburban property in Blackwood, a suburb of the Adelaide Hills.

The aim of the analysis was to determine the level of transfer of infrasound from outside to inside the chamber. The following procedure was used:

- Generation of a constant level of infrasound using a tone signal generator and sub-woofer speaker, mounted 1m above the ground at a distance of 10m horizontally from the chamber. The infrasound was generated at a number of discrete frequencies between 8 and 20 Hz;
- Measurement of the infrasound using the IEC 61400-11 above ground technique;
- Measurement of the infrasound using the below ground technique;
- Measurement of the infrasound without the tone signal generator operating (ambient infrasound).

In addition, to provide additional information regarding the noise level reduction of infrasound from outside to inside a dwelling, a measurement of infrasound inside a lightweight dwelling with the windows open was also made at a number of discrete frequencies.

The testing was conducted between approximately 9pm and 11pm on two occasions in Blackwood under conditions of negligible breeze and no appreciable ambient noise sources.

The measurement results are summarised in the following tables and the ambient noise level is shown in Figure 6.

Table 1 - Measurement approximately 10m from controlled source with no wind

Frequency (Hz)		8.00	10.0	12.5	16.0	20.0
Noise Level (dB)	Inside chamber	47	50	54	60	63
	Outside chamber	47	50	54	60	63

Table 2 - Measurement of ambient conditions in test location (controlled source turned off)[1]

Frequency (Hz)	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	39	38	39	39	37	**51**

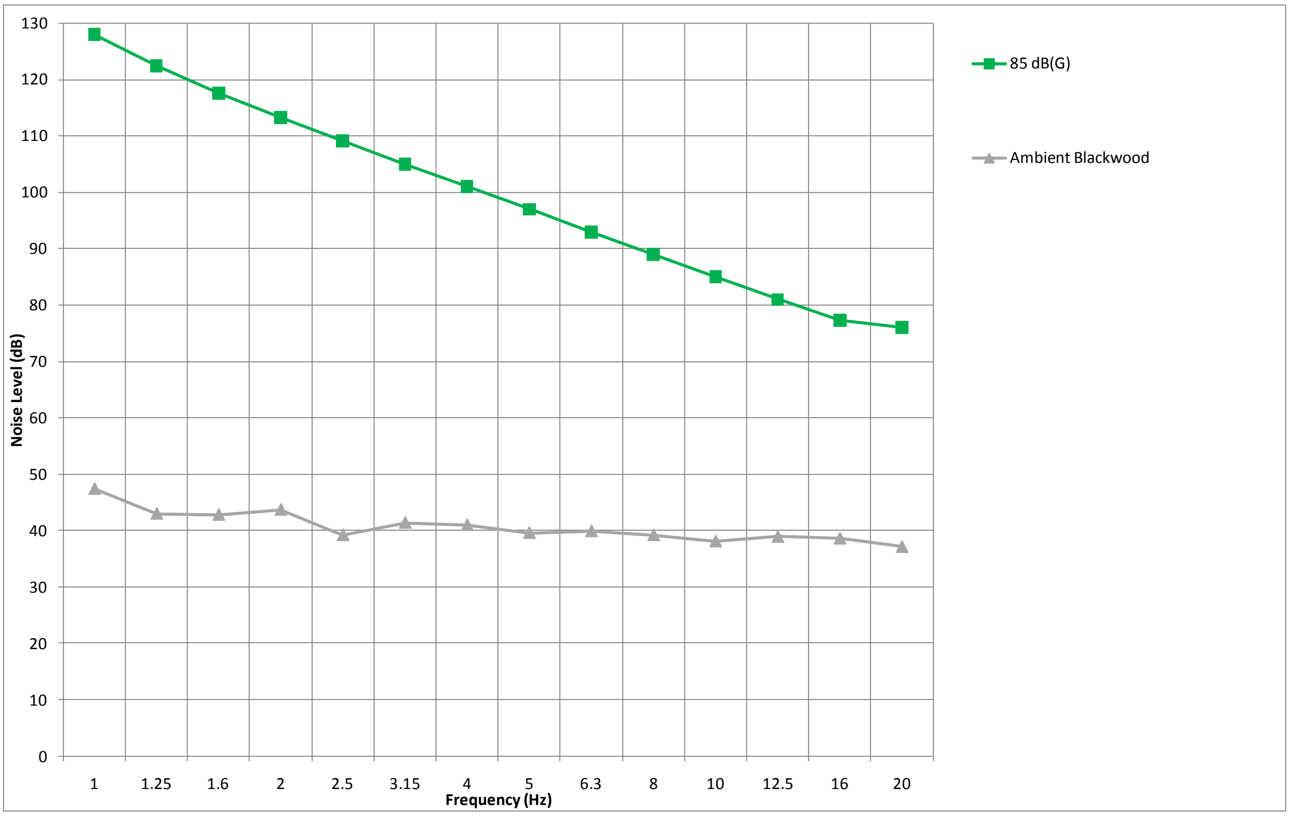


Figure 6 - Ambient infrasound noise level measured without any appreciable noise sources or wind

[1] Measurements of the ambient levels of infrasound were also made at frequencies lower than 8 Hz. These results are shown in Figure 8. The sub-woofer arrangement was not able to generate infrasound below 8 Hz. Table 7 shows the results from 8 Hz to 20 Hz for the purposes of comparison with Table 6.

The results of the testing of the effect of a lightweight facade (with the windows open) on the transfer of infrasound are presented in the following tables:

Table 3 - Measurement of facade transfer with controlled source

Frequency (Hz)		10.0	16.0	20.0
Noise Level (dB)	Inside house	47	61	54
	Outside house	54	63	56

Table 4 - Measurement of ambient conditions in house locations

Frequency (Hz)		10.0	16.0	20.0
Noise Level (dB)	Inside house	37	41	34
	Outside house	42	43	41

The above conclusions can be made from the above results and on site observations:

- The measurement of a constant source of infrasound in still conditions is the same above the ground as in the chamber using the technique described above. Therefore, the below ground technique can be used to measure the infrasound from a source;
- The results are consistent at a number of discrete frequencies between 8 Hz and 20 Hz;
- The levels of infrasound inside a dwelling will be lower than the levels of infrasound outside a dwelling for an external noise source. This information is important because there is limited research available on this transfer. These results are consistent with Jakobsen, J., 2005, who found that “the outdoor to indoor correction may be quite small in a part of the infrasound range, but it is unlikely to become negative, which would imply a higher level indoors than out of doors”.

RESULTS

Infrasound was measured at Clements Gap in the mid-North of South Australia (CGWF) and Cape Bridgewater in the coastal region of south-western Victoria (CBWF), using the verified below ground methodology. At Clements Gap, measurements were also made concurrently using the above ground technique provided by IEC 61400-11.

The following sections summarise the results of the measurements at the wind farms and in the vicinity of other sources of infrasound including a beach, the coastline, a central business area and a power station.

Testing at Clements Gap Wind Farm

Testing at the Clements Gap wind farm was conducted using the following procedure:

- Measurement of infrasound using the IEC 61400-11 above ground technique at distances of 85, 185 and 360m from the base of the turbine in a downwind direction; and
- Measurement of infrasound using the below ground technique at distances of 85, 185 and 360m from the base of the turbine in a downwind direction.

The testing was conducted between approximately 7pm and 11pm on Tuesday the 11th of May under a clear night sky with a light breeze. Operational data indicates the turbines were subject to hub height wind speeds of the order of 6 to 8m/s during the period of the testing.

The measurement results in close proximity to the wind turbine are summarised in the following tables and shown in the following figure. The tables provide the measured noise level at each 1/3 octave band between 1 and 20 Hz and also sum the results to provide an overall dB(G) noise level. The figure includes the 85 dB(G) audibility threshold.

Twenty (20) continuous 1 minute measurements were made at each location. The presented results are typical of those during the measurement period, excluding those at the start and end of the period, where movements adjacent the measurement equipment might influence the results. The number of continuous measurements is based on the on site observations regarding the repeatability of the results.

Table 5 - Measurement approximately 85m downwind from closest operational turbine (No. 25)

Frequency (Hz)		1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	Inside chamber	68	70	73	70	71	69	68	66	64	63	63	58	57	57	**72**
	Outside chamber	70	71	72	70	69	69	68	67	66	63	60	57	57	56	**71**

Table 6 - Measurement approximately 185m downwind from closest operational turbine (No. 25)

Frequency (Hz)		1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	Inside chamber	67	66	69	66	67	64	62	63	61	58	56	53	52	52	**67**
	Outside chamber	80	79	79	77	77	77	75	75	73	72	71	69	66	64	**80**

Table 7 - Measurement approximately 360m downwind from closest operational turbine (No. 25)

Frequency (Hz)		1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	Inside chamber	63	60	66	59	65	60	59	57	54	51	50	47	45	46	**61**
	Outside chamber	71	69	72	72	72	68	69	65	64	61	59	55	53	50	**67**

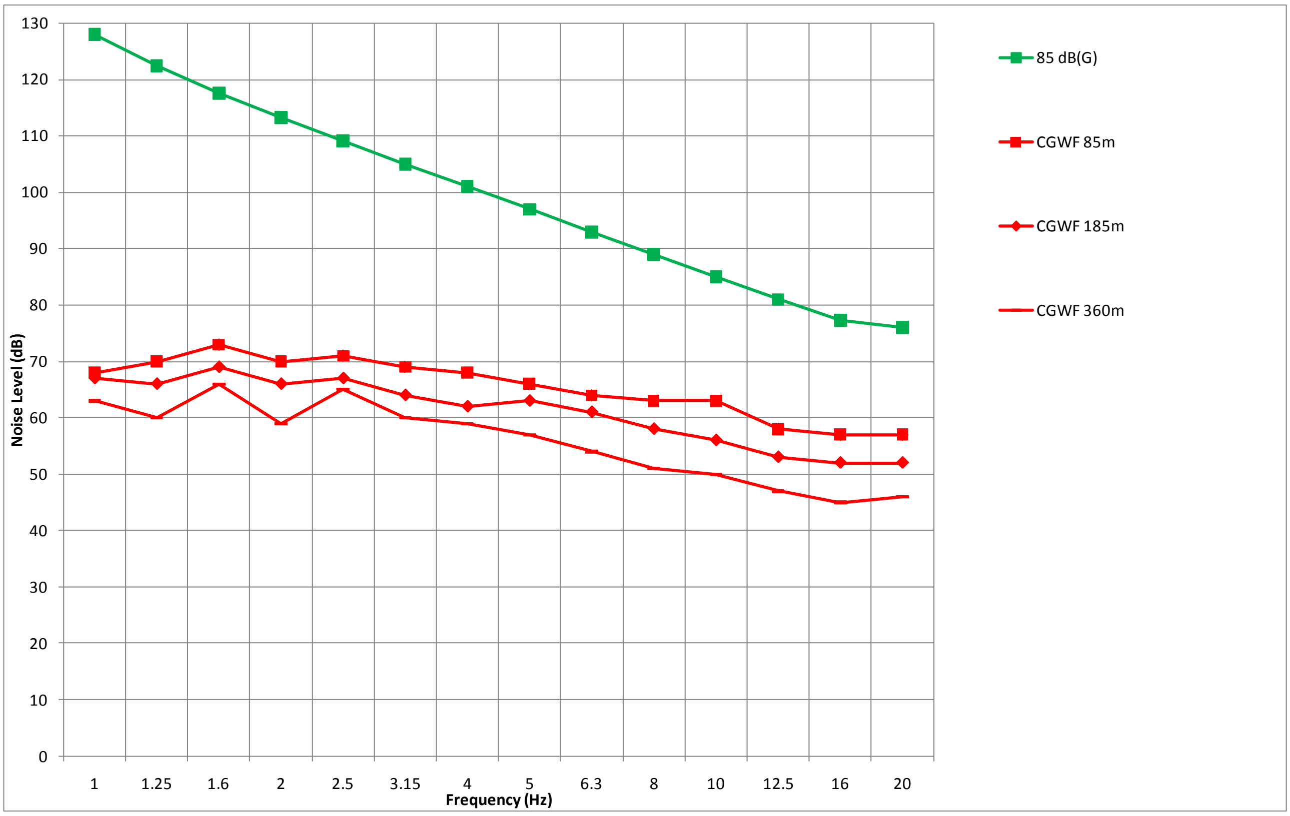


Figure 7 - Infrasound measurements below the ground at Clements Gap wind farm

The theoretical reduction in noise level from a noise source is 6dB for every doubling of the distance from that source due to the "hemispherical spreading" of the sound wave. This reduction theoretically applies to noise at all frequencies, including below 20 Hz. Tables 5, 6 and 7 indicate that a reduction in the order of 6 dB is achieved using the below ground technique, but not for the above ground technique. This is due to the above ground measurements being influenced by surface wind on the microphone.

The following conclusions can be made from the results and on site observations:

- The wind turbines generate infrasound;
- The level of infrasound is well below the audibility threshold of 85 dB(G);
- The distances at which the measurements of the operational wind farm were made are significantly less than separation distances expected between a wind farm and a dwelling, where the levels of infrasound will be correspondingly lower;
- A noise level reduction of approximately 6 dB was measured inside the chambers when doubling the distance from turbine 25. This indicates the level of infrasound measured below the ground was directly associated with turbine 25;
- The measurements above the ground surface did not reduce by 6 dB due to the presence of surface winds and their influence on the results. This indicates the IEC 61400-11 based test does not enable the infrasound from the turbines to be separated from infrasound due to the wind.

In addition to the above testing in close proximity to an individual turbine, the "Byarlea" residence was visited, which is approximately 1200m to the east of the nearest turbines in the Clements Gap wind farm.

An infrasound measurement was made within a room of the dwelling. The refrigerator was operating in the dwelling at the time of the measurement but a full survey of other operating equipment was not made. A level of the order of 51 dB(G) was measured.

Given the still conditions at the dwelling at the time of inspection, a local above ground infrasound measurement outside the dwelling was able to be made. A level of the order of 58 dB(G) was measured. The results of the measurements are presented in Tables 8 and 9 and Figure 8 below:

Table 8 - Measurement inside a room of a dwelling

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	60	49	54	54	59	52	50	45	43	41	43	38	38	33	**51**

Table 9 - Measurement outside of dwelling

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	47	45	53	47	54	54	50	50	45	44	44	43	43	43	**58**

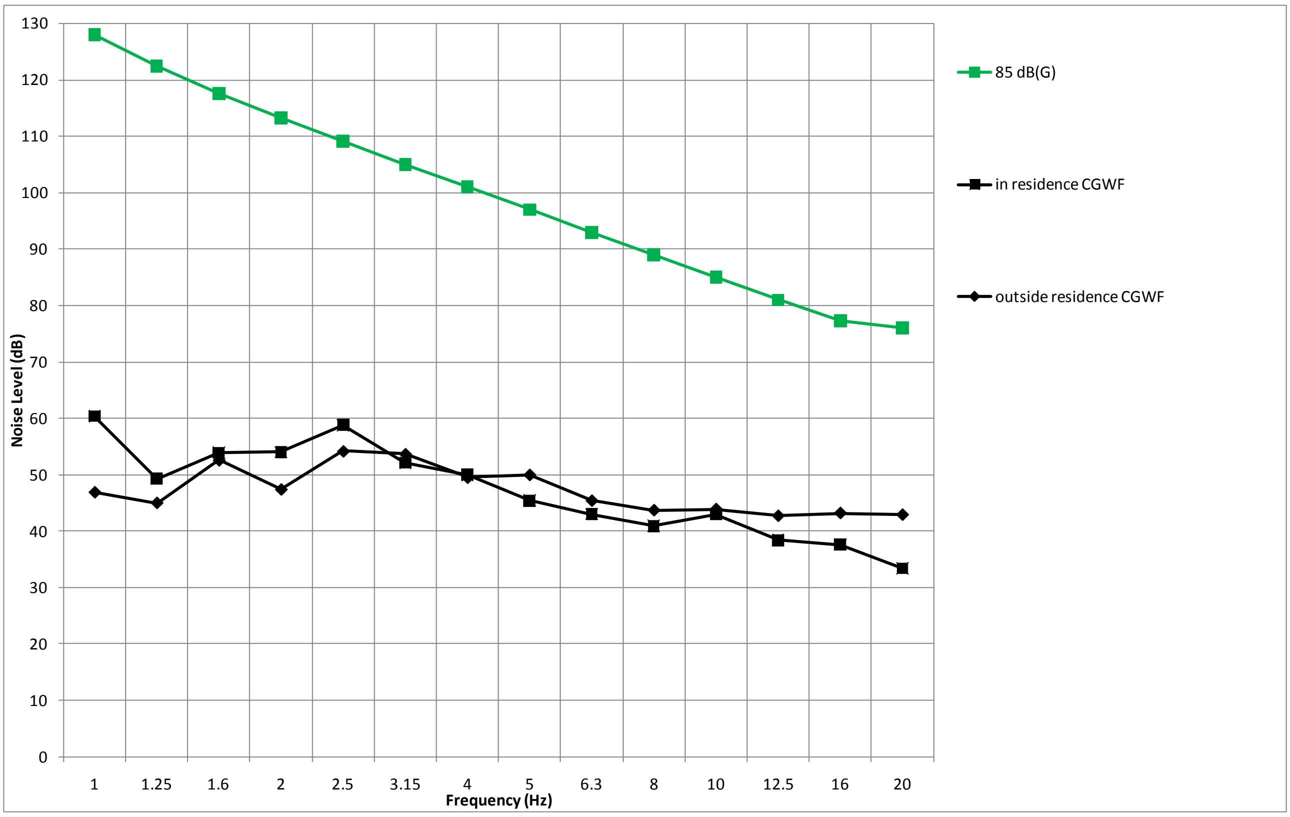


Figure 8 - Measurements of infrasound inside and outside a dwelling in the vicinity of the Clements Gap wind farm

The above conclusions can be made from the above results and on site observations:

- The levels of infrasound inside a dwelling in the vicinity of a number of turbines associated with the Clements Gap wind farm is well below the audibility threshold of 85 dB(G);
- The levels of infrasound outside a dwelling in the vicinity of a number of turbines associated with the Clements Gap wind farm is well below the audibility threshold of 85 dB(G).

Testing at Cape Bridgewater Wind Farm

The controlled verification testing and the Clements Gap Wind Farm test confirmed that the use of the below ground technique was able to reduce the influence of wind on the microphone and identify the level of infrasound associated with a wind turbine and/or a wind farm.

Therefore, testing at the Cape Bridgewater wind farm was conducted using the following trialled and analysed procedure based around the below ground technique:

- Measurement of infrasound using the below ground technique in close proximity to an operating wind turbine at distances of 100 and 200m from the base of the turbine in a downwind direction;
- Measurement of infrasound with the wind farm not operating;
- Measurement of infrasound at the beach to the east of Cape Bridgewater;
- Measurement of infrasound in the vicinity of the coastline to the west of Cape Bridgewater;
- Measurement of infrasound in a designated forest area approximately 8km inland from the coast, under conditions of negligible wind.

The testing at the wind farm site was conducted between approximately 4am and 6am on Wednesday the 2nd of June under a clear night sky with a light breeze. During the testing, the operational status of the turbines was constantly observed and confirmed. The results in Tables 10 and 11 were taken at distances of 100m and 200m respectively from the closest operational turbine. The results in Table 12 were taken with the wind farm stationary at the 100m measurement location.

The measurement results in close proximity to the wind turbine are summarised in the following tables and shown in the following figure. The tables provide the measured noise level at each 1/3 octave band between 1 and 20 Hz and also sum the results to provide an overall dB(G) noise level. The figure includes the 85 dB(G) audibility threshold and the ambient noise result from the Adelaide Hills.

Twenty (20) continuous 1 minute measurements were made at each location. The presented results are typical of those during the measurement period, excluding those at the start and end of the period, where movements adjacent the measurement equipment might influence the results.

Table 10 - Measurement approximately 100m downwind from closest operational turbine

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	61	57	59	58	58	59	55	54	54	53	51	50	54	53	**66**

Table 11 - Measurement approximately 200m downwind from closest operational turbine

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	54	52	50	54	56	55	55	54	52	52	50	49	53	49	**63**

Table 12 - Ambient infrasound measurement (with the wind farm not operating)

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	54	52	51	52	55	56	56	56	55	54	52	51	50	47	**62**

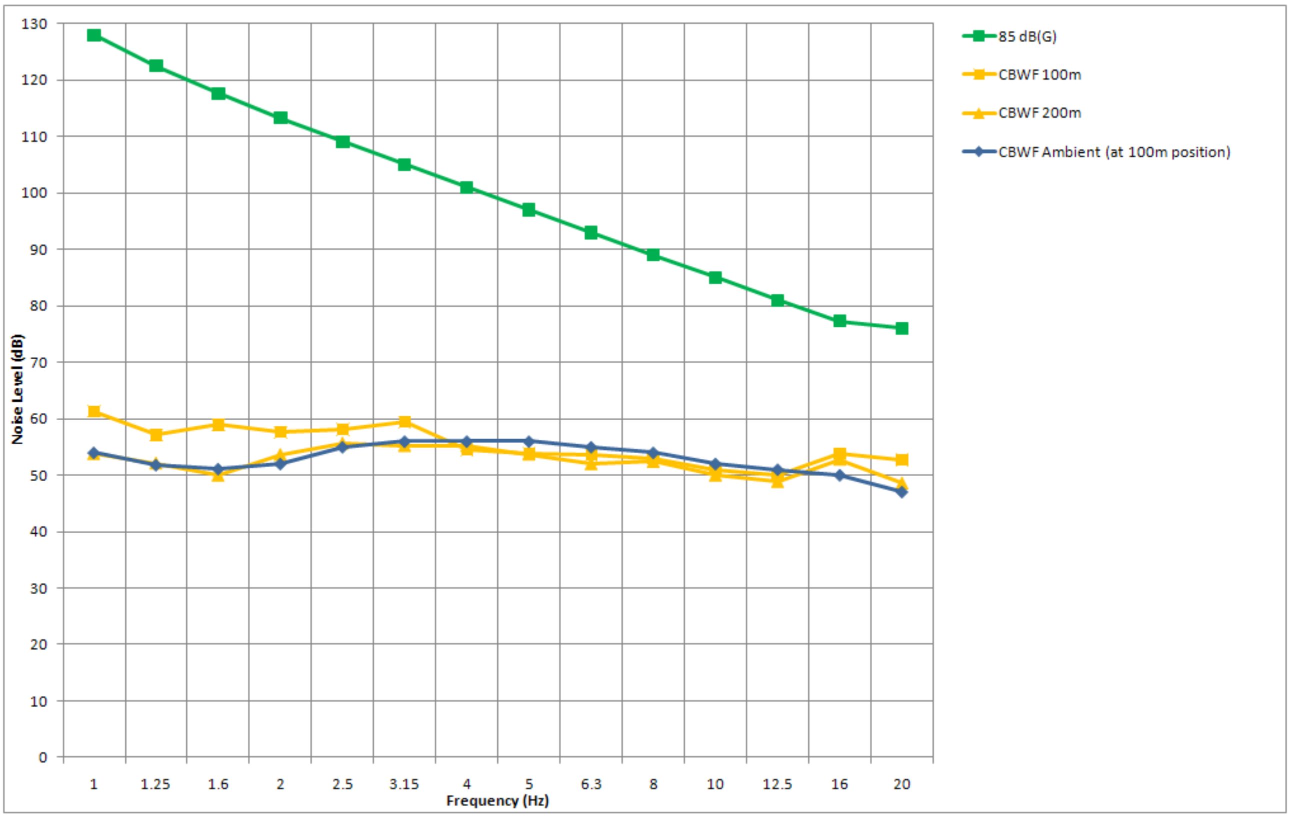


Figure 9 - Infrasound measurements below the ground at Cape Bridgewater wind farm

The above conclusions can be made from the above results and on site observations:

- The wind turbines generate infrasound;
- The level of infrasound is well below the audibility threshold of 85 dB(G);
- The distances at which the measurements of the operational wind farm were made are significantly less than separation distances between a wind farm and a dwelling, where the levels of infrasound will be correspondingly lower;
- A high level of ambient infrasound exists (infrasound in the absence of noise from the wind farm) which influences the results for the wind turbines.

Measurements were made in the vicinity of the adjacent beach and the coastline to confirm the source of the high ambient infrasound levels. In addition, a measurement was made inland to determine the extent of influence of the high ambient infrasound levels.

The results of the measurements are presented in Figure 10 below:

Table 13 – Beach at approximately 25m from the high water mark

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	53	53	65	64	66	62	70	70	67	69	63	63	63	59	**75**

Table 14 –On the cliff face at approximately 250m from the coastline

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	59	59	61	64	65	67	65	62	60	60	58	56	56	54	**69**

Table 15 – Inland at approximately 8km from the coast

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	50	46	62	61	55	50	52	52	51	47	44	44	44	43	**57**

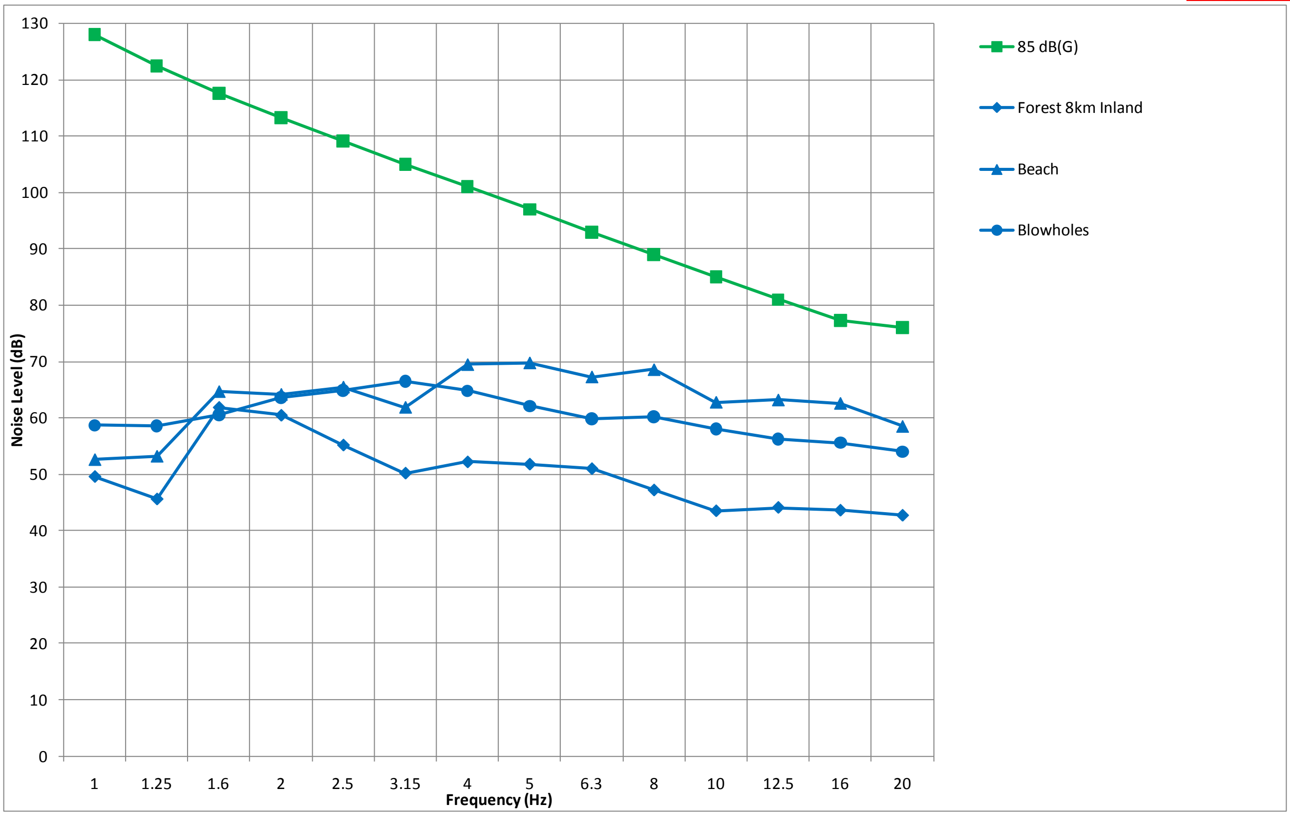


Figure 10 - Ambient noise measurements in the vicinity of Cape Bridgewater

The following conclusions can be made from the above results and on site observations:

- Natural sources generate infrasound;
- The levels of infrasound from natural sources are of the same order as those measured within 100m of a wind turbine;
- Measurable levels of infrasound that are of a similar order to that measured in close proximity to a wind farm are prevalent in the natural environment over a large area due to sources other than wind farms.

The following map depicts measurement locations relative to the turbine:

Map 1: Cape Bridgewater Wind Farm Measurement Locations

Testing of other man-made noise sources

Testing has been conducted using the below ground technique in the vicinity of other man-made noise sources using the following procedure:

- Measurement of infrasound using the below ground technique at a distance of approximately 350m from a gas fired power station;
- Measurement of infrasound using the below ground technique within the Adelaide Central Business District at approximately 70m and 200m from two major road corridors;

The measurement results are summarised in the following tables and shown in the following figure. The tables provide the measured noise level at each 1/3 octave band between 1 and 20 Hz and also sum the results to provide an overall dB(G) noise level. The figure includes the 85 dB(G) audibility threshold and the ambient noise result from the Adelaide Hills.

The results presented are typical of those during the measurement period, excluding those at the start and end of the period, where movements adjacent the measurement equipment might influence the results.

Table 16 – Power Station

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	63	57	57	54	53	50	50	49	54	55	57	62	61	61	**74**

Table 17 - CBD

Frequency (Hz)	1.00	1.25	1.60	2.00	2.50	3.15	4.00	5.00	6.30	8.00	10.0	12.5	16.0	20.0	Total (dB(G))
Noise Level (dB)	63	60	61	62	61	58	59	56	56	53	55	60	65	63	**76**

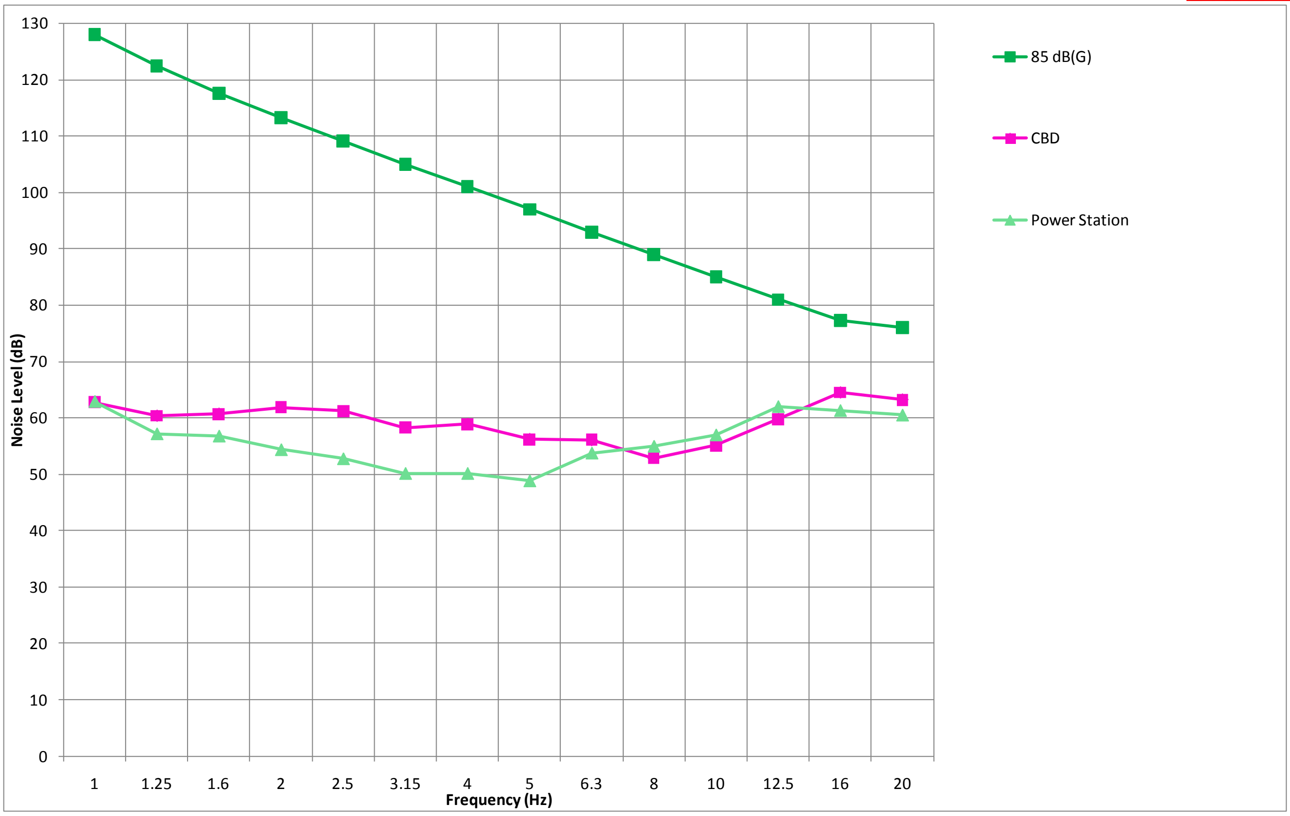


Figure 11 - Infrasound from man-made noise sources

The following conclusions can be made from the above results and on site observations:

- Man made sources generate infrasound;
- The levels of infrasound from man made sources are of the same order at those measured within close proximity of a wind turbine;
- Measurable levels of infrasound that are of a similar order to that measured in close proximity to a wind farm are prevalent in the urban environment over a large area due to sources other than wind farms.

Comparison against International results

The Canadian Wind Energy Association (Howe, 2006) and Jakobsen, J., 2005, provide a summary of results of infrasound testing at a range of sites. The data is presented as an overall dB(G) level. The methodology used to measure these data is not known and therefore the results might be influenced by wind or other sources. These data and the measured levels as part of this study are summarised in the following table:

Table 18 - Summary of Infrasound Levels

Noise source	Distance (m)	Infrasound level dB(G)	Comments
General Electric MOD-1	105	107	Downwind turbines, known to generate higher levels of infrasound compared to a modern upwind turbine
General Electric MOD-1	1000	75	Downwind turbine
Hamilton Standard WTS-4	150	92	Downwind turbine
Hamilton Standard WTS-4	250	85	Downwind turbine
Boeing MOD-5B	68	71	Upwind two bladed turbine at a limited separation distance – this shows the significant reduction between downwind and upwind turbines
US Wind Power USWP-50	500	67-79	14 downwind turbines influencing the results
WTS-3	750	68	Downwind turbine
WTS-3	2100	60	Downwind turbine
Enercon E-40	200	64	Modern upwind turbine
Vestas V66	100	70	Modern upwind turbine
Vestas V80	60	79	Influenced by wave action from the Atlantic Ocean (HGC Engineering, 2006)
GE 1.5MW	300	67	Modern upwind turbine
Nordex N-80	200	60 (7m/s)	Measurements were made downwind from 5m/s to 12m/s. The level increases by approximately 1 dB(G) for each 1m/s increase in wind speed from 5m/s
DTI Wind Farm	1000	65	Details of the turbine type were not provided in the DTI study. The wind farm included seven turbines (DTI, Hayes McKenzie, 2006)
Siemens SWT 2.3-93	300	73	Measured as part of the "Epsilon" study (O'Neal, 2009)
GE 1.5sle	300	70	Measured as part of the "Epsilon" study (O'Neal, 2009)
Clements Gap	85	72	Modern upwind turbine
Clements Gap	180	67	Modern upwind turbine
Clements Gap	360	61	Modern upwind turbine
Cape Bridgewater	100	66	Modern upwind turbine, influenced by the ambient noise environment
Cape Bridgewater	200	63	Modern upwind turbine, influenced by the ambient noise environment

The main source of uncertainty associated with the measurement of infrasound is the influence of wind on the microphone. The methodology used by the international studies is not explicitly nominated, and therefore the contribution of wind on the microphone in the above results is not known. However, the infrasound associated with the turbines will be at most the same and more likely less than the results in the above table.

This study employs a specific methodology that aims to reduce the influence of wind on the microphone and therefore the extent of the uncertainty in the infrasound attributable to the turbines. However, the influence of wind and the presence of infrasound in the ambient environment when measuring in the vicinity of the coast, as is the case at Cape Bridgewater, are still expected to influence the results. Therefore, as for the international studies, the uncertainty predominantly relates to the extent that the infrasound from the turbines is below the results presented in this report.

Jakobsen, J. 2005 notes the following with respect to review of the data available for the 2005 works:

> *….the level from an upwind turbine of contemporary design at 100m distance would be about 70 dB(G) or lower, while the level from a downwind machine can be 10 to 30 dB higher.*

The results of this study show infrasound noise levels of the order of 60 to 70 dB(G) in close proximity to wind turbines. Based on the above table, these levels show consistency with other International measurements of modern upwind turbines. In addition, the measured noise levels in this study are provided by a detailed methodology that reduces the influence of the wind and therefore the uncertainty for the results.

CONCLUSION

The following conclusions can be made from the results of the study:

- Wind turbines generate infrasound, however, measurements made both outside and inside and at a variety of distances significantly less than separation distances between wind farms and dwellings, indicate the infrasound produced by wind turbines is well below established guideline perception thresholds;
- The level of infrasound that has been measured in both a rural coastal and an urban environment is of the same order as that measured within 100m of a wind turbine.

The following figure overlays the compiled results of the study:

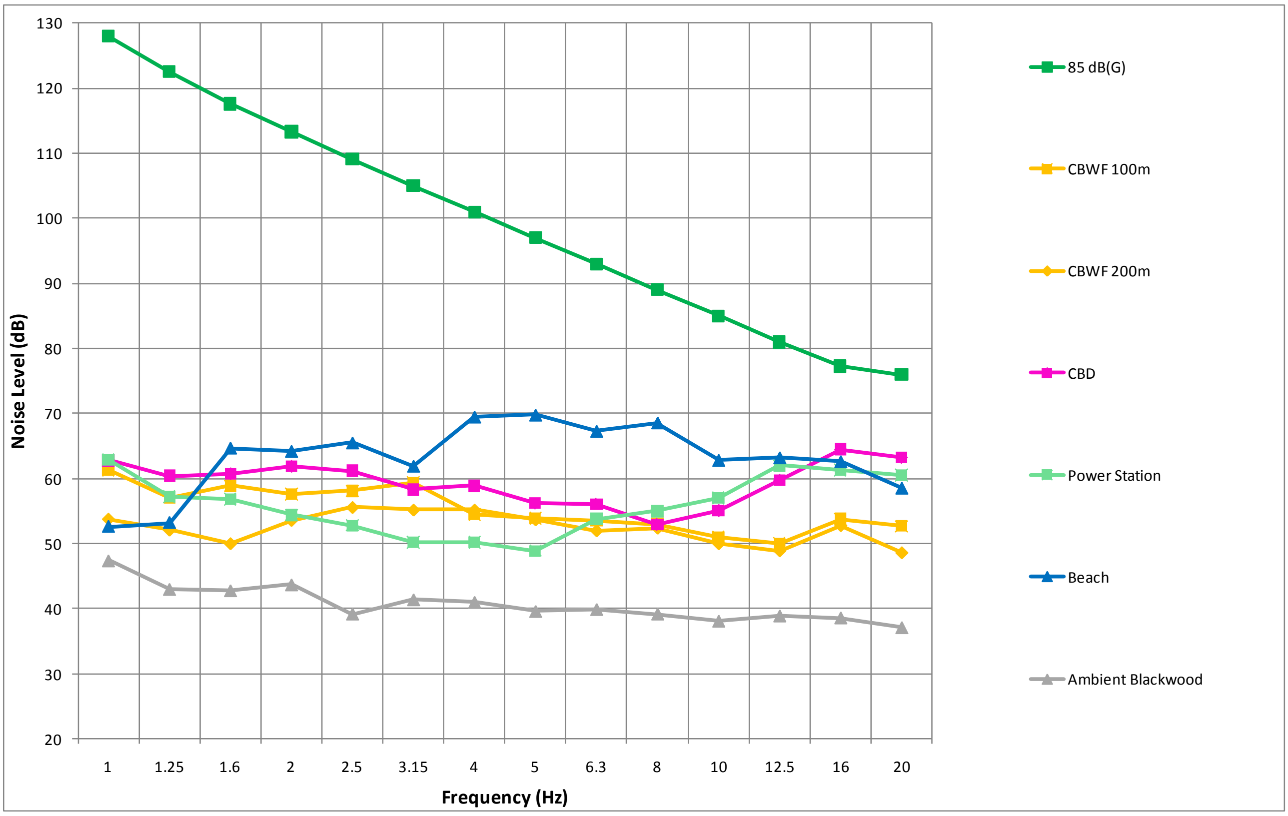


Figure 12 - Summary of Measurements Cape Bridgewater Wind Farm (CBWF)

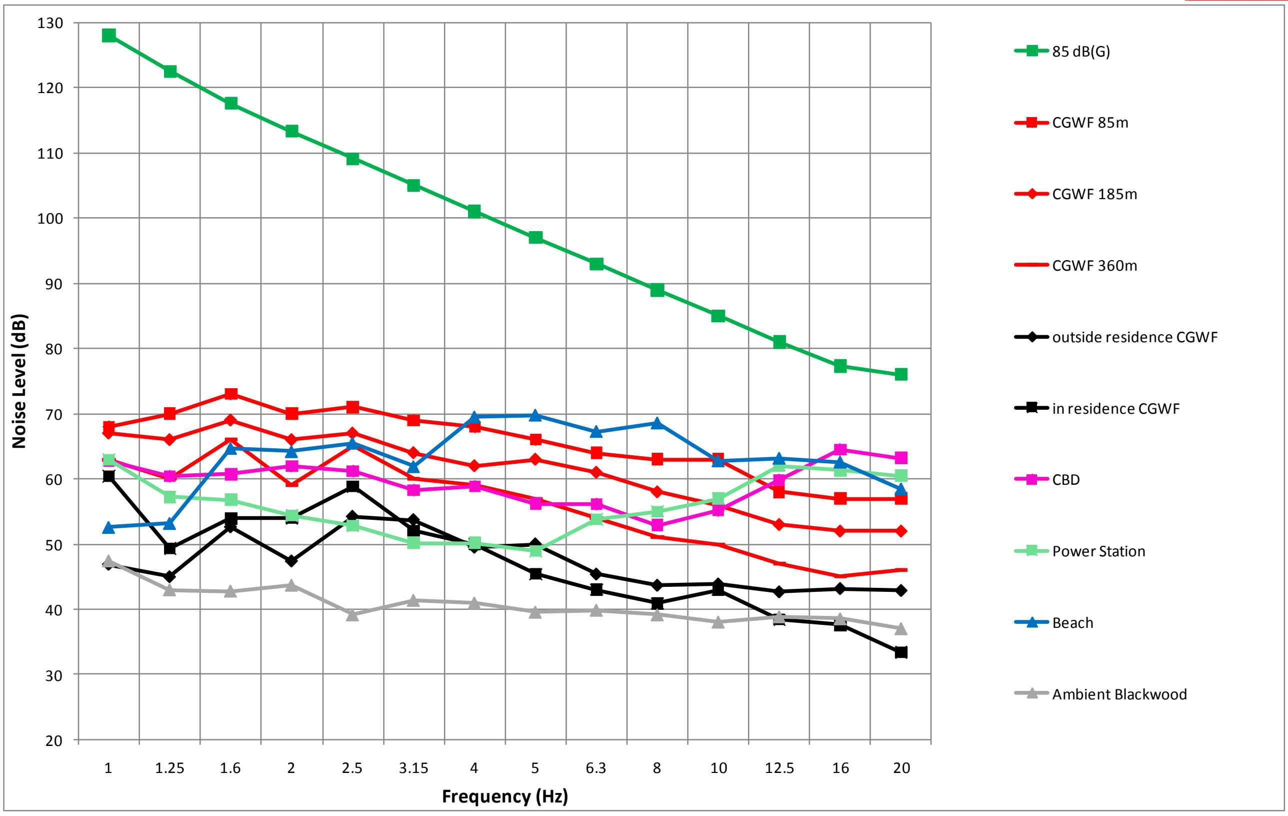


Figure 13 - Summary of Measurements Clements Gap Wind Farm (CGWF)

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