IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of applications to the **WAIKATO DISTRICT COUNCIL** and **WAIKATO REGIONAL COUNCIL by WEL NETWORKS Ltd** for resource consents to authorise the erection, operation and maintenance of 28 wind turbines for the generation of electricity and associated activities near Te Uku.

STATEMENT OF EVIDENCE OF ROGER BURCHETT

1 INTRODUCTION

Qualifications and experience

1.1 My name is Roger Burchett. I am an electricity generation business engineering consultant living in Cambridge.

1.2 I am a certified marine engineer (NZ Marine Dept, 1971), a graduate civil engineer (Society of Engineers, London, 1984), first registered as a professional engineer in 1986 (P.Eng. UK), am currently a member of the Institute of Professional Engineers of New Zealand and a member of the New Zealand Institute of Management.

1.3 I have 40 years experience in the power generation industry, with 14 years wind generation experience in New Zealand, Australia, Asia, and Europe.

1.4 In my last corporate position I established and managed TrustPower's generation division, and established their wind generation business in Australia. In that position I had overall responsibility for 34 power stations in NZ, including the Tararua windfarm.

1.5 I have worked as an independent consultant since 2003, specialising in the business engineering and modelling of hydro and wind generation assets.

Involvement in the project

1.6 I was engaged as a contractor by WEL Networks Ltd (WEL) in January 2006 to assist with the development of the Te Uku Wind Park. My position at WEL was initially as project director, and then as the project developed, my role evolved into a technical advisory position.

1.7 In this position I have provided direction for the project concept for which consents are sought. Because of my background in wind power I was engaged by WEL to establish the contract resources required to bring the Te Uku Wind Park to the consents and feasibility stage, provide guidance on the development of concepts to consent level design, provide guidance on related business and economic matters, and help develop internal resources to a level where they could assume responsibility.

1.8 As a network operator with no previous wind farm experience WEL had limited resources and expertise in this area when I started. During my tenure this has developed to a stage where my active involvement has reduced to an advisory capacity.

1.9 I have visited the site many times, and am familiar with all aspects of the project.

Purpose and scope of evidence

1.10 The purpose of my evidence is to describe the proposed project and how it will be constructed, and how it fits in the context of the electricity industry. My evidence relates to general physical and business issues rather than specific details which are addressed in the evidence of relevant experts.

1.11 In my evidence I will address the following matters:

a) A description of the proposed site (section 3);

b) Commercial feasibility and how the project fits in the national and regional contexts (section 4);

c) Outline the key elements of the proposal(section 4);

d) Outline the issues arising in the construction phase of the Wind Park (section 6);

e) Outline the issues arising in the operations phase of the Wind Park (section 7);

f) Reply to issues raised in the Council's Officers reports and appendices (section 8);

g) Address matters raised in submissions (section 9); and

h) Comment on the conditions proposed by WEL (section 10).

Expert Witness Code of Conduct and Authorisation

1.12 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Consolidated Practice Notes 2006. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

1.13 I am authorised to present this evidence on behalf of WEL.

2 SUMMARY

2.1 In Section Three I describe the Wind Park in the context of characteristics of a good site, and describe WEL's tenure over this site.

- My conclusions in this section are that it is a good site, and that appropriate land agreements are in place.

2.2 In Section Four I explain the methods used to evaluate commercial viability, and the results of key assessments with due regard to national and regional energy strategies. I describe what investigations have been carried out; give the current energy estimates for the Wind Park, and the value of this energy in both supply and emissions offset.

- My conclusions are that this is a commercially feasible project. Based on current evaluation it will provide long-term mean electricity output of 259 GWh/yr which is equivalent to the supply to 32,000 homes, and displace 168,000 tonnes of carbon dioxide per year in the short to medium term which is equivalent to the emissions of 39,000 cars.

- In this section I also discuss and confirm the need for 28 turbine locations.

- I also find this development is consistent with national, regional, and district strategies.

2.3 In Section Five I describe the key elements of the proposal including layout and consents envelope. I also discuss the connection of the Wind Park to the network from an energy conveyance perspective.

- My conclusions are that that a smaller number of large machines is better, but that 28 locations are needed for this to be viable. I doubt that a large number of small machines could be accommodated on this site due to a number of constraints.

- I explain why the consent envelope is necessary to allow for the plant types that could be used on this site.

- I explain the need for meteorological masts and the electrical connection of the turbines.

- From my experience with wind farms, the layout, turbine type and connection proposed are appropriate for both the site and network.

2.4 In Section Six I describe how various parts of the Wind Park will be built.

- From my experience the combination of wind resource, geology, topography, existing land use, logistics, on site resources and proximity to transmission make this an ideal site for development.

- The construction methods proposed by WEL are in my opinion suited to both the site and the construction planned.

2.5 In Section Seven I describe how the Wind Park will be operated.

- I have experience in managing wind farm operations and based on that experience can describe how the Wind Park will be operated with due regard to issues that have been raised in both submissions and the Council peer reviews.

2.6 In Section Eight I respond to issues in the officer's reports that pertain to my evidence and in particular to the peer review off benefits.

- I reply in particular to energy and operational issues raised. My calculations are that the Wind Park does in fact provide material national and regional benefits, and that operational concerns can be addressed in appropriate conditions.

- I do not agree that a finite term for land use consents is required.

- I do agree that the resource from the quarry is limited and could be depleted by existing use if construction is delayed. I suggest a condition to ensure that construction activities as applied for are retained.

2.7 In Section Nine I respond to submissions that pertain to areas addressed in my evidence and which are lapse period, alternative sites, future expansion, costs, turbine size, ground vibration issues, transmission lines, access roads, decommissioning, and where the electricity generated will go.

- In particular I address submissions by Mr Sean Cox, and a paper supporting his submissions.

- My conclusions are that valid issues raised in submissions are addressed or provided for either in design, land agreements or proposed conditions.

- I do not agree with a number of issues raised directly and indirectly by Mr Cox and address these where possible. His submission proposes conditions that are not justified.

2.8 In Section Ten I comment on proposed conditions with due regard to matters raised in my evidence.

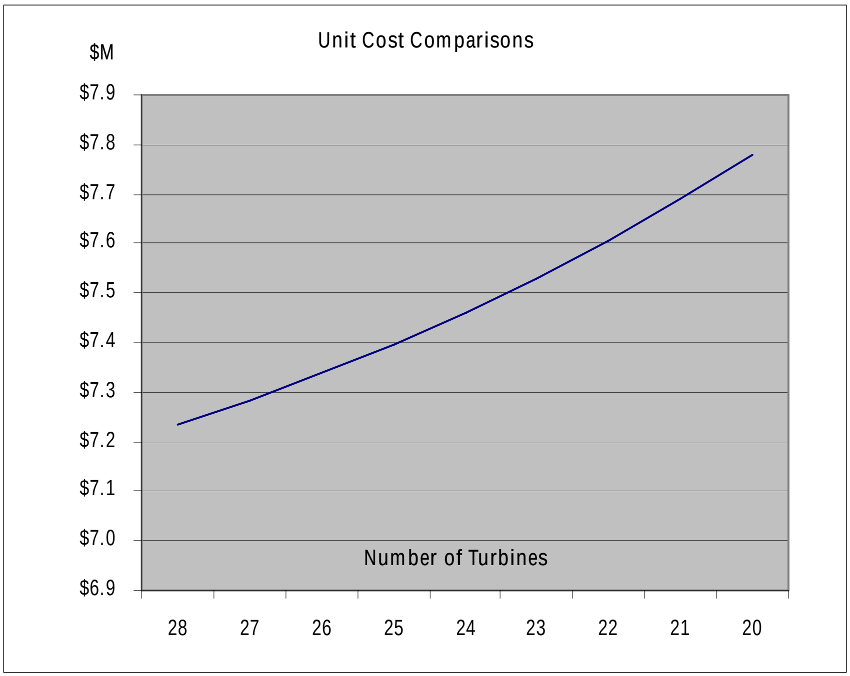
- In my opinion the conditions proposed by WEL and amended in light of submissions and Council reports address the effects of this application and provide WEL with an economic proposal that it can carry forward to construction.

3 WIND FARM SITE REQUIREMENTS AND THE PROPOSED SITE

3.1 In this section of my evidence I will address the characteristics of a good wind farm site and the Te Uku site in this context.

Wind farm size

3.2 Wind farms need to be over a certain size to economically absorb fixed costs. Calculations using the indicative turbine and layout applied for at Te Uku are that 19% of the total cost is fixed, which leads to a quadratic increase in unit costs for reduced turbine numbers as shown in the graph below.



3.3 For economic scale at Te Uku it is critical to WEL to retain the 28 turbine locations applied for. I discuss this further in section 4.

3.4 As discussed in the evidence of Mr Walter, it is necessary both in finding a site and in locating turbines within that site to capture the best available wind speeds. Sites are also constrained in layout due to topography, geology, land use, and other existing uses such as telecommunications. The Te Uku site is typical in all these respects.

3.5 There is intense global demand for wind turbines and a shortage of manufacturing capacity at present. It is not possible to determine at this stage exactly what machine will be used at the site, and not until tenders are called can this decision be made. The turbines finally selected will be subject to price and availability at the time.

3.6 Because of constraints, and a confidence that fewer and larger turbines are better than a large number of smaller turbines, the Wind Park has been carefully developed around 28 locations, and a consent envelope at each location that will accommodate the most probable turbine type for this site.

Classification of wind sites

3.7 Wind sites and wind generation machinery are classified to an international standard[1] that takes into account the long term average wind speed and the

1.1

1 International Electro-technical Commission IEC61400 – Wind Turbines

maximum storm conditions of a site. Sites are generally rated from one to five, one being the higher wind speed sites. Machinery for Class 1 sites is built to resist tougher conditions and as a result has lower capture efficiency whereas and the lower classes are built to capture lower wind speeds have lower resistance to extreme weather conditions.

3.8 It is important to optimise the output of a site with the right class of machinery. This can only be done with monitoring at each of the proposed turbine locations before a final class selection is made.

3.9 Whilst sufficient work has been done to ensure the application provides for eventual requirements further work is required to define exact locations and plant within the envelope applied for.

3.10 The relative merits of machine ratings are discussed further in Section 4.

Consideration of alternative sites

3.11 The services I have provided to WEL include identifying and evaluating other potential wind farm sites in the Waikato area. In my view the Te Uku site is one of the best in the Waikato region due to resource availability, the suitability of the site for construction, the proximity of the site to both network connection and demand, and the location of the site with regard to construction logistics.

3.12 I evaluated six other potential wind farm sites located to the south of Te Uku and as far north as Matira, being the upper limit of WEL's network area. These sites were evaluated by on-site inspection for general suitability as above and by synoptic modelling of the wind resource as described by Mr Walter. Consideration was also given to logistics and RMA compatibility for each site.

3.13 I found Te Uku to be a superior site to any of the alternatives evaluated. Te Uku has a better wind resource partly due to location and partly due to elevation. The site is well located to connect into the local network, has all the bulk materials required for construction on site, has generally easy contour for construction works, and has good access roads to a port of entry for imported equipment. It is also hill country pastoral land where neither farming nor natural vegetation qualities are affected to more than a minor degree.

3.14 The location of the site relative to major population centres also needs to be considered. It is sensible to build generation close to demand to minimise the economic and environmental cost of transmission. The Te Uku Wind Park is very well located to serve existing and growing regional demand.

3.15 As part of my brief I also evaluated other forms of generation for WEL and am aware it has been assessing generation potential for a number of years. My input into alternatives resulted from response at the public meetings described by Mr Dawson.

3.16 I evaluated micro hydro, land fill gas, coal seam gas, and biomass alternatives. Ocean technologies were not considered both because they are unproven and the coastline was perceived to be sensitive to major development.

3.17 I evaluated the above myself and using consultant advice, and concluded that the proposed Wind Park is the best generation option for WEL to pursue in the Waikato region.

3.18 I have also evaluated wind sites outside the Waikato area[2] for WEL, but with a strong sense of community ownership WEL decided to keep its generation business development within its network area.

The proposed Te Uku site

3.19 The proposed Te Uku Wind Park extends generally in a north-south direction along the Te Uku ridge line and on to the Wharauroa plateau at the southern end. The extent of the Wind Park is approximately 1 kilometre north of the existing telecommunications tower and approximately 5 km south of that point.

3.20 The proposed Wind Park will be built across four adjacent farms which are owned by:

- The Vanhoutte Family Trusts — 21 turbines
- JA & MF Greenwood — 1.5 turbines
- TAH Jowsey — 3 turbines
- TA Clifford and Ellice Tanner (West) Trustees — 2.5 turbines

Legal descriptions of these properties are as set out in the WEL application. The ½ turbine allocations result from one unit that is placed on a boundary line.

3.21 In addition, the main access road onto the site from Plateau Road and the quarry from which roading and concrete materials will be sourced is on one of these farms (the Jowsey farm).

1.1

2 Puketoi

3.22 The total land area of the 4 affected farms is 2,362ha and whilst the land to be taken up by the Wind Park is yet to be surveyed post construction I would not expect it to exceed 25ha. Thus the area of land involved in the current proposal represents some 1.06% of the farms involved.

Land agreements

3.23 WEL has agreements with these four landowners for the construction and operation of the Wind Park. These agreements are essentially the same with regard to tenure and compensation.

3.24 These agreements are for 40 year easements from the date of commissioning the Wind Park. They all anticipate the Wind Park will be decommissioned at the end of this period and provide for all works above ground level to be removed at this time.

Why this site

3.25 Evaluation to date confirms the Wharauroa plateau and nearby ridges to be an ideal site for a wind farm. Sites with higher wind speeds are very hard on machinery and my experience is that high wind speed sites suffer from outage time for high wind speed hysteresis[3] and higher forced outage time due to machinery break down. Although this site has a slightly lower resource than a class one site, I would expect it to have a correspondingly higher availability, and also have the ability to take advantage of class 2 machinery.

3.26 Whilst it is too early to say what turbines will be finally selected for use on the site analysis has been carried out using class 1 & 2 machines in appropriate locations over the site. This mix gives the higher capacity factors quoted in section 4, and indicates that such a hybrid layout may be competitive. In this regard the towers and nacelles for the class 1 & 2 machinery evaluated are identical, but the class 2 machines have a larger rotor diameter[4]. Both fit within the consent envelope sought.

3.27 WEL considers it is important to build generation that is both efficient and close to areas where output can be used. This is consistent with the nodal pricing methods used to value transmission costs in New Zealand. The Wind Park site is ideally located to minimise the transmission requirements to match generation to load.

1.1

3 The time from when a turbine shuts down due to high wind speed until it can restart again at a point lower than the cut out speed – this time equating to outage loss

4 Class 1 is 83m, Class 2 is 93m

4 COMMERCIAL FEASIBILITY

4.1 In this section I address the way in which the Wind Park has been assessed for commercial feasibility to a level that gives WEL the confidence to seek consents.

4.2 WEL is pursuing the development of this wind park to grow its business in an area that is related to its core functions. From the outset however WEL has communicated both at public meetings and through press statements that it will proceed to construction only if, at the final test, it is good business. WEL is very mindful of its community ownership in the context of both public relations and commercial performance. As a company it is risk averse and will not proceed with this project unless it is confident it makes good business sense.

4.3 Because of this a lot of effort has been put into accurately estimating both the cost of developing this project and the likely returns. These values are updated and entered into a series of models from which the company remains informed on current commercial feasibility.

Methodology

4.4 The viability of a project like this is calculated by discounting the sum of expected cash flows over the life of the project. Cash flows include projected revenues and costs, discounted at the weighted average cost of capital for the enterprise.

4.5 As project analysis and design proceeds with positive results, increasing confidence leads to further investment which in turn leads to both technical and commercial viability firming up over time. In this progression, the final test is when construction tenders are evaluated.

Energy Estimates

4.6 WEL has monitored the wind resource on this site at 30 metre, 40 metre, and 50 metre elevations since April 2005. These monitoring devices are on a single 50 m mast. An 80 metre mast monitoring the wind resource up to the proposed hub height was erected in March 2007, correlated to the 50 metre mast, and then the 50 metre mast was relocated to another position in the Wind Park. Data from masts on site is compared to data available from other records in the region to find long-term correlations.

4.7 Data from both masts is downloaded daily, and analysed monthly.

4.8 Contour data is used to build a digital terrain map and wind farming software is used to combine digital terrain, turbine locations, and wind resource to calculate the output of each turbine location, and the total output of the Wind Park, for the output characteristics of a particular wind turbine.

4.9 WEL has used the Vestas V90-3 on an 80 tower mast for this calculation. This is the same machine that is used as the indicative turbine in WEL's consent application. WEL has also used other potential turbine types for the same calculation to define the range of plant suitable for use on this windfarm.

4.10 Energy estimates are updated every 6 to 12 months. The last analysis was done in March 2007 and the next is due early 2008. This analysis is being done by Hydro Tasmania Consulting, who are world recognized experts in this field.

4.11 Using the consent application layout, the latest energy estimates calculate gross output of 274.7 GWh/yr[5] as the long term annual mean. Output varies from 8.9 GW hours per year for turbine 23 up to 11.7 GWh per year for turbines 15 and 29. This variation across a site is normal.

4.12 The capacity factor[6] for this Wind Park varies from 37.3% to 41.1% depending on the turbine type used. Analysis to date indicates a mix of class 1 and class 2 locations across the site, where a corresponding mix of machine classes could be used to advantage. The key measure for the viability of any wind farm is capital cost per megawatt hour output, and this test can only be applied when wind turbine tenders are called.

Turbine numbers

4.13 As has been identified in the evidence of Mr Dawson, WEL publicly announced its intentions early and before a final layout was determined.

4.14 I negotiated all the final landowner agreements for WEL. At the time the first public meetings were held none of these had been concluded and the 24 turbine layout was not agreed. This was made clear in WEL's publicity.

4.15 There are two airstrips on the Vanhoutte property, both of which are used. In the 24 turbine layout airspace was compromised at both locations, even though turbine locations on the plateau were worked around the airstrip. As part of the land negotiations we found this layout was not to the satisfaction of local topdressing operators, and their agreement was required to finalise the land agreements.

1.1

5 Metered at the connection to the network.

6 Capacity Factor is defined as {actual output/rated output} e.g. an 84MW windfarm producing 250,000MWh/yr has a Capacity factor of $^{250,000}/_{(84\text{ MW x 365 days x 24 hrs})}$ = 40%

4.16 In subsequent negotiations the landowner agreed to abandon the airstrip on the plateau, part of this agreement being that turbine 22 which compromised the lower airstrip had to be removed to allow safe operation of that airstrip. This has been certified in writing by the local topdressing operator and to the satisfaction of the land owner.

4.17 This allowed turbine locations to be redefined on the plateau and turbine 22 was replaced by turbine 29 to the west of the lower airstrip. The resulting layout change materially improved project economics.

Need for 28 locations

4.18 As WEL has calculated energy at each of the turbine locations, the economic model can be adjusted for reduced capital cost and reduced energy if a turbine is deleted. These inputs are asymmetric because energy production varies across the site and part of the capital cost is fixed no matter how many turbines are installed.

4.19 Whilst the capacity varies for different turbines considered, the determining economic criteria are always cost and output. As selection quality data is not available at this stage estimates for each type have been used to calculate economic efficiency.

4.20 Whilst total capacity will be different for different turbine types, each will require the same site optimisation to be cost effective. To this extent they all mirror the increased unit costs for reduced numbers as given in section 3, with an output adjustment depending on turbine location. The result for each the turbine types is that 28 locations are required to ensure commercial feasibility.

4.21 Energy is location specific and clearly the more productive turbines are more critical to retain. Turbines 29 and 15 are thus important locations for project economics.

Homes Supplied

4.22 The net revenue metered output of the Wind Park is calculated at 259 GWh/yr. This is the saleable volume from the Wind Park after all transmission and network losses to the point of supply are accounted. The average electricity use for a New Zealand home is 8000 kWh per year, which means a wind farm of this size will supply about 32,000 homes. By comparison there are 22,950 residential customers plus some 5000 commercial/industrial customers connected to the WEL Network supplied from Te Kowhai, so the windfarm has the potential to supply all of that part of the network. With expected growth in this area the total output will be absorbed into that part of the network in the medium term.

Carbon Offset

4.23 Wind farms generate when the wind is blowing. While that is occurring the power generated is in effect base-load generation, which in the wholesale market is automatically dispatched. Wind generation will therefore at that time displace the highest priced generation otherwise on offer in the market. With a carbon trading regime in place it is most likely that the high price bids will come from coal or gas fired plant.

4.24 The carbon emissions factor for coal-fired plant using average coal types is 900 g/kWh so the calculated output of this Wind Park will displace about 233,000 tonnes of CO2 per year from a coal-fired plant. (e.g. the main Huntly Power Station)

4.25 The carbon emissions value for gas-fired plant is 400 g/kWh so the calculated output of this wind farm will displace about 104,000 tonnes of CO2 from a modern combined cycle gas fired plant. (e.g. the new "e3p" gas fired plant at Huntly)

4.26 Under a trading regime of 650g/kWh[7] at $20/tonne the Wind Park has any emissions reduction value of 168,000 tonnes and a carbon value of about $3.3M per year at average output. This emissions rate is equivalent to about 39,000 cars[8].

Fit to National and Regional Strategies

4.27 The relevance of this proposal to national requirements is covered in detail in the evidence of Mr Walter and Mr Ashby.

4.28 The NZ Electricity Commission forecasts an average 3%pa growth in demand for the North Island to 2012. Demand for 2006 is given as 23,951GWh so 3% growth represents a requirement for energy saving or new capacity in the order of 756GWh per year, and to achieve this with New Zealand's commitment to the Kyoto Protocol it is necessary for the country to invest in renewable generation such as this site.

4.29 If total demand growth is supplied by new generation at the current mean national capacity factor then 163MW per annum is required to satisfy this demand growth for the North Island alone.

4.30 Further, the Government has issued a challenge in its energy strategy to have 90% of national generation come from renewable resources by 2025. This implies the

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7 This is the carbon credit rate allocated to wind farms under the Government Program to Reduce Emissions (PRE) initiative.

8 At 4.33t/car/pa as given in the "Policy and Planning Guidelines for the Development of Wind Energy in Victoria"

retirement of fossil fuelled stations which will add considerably to the growth requirements as above.

4.31 Whilst there are numerous national and regional references to the use of wind power as a sustainable means of providing for the future economic and social well being of communities in an environmentally friendly way, I think these are well summarised in s34A of the Government Policy Statement on Electricity Governance dated Oct 2006, which records;

> *Encouraging the development of renewable energy resources is a key part of the Government's strategy for managing climate change and long term energy security. To further this aim the Government's objectives in relation to renewable energy, are that:*
>
> - *undue barriers to investment in renewables should be reduced or removed*
> - *the efficient uptake of renewable generation should be promoted and*
> - *the national transmission grid should be planned and made available so as to facilitate the potential contribution of renewables to the electricity system and in a manner that is consistent with the Government's climate change and renewables policies.*

4.32 Similarly in the recently published Waikato Regional Energy Strategy Working Document facilitated by Environment Waikato the overall purpose includes:

> - *to facilitate access to renewable energy sources within the region by identifying and addressing unintended barriers to development; and*
> - *to recognize the importance of the Waikato region's role in maintaining security of energy supply.*

4.33 I also refer to the proposed Waikato District Plan which includes the following policy statement:

> - *Positive effects to the environment and the community of generating and using renewable energy sources should be recognised and provided for*[9]

5 OUTLINE OF KEY ELEMENTS OF THE PROPOSAL

5.1 In this section of my evidence I address turbines and layout, other works required, and how these elements inter relate.

1.1

9 Policy Statement 7.4.2

Number of turbines

5.2 Turbines evaluated for use on this site range from 500 kW to 3 MW in capacity. The 2 to 3 MW range turbines have similar physical dimensions and component weights. All are of similar construction as described in the evidence of Mr Walter.

5.3 More efficient energy capture occurs with higher hub heights, but the ultimate height of a wind turbine is limited by the ability of the crane required to erect it. The capacity of cranes available in NZ allows 80 to 90m towers, depending on nacelle weight.

5.4 WEL is proposing a small number of large machines. This is consistent with overseas trends for wind farm construction where smaller numbers of larger machines are proven to be more acceptable from both economic and environmental perspectives.

5.5 For example, if 500 kW turbines were used on this site it would require 168 turbines to provide the same capacity from within the same site area. Site constraints prohibit this density of turbines and in any event the economics mirror common sense – to have 168 turbines compared to 28 large turbines is more expensive to build, operate and maintain. For 84MW installed capacity the capital cost of 500kW units is about 3 times more than 3MW units.

5.6 Twenty-eight turbines is the maximum number of 2 to 3 MW machines that can be fitted on to the site. WEL is satisfied that this represents the optimal configuration for the site. However, the final economic test in selecting which turbines will be installed will be the capital cost per unit of energy generated (and guaranteed by the manufacturer). As discussed elsewhere the class of turbine used, market forces at the time and economic factors will all influence this outcome, but the size of turbine used for 28 locations will be from 2 to 3 MW based on current models available[10].

Layout

5.7 As with all wind farms, layout is determined by a series of fundamental constraints. These are

- wind resource, i.e., the strength and consistency of the wind, and topographic influences;

1.1

10 If models over 3MW with the same dimensions (especially weight) become available these will need to be considered.

- access, i.e., the suitability of roading to site and proximity to electricity demand;

- foundation materials, i.e., geomorphology suitable for roading and foundations;

- land use, i.e., land and vegetation cover that is compatible with development avoiding sensitive environmental or ecological areas;

- airway use. - airway use maybe be due to aircraft or landing strips but generally relates to telecommunications paths. Also, the separation distance required between turbines is also a fundamental constraint to minimise wake losses. For a site of a set size, these constraints limit number of turbines that can be accommodated.

5.8 There can also be a considerable difference in yield across a windfarm of this size. There is generally a better wind resource at higher elevations; however topographic features such as the heads of valleys and exposed ridge ends can also produce higher than average yield.

5.9 The layout for the Te Uku Wind Park is highly constrained by topography, access, and telecommunications paths. There is also a very material difference in the wind resource across the site and for these reasons the layout selected is critical.

5.10 Energy output is estimated from wind monitoring, topography and layout. Calculations are done by computer simulation modelling.

5.11 Yield varies by 32% across this site. Yield is generally lower at the southern end, the least productive turbine is number 23. The most productive turbines are numbers 15 and 29. These are critical to the economic viability of the proposal, for reasons I have discussed in section 4.

5.12 Turbines 14, 18, 20, 24, 28, and 29 are very close to telecommunications paths, and it is not possible to move these turbines far from their shown locations. (Note: Whilst turbines number to 29 there are only 28. This is due to turbine position 22 being deleted and retention of original numbering for the remainder.)

Indicative turbine and consent envelope

5.13 For the reasons above, it has been necessary to seek consent to an envelope which will accommodate the most likely turbine type to be selected for this site. As discussed elsewhere, turbines for this site will be in the 2 ~ 3 MW size and could be either class 1 or 2 rating. Class 2 turbines have a larger rotor diameter and in any event the highest hub height is desirable. The indicative turbine is a Vestas V-90-3MW which at 80m hub plus 45m blade length is 125m overall whereas the tallest potential machine is a Siemens 2.3mkII Class 2, which on a 90m hub plus 46.5 m blade length gives 136.5m overall. The dimension envelope is needed to accommodate this range of plant.

5.14 The proposed consent envelope also allows for micro-siting. Whilst a number of the proposed locations have been test bored, every location will need at least two further test bores to determine foundation suitability, as discussed in the evidence of Mr Mitchell. It is therefore possible that some proposed turbine locations may need to be adjusted in order to secure a satisfactory footing. There are also a number of other issues which may affect final location. These include farming activities and local topography. For these reasons, a contingency zone around each of the selected locations is sought within which a final turbine position can be selected.

5.15 A lot of evaluation has been undertaken to confirm both the minimum physical dimension window and the minimum layout window required to accommodate both the most likely machinery and layout constraints.

5.16 The consent envelope applied for will accommodate a number of turbine types ranging from 2.1 MW size through to 3.0 MW, in Classes 1 and 2. In total this gives 58.8 to 84.0 MW installed capacity, which will provide a project of economic scale.

5.17 As discussed in Section 4 the critical economic test is capital cost per MWh output, where output is capacity x capacity factor. As class 1 & 2 have different characteristics, as described in paragraph 3.7, it is not possible to say at this stage whether 2.1MW class 2 machines or 3.0MW class 1 machines will be more economic, however both need 28 locations for optimal economic use of this site.

Description of wind turbine generators to be used

5.18 Further to the generic description given by Mr Walter, the class and size of turbine proposed for this project all have a number of common characteristics. Main component parts are foundations, tower, nacelle, rotor and blades, as described in the evidence of Mr Walter.

5.19 Whilst a variety of foundations are used for specific conditions the common form and type of foundation that will be used here is a massive reinforced concrete pad into which the formed steel tower base is cast. Typical dimensions are 18m x 18m x 2m thick for founding onto competent soils. As noted in the evidence of Mr

Mitchell, the underlying soils on this site are competent but in places solid rock is close to the surface and such places the thickness will be adjusted to found onto rock.

5.20 The towers that will be used on this site will be slender cylindrical form fabricated from high grade steel. For 80m towers they are typically 4.5m diameter at the base tapering to about 3.0m at hub height. They are manufactured in about 20m lengths with bolted flange connections to the cast in base and between lengths. The flange connections are internal so the external form is smooth. Modern towers limit welding to longitudinal and circumferential joints between the plates and use magnetic or bolted connections at the flanges to secure internal components. This allows lighter steel sections to be used. The towers not only support the turbine but provide access with ladders, a service lift or internal crane, and power connection to ground level.

5.21 The nacelle houses the rotor shaft, gearbox, braking system, generator, ancillary mechanical systems and control systems. In some types the generator transformer is mounted in the nacelle and in others it is mounted at the base of the tower. The nacelles have a substantial steel frame that is connected to the tower through a slew ring which points the tower in any direction relative to the tower; this allows the turbine to be pointed into the wind as it changes direction. The housing for nacelles is fibreglass over a steel frame, with a cross section of about 3m x 3m.

5.22 All types considered for this site will be 3 blade machines.

5.23 Turbines will be actively controlled. Each one has sensors that monitor wind speed and direction, feeding this data to the control system for that turbine. The control system then starts or stops the turbine, points it into the wind and controls the pitch of the blades to optimise energy capture. For the indicative turbine the nominal rotor speed is 16.1 rpm[11] which the gearbox converts to 1500rpm for the generator. Generation voltage is 660V and transmission voltage 33kV.

5.24 Turbines used are likely to be "slip wound" which allows a variation in rotor speed to minimise mechanical wear from constantly changing pitch. For the indicative machine which has a nominal rotor speed of 16.1 rpm the rotor speed may vary from 9 to 19 rpm.

1.1

11 Revolutions per minute

Meteorological masts

5.25 The application includes up to three permanent meteorological masts within the Wind Park area. These replace two masts that are presently on the site, but which only have limited term resource consents.

5.26 Meteorological masts are required initially to determine the resource available across a site, are required at commissioning to determine performance warranties, and are required in permanent locations to maintain a wind resource record independent of the sensors fitted to each turbine.

5.27 It is not possible to say at this stage how many meteorological masts will be permanently required, or where they will be situated. Turbine supply will be subject to performance guarantees and the use of meteorological masts will be largely determined by performance tests at commissioning.

5.28 In any event it will be good to retain the existing 80m mast for a long term record so this can be considered the minimum requirement.

Roads

5.29 Construction roads need to accommodate blade lengths up to 46.5 m, heavy loads up to 90 tonnes, and a crane with track width up to 9 m for erection of the turbines. These constraints mean construction roads are built to a high standard with limitations on gradient, horizontal and vertical radius, and cross slope.

5.30 Roads are classified as primary or secondary, primary being the main access road into the site and through the site, with secondary being the spur roads to each turbine.

5.31 The main internal road into the Wind Park site will be formed to 6 m width to accommodate components trucked on to the site in broken down form, as well as two way traffic from the quarry to the plateau. The crane used to erect the turbines will be assembled on-site and walks between turbine locations. In built-up form this crane has up to 9 m track width, so interconnecting roads are formed to 10 m width.

5.32 At the end of construction 10 m roads are reduced to a 3 to 5 m width for permanent access use. The construction sequence is normally that topsoil is wind-rowed outside the 10 m width during construction, the outside formation wedge is then graded into the reduced width after construction, and the topsoil replaced over the outer construction width area. This means that the permanent access road surface is elevated above adjacent land, and the reduced width is a substantial formation.

5.33 The reason why road widths are reduced is simply to maximise available farming area. In some circumstances, it can also be useful to minimise the visible presence of roads.

Electrical connection of turbines

5.34 Each turbine is connected to a single transmission point by electrical cables buried under the roading network between the turbines. Up to seven turbines of the indicative size can be connected in series referred to as a string, to minimise cable length. It is normal for the cables to be laid under the construction roads after the turbines are erected but before crane width roads are reduced.

5.35 Because of the distance from the southern end of this Wind Park to the point where it will connect into the WEL network the southern strings will probably be connected at a switch with a single cable to the transmission point. The voltage for this interconnection system will be 33 kV.

Transmission point

5.36 The cable strings will connect to a common 33 kV "bus" in the Operations and Maintenance building. This is the demarcation point between the Wind Park and the WEL network. The word "bus" describes a conductor rail to which each of the cables is bolted to unify the output, noting each connection is through a circuit breaker so that each string can be isolated for maintenance.

5.37 The general arrangement for the transmission point is shown in the diagram attached as Appendix 1 to my evidence.

6 CONSTRUCTION OF THE WIND PARK

6.1 In this section I describe how the Wind Park will be constructed. The engineering issues and volumes for earthworks, roading and concrete works are given in the evidence of Mr Keyte. My comment is on the way these works will be undertaken.

Civil Works

6.2 The main components for civil works construction are roads, turbine foundations, and temporary equipment and materials lay down and crane standing areas. Civil works construction involves the excavation and placement of earthworks, the placement of aggregates for road works, and the construction of mass concrete foundations for the turbines.

6.3 It is the intent of WEL to construct civil works by alliance contracting. This process involves a client, engineer and contractor working together from the outset to design and build, ensuring the best solution is delivered on time.

6.4 The time required for civil works is the critical path for on-site delivery. On this site these works will probably be constructed over two summer seasons. In the first season the quarry and batch plant site will be prepared along with the main access road to the Wind Park site. This provides minimum exposure to winter conditions and the ability to move quickly on the bulk of civil works during the following summer.

6.5 During the intervening winter months materials will be mined, processed and stockpiled at the quarry. The concrete batching plant and other construction facilities will also be set up during this period.

Quarry

6.6 The construction of the Wind Park requires the formation of substantial construction roads and large concrete foundations. In this proposal the aggregates required for both roading and concrete total approximately 350,000 tonnes, as given in the evidence of Mr Keyte.

6.7 A unique feature of this proposal is that a quarry suitable to provide these aggregates is situated within the properties involved. The same quarry area has a good water supply and is suitable for locating a temporary concrete batching plant as described by Mr Keyte.

6.8 Having these facilities within the construction zone contains off-site requirements and keeps all bulk construction traffic off public roads. The volume of aggregates noted above equates to about 17,000 truckloads which at other locations would need to traverse public roads.

Concrete batching plant

6.9 A major consideration with any wind farm construction is the concrete required for turbine foundations. These are generally mass concrete pads which need to be cast in one continuous pour, and for the indicative turbine volumes are in the order of 800 cubic metres per turbine.

6.10 A continuous pour of this size is very big, and requires concrete to be batched close to the pour site. The Te Uku site is very good in this regard in that the mined materials, water, and a suitable site for concrete production are all within the confines of the Wind Park. This means that approximately 4500 truckloads of concrete are kept within the construction site, and off public roads.

Generation Plant

6.11 Generation plant includes the wind turbines, towers and ancillary equipment. This plant is normally imported as broken down units under a contract to design, supply, erect and commission the generation plant.

6.12 Due to global demand there is considerable lead time required for the delivery of wind turbines. This is up to two years at present. Turbine orders will be placed as soon as a decision to construct is made.

6.13 Turbines for a particular site will be manufactured in one batch and delivered in a single shipment. Delivery is timed to commence at the end of the second summer season and when civil works are more or less complete.

6.14 Arrangements for a suitable crane and erection services also need to be timed to suit. With all these arrangements in place erection of the turbines will occur during the second winter period. Turbines of the indicative type can be erected at a rate of two per week depending on the weather conditions (especially wind), so it should only take about three months to erect all turbines on the site.

Balance of Plant

6.15 Balance of Plant refers to miscellaneous equipment and electrical interconnection of the turbines. The turbines will be connected by underground cables with strings of up to seven turbines in series. Cables from these strings will also be joined to minimise overall cable length. The interconnecting cables are brought together at the transmission point where they are joined to the common bus.

6.16 The cables between turbines and connecting the turbines to the transmission point will be laid in trenches excavated along the middle of the road to each turbine. The cables are laid after each turbine is erected and the crane has moved to the next location, but before the road width is reduced as described above. As such the entire interconnection system is buried, and has a long low maintenance service life.

Transport to NZ

6.17 Generation plant and other equipment will be shipped to New Zealand and offloaded at either Auckland or Tauranga. The nacelles and tower elements are shipped on shipping frames or “bookends” (similar to a container base that fits to special trailer units each end without a crane), the blades come in framed packs, and the sundry parts in containers.

Transport to Site

6.18 Transport from the port of entry to the site will be by road on conventional heavy haulage equipment and purpose-built trailers for the rotor blades. Specialised transport equipment is available in NZ.

6.19 The roadway from the Port of Auckland to site has been checked for weight restrictions and test driven for over length loads. This route can accommodate the transport requirements without modification.

Turbine erection

6.20 Ideally, as wind turbines are brought to site, they will be offloaded on the hardstanding where they are to be erected. As this will not always be possible temporary laydown yards will be included in the civil works so that transport and erection operations are not constrained.

6.21 Erection of the turbines will commence at the south end of the Wind Park and progress northward. Each location is completed before equipment moves to the next.

6.22 The towers will be delivered in four sections and erected in sections which are bolted together. The nacelle and slew ring are then fitted, followed by the rotor hub and rotor blades.

Commissioning

6.23 Each turbine is commissioned individually. This involves a series of static tests followed by run-up and dynamic tests before each unit is put into service. WEL will accept the turbines from the supply contractor when the final turbine is commissioned.

7 OPERATION OF THE WIND PARK

7.1 Wind turbines operate automatically in response to wind speed and direction at all times when they are connected to the network. Each turbine is actively controlled and has its own sensors measuring wind speed and direction. This data feeds into a Programmable Logic Controller (PLC) which then points the turbine to face into the wind and sets the blade pitch to match wind speed. This operation is carried out more or less on a continuous basis noting that modern wind turbines are capable of some speed variation to minimise the need for pitch control. With the indicative turbine the nominal speed is 15 rpm but the rotor can operate from 9 to 18 rpm.

7.2 The same active control mechanism will shut the turbine down at very low or very high wind speeds. During high wind speeds, normally at over 25 m per second, the wind turbines close down with the blades at zero pitch and turned into the wind with the brakes on. This is to prevent damage to the turbines and prevent overload to the towers and foundations.

7.3 Turbines will normally be connected to the network and free to operate when wind is available. They will be disconnected from the network for scheduled service or maintenance, or when mechanical or electrical protection devices operate.

7.4 As such the operation of the Wind Park will be in the main automatic apart from service outage time. The performance and condition of each turbine is constantly monitored by an array of sensors and diagnostic software. These measure and log key mechanical and electrical parameters in real time, with trend analysis, warning, alarms and trip protection.

7.5 Whilst the actual operation is automatic full details will be recorded on a Supervisory Control and Data Acquisition system (SCADA) and telemetered to the WEL control centre in Hamilton in real time. As a network operator WEL has a 24/7 control centre which has the capacity to oversee and remotely intervene in control functions if and when required. This provides a robust backup to automatic control.

7.6 Turbines will be shut down for time based routine service, for preventative maintenance based on condition monitoring, or due to grid or plant failure. Condition monitoring is comprehensive and flags problems early so as to avoid failure.

7.7 A key condition monitoring parameter is vibration. A number of phenomena from icing of the rotor blades to bearing failure will cause mechanical vibration and sensors are set to detect this and take appropriate steps this before failure occurs.

These sensors[12] are very sensitive and will detect mechanical vibration or noise before it becomes perceptible to human senses.

7.8 Much of the routine service is done with the turbines running but a shut down of about annual frequency is required for major service.

7.9 I would expect 2 persons to be employed full time on site to service and maintain this facility. Unlike hydro or thermal generation facilities of this capacity, wind farm capacity is spread over a lot of units so risks such as bulk storage of petrochemical products are substantially reduced. Such products are in small volumes and diverse locations lowering the risk of bulk storage or concentrated use. There is no direct connection to waterways in operations.

7.10 Wind Park maintenance will include the control of weeds or the like that result from construction and/or are specific to operational areas. It is usual however for most if not all land affected by construction to return to farming use and management post construction.

7.11 Overall the availability of turbines in the Wind Park is calculated at 98.5%[13]. The network connection proposed by WEL is robust so forced outage to network faults is low probability.

8 RESPONSE TO PEER REVIEW COMMENTS

8.1 In this section I will respond to issues raised in the council officers' reports that pertain to my evidence but are not covered elsewhere, and in particular reply to the recommendations and questions arising from the energy review.

8.2 In paragraph 9.3.5 reference is made to land use consents being limited to a finite period. With the provisions for decommissioning there is nothing to be gained from a finite term. Apart from the turbines (which have to be removed on decommissioning) remaining works have negligible effect. Project viability is modelled on a 40 year life cycle.

8.3 In paragraph 9.8.1(a) WDC's geotechnical advisor considers a final earthworks design should be approved by Council. WEL agrees that a Construction Management Plan including design and performance parameters should be prepared and agreed with Councils prior to works commencing but considers it is more appropriate to make detailed design subject to the certification of a suitably

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12 Piezoelectric accelerometers
13 Hydro Tasmania Consulting March 2007

qualified and registered engineer, and to allow for detailed design to broaden as work progresses and site conditions are exposed.

8.4 In paragraph 9.9.6 concern is expressed that quarry resources required for the Wind Park may be depleted by existing use if construction is delayed. This is a valid concern. WEL is conscious of the volumes required, is monitoring this and will need to secure supply before timing becomes critical. There are good resources elsewhere on the Jowsey property. In this regard I refer to the evidence of Mr Mitchell to the effect that rock excavation will be required for road alignment and there are good rock sources are adjacent to these areas. Subject to a rock extraction plan as described by Mr Mitchell it is proposed to use this material. This both reduces the volume required at the quarry and considerably reduces haulage costs. WEL does however recognise the apparent anomaly between lapse period and aggregate supply if construction is delayed, and will accept a condition that requires aggregates to be sourced from the within the wind park to comply with other parameters of the application.

8.5 In paragraph 9.9.7 it is suggested the viewing platform be erected prior to the first turbine. Land agreements require WEL to construct progressively from the south. Because of this there will be no appreciable view from the platform site until the end of construction so no value in building the platform early. WEL does accept that the viewing platform should be available when construction comes into view and has amended the proposed conditions accordingly

8.6 In paragraph 9.9.8 concerns are raised about public interest, use of Van Houtte or Plateau Roads by the public, and the possibility of guided tours. All of the Wind Park will be built on private land over which WEL will have restricted rights of way to operate and maintain. WEL does not have the rights to invite or allow other persons on to these farms and that remains solely at the discretion of the landowners. As noted in the evidence of Mr Keyte application is sought to deem Plateau Road a construction zone for the construction period, but in any event there will be nothing to see from the public parts of either Van Houtte or Plateau Roads. WEL accepts cars may try to access the site by these roads and construction contracts will need to include security to prevent this. The concern of damage to public (WDC) roads during construction is also raised, and in this regard WEL is agreeable to recording road condition preconstruction and returning roads to no less than this condition post construction.

8.7 In paragraph 9.10.1 concerns by the Airways Corporation of NZ (ACNZ) are raised. An application has been made by WEL to the Civil Aviation Authority and an authorising determination has been received from it. This determination lists conditions including those sought by the ACNZ. WEL has agreed to abide by the CAA conditions.

8.8 In paragraph 9.10.2(b) confirmation is sought that any effects on the telecommunications mast at Te Uku are resolved to the satisfaction of Telecom NZ Ltd. I assisted WEL in negotiating a Memorandum of Understanding it has entered with Telecom in this regard. WEL is contractually bound to comply with this agreement and has satisfied Telecom's requirements thus far with the layout applied for which avoids telecommunications paths.

8.9 In paragraph 9.11.6 the protection of the identified pa site is sought. This agreed to and is offered in proposed conditions.

8.10 In paragraph 9.12.1 WEL is asked to comment on potential effects on atmospheric conditions. The physics of wind flow around the turbines is discussed in the evidence of Dr Black. Clearly turbines do cause local disruption to wind flow however as with wind flow over any aerofoil this effect is limited. For wind farm layout the "rule of thumb" is a separation distance equivalent to 7 rotor diameters to avoid these effects on leeward machines (known as waking effects). This is based on empirical data which shows both wind speed and laminar flow has recovered within this distance. Apart from the local disruption of wind flow I am not aware of any micro climatic changes caused by wind farms.

8.11 In paragraph 9.12.3 WEL is requested to comment on supporting community projects and/or reducing electricity prices to the local area, providing a bond for unspecified reason, providing a dismantling bond, and project viability.

- WEL presently supports both energy saving and community initiatives in this area and will continue to do so as part of its normal operations.
- The Wind Park is being proposed as a business venture from which all customers in the WEL network will derive economic benefit.
- In my view, it is unacceptable to require a bond for undefined reasons, and it is unreasonable to expect that the turbines be decommissioned if the wind is low in a particular month. In any event WEL is contractually bound to remove turbines if and when the Wind Park is closed.
- I have already discussed the viability of the proposal.

8.12 The Waikato District Council engaged Steve Goldthorpe Energy Analyst Limited to peer review the benefits and positive outcomes of the proposed windfarm. This report concludes that "the validity and scope of the positive outcomes claimed in the windfarm consent application is questionable". I challenge this conclusion and the promotion of photovoltaic generation being promoted by Mr Goldthorpe.

8.13 Before replying to Mr Goldthorpe's questions and recommendations I will first refer to the fundamental references and related calculations that had been used by WEL in areas of its application that have been questioned by Mr Goldthorpe.

8.14 To place the WEL proposal in a national context, WEL has used the electronic data files published by the Ministry of Economic Development, the Statistic Department and the Electricity Commission for its source data. Relevant parameters derived from this data are:

- the national average capacity factor (CF) is 53%;
- the average national growth rate for generation over the last five years is 1.9%;
- total NZ generation for the 2006 year was 42,083,982 MWh[14];
- extrapolated growth is 798,726 MWh per year;
- generation and /or efficiency required to satisfy this growth is equivalent to171.78 MW of generation.

8.15 In reply to Mr Goldthorpe's questions and recommendations that pertain to my evidence (noting I have reiterated each question in italics and answered below each):

a) WEL should be asked to justify their assertion that annual electricity demand growth in New Zealand is 150 MW.

8.16 I calculate the capacity required to satisfy the current growth in generation at about 172 MW per year, with due regard to the current national average generation growth and capacity factor. I generally agree with the consumption data used by Mr Goldthorpe[15] but he assumes 100% capacity factor in calculating the generation required to meet this demand. Such a capacity factor is unsupportable. I consider that the appropriate capacity factor is the statistical national average of 53% or lower. With the development of wind generation the average national capacity factor will become lower.

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14 Demand and supply statistics vary because some generation is net of demand.
15 Note the MED tag this data set as having errors and lower reliability

8.17 Most government agencies use 2% as the nominal projected electricity demand growth rate. This results from the calculation given by Mr Walter. The NZ Electricity Commission forecasts an average of 3% pa for the North Island to 2012, and the statistical national average growth for generation is 1.9%.

8.18 I also point out in this regard that there are initiatives by several government agencies to reduce demand growth by demand-side efficiency measures. The sum effect of these measures is significant, and nets off the statistics used by Mr Goldthorpe, making the generation component required to satisfy demand growth difficult to determine.

8.19 The analysis used by Mr Goldthorpe includes energy savings, and more importantly assumes 100% capacity factor (i.e. 550GWh / 365 days / 24 hrs = 63MW). This is incorrect and needs to be adjusted by actual capacity factor to determine the generation required to supply 550GWh, which is 118MW at 53% CF. Also in this regard generation is constrained and needs to be able to supply peak demand and not just average demand.

8.20 Further, it is the objective of Government's Energy Strategy that 90% of electricity in the future should come from renewable resources. This implies the retirement of major thermal plant and in particular the Huntly Power Station. If for example Huntly was to be retired in 10 years time it would require the introduction of at least 100 MW per year of renewable generation just to replace this facility (ie over and above the growth calculation).

8.21 My view is the 150 MW used in the WEL application is a fair representation of where generation required for national demand growth sits, and that in this context the Wind Park is material. I am uncertain as to what Mr Goldthorpe is seeking to establish here but clearly if demand growth is only 63MW/yr the WEL application is much more significant.

b) WEL should be asked to justify the need for this wind generation project in the context of the bigger picture of the need for wind power generation in New Zealand and other wind developments.

8.22 Answer: Clearly to achieve the objective of 90% renewable generation as referred to in Mr Goldthorpe's report, and with wind power as the most economic means of doing this with current technology the "bigger picture" is that rapid development of wind resources is required. The NZ industry is market driven so the most economic and efficient sites will develop in merit order. Due to commercial sensitivity there is no means of ranking other than market drivers, however for the numerous reason set out in my evidence WEL considers this site to be competitive.

c) WEL should be asked whether the minimum electricity demand on the accessible parts of the WEL distribution network is always greater than 84 MW or whether there would be a need to use the Transpower grid to accommodate peak output from the windfarm.

8.23 Answer: As described in evidence given by Mr Shaw maximum demand on the GXP at Te Kowhai is presently 75 MW. In my evidence I have assessed the capacity of the windfarm will be between 58.8 and 84 MW. Whilst the volume of energy demand on the GXP is greater than the energy output of the Wind Park there will be times when capacity exceeds demand on the GXP. In these times energy from the windfarm will be exported into the grid, however, with due regard to load growth in the evidence of Mr Shaw this export component will soon be fully absorbed into the network.

d) WEL should be asked to explain the rationale behind proposing 3 MW turbines for the project in preference to small more manageable wind turbines.

8.24 Answer: This is covered in detail in paragraphs 5.2 to 5.6 of my evidence.

e) The resource consent shall be worded so as not to present a barrier to future PV farming on the site.

8.25 I consider it is inappropriate to constrain use as promoted by Mr Goldthorpe.

8.26 Although not carried through to a question or recommendation Mr Goldthorpe comments on air discharge avoidance, and this is referred to in the officer's report. Mr Goldthorpe states that if generation from the windfarm is only used within the WEL network area the generation it displaces will be different than would be the case if it was connected to the grid. This is incorrect in that displacement and connection are mutually exclusive. I do agree with Mr Goldthorpe that if the government's objectives of 90% renewable generation are achieved that wind may displace other renewable (hydro) generation. However the MED statistics show that 35% of current generation is fossil fuelled, and that wind penetration has only grown to 3.5% of total generation. It follows that it will be some time before fossil fuelled generation is replaced as the major form of generation on the margin for dispatch. In the meantime wind as base-load generation will displace fossil fuelled generation on the margin, and to that extent has displacement value whether it is connected directly to the grid or embedded in a grid connected network. I also note that wind farms qualifying under the government's programme to reduce emissions scheme were allocated the full displacement value for carbon credits at the rate given in my evidence.

9 SUBMISSIONS

9.1 The purpose of this section is to address issues raised by submissions that are relevant to evidence I am giving.

10 Years for Resource Consents

9.2 Some submissions oppose WEL being given 10 years in which to give effect to the consent. In my experience, the construction of wind farms is subject to a number of time constraints which can add up to significant delays. For this reason an extended lapse period is sought.

9.3 About 70% of total windfarm cost in New Zealand is imported components These are sensitive to exchange-rate variations. In the case of Te Uku one percentage point difference in the \$US/\$NZ exchange rate has an effect of about \$1M on the net present value of the project. Orders cannot be placed until precursors such as consents are in hand and exchange rates are favourable, and there may then be a considerable delay between order and delivery. There can also be significant delays in finding output contracts or power purchase agreements that are sufficient to commit to a project. It can take years for all of these factors to line up.

9.4 To date, the New Zealand electricity market has been very volatile and wind power has been relatively high cost generation when compared to thermal generation, because the environmental costs of thermal generation have not been accounted for. Until recently there has also been a paucity of government initiatives to account for environmental cost (carbon value) and wind generation needs this accounting to be viable. In theory, the government's recent move to establish a 'cap and trade' system will increase the viability of the Wind Park development. However, it will take some time before the true nature of the carbon market is established and its effects on Wind Park economics can be truly assessed.

9.5 In my view whilst the 10 years sought is at the upper end of the lapse period required, I consider it is needed to provide reasonable comfort to WEL

Alternative Sites

9.6 Some submissions refer to alternative sites. Part of my responsibility to WEL has been to evaluate as many alternatives as possible in the Waikato area and this is covered in Section 3 of my evidence.

Submission by Sean Cox

9.7 The submission by Mr Sean Cox addresses a wide range of issues but I will address those matters within my field.

Mr Cox submits (through attachments) that additional reserves are required to balance wind farm variability and this negates the value of wind power.

9.8 In any electricity system demand and supply must be balanced. As demand varies the supply side must be able to instantly respond to this variation. This is done by having reserve generation on line and interruptible load. Together these mechanisms to balance supply to load form the reserves market. "Spinning Reserve" describes hydro plant which is motoring on line but with the turbines running in air. Water can be introduced within seconds to change the mode from motoring to generating to compensate for demand surges in the system. Interruptible load is load that can be shut down very quickly, such hot water circuits on a network.

9.9 Wind generation is variable and so acts like demand in a system. The net effect of variability is however reduced by geographic separation of wind farms which is another reason why the Te Uku site is valuable. WEL does however accept that wind power does require more reserve capacity. It is important to note that spinning reserve is low cost and does not use water; this means that while the wind is blowing, water is being reserved in the hydro lakes and to this extent hydro and wind are very complementary. I also point out that as a network operator WEL has the capability to manage variability with interruptible load within its own network. This is very simple to manage and negates the issues raised by Mr Cox in this regard.

Mr Cox submits generation from biomass would be better in this location.

9.10 Following comments by Mr Cox regarding biomass in his submission, WEL engaged Connell Wagner to evaluate this potential in the Te Uku area. Their conclusions were that this option was both technically and commercially not feasible.

9.11 In the NZ ETS[16] which has recently issued by Government it was noted that whilst forests sequester carbon during growth (and so attract credits), they cause emissions during harvest. If those forests are to be used as biomass fuel they will require credits. The life cycle carbon value is then likely to be carbon neutral where wind power is carbon positive.

Mr Cox has attached a paper by Richard S Courtney (USA) which purports that windfarms have negligible value.[17]

9.12 This paper is erroneous in the NZ context in that it ignores the resource and efficiency levels that can be captured in NZ and prices reserve cost on building gas fired generation. This paper tabulates European data to arrive at capacity factors sub 30% whereas from the time I managed Tararua stage 1 the average capacity factor was 44% with monthly records up to 60%. As noted in my evidence calculations for Te Uku are a capacity factor between 37.3% and 41.1% (depending on turbine type) which is well above the paper upon which Mr Cox relies to suggest this will be an inefficient facility. NZ has one of the best wind resources in the world. Further, NZ has about 55% of its generation in hydro capacity which benefits from managing variable wind load so does not impose the reserve cost the paper used by Mr Cox implies.

9.13 I do accept there is a limit to how much wind power can be used on a system, however NZ is still well below that threshold and needs to increase wind capacity to that level to take advantage of the positive attributes of wind generation. Te Uku is well located in the regard. The current installed (including Tararua Stage 3 which is under construction) wind generation capacity in NZ is 321MW (ref NZWEA) out of a total 9050MW (ref MED) active on the grid. This represents wind penetration of 3.5% which is well below the 20% that a closed mixed generation system can absorb.

Mr Cox suggests a number of measures that would mitigate effects. These include only approving specific makes of turbine, a 2 year lapse period, operational constraints, deleting 10 turbines, bird warning radar, decommissioning bond, minimum output requirements and a 20 year term.

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16 New Zealand Emissions Trading Scheme September 2007

17 The publisher "Centre for Science & Public Policy" is a policy centre for the Frontiers of Freedom Institute which is a privately funded group whose mission is to promote conservative public policy based on traditional American values.
Richard S Courtney was a materials scientist for British Coal, and technical editor for CoalTrans International. He is a member of the European Science and Environment Forum and founding member of the Christ and the Cosmos Initiative. He is a prolific writer particularly in the topic of coal technologies

9.14 I consider that none of these proposed conditions are justified in the context of the WEL application.

Further Growth of Wind Park

9.15 Some submissions express concerns about the potential to extend the current application at some time in the future. The elevated land area is finite and the layout applied for occupies all of the available area, bearing in mind other constraints set out in my evidence on layout.

9.16 An early layout showed 24 turbines compared to the final layout with 28. To optimise viability it is necessary to get the maximum number of turbines on this site. The reason why numbers were increased after the project was made public is due to the completion of landowner agreements, and the main land owner relinquishing his air strip in the plateau area which permitted a more optimal layout and additional turbines. This is covered in my evidence.

9.17 There is no ability to fit more of the same turbines in the area subject to this application, without compromising the yield efficiency of the consent application layout. In my opinion it would not be economic to do this.

9.18 In any event, the application is for 28 turbines and any further turbines would require assessment under a separate consent process.

Cost

9.19 A number of submissions refer to cost and question whether the high cost of wind turbine machinery will result in a viable project.

9.20 Wind generation is currently the most cost-effective of the renewables technologies with a very strong demand for plant worldwide, and a scarcity of supply. It follows that the price for plant is very high and in a global market where many countries subsidise wind generation New Zealand is not in a strong position to compete.

9.21 At present there is up to two years lead time from placing orders to delivery. About 70% of the value of a windfarm in New Zealand is imported, and in this respect price is very sensitive to exchange rates.

9.22 The economics of a project such as this are based on costs at the time. Whilst the combination of high prices and high exchange rates cancel each other out at present, by the time orders are placed each of these factors could have materially changed. To that extent the economic worth of a project such as this can only be determined at the time tenders for all costs are received.

9.23 The key issue here is that any project such as this has to be good business for it to proceed to construction. This decision can only be made when consents are in place, conditions of consents known, final design is complete, pro forma offtake agreements are negotiated, and construction tenders are called.

9.24 As set out in my evidence WEL has undertaken a thorough economic assessment and is confident this project can proceed to construction.

Turbine Size

9.25 Some submissions refer to both turbine size and the number of turbines in this application.

9.26 As set out in my evidence considerable effort has been applied by WEL to find the best solution for this site. On issues that can be quantified the turbine envelope sought will provide for the optimal solution.

9.27 In my view there is a positive visual outcome in using fewer larger machines, as compared to many smaller machines. Visual effect is addressed by Mr Mansergh in his evidence, but in my experience the visual impact of wind farms is subjective. I note that trends in global windfarm developments are very definitely towards fewer numbers of larger machines.

9.28 For commercial feasibility fewer larger machines is positive.

Vibration

9.29 A number of submissions referred to vibration in the context of “noise and vibration”, with two referring to mechanical vibration and the possible effect on the integrity of surrounding slopes. I note that both these submissions use essentially the same wording.

9.30 Airborne noise and vibration issues are addressed by Dr Black and Mr Hegley. I do have some comment on mechanical vibration and ground effects.

9.31 There is very little reference data on mechanical vibration from wind turbines simply because this is not a characteristic of modern wind turbines in good operating order. All modern turbines have vibration sensors that detect vibration caused by mechanical failure and immediately shut that turbine down. Because of this, vibration levels are very limited in normal operations.

9.32 Measurements taken on similar sized turbines in the UK are in the order of 10^{-4} mm/s producing ground vibrations with amplitudes of about one millionth of a millimetre. This level of vibration is so small that only the most sophisticated instrumentation and data processing can reveal its presence.

9.33 Commentary published by the Canadian government is that "*a failure of mechanical components may result in adverse mechanical noise as well as vibration. However, there is no evidence that even such serious failure may generate significant vibration outside of a 50 m radius from the wind turbine tower*".

9.34 As with noise, ground borne vibration attenuates with distance and is safely absorbed. The massive concrete footing for each tower will dampen vibration effects. It should also be noted that many onshore wind farms in the world are built on ridge lines, and I am not aware of any of these areas slipping due to induced ground vibration.

9.35 There is published data on a major landslide during the construction of the Derrybrien Windfarm in Ireland. This was however due to construction techniques and was on no way related to turbine vibration. As far as I am aware this is the only reported land failure related to a windfarm.

Transmission Lines / Substation

9.36 A number of submissions question how electricity generated will be transmitted to end users. Typically, a wind farm will need a new transmission line to link it to a grid or network connection. However, this situation is somewhat unique in that the Wind Park sits beside an existing network connection from Hamilton to Raglan that needs to be duplicated in the medium term.

9.37 The proposal is to build the duplicate line capable of transmitting windfarm capacity if the Wind Park proceeds, or at reduced capacity if it does not.

9.38 In evidence provided by Mr Shaw the second line to Raglan without the Wind Park will not be realized for several years. The Wind Park therefore has the potential to advance the construction of this line by several years.

9.39 At present the Raglan area is dependant a single 33 kV supply to Te Uku, and is sensitive to power outages because of the unsupported nature of this supply. The Wind Park will thus improve reliability and security of supply to Raglan.

9.40 Because this strategic network development is close to the proposed Wind Park, it is logical for the Wind Park to connect into and be a part of this network. The second line to Raglan and associated works are part of WEL's network expansion, and as such will be designated at a later date and when they can be defined with the Wind Park consent and conditions known.

Viewing Platform

9.41 A number of submissions question the proposal to have a viewing platform at Te Uku and the effects this may have. I have been involved in a number of discussions with Transit New Zealand and others that result in the viewing platform concept.

9.42 I am also familiar with the viewing area built as part of the Tararua wind farms and with similar facilities in Australia.

9.43 There are two main issues that lead to the use of viewing areas. Firstly it is essential to provide an outlet for driver interest where major roads are in the vicinity of a wind farm and secondly it provides a convenient place for education.

9.44 For drivers travelling towards Raglan the Wind Park will become visible at the top of the deviation where there is no convenient place for vehicles to stop and take time out to observe. For road safety reasons it is proposed to provide signage at the top of the deviation that directs drivers to the viewing point at Te Uku. A substantial part of the road from that point to Te Uku is winding, requires driver attention, and has no views of the Wind Park.

9.45 Experience both in New Zealand and Australia is that there is considerable interest in wind farms when they are observed, and a thirst for general knowledge as to how they work. The viewing platform concept provides a convenient place to do this.

9.46 The area presently covered by unused tennis courts at the Te Uku Community Hall appeared as the ideal area in which to build a viewing platform, but WEL has other sites available for this purpose if required. Any alternative sites would need to be acceptable to Transit and, depending on the circumstances, and may require consent or building permit.

Access Road

9.47 Some submissions question the effect of construction traffic on both State Highway 23 and Te Mata Road. These submissions seem to assume a significant increase in road traffic due to construction. But as discussed in Mark Apeldoorn's and Tony Keyte's evidence the net increase in traffic due to construction is minor.

9.48 The Te Mata quarry presently produces about 50,000 tonnes of aggregate per year which is transported along these roads. This equates to about 2500 truck movements per year that will come off these roads during the construction of the Wind Park.

9.49 Wind Park traffic will comprise worker transport, general construction transport, and heavy haulage of wind turbine components.

9.50 Because roading aggregates and concrete production will be contained within the site, and truck movements from the quarry as above will cease during the construction period, the effects of general construction transport will be small.

9.51 Worker transport will be able to access the site from both the north (Van Houtte Road) and south (Plateau Road) ends. Predominant traffic flow will be to the Plateau road entry but some light traffic and emergency services may use the northern entry. This is covered in the evidence of Mr Keyte and Mr Apeldoorn.

9.52 Transport of the wind turbine components to site will be made up of overweight or over length loads. For each turbine the towers normally come in four sections, the nacelle as one unit, the rotor hub is one unit and rotor blades either individually or in a pack of three. The nacelle is the heaviest component at about 90 tonnes and the rotors the longest at up to 47m. The over dimension loads to site for turbine components is then from 200 to 250 in total over about a three month period.

9.53 As noted in my evidence and in that given by Mr Keyte, the public roads to site have been proven for these loads. The over length loads are likely to have the most impact on traffic due to the winding nature of State Highway 23 over the deviation. These loads are likely to be transported at any time of the day or night, and each load will be subject to traffic control as required by transport permits. .

Decommissioning

9.54 A number of submissions express concern that the turbines will be left standing if the site is abandoned or decommissioned. WEL agrees that this would be unacceptable.

9.55 As set out earlier in my evidence, decommissioning is provided for in land owner agreements. Under those agreements, WEL must remove everything relating to the Wind Park that is above ground level if and when the Wind Park is decommissioned, and reinstate all disturbed areas.

9.56 A consent condition requiring decommissioning is therefore acceptable to WEL.

Electricity will go elsewhere

9.57 Some submissions express concern that the electricity produced by this Wind Park will go elsewhere and so benefit others at the environmental cost of the local community.

9.58 There are perhaps three issues to be considered here, firstly what physically happens, secondly what contractually happens, and finally who financially benefits.

9.59 In a physical sense electrons will take the path of least resistance. Electricity generated on the site will therefore be used progressively by loads closest to its point of connection. As the load demand on the WEL network exceeds the capacity of the Wind Park most, if not all, of the output will physically be used within the network.

9.60 In a contractual sense output from the site will either be sold into the wholesale electricity market or under a power purchase agreement to retailer or directly to consumers. These contracts are reconciled by metering what is injected into the network or grid at one end and what is taken from the network or grid by the user at the other end, and accounting for differences between them.

9.61 The financial beneficiaries of power generated by this Wind Park are the owners of WEL Networks Ltd. This is the WEL Energy Trust which represents all consumers connected to the WEL network. This trust presently returns the profits of WEL Networks Ltd to the consumers by way of rebates on line charges. Therefore under the present circumstances the financial beneficiaries of the Wind Park are all customers connected to be WEL network.

9.62 It follows that electricity generated from the Wind Park will physically and beneficially remain in the WEL network area no matter how it is contracted.

10 PROPOSED CONDITIONS

10.1 In this section I will comment on the proposed conditions that pertain to my evidence.

Turbine Characteristics

10.2 The conditions proposed for turbine dimensions and micro siting accommodate the most likely plant for the site in the 2 to 3 MW range, including the indicative plant used in this application.

10.3 For this site to be technically and commercially viable it is necessary to have the 28 turbine locations and the window of opportunity at each location that will accommodate suitable plant.

Environmental Management Plan (EMP)

10.4 The concept of an environmental management plan is consistent with industry practice for windfarm construction and is a practical way in which to implement conditions relating to construction issues.

10.5 The constraints in the conditions proposed by WDC are however impracticable. WEL is comfortable with the conditions proposed by Environment Waikato but, in my view, the proposed WDC conditions unnecessarily duplicate regional responsibilities and are overly prescriptive.

10.6 I consider the EMP should outline principles and performance parameters and be received by Councils 20 days prior to the commencement of works. It should reference earthworks or environmental issues as required by both Councils and set out how these will be satisfied, but Councils need to be clear as to which is the authority for what and avoid any duplicity or ambiguity in the discharge of responsibilities under the EMP.

Landscape, Vegetation and Earthworks

10.7 It is not possible to disguise large wind turbines on a ridge line. All other works proposed can however be done in a way they has minimal visual impact and reinstated to mimic existing conditions.

10.8 WEL propose to control runoff erosion and sedimentation during construction, and to control dust or other construction products in accordance with good construction standards.

10.9 The conditions proposed by WEL include the reinstatement of all land areas uncovered or despoiled by construction activity.

Noise

10.10 The New Zealand standard for acoustic levels from wind farms is consistent with similar standards worldwide which have developed to address concerns over wind farm noise throughout Europe.

10.11 The early wind turbines did produce unacceptable noise levels and over the last decade this has been a major issue with wind farms in Europe. Because of this, standards and conditions relating to noise have become very tight and manufacturers have responded by a reducing the noise and vibrations produced by wind turbines through a considerable development effort. As a result modern wind turbines are relatively quiet.

10.12 As stated in the evidence of Mr Hegley, WEL is confident that the New Zealand standard can easily be achieved at the nearest dwellings.

Ecology

10.13 The proposed Wind Park will be built on land that has been used for farming for more than a hundred years. The evidence of Mr Kessels is that the proposed construction will have little impact on the ecology of this area.

10.14 WEL does however accept that as found by Mr Kessels there are long tailed Bats in the Wind Park zone and there is the potential for New Zealand Falcon to fly through this area.

10.15 Because of this, I, and other representatives from WEL, have had a number of meetings with the Department of Conservation and have negotiated with it a Memorandum of Understanding to address DoC's concerns with regard to long tailed Bats, NZ Falcon, and other indigenous birds.

10.16 The conditions proposed reflect this agreement which will be implemented if consents are issued and construction proceeds.

Traffic

10.17 The conditions with regard to traffic, traffic management, minor works that may be required on public roads, and the monitoring of construction effects on public roads are in my view appropriate and workable from a contractor's perspective.

Viewing Platform

10.18 The conditions relating to the viewing platform are couched as discussed with the community hall but presented in a way that can be transferred to another location.

Air safety

10.19 The Wind Park has been approved by the Civil Aviation Authority and is subject to a determination issued 13 June 2007.

10.20 In addition to this I have also been involved in discussions with local aircraft operators, in particular those involved in farm top dressing. As a result of these discussions agreement has been reached with the main land owner to close the air strip on the Wharauroa plateau if the Wind Park is built. All top dressing currently done from that air strip would then be done from a lower air strip on the same property. WEL has a letter from the aircraft operators confirming the lower air strip is not compromised by the Wind Park.

Radio-communications

10.21 WEL has entered an agreement with Telecom New Zealand to protect the integrity of services they provide through the existing Te Uku telecommunications tower.

10.22 Dr Black has identified the potential for microwave emissions from the existing Telecom services to be harmful to construction workers. In my opinion the likelihood of this occurring is small in that the location of each wind turbine is selected to be outside telecommunication paths. As such the probability of construction workers being in the path of radiation is small, however WEL accepts the risk identified by Dr Black and will comply with the New Zealand standards for safety in this regard.

10.23 Assessment of the effects of the Wind Park on television reception has identified that a number of viewers with analogue reception could be affected. WEL accepts it should be responsible in this event and can easily correct any such problems that can be proven to arise by the installation of free to air digital reception at subject locations.

10.24 The conditions provide for this but I do opine that mitigation of these effects should be limited to dwellings existing at the time consents commence.

Cultural Heritage

10.25 I have been involved in a number of discussions with Ngati Mahanga who advise they represent all seven Marae in the area of the proposed Wind Park.

10.26 Representatives of Ngati Mahanga were engaged to provide a cultural assessment which is attached to the consent application.

10.27 The proposed conditions of consent protect the areas they advise have cultural value and also provide protocols if relevant archaeological discoveries are made during construction.

10.28 I have also been involved in discussions with Mr Vanhoutte with regard to the remains of his family's original homestead on the plateau. The proposed conditions of consents incorporate the protection he requires for these areas.

Community

10.29 WEL wish to acknowledge the local community if the Wind Park is built, by way of a mechanism that will address local concerns. WEL considers the best way to do this is to make available such support as is necessary to hear and address the concerns of the community during the construction and post construction period. The conditions proposed reflect this through the offer to establish and support a Community Liaison Group.

Lapse of Consent

10.30 As set out in my response to submissions the lapse period proposed is consistent with the time they can be required to implement any consents that is granted.

Roger Burchett
19 November 2007

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