Wind energy basics

(Updated January 2011)

Wind energy in NZ - quick facts

Capacity of installed turbines (as at end Janurary 2010): 530.1 MW (megawatts)
Capacity of turbines under construction: 92.75 MW

Total electricity generated in New Zealand in 2009: 42,012 GWh (Gigawatts-hours)

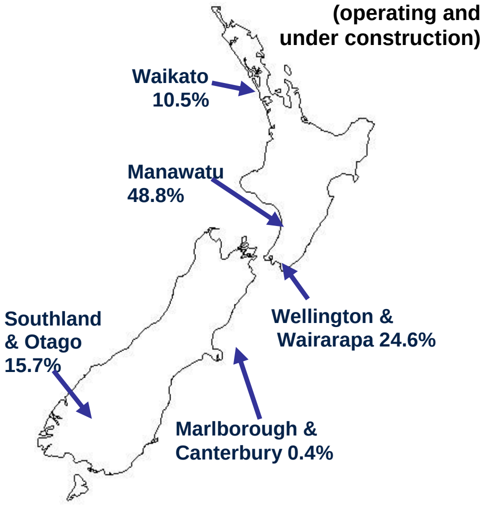
Total wind generation in NZ in 2009: 1456 GWh (3.5% of total generation)

Record wind generation for a 12 month period: 1722GWh in the year to 31 September 2010 (4% of total generation)

Quarterly record: 511GWh in the
October-December 2009 Quarter (4.9% of total generation)

(Source: New Zealand Energy Quarterly, Ministry of Economic Development)

Wind energy capacity in NZ (operating and under construction)



Wind farms and turbines operating or under construction in New Zealand

Name	Operator	Region	Operating capacity	No. of turbines	Date commissioned	Turbine capacity
Brooklyn	Meridian	Wellington	225 kW	1	1993	225 kW
Gebbies Pass	Windflow	Canterbury	500 kW	1	2003	500 kW
Hau Nui	Genesis	Wairarapa	8.7 MW	15	1996, 2004	600 kW and 550 kW
Southbridge	Energy3	Canterbury	100 kW	1	2005	100 kW
Tararua	TrustPower	Manawatu	161 MW	134	1999, 2004, 2007	3.0 MW and 660 kW
Te Apiti	Meridian	Manawatu	90.8 MW	55	2004	1.65 MW
Te Rere Hau	NZ Windfarms	Manawatu	38.5 MW (48.5 MW when complete)	77 (97)	2006,2008, 2009 (2011)	500 kW
White Hill	Meridian	Southland	58.0 MW	29	2007	2.0 MW
West Wind	Meridian	Wellington	142.6 MW	62	2009	2.3 MW
Horseshoe Bend	Pioneer Generation	Central Otago	2.25 MW	3	2009	750 kW
Weld Cone	Energy 3	Marlborough	0.75MW	3	2010	250 kW
Chatham Islands	CBD Energy/ Chatham Island Enterprise Trust	Chatham Islands	0.45MW	2	2010	225 kW
Lulworth	Energy 3	Marlborough	1 MW	4	2011	250 kW
Te Uku	Meridian	Waikato	25.3MW (64.4 MW when complete in mid 2011)	11 (28)	(2011)	2.3 MW
Mahinerangi	Trustpower	Clutha	(36 MW)	(12)	(2011)	3 MW
Mt Stuart	Pioneer Generation	Clutha	(7.65MW)	(9)	(2011)	850kW
Total currently operating			530.1 MW	398		
Total under construction			**(115.1 MW)**	**(75)**		
Total expected to be operating end 2011			**623 MW**	**456**		

Proposed wind farms

Wind farm developers are investigating potential wind farm sites throughout New Zealand. The following table lists projects that wind farm developers are investigating, are seeking consent for, or have consent but have not begun construction. NZWEA makes every effort to ensure that this list is comprehensive and up-to-date, but does not guarantee that all projects being investigated are included. Not all projects under investigation or with consent will be built. In many cases projects are put on hold or abandoned after initial site investigation, as the wind resource may not be sufficient or for economic reasons.

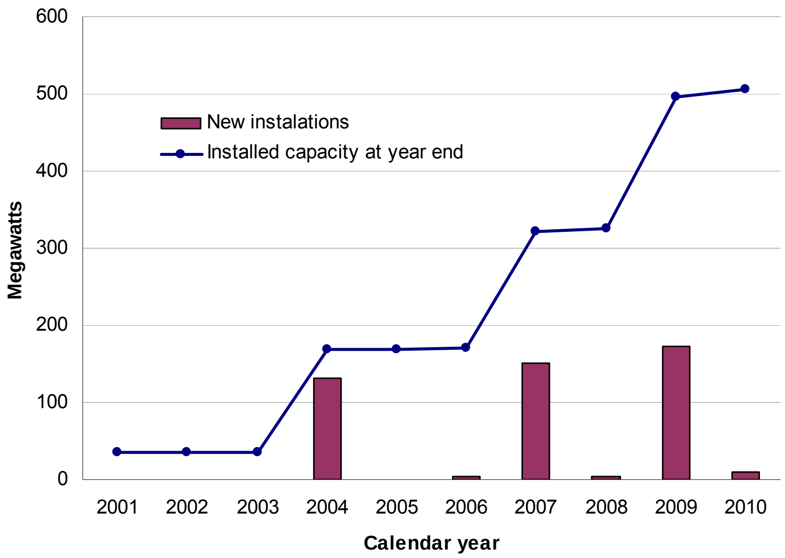
Site	Developer	Maximum capacity (MW)	Region	RMA application status	Date publicly notified
Awhitu	Genesis Energy	18	Franklin	Consented after appeal but on hold	April 2004
Titiokura	Meridian Energy	48	Hastings	Consented after appeal	April 2005
Hawkes Bay	Meridian Energy	225	Hastings	Consented after appeal	May 2005
Taumatatotara	Ventus	20	Waikato	Consented but on hold	
Kaiwera Downs	TrustPower	240	Gore	Consented after appeal	November 2007
Taharoa	Taharoa C and PowerCoast	54	Kawhia	Consented after appeal	
Central Wind	Meridian Energy	130	Ruapehu and Rangitikei	Consented after appeal	July 2008
Long Gully	Windflow	12.5	Wellington	Consented	May 2009
Waitahora	Contact Energy	156	Southern Hawkes Bay	Consent after appeal	September 2008
Project Hayes	Meridian	630	Central Otago	Application to be reconsidered by Environment Court	November 2006
Mill Creek	Meridian	71	Wellington	Consented, but appealed to the Environment Court	April 2008
Mt Cass	MainPower	69	Hurunui	Consent declined, but appealed to the Environment Court	June 2008
Hauauru ma raki	Contact Energy	540	Waikato	Called in to a Board of Inquiry, application publicly notified	September 2008
Turitea	Mighty River Power	288	Manawatu	Called in to a Board of Inquiry, application publicly notified	January 2009
Slopedown	Genesis Energy		Southland	Not yet applied	
Puketiro	RES		Wellington	Not yet applied	
Hurunui	Meridian		Hurunui	Not yet applied	
Castle Hill	Genesis Energy		Wairarapa	Not yet applied	
Windy Peak	Meridian		Wairarapa	Not yet applied	
In addition, developers are in the initial stages of investigating sites through out New Zealand.					

Annual wind generation and capacity

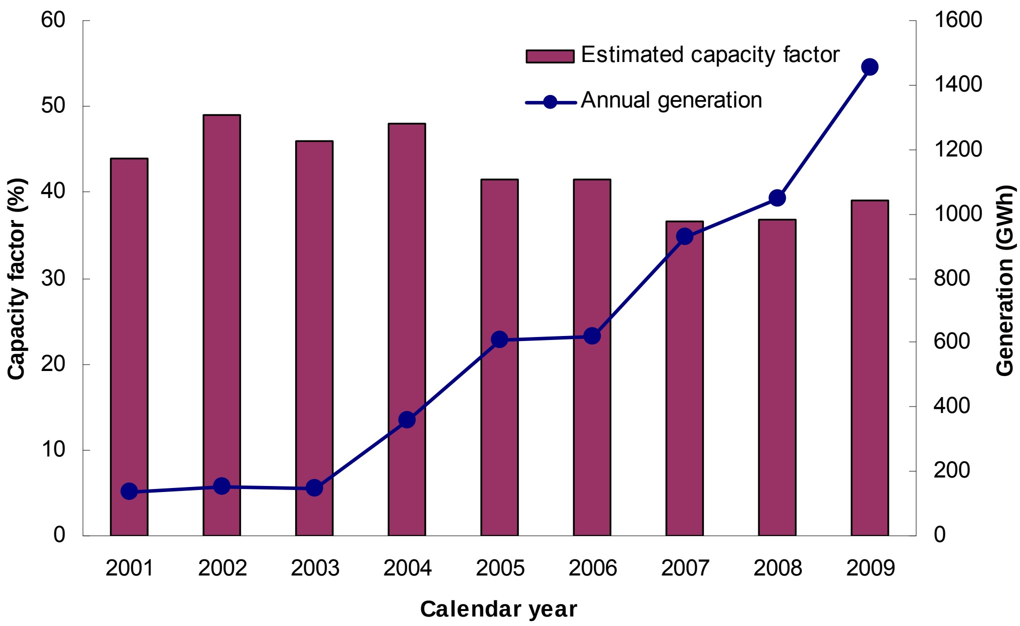
Calendar year	New installations	Installed capacity at year end (MW)	Annual generation (GWh)	Estimated capacity factor (%)
2001	0	36	138	44
2002	0	36	154	49
2003	0	36	146	46
2004	132	168	360	48
2005	0	168	610	41
2006	3	171	617	42
2007	151	322	928	37
2008	3	325	1048	37
2009	172	497	1456	39
2010	9	506		

Note: Annual capacity factor is an estimate only, with the calculation reflecting that new installations will have come online during the course of the year and so will have been generating electricity for only part of the year.

Annual installed and cumulative wind energy capacity



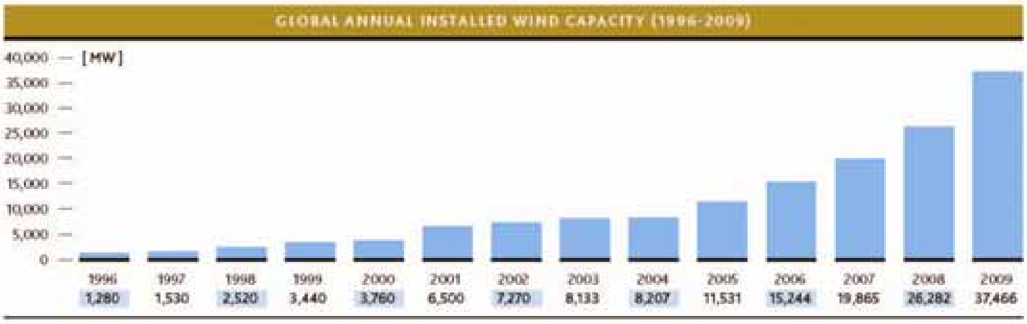
Annual generation and capacity factors

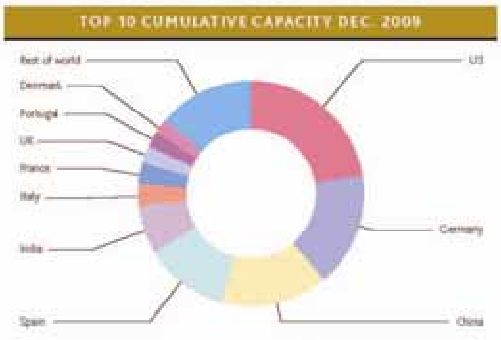


Wind energy around the world

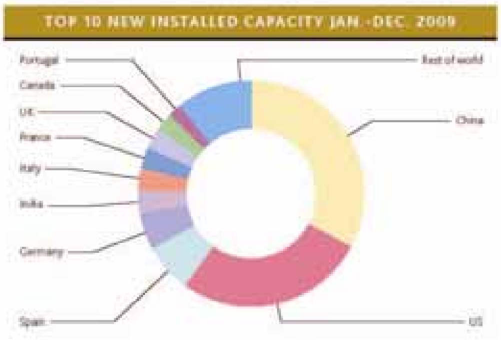
Globally, more than 37,500 MW of new wind capacity was installed in 2009, bringing global wind energy capacity to over 157,900 MW. According to the Global Wind Energy Council, the global wind market for turbine installations in 2009 was worth about 45 bn EUR or 63 bn US$. GWEC estimates that around half a million people are now employed by the wind industry around the world.

Wind energy has been the largest source of new generation capacity in Europe for the last two years, well ahead of gas and coal, and it has been equal to natural gas in the USA.





	MW	%
US	35,159	22.3
Germany	25,777	16.3
China	25,104	15.9
Spain	19,149	12.1
India	10,926	6.9
Italy	4,850	3.1
France	4,492	2.8
UK	4,051	2.6
Portugal	3,535	2.2
Denmark	3,465	2.2
Total top 10	136,508	86.5
Rest of the world	21,391	13.5
World total	157,899	100



	MW	%
China	13,000	34.7
US	9,922	26.5
Spain	2,459	6.6
Germany	1,917	5.1
India	1,271	3.4
Italy	1,114	3.0
France	1,088	2.9
UK	1,077	2.9
Canada	950	2.5
Portugal	673	1.8
Total top 10	33,471	89.3
Rest of the world	3,994	10.7
World total	37,466	100

Source: Global Wind Energy Council
http://www.gwec.net/fileadmin/documents/PressReleases/PR_2010/Annex%20stats%20PR%202009.pdf

Wind energy and electricity security

The Electricity Commission's Annual Security Assessment, released in December 2009, identified expected shortfalls in energy (gigawatt-hours produced) in 2013 and capacity (installed megawatts) in 2012. With all New Zealand's major generators, along with several smaller or independent companies, operating wind farms or investigating potential sites, wind energy is likely to make a significant contribution to meeting future energy and capacity requirements.

NZWEA believes wind energy can – and should – meet 20% of New Zealand's annual electricity demand by 2030. There is a huge wealth of experience – and success – to draw on for managing increasing wind generation in electricity systems. Many countries are already well ahead of New Zealand with integrating wind into their electricity systems. These countries include Ireland and Spain, which are comparable to New Zealand as they have very limited connections into other power systems.

In New Zealand, wind energy makes an important contribution to security of supply through:

- **Further diversifying sources of energy away from our current reliance on hydro (especially) and gas.** Wind power is a reliable and valuable source of energy – the units of electricity (kilowatt-hours) that we actually consume, rather than the megawatts of capacity that we hold on standby. The use of wind energy when it is available enables the fuel that would otherwise have been consumed in thermal or hydro plants to be stored for use some time in the future. This stored energy can then be used to meet peaks in demand or to provide back up when another generator unexpectedly goes off line.

- **Having the ability to generate electricity across a wide range of conditions**. Wind generation occurs across a wide range of wind speeds – from a gentle breeze to a strong gale. New Zealand's existing wind farms are generating electricity for more than 90% of the time, helping to ensure that we always have electricity whenever we want it, not just at 6 pm when demand peaks.

- **Providing geographic diversity in electricity generation.** Significant wind resources exist in a range of locations across the country, each with its own independent weather patterns. In many instances new wind farm projects are being pursued in regions where no electricity generation currently occurs. These projects will contribute to meeting regional electricity demand, reducing the requirement to be transported into the region via the transmission system. Under these circumstances wind energy provides the flow-on benefits of reducing transmission losses, and increasing the robustness and stability of the local network.

Renewable Generation and Security of Supply, a report published by EECA, provides a good overview of the implications for security of electricity supply from increasing levels of renewable generation. It is available on EECA's website at: http://www.eeca.govt.nz/node/6906.

Suggestions that wind energy in New Zealand has significant seasonal variations and so cannot complement hydro generation have been based on analysis that considers output from wind farms in the Manawatu, which are exposed to the same wind regime. Many new and proposed wind farms are located in other areas of the country and will utilise independent wind regimes. Following the commissioning of White Hill wind farm in Southland, analysis undertaken for the Electricity Commission revealed little correlation between output from the wind farms in the Manawatu and White Hill. Wind farms are now operating or under construction in the Waikato, the Manawatu, Wellington, Marlborough, Canterbury, Central Otago and Southland.

Other analysis conducted by NZIER, on behalf of the Major Electricity Users Group[1], concluded that there was a 'complementarity between wind and hydro power' and confirmed the role of wind and hydro power in suppressing spot prices.

[1] See *Exploring wind-hydro correlation* at http://www.meug.co.nz/includes/download.aspx?ID=97686

Suggestions that wind energy creates high costs for reserve generation or ancillary services, such as instantaneous reserves and frequency keeping, often fail to recognise that these services are required regardless of the forms of generation (as electricity supply must be match to continually changing demand) and that any changes will only be incremental.

NZWEA is aware of only one study that has considered this issue in any detail and with accurate modelling of the actual electricity system. This work, conducted by Goran Strbac and his colleagues at Imperial College London for Meridian Energy calculates a total additional system cost attributable to wind of just $2.06 to $2.76 per MWh for 2,066 MW of wind in 2020.[2](There is currently only 500MW of capacity in New Zealand.)

In addition, it is unlikely that shifts in wind patterns will cause either:

- instantaneous power changes as large as those currently managed when a thermal generator goes offline without warning because of a fault
- changes in power supply over an hour or two that are as great as currently managed every morning when demand increases several hundred megawatts.

The cost of wind energy and electricity prices

It is often assumed that because wind farms have a high capital cost, wind energy will push up electricity prices. Far from being a price-setter, wind energy is actually a price taker in the electricity market, as it is offered in at 1 cent per megawatt-hour. This means it displaces electricity that is offered in at a higher price and so suppresses spot electricity prices.

New Zealand wind farms receive no subsidies. They are constructed only when they can produce electricity at a cost that is competitive with other forms of generation. There is no 'average' cost for wind farm development as a range of factors influence a projects cost and return on investment. These factors can be very site-specific and include:

- The site's wind regime
- The cost of civil works
- Access to transmission
- The price of wind turbines – and the influence of the exchange rate on these prices
- Operations and maintenance costs
- The developer's generation portfolio

The US Department of Energy's (DoE) recent "2008 Wind Technologies Market Report" revealed that project costs in the US varied between US$1500 and $2500 per kilowatt in 2008. As there is far less development activity in New Zealand than in the US, we do not have the same depth of data to draw on. Nonetheless, the US data provides a good guide to the extent of variation in costs that are also likely to be seen in potential New Zealand developments.

Wind energy contributes to ensuring New Zealanders have an affordable supply of electricity by:

- ***Providing certainty in the cost of generation.*** The costs of operating wind farms are well understood and are expected to continue to reduce as the technology continues to improve. A single modern wind turbine produces roughly 180 times more electricity per year - at less than half the cost per kWh - than its predecessor of 20 years ago. Further advances are expected into the future.

  In addition, wind energy has no fuel supply or price risk. With low and well-known operating costs and a free fuel source, wind energy provides a valuable hedge against the variability in the costs of hydro and gas generation – including the introduction of a price on greenhouse gas emissions and increasing gas prices.

[2] See *http://www.meridianenergy.co.nz/AboutUs/News/Economic+virtues+of+future+wind+generation.htm for details of the Strbac study*

Accordingly wind energy is the only current, commercially viable source of generation that can be confident not only in the availability of its fuel, but of its costs of operation over its full 25 year operating lifetime, and beyond.

- ***Reducing spot electricity prices.*** Under the rules of the New Zealand electricity market wind energy operates as a price-taker, as it will always displace the most expensive form of generation that would otherwise be dispatched into the market. Wind energy will generally be dispatched in preference to a more expensive source of generation such as thermal generation - or even hydro when low lake levels have increased the value of the stored water.

  Analysis presented at the 2009 Wind Energy Conference by Paul Baker, Energy Link, suggested that output from the Manawatu wind farms reduced the average spot electricity price at Haywards by $10/megawatt-hour between September 2004 and March 2009.

  Modelling by Energy Link for MainPower as part of their evidence for the resource consent hearing for their proposed Mt Cass wind farm in Canterbury (41.5 to 69 MW, depending on the turbine) suggested that it would reduce New Zealand's weighted average wholesale power price by between $0.50 and $1.12 per MWh, equivalent to savings of around $20m to $46m per year.

  This modelling is consistent with actual experience elsewhere in the world where renewables have priority of dispatch. For example in Denmark wind energy was calculated to have saved €4.5 per MWh (approx. NZ$9 per MWh) in 2005 when compared to the price if no wind generation was in operation.

Wind energy is now well accepted and established with all of the leading electricity generators as a valid and viable option for electricity generation in New Zealand. Unlike any other source of generation, all five of the major gentailers are now either operating wind farms and/or seeking resource consents for new projects. Projects are also being pursued by a number of other independent generators, including several lines companies and experienced international developers. Analysis released by both Meridian Energy and Contact Energy shows that they consider the cost of wind generation to be within the same range as of other forms of generation.

Wind energy as a climate change solution

While the power sector is far from being the only culprit when it comes to climate change, globally it is the largest single source of emissions, accounting for about 40% of CO_2 emissions, and about 25% of overall emissions.

In New Zealand, the fastest growing source of emissions is electricity generation (increasing 91% between 1990 and 2007). This increase is despite New Zealand having one of the world's best renewable, low-emissions energy resources.

The benefit of a high proportion of renewable generation is directly reflected in the statistics for greenhouse gas emissions from the electricity sector. During the December Quarter 2009, renewables provided some 73% of electricity – the highest portion for a March quarter since 2004. For the December 2009 quarter emissions from electricity generation were at their lowest level since the March quarter 2002, and down 23% on 2008 levels, when there was a high portion of thermal generation.

Wind-generated electricity is produced without emitting carbon dioxide, the greenhouse gas that is the major cause of global climate change. The lifecycle emissions (including manufacturing of components, construction, operation and decommissioning) from wind farms are about 1% of emissions from thermal generation.

Greater diversity in renewable generation will also benefit New Zealand by preventing peaks in greenhouse gas emissions from electricity generation during dry years. The 2009 Net Position Report, published by the Ministry for the Environment, showed that emissions from electricity generation had increased by between 0.6 to 1 million tonnes in 2008 compared to the previous year as a result of increased thermal generation during the dry weather conditions.

Given the massive uncertainties around measuring agricultural emissions and forestry offsets, acting now to increase renewable generation is one way that we can be absolutely certain of achieving long-term reductions in greenhouse gas emissions.

The electricity market arrangements for wind energy means that wind will always displace the most expensive form of generation that would otherwise be dispatched into the market, which is generally thermal generation, thereby simultaneously lowering spot market electricity prices and reducing our Kyoto liabilities.

Frequently Asked Questions

How much time do wind turbines operate?

Wind turbines in New Zealand operate about 90-95% of the time, in conditions from a gentle breeze to near gale. Their electricity output varies with the wind speed.

Because of NZ's exceptional wind resource, wind farms in New Zealand operate at a capacity factor of around 40%, which is almost twice the global average. What this means is that wind farms in New Zealand will, on average, generate almost twice as much electricity per megawatt installed as the global average.

What is "capacity factor"?

The capacity factor (also called load factor) is the amount of electricity actually generated relative to the amount that would have been produced if the generator had been running at its full output over the same period. Capacity factor is not a measure of efficiency, nor a measure of the time spent operating.

Some people think that because a wind turbine does not produce wind energy at 100% capacity factor, wind energy is not reliable. The simple truth is that no form of generation produces energy at 100% capacity, 100% of the time. Generators are often offline because of maintenance, unexpected faults and fluctuations in demand.

Wind energy's capacity factor is comparable with other forms of generation in New Zealand:

	Capacity factors (%)	
	2007	**2008**
Hydro	50	47
Geothermal	83	80
Gas	63	67
Coal	50	51
All fossil fuels	56	58
Wind	41	37
All sources	**53**	**52**

While the capacity factor for geothermal is relatively high it has limited ability to modulate its output to match demand. Other forms of generation must assume this role. No one technology can meet all of the power system's requirements – they all play different, but complementary roles.

Do wind farms receive carbon credits?

Wind farms are not eligible for carbon credits under the emissions trading scheme, and have not been eligible for carbon credits since the second and final round of the Ministry of the Environment's Projects to Reduce Emissions Scheme in 2004.

Wind farms proposals that are going through the consent process now do not qualify for carbon credits. These projects will compete directly against all other sources of electricity without any subsidy or support.

What about efficiency measures and electricity conservation?

Conserving electricity and using electricity more efficiently are very important. Measures such as consumer-side demand response will become increasingly important over the coming years. However, government forecasts show New Zealand's energy use growing (between 1 and 2% per year), even taking into account conservation and efficiency measures. The question is not whether new generation is required, rather, what form and where? NZWEA believes that generation built to meet growing demand should make use of renewable resources.

Does the public support wind energy?

Opinion polls continually show that the New Zealand public cares about where their electricity comes from and supports the development of renewable energy.

A public opinion poll undertaken for the Energy Efficiency and Conservation Authority in 2008 showed that:

- 94% of respondents said that renewable energy is something New Zealand needs to focus on for the future.
- 88% of people expressed support for wind farms,
- 71% expressed support for a wind farm that could be seen from their home.
- 79% of respondents expressed concern about where their energy comes from.

Shape NZ, an organisation run by the New Zealand Business Council for Sustainable Development, conducted a national survey of 3546 respondents in February and March 2008. In the survey:

- 77% of respondents said they prefer wind as the best energy source in the next decade, Respondents also expressed strong support for other renewable energy sources, with 69% supporting solar, and 47% supporting geothermal.
- 48% said they like the way wind farms look, while 44% say it depends on where they are located.
- Only 5% said windfarms do not look acceptable.

Given this support, we believe it is possible to develop New Zealand's wind energy sector to the point where it makes a significant and sustainable contribution to NZ energy mix.

Does it take a lot of energy to construct and operate a wind farm?

Reputable international studies show that a wind farm generates more energy in six to ten months than is used to manufacture its turbines, as well as to construct, operate and decommission it. This means a wind farm repays its energy use at least 20 to 30 times over throughout its lifetime.

The energy it takes to construct and operate a wind farm does vary from site to site, along with the energy produced, because of factors such as terrain and wind conditions. However, New Zealand has one of the world's best wind resources, so it will take even less time to pay back energy use here than overseas. An independent study competed by Scion for TrustPower's proposed Kaiwera Downs Wind Farm (in Southland) indicated that the wind farm would produce the amount of energy used in manufacturing, construction and use within 4 to 6 months of operation, or 7 to 9 months in a worst-case scenario.

Are wind turbines noisy?

Wind farms, like many other activities, are subject to regulations regarding noise levels. NZ Standard 6808 (a Standard specifically designed for measuring and assessing sound from wind farms) is used by NZ wind farm developers and councils for setting noise-related resource consent conditions.

An updated version of this Standard was released in March 2010. It outlines practical and enforceable measures for managing sound from wind farms. The methods and recommendations in the new Standard were agreed upon by a Committee established by Standards New Zealand. The Committee included representatives of local authority and community interests, experts in acoustics, practitioners in planning, resource management and environmental health, and wind farm developers. The committee released a draft for public comment, and received over 600 submissions.

The Standard ensures that while turbines may be audible occasionally at houses near wind farms, the level of sound will not be out of place with other sounds in the environment. The wind farm noise Standard recommends that in most cases the sound from a wind farm outside a noise sensitive location – such as homes and schools – should not exceed a level of 40 decibels, or 5 decibels above the background sound, which ever is the greater. The Standard introduces a provision that allows councils to set a lower, more stringent limit for particularly quiet locations to provide greater protection for the amenity of nearby homes.

The standard recommends a limit that is relative to background sound as sometimes the background sound will be louder than 40 decibels. Limiting the wind farm sound to 40 decibels when the background sound is louder provides no benefit to residents. Also, if the background noise is as loud as or louder than the wind farm, the wind farm's sound could not be monitored properly.

If the limits recommended in the Standard are properly applied, people living near a wind farm may hear the wind farm but only at a reasonable level. 40 decibels is typical of a quiet residential area with only light traffic and natural sounds such as the wind in the trees. In contrast, sound levels alongside an urban road would be around 60 to 70 decibels during the day and about 50 to 60 decibels at night.

What about the alleged health effects of wind farms?

In 2009 an international panel of experts released a report based on a review of a large body of scientific literature on sound and health effects, and specifically with regard to sound produced by wind turbines. After extensive review, analysis and discussion, the panel concluded:

- There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects.
- The ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans.
- The sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences.

The Panel also reaches the conclusion that: 'The evidence indicates that "wind turbine syndrome" is based on misinterpretation of physiologic data and that the features of the so-called syndrome are merely a subset of annoyance reactions. The evidence for vibroacoustic disease (tissue inflammation and fibrosis associated with sound exposure) is extremely dubious at levels of sound associated with wind turbines.' The report, *Wind Turbine Sound and Health Effects, An Expert Panel Review*, can be viewed in full at: http://www.canwea.ca/pdf/talkwind/Wind_Turbine_Sound_and_Health_Effects.pdf

When drafting the 2010 NZ Wind Farm Noise Standard (see above) the Standards NZ technical committee considered a wide range of published material on the effects of wind farm noise on people's health, including effects of low frequency sound. The committee determined that, based on available evidence at the time the Standard was drafted, the noise limits in the Standard provide protection against adverse health effects.

Recommendations in both the 1998 and new 2010 versions of NZS 6808 are based on the World Health Organisation guideline noise limit of 30 dB LAeq inside bedrooms to prevent sleep disturbance. This equates to the noise limit in the Standard of 40 dB LA90(10 min) outside noise sensitive locations as sound attenuates – or become quieter – as it travels through walls and windows.

Should there be a set buffer zone between wind farms and houses?

A minimum setback distance – or buffer zone – between wind turbines and residences is typically proposed as a means to address concerns associated with the following potential effects:

- noise (including any potential vibration effects)
- shadow flicker (shadows from the revolving blades passing over houses)
- visual effects (where the proximity of a tall turbine to a house dominates the outlook).

The potential significance of these effects will in turn be influenced by factors such as:

- turbine size (ranging from 45 metres to the blade tip for the turbine in Brooklyn, Wellington, to up to 150 metres for some proposed wind farms).

- number of turbines (ranging from single turbines at Brooklyn, Gebbies Pass & Southbridge to up to 180 turbines proposed at Hauāuru mā raki in the Waikato).
- turbine sound power level (the sound generated by the turbine as opposed to the sound heard at a distance) and its operating mode (fixed speed, variable speed, etc.)
- terrain – including the relative height of the wind farm to the residence, and the presence of any landforms between the wind farm and the residence.
- the presence of vegetation or other structures that might screen the turbines or mask some of the sound generated by the wind farm.

As a result of these factors the effects observed by residents at a given distance from a wind turbine can differ significantly between projects and sites.

A buffer zone would imply that the effects of turbines located beyond the minimum distance are acceptable. Where a large number of turbines are located beyond that distance the effects could be greater than for a single turbine located within the minimum distance. As a result a wind farm that complies with the setback could still have significant effects that the minimum distance method will not prevent.

A more appropriate approach for addressing concerns is to use robust and accepted methodologies (such as the Standard for Wind Farm Noise discussed above) to determine the actual effects of a proposed project – and their significance – and then determine what, if any, mitigation measures are required.

What is a watt?

A watt is a unit of electricity. If you go back to a text book you will find that a watt is the unit rate at which work is done in an electrical circuit and the definition commonly applied to it is that one watt is equivalent to; 'one joule per second' . To put this into context of everyday objects, when turned on a 60 watt incandescent light bulb will require 60 watts of power or, in terms of joules, 60 - 100 joules per second.

As watt is a pretty small unit of power. In order to talk about meaningful amounts, there is very soon a need to refer to thousands, millions, billions or even trillions of watts. Common prefixes used to express large numbers of watts include:

- kilowatt (kW) = 1,000 watts
- megawatt (MW) = 1,000 kW
- gigawatt (GW) = 1,000 MW
- terawatt (TW) = 1,000 GW

The capacity of wind turbines is expressed in watts – so a 2 megawatt wind turbine, when operating at full capacity will generate 2 megawatts of electricity at any given point.

A watt-hour is equivalent to one watt of power consumed or generated for a period of one hour.
So a 2 megawatt wind turbine operating at full capacity for an hour will generate 2 megawatt-hours of electricity. If the same turbine operates at 50% capacity for the same period, it will generate 1 megawatt-hour of electricity.

The same prefixes are used with watt-hours as are used with watts:

- one kilowatt-hour (kWh) = 1,000 watt-hours
- one megawatt-hour (MWh) = 1,000 kWh
- one gigawatt-hour (GWh) = 1,000 MWh
- one terawatt-hour (TWh) = 1,000 GWh

Electricity bills usually record your electricity use in kilowatt-hours.

To put watts in perspective:

- Most wind turbines in New Zealand range in capacity from 500 kilowatts to 3 megawatts.

- The wind turbines at Meridian Energy's West Wind wind farm have a combined capacity of 142.6 megawatts, the Clyde Dam has a capacity of 432 megawatts.
- An 'average' New Zealand home will use about 8 megawatt-hours (or 8,000 kilowatt-hours) of electricity each year.
- Total electricity generating capacity in New Zealand is about 9380 megawatts.
- Total wind energy capacity in New Zealand is 497.3 MW.
- The total electricity generated in New Zealand in 2009 was 42,012 gigawatt-hours.
- Total wind generation in New Zealand in 2009 was 1456 gigawatt-hours.

About NZWEA

NZWEA is a membership-based industry association that works towards developing wind energy as a reliable, sustainable, clean and commercially viable energy source. NZWEA is a non-Governmental, non-profit organisation that was incorporated in 1997. Its activities are funded by its members and industry events, such as the annual New Zealand Wind Energy Conference.

NZWEA's principal activities include policy advocacy with local and central government, public outreach & education, and industry networking and development.

NZWEA's membership includes more than 80 companies and organisations involved in the New Zealand wind energy sector, including:

- all of the major electricity generator-retailers (Contact Energy, Genesis Energy, Meridian Energy, Mighty River Power & TrustPower)
- a number of other local and international independent electricity generators
- Transpower and several lines companies
- a number of major international & domestic wind turbine manufacturers
- a range of other companies with interests ranging from site evaluation through to operations and maintenance.

More information about NZWEA, its members and activities, and the New Zealand wind energy industry in general, is available on the Association's website:

For more information about NZWEA and our members please visit: www.windenergy.org.nz.

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