Technical Note

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THE STEEP AND THE TEARFUL - A NEW ZEALAND PERSPECTIVE OF WIND TURBINE NOISE

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WIND

Oh, for the gentle breeze. On one wind farm in the North Island, when I was struggling to stand up and commented on how windy it was, the farmer nonchalantly replied that it wasn't as windy as the day before, when he had trouble shutting his front gate. His response wouldn't have surprised me as much as it did, if I hadn't noticed that his front gate was galvanized netting on a pipe frame—not something I consider to have any significant wind resistance at all. On that occasion, wind records showed that the wind speed didn't drop below 23 m/s for 3 days.

Both Australia and New Zealand bat well above average when it comes to wind resources. According to Wikipedia, the world average 'capacity factor'[1] is 25%, while Australia is 30-35%. Contrast this with New Zealand, where the average is 41%, with some farms reporting 46% or more. To achieve this, wind farms are typically generating power 85-95% of the time.

New Zealand is known for strong gusty winds, and in the early days of wind turbines, European manufacturers had to do a bit of soul searching to develop systems for coping with this situation—something that isn't normally experienced in the northern hemisphere. Imagine acoustic modelling of wind farms in The Netherlands, where the terrain is completely flat, and the wind seems to blow about 5 m/s all day every day.

TERRAIN

New Zealand, built on a significant geological faultline, has an abundance of rather large hills, and it is hardly surprising to find that the windiest places in the country are on top of some of these landforms. Contrast this with Australia, where the gentle rolling grasslands of some wind farm sites resemble cricket pitches.

A paper presented at the 2011 Australian Acoustical Society conference discussed the need/merits of terrain modelling for wind farms. The study concluded that it was necessary to model terrain effects, otherwise noise measurement data from one location near an existing wind farm could not reliably be used to validate the model for other locations.

This may well flow from the now obsolete New Zealand wind farm noise standard (NZS6808:1998) still used in parts of Australia. That standard adopted a simple prediction model which ignored all terrain effects—and ground/wind effects for that matter. The standard was revised in 2010, and terrain modelling is now very much the norm. When one visits some of the New Zealand wind farms, it is easy to see why (see Figure 1).

Figure 1. West Wind, Wellington (Source: Wind Energy Association of New Zealand)

HOUSES

Contrary to the long-held belief of some Australians, we do have houses in New Zealand. Just not very many. And, because wind turbines are perched on the top of steep hills in unbelievably windy places, the few which do exist tend to be snuggled into secluded valleys, sheltered within copious plantings of trees, or generally somewhere well away from the ridgeline.

[1] Capacity Factor is the ratio of the actual output over a period of time to the potential output if the wind farm had operated at full capacity the entire time.

The upside of this is that the number of houses affected by turbine noise is often very small. On one proposed wind farm, for example, the application for 33 turbines (2.3 MW each) assesses noise levels at 73 existing dwellings. Of these, only 3 will receive noise levels above 35 dBA. Most houses are at least 2 km from the nearest turbine. One might therefore expect the number of complaints about noise, and/or the opposition to proposed wind farms to be small. More on that later.

The downside is that long-time residents in these areas have often planted extensive landscaping, using large trees. Whilst the trees can generate wind noise, there are examples where the tree planting is so dense that the garden surrounding the house can be remarkably sheltered from wind. Ambient noise data for one proposed wind farm showed that at one existing dwelling, the background noise level didn't exceed 20 dBA when the wind was blowing from the north-west—despite hub height wind speeds of up to 13 m/s.

Despite most of New Zealand having been modified by man for a century or so, rural residents are still known to refer to their living arrangements as "going back to nature". Even farmland is now considered to be natural, and those who choose to live in rural areas don't take kindly to the idea of a man-made intrusion such as a wind farm. Not only is the "industrial" noise from wind turbines a totally abhorrent idea, the rugged terrain means that turbines can be visible from many kilometres away.

TURBINE LOCATIONS

Optimising turbine locations in New Zealand is a simple task—at least when viewed from the eyes of a mere acoustic consultant. To a large extent, the terrain dictates the locations. Move a turbine more than a few dozen metres, and it falls off a cliff, or ends up in the lee of a hill and prone to significant turbulence. Couple this with some windy spots being inaccessible by anything other than a mountain goat, and our wind farm is more or less laid out by nature.

The whole idea of optimizing the number of turbines based on predicted noise levels and surrounding dwellings doesn't enter the fray in New Zealand. The acoustic consultant is presented with a plan showing proposed turbine locations, a computer model is undertaken, and the resource consent process begins. It is rare for there to be houses exposed to greater than 40 dBA, other than the landowners, and the energy company doesn't often have to forego turbines to reduce noise levels at affected dwellings.

COMMUNITY REACTION

There is a saying in New Zealand, "no sooner is an idea proposed, than a community group is set up to oppose it". This has never been more true than with proposed wind farms. Communities are united, and strengthened by their opposition to turbines blotting their back yard. Experts are engaged to counter other experts, lawyers get rich, and the courts are filled with warring factions.

Many wind farms are eventually approved, and built, and what then? Are the actual effects as horrific as the community said they would be?

A difficult question to answer, because tempers are too raw from the fight for researchers to be able to judge quite what is real and what is a defence against a pre-disposition. What is seen in some instances, is complaints about noise which don't seem to bear any relationship to noise level. Residents at the 40 dBA contour can be quite happy, sleeping peacefully, with no concerns, whilst others exposed to 30 dBA or less complain vigorously, and sleep hardly at all.

But perhaps this is to be expected. After all, when one examines the well defined "Schultz" curve of dose-response to other forms of environmental noise, one sees an exponential curve, until a closer examination of the data reveals a scatter plot reminiscent of a large ink blot. When a new road is built through the middle of a quiet area, the annoyance is almost 100%, irrespective of noise level. Over time, with the expected change in house ownership, we gradually see some sort of acceptance of noise, and the dose-response moves towards what Schultz foretells. Those of us who don't like traffic noise choose not to live in those areas, and those of us who happened to live there when the road got foisted upon us, sooner or later buy a bigger house to accommodate the growing family, and we leave the area. The raw tempers are soothed over time, and the actual effects become the driver for response rather than the pre-disposition.

So, maybe we will see a growing acceptance of wind turbines. Small rural farms, traditionally called lifestyle blocks, are more cynically known as life sentence blocks because of the hard work involved on them, and as a result, the average ownership period in some parts of New Zealand is only about 2 years. We can therefore expect to see a number of dwellings around wind farms to change hands over the next decade—irrespective of effects from the wind farm, and the new owners will only choose to move in if they are happy with the generation capacity at their back door.

An interesting anecdote from one recently completed wind farm. There is another proposal in the wind several kilometres away, if you'll pardon the pun, and complaints about noise have been received from residents who could be affected by the next wind farm—even though they are in the order of 6 km from the existing turbines.