WINDFLOW

Windflow Technology Newsletter

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Te Rere Hau Turbines: Made in New Zealand, for New Zealand

CEO Introduction

2015 feels like it has been a year for "turning the corner":

- For Windflow we have closed a chapter in our commercial history by reaching the end of 5-year warranties at Te Rere Hau and achieving a final settlement of outstanding issues
- Our "beach-head" in Britain is somewhat more secure as the operating fleet in Scotland has increased to six, of which we have sold two to satisfied customers. We expect to install another eight turbines in Britain in the coming 15 months, and hope then to address a market potential there for wind farms below about 30-50 MW.
- The 45 m Class 2A turbine was successfully commissioned in Texas.
- Strong support by our largest shareholder will enable us to continue with our business plan through 2016 at least.
- For the global community, the Paris Agreement, together with the bold foray into climate politics by Pope Francis earlier this year and bilateral announcements by China and the USA, suggest that 2015 will mark the beginning of the end of the prevarication that has to date characterised our attempts to restore climate stability for future generations.

This newsletter will discuss these developments in more detail, and will also outline Windflow's plans for 2016, as well as reprising the positive attributes (or unique selling points – "USP"s) of the Windflow design which underpin those plans.

While the year is closing on a positive note, it has not been without its stresses. At the beginning of 2015 the difficult trading conditions and lack of revenue forced us to reduce staff numbers so that the company has been operating at a bare minimum in terms of maintaining its operational capability to support turbine builds and licensing activities. And the UK market that we have worked so hard to enter is under huge threat from the new government that seems intent on minimising the development of onshore wind power.

Nonetheless we remain committed to realising the value of the intellectual property that Windflow has created over the years. We look forward to the challenges and prospects ahead of us in 2016 and would like to take this opportunity to thank all the shareholders who have made it possible to progress this far.

Merry Christmas and all the best for the New Year,

Geoff Henderson, CEO/Director

TRH a Good News Story

The 97 Windflow turbines at Te Rere Hau continue to perform well with high availability (>95%). Due to the speed-up over the Manawatu Saddle, the site experiences high mean wind speeds with frequent gales and, quite a few times per year, hurricane force winds. Te Rere Hau itself has very complex terrain so that many of the turbines experience high turbulence, inflow angles well away from the horizontal, and in some cases high wind shear. Thus the site has robustly tested the Windflow turbines.

For comparison, the imported 3-bladed turbines on the Manawatu Saddle have also experienced high wind speeds but the terrain is somewhat less steep where those turbines have been sited. We understand that all those turbines had multiple replacements of their complete gearboxes in their first five years of operation. While the Windflow turbines have experienced some gearbox issues (due to a range of early production issues that have been identified and eliminated) the total number of gearbox replacements has been much lower than for the imported turbines. Similarly we have identified and eliminated other early production issues over the years, giving us increased confidence about the fundamental merits of the Windflow design.

Now that we have reached the end of 5-year warranties at Te Rere Hau and achieved a final settlement of outstanding issues, it is important that we celebrate the engineering successes that have been achieved with a design that has a significantly higher power:weight ratio than 3-bladed turbines:

- High availability, especially for a first production run
- Similar year-round output per square metre of swept area (160 W/sq.m) to other turbines in the lower North Island
- Cost of construction at the time (2006-2011) was similar per sq. metre of swept area to other turbines in the lower North Island.

Windflow's USPs

The Windflow design has multiple unique selling points (USPs). Principally its low tower-top mass, due to the fundamental load-reducing technologies of the teetering hub and the torque limiting gearbox system, gives it the best power-to-weight ratio in the wind industry. Whether one compares the class 1 turbine with other class 1 machines or the class 2 turbine with other class 2 machines, the statement holds for both rated power and average year-round power. The Windflow turbine has the best power-to-weight ratio in the wind industry.

Why does this matter? Because in the long run, wind turbine design and manufacturing is all about weight reduction. In volume manufacturing the lightest turbine will have the lowest manufacturing and installation cost (assuming, as is the case here, that there are no exotic materials being used and other manufacturing costs are the same). This is a compelling argument that we are making to potential licensees in the major economies of North America and Asia where high volume markets can be addressed.

Other USPs include:

- Synchronised, synchronous generator for grid integration
- No power electronics or in-hub pitch drive
- Two blades leads to easier installation (one crane, not two)
- Two blades gives outstanding robustness in hurricanes
- Mid-size turbine has many times lower visual impact (affected area) per unit output than large turbines
- Mid-size gives good trade-off between cost of energy (turbine not too small) and environmental impacts (turbine not too big).
- Best power-to-weight ratio means that scaling up to 2 MW scale (which some potential licensees are interested in) will result in better economies than other turbines.

Market Overview

The global wind industry continues to grow dramatically with 52 GW, worth over $100 billion, being installed in 2014. This was an increase of 44% on the previous year and remains the largest form of renewable power worldwide (though solar photovoltaic, PV, is catching up fast). The epicentre of the global wind industry (and PV) is now China, which overtook the USA a few years ago and now accounts for about half of global annual installations (23 GW of wind in 2014, more than 25 GW in 2015).

Most of the development in recent years has used 1.5-2.5 MW turbines in onshore wind farms, with major investments being made in offshore wind farms (using turbines up to 7 MW each). However there remain long-term market drivers for mid-size turbines:

- "a rising tide raises all boats" applies to the wind turbine market in general – global growth remains strong
- Site-specific factors can mitigate against large turbines or large wind farms (network capacity, terrain or access)
- Environmental impact is reduced, particularly visual impact, when compared to the project output.

Most of these drivers are common to all countries to a greater or lesser extent. Our view of the markets we have studied (China, India, USA, UK and offshore islands) is that significant opportunities for mid-size turbines exist, whether for green-field projects or for repowering existing wind farms.

Windflows' strategy is to license our technology to companies that are looking to pursue such opportunities with a range of innovative mid-size turbines that have a proven competitive edge. (See also page 4 for more about licensing.) In addition we continue to pursue direct sales and project investments in the UK and elsewhere for the class 1 and 2 turbines.

The Long Road to Paris

Climate change and renewable energy are inextricably linked. If one views the increase of carbon dioxide in the atmosphere with concern, one will understand why fossil fuels must be substantially phased out. Logically the converse applies. Renewable energy advocates have understood the need for zero-net emissions since the 1980s, but it has taken 20-30 long years for that view to become more general.

In 1992, all the nations of the world signed and ratified a Framework Convention with the objective of stabilising greenhouse gas concentrations. For this objective to be achieved, net emissions must fall to zero, which means that fossil fuel use must be substantially phased out, at least to the point where it is practical to absorb the remaining emissions somehow. But in 1997 a protocol to the Convention was signed which did not really address the long-term objective, was not ratified by the richest nation, and enabled emissions to increase overall because the poorer nations were not required to reduce. This "leakage" of emissions was bound to work against the Convention's objective, (although to the extent it contributed to an unprecedented rise in the living standards of the poorer nations, history may judge it a good thing overall).

Now in 2015, the Paris Agreement addresses the Convention's objective. Logic says we should see strong upward pressure on the cost of carbon emissions (i.e. the value of being a zero emitter like wind power) as sinking caps on emission rates are applied around the world over the next 15 years. Working in New Zealand, with its absence of subsidies for renewable energy and its near-zero cost of carbon, tends to make one wary as to the timeframe over which such logic will apply. But Paris appears to have been a great step forward.

Windflow's UK Turbines ...

Hammer Farm, Westray, Orkney Islands

New Holland Farm, Mainland Orkney (sold to land-owners)

Easter Aberchalder, near Loch Ness, Scotland (sold to land-owner)

Monan Hill, North Harris, Outer Hebrides

The photos above show the six turbines which have been installed in Britain to date (all in Scotland's Highlands and Islands). On average one of these turbines generates as much revenue as about eight turbines in New Zealand. This is due to a combination of the favorable pricing of power from single 500 kW turbines under the UK Feed-in-Tariff (FIT) scheme, and the very low value of electricity generation in general, and wind power in particular, in New Zealand.

... and Pipeline

Two further turbines have now been confirmed for build by Windflow in the coming year:

- Ludenhill, Mainland Orkney – 1 x class 1 turbine
- Cuddyhouse Rd, Kingseat, Scotland – 1 x class 2 turbine

In addition nine other turbines were pre-accredited under the FIT before September 30 at five other sites around Britain. We currently expect six of these to proceed, taking the total build in 2016 to eight turbines (7 x class 1 and 1 x class 2). These could possibly be the last for the single turbine FIT market although there are some indications the market will continue to be supported for community-owned projects and offshore island projects.

Beyond this, it remains to be seen how the UK market for onshore wind power will develop. The government in Westminster seems intent on minimising the development of onshore wind power. Within months of the May election it had announced a review of the FIT (which has dramatically reduced its value for projects pre-accredited after September 30), shortened the life of the main scheme for large wind farms by one year, and required local councils to reject wind farm applications unless they are in a designated wind development zone, thus creating a presumption against onshore wind power.

The "dust" has not yet settled from these decisions and we will review the market potential in 2016. Our best option is likely to be in small to mid-size wind farms (less than 30-50 MW scale). We have identified nine such projects in the Orkney Islands (which won't proceed until about 2020), two existing wind farms in England needing repowering with mid-size turbines, and many sites where wind farms using large turbines have been turned down on grounds of visual impact or radar interference.

Class 2A Prototype

The Class 2A Prototype near Westbrook, Mitchell County, Texas, commissioned in April 2015.

Licensing Activities

Windflow's Licensing Manager, Chris Holsonback, together with the CEO, Geoff Henderson, have made good progress with a number of potential licensees in the major economies of North America and Asia. It is still early days in terms of reaching substantive agreements, but we hope that these will be forthcoming in due course.

We have had great assistance from NZ Trade & Enterprise in country, including participation by Windflow in a Cleantech Mission to India led by Minister Amy Adams in late September (see photo below).

We have visited China on two occasions this year, including attendance at the annual China Wind Energy Association conference/exhibition in Beijing during October.

The USPs of the Windflow design, particularly its power-to-weight ratio, make a compelling case. The Windflow 500 is quite unique in the quality of its IEC Certification and the extensive track record (getting on for 600 turbine-years) at the demanding Te Rere Hau wind farm site.

We have found the vitality and dynamism of China and India to be hugely refreshing. While their pace of modernisation has caused problems such as air pollution, it is now enabling them to take the lead in the move to renewable energy. They have also played a major role in driving down the cost of wind turbine components in recent years, and of course this is an aspect that Windflow hopes to benefit from as part of any licensing arrangement.

Welcome new staff

Damith Don – Junior Accountant

Born in Sri Lanka, Damith trained as a book-keeper and worked in Colombo for several years before moving to Sydney to further his studies in accounting and business management. Damith has lived in Christchurch since 2012.

Graeme Adriaens – Mechanical Engineer

Originally from Christchurch, Graeme trained as a mechanical engineer at CPIT and Waikato University before moving to Western Australia where he worked on the development and design of drilling rigs. Graeme recently returned to Christchurch to join Windflow's mechanical design team.

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