Altitude Energy

Reach For The Sky

SUBMISSION

on

MODERNISING AUSTRALIA'S ELECTRICITY GRID

from

ALTITUDE ENERGY PTY. LTD.

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# EXECUTIVE SUMMARY:

Altitude Energy's objective in this submission is to show how harnessing the energy of the very powerful and persistent winds above Australia can dramatically improve the reliability and security of Australia's electricity grid, while simultaneously reducing consumer costs and reducing greenhouse gas emissions.

The introduction to the submission describes the nature of the winds aloft and details how twin-rotor or quad-rotorcraft can be tethered at altitude to generate electricity, windmill-style, while simultaneously developing sufficient lift to maintain flight, gyroplane-style. The quad-rotor version is almost identical in form to the now-common, four-rotor 'drone' craft. University experiments, with an actual craft flying at low altitude, verifies beyond doubt that the technology is valid. Photographs are included and patents are held in Australia and the USA.

The submission highlights how the electricity grid can be supplied at capacity factors (CF) in the 70 to 80% range, because of the wind's persistence at altitude. A theoretical justification of the aeronautical and electrical engineering in the above CF range is available upon request. These capacity factors are spectacular when compared to recently published capacity factors of 17.6% for solar PV systems and 33.6% for ground-based wind turbines. The latter two figures were derived using Australian 2015 Clean Energy Council data.

Three different scenarios are then examined in fine detail. Firstly grid-connected, solar PV units, supported by open cycle, rapid-response gas turbines driving generators, are examined. The supporting gas turbines are used to overcome the intermittency of the solar component. Generation by ground-based wind turbines is similarly treated, while generation by the third system uses grid-connected, quad-rotorcraft tethered in the persistent winds aloft. Storage support systems from pumped-hydro and/or batteries have been considered, but these are believed to be more expensive than gas turbine support. Therefore, it is important to realise that the subsequent analysis has been here examined using gas turbine support, but pumped-hydro or battery storage could be used and examined to produce the same result, namely the highly favourable outcome from electricity generated at altitude .

Power-Duration Curves (PDC) are shown in Figures 4, 5 and 6 for the three cases, each based on the Australian 2015 data for relevance. Capacity factors, system costs and greenhouse gas savings are all derived to indicate how Australia's grid can be made more secure, reliable and cost effective. These 2015 figures are then linearly extrapolated assuming that each of the three above systems is used alone to generate 50% of the nation's electrical energy (about 120 TWh/annum) at some time in the future.

The submission demonstrates the supreme position of Capacity Factor (CF) in determining answers to grid security, reliability and energy costs. For example, a CF of 80% for altitude energy generation compared to CFs of 17.6% and 33.6% for solar and ground-based wind turbines means that for equal installed power levels, at more or less identical installation costs of around $2,000/kW, the renewable energy produced per annum will be 4.5 and 2.4 times greater respectively for the system at altitude. This gives more saleable energy arising from similar capital cost expenditure on each.

This leads directly to lower and highly favourable LCOE electricity costs for the community. In addition, it is shown below that high capacity factor generation brings superior greenhouse gas savings and improved security through the need for much lower supporting generation from gas turbines, pumped-hydro or batteries.

The conclusion summarises the findings for each of the three cases. It shows beyond doubt that the altitude generating system, with its paramount capacity factor, is the way to the future giving superiority in reliability, cost with greenhouse gas savings. Altitude Energy has designs and a procedure ready to demonstrate the quad-rotorcraft capabilities. This technology needs to be urgently advanced through an appropriate Commonwealth agency to demonstrate that altitude generation produces a solution to current grid issues.

## 1. INTRODUCTION:

Altitude Energy Pty. Ltd. is an Australian owned company that promotes the use of quad-rotorcraft, or put more simply “generating drones”, tethered at known locations to generate electricity. These craft could harvest the energy of the extremely powerful and persistent winds above Australia. It will be shown that in Australia and elsewhere the wind’s annual average power density increases with altitude to a maximum of about 20kW/m2 at 10 km, with a corresponding increase in the wind’s persistence. Due to this persistence the electricity generated at altitude is potentially about three times greater than that obtained from a ground-based wind turbine of the same power rating. In addition, it has been shown in an Australian paper on electricity cost and security (1) that the resulting LCOE cost of electricity generation at altitude is equal to that of coal, prior to the application of any LREC credits. A similar result is given in a USA publication (9) for tethered quad-rotorcraft generating electricity at altitude. This resource aloft, described below in more detail, can be used in the future to significantly increase the security and reliability of Australia’s electricity network, because of the wind’s unmatched power and persistence.

### 1.1 High altitude wind resource:

It is well known that extremely powerful and persistent winds, called jet streams, exist at altitude in both Earth hemispheres. Over Australia these winds are amongst the best in the world, if not the very best. They also exist in bands running over the Mediterranean, Northern India, China, Southern Japan, North and South America, Africa and elsewhere. Extensive studies of wind probability statistics for Australia, using Bureau of Meteorology radiosonde data, gave annual average power densities of up to 19kW/m2 in a 1000 km band along an axis extending from Perth to Brisbane. Figure 1 shows the isopleths of power density over Australia at an altitude of 250mb.The power distribution therein is spatially well organized because of the lack of high mountains which tend to upset the orderly flow of air over a continent. These winds are about **eighty times more powerful and about three times more persistent** than the winds generally available to ground-based wind turbines. For example, the persistence of the winds at the abovementioned altitude have been measured at or above 10 m/s for 95% of the year, while for ground-based turbines the 10 m/s percentage is comparatively of much lower persistence, namely at or above 10 m/s for only about 30% of the year. This trend is quite striking and reported by Welch (2) for the Moree area in NSW.

Similar persistence trends can be found in (2) for all values of wind speed, for example speeds of 5, 15, 20….m/s.

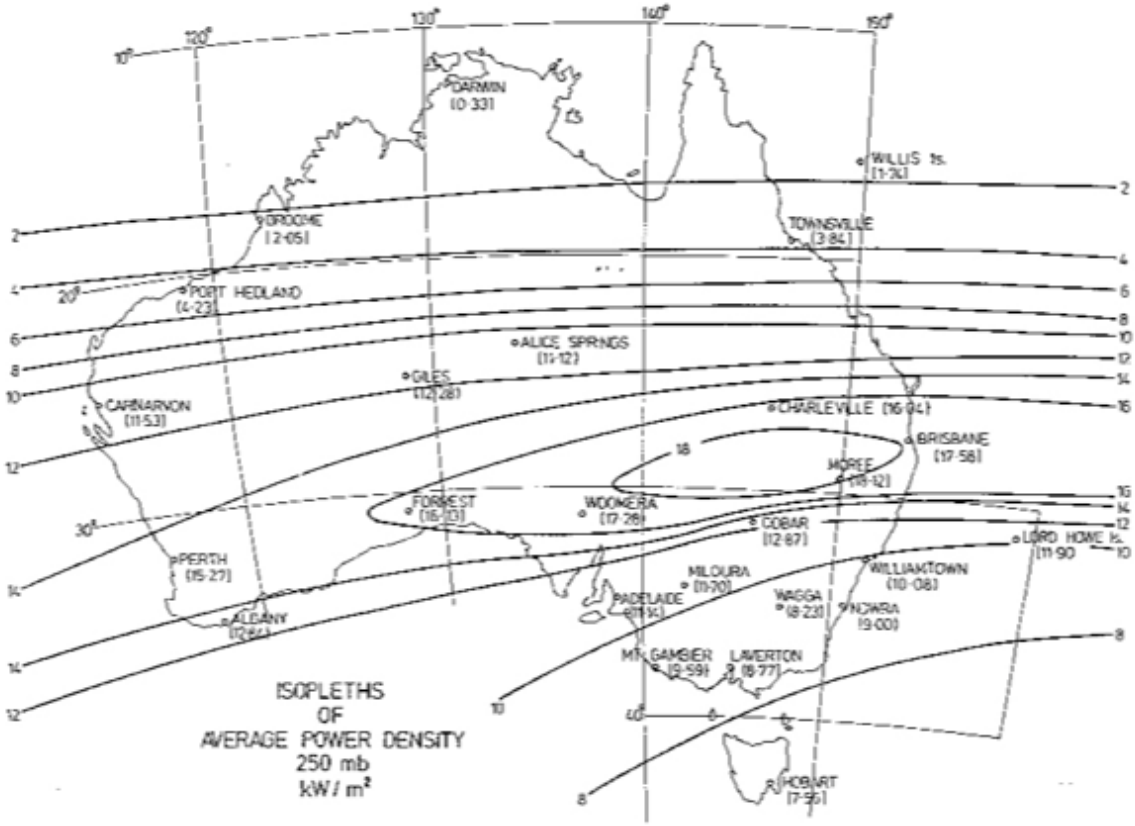


*Figure 1*

These average power densities are the highest found anywhere on Earth from any large scale renewable resource. They vastly exceed it from solar radiation. The latter's power density is generally only around 0.25 kW/m2 at the surface, depending on latitude. It also exceeds the power of near surface winds, ocean currents, tidal and the geothermal resources. This wind resource begins just 4km above ground level, where the energy is needed. Because of its vast power and persistence it would, if captured, be a very attractive and inexhaustible power supply.

### 1.2 Development of a twin-rotor airborne generator:

Various systems have been examined to capture the kinetic energy of the winds at altitude. These studies, primarily undertaken overseas, cover tethered balloons, tethered fixed-winged craft, tethered kites in simple or cross-wind flight, climbing and descending devices and rotorcraft. The general object of this work was to develop a pollution-free, renewable energy system for the generation of grid electricity.