Using Large Commercial Wind Turbines in Antarctica
(Wind Power for Australian Antarctic Stations)

a poster paper by
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INTRODUCTION

Research and data collection over several years has allowed us to determine the best alternative energy option for Australian stations. This is to install a small number of large commercially available, minimally modified wind-turbines. They would be variable-speed, 280kW machines without gearboxes, mounted on 33m or 50m steel towers. Matching an appropriate turbine design to the local climatic conditions has to be coupled with innovative solutions to the logistics and installation issues.

A computerised power-house management system is vital to the efficient operation of such a windfarm This will optimise the instantaneous wind resource and diesel generator outputs to the station load. When the wind resource exceeds around 40% of the station load, short-term energy storage systems such as fly-wheels, batteries or hydrogen powered fuel cells are required to hold the station load while different combinations of wind and diesel are switched onto the grid.

The planned windfarm, initially at Mawson, together with a power-house control and flywheel storage system will provide 100% of the station load for at least 75% of the time. The pay-back period in terms of fuel and infrastructure savings is expected to be between 4 and 5 years.

INSTALLATION ISSUES

Transport

Large (up to 250kW) commercial turbines can have individual components weighing up to 13 tonnes and 15 meters in length. Special cranes and transport equipment may be required to move the components from the re-supply vessel to the site.

Erection

Usually, cranes of 100 tonnes or greater are required to erect large turbines. Alternative erection systems such as tilt-up or self-erecting climbing cranes will need to be considered for remote installations such as those in Antarctica. Also to be considered is the small window of opportunity over summer to undertake an installation.

Foundations

Special consideration should be given to foundation design due to the high winds and cold temperatures. Permafrost ground conditions at some coastal sites is also a critical design factor. In general, concrete mass and cantilever designs are required with high quality control during construction.

Training

Specialised maintenance and servicing of turbines will need to be undertaken by station staff for which specialised training will be required each year. The training would include safety aspects of working at heights.

Siting

Turbine design life and annual output can be greatly decreased by turbulence generated by buildings, other turbines and prominent land formations upwind and in the near vicinity. Depending on wind speeds, “near vicinity” can be many hundreds of meters.

Wildlife

Experience has shown that the chance of bird-strikes is greatly reduced if the turbine is un-guyed, mounted as high as possible and is slow revving. Modern large commercial wind-turbines fit this profile.

RFI

Large variable-speed turbines use complex switching electronics to maintain fixed voltage and frequency output to the load. Care must be taken to ensure that interference from these electronics systems does not impact on sensitive scientific instrumentation which can be located near-by.

Electrostatic

Static build-up on cables, turbine blades etc due to the low humidity and blowing drift snow can be a problem at some sites. Sound earthing practices especially around control electronics need to be considered at the design stage.

Temperature

The constant low temperatures in Antarctica can lead to costly problems with gearbox oils, oil seals etc. Turbine designs which do not use gearboxes are therefore to be recommended.

Icing

Icing of blades, furling mechanisms and monitoring equipment would normally only be a problem at sites where onshore wind-blown wet snow or rain occurs. At most Antarctic stations, cold dry snow from the continental interior prevail and icing would not be an issue. Most large turbines are now available with blade heating.

Wind Abrasion

At sites where the prevailing wind direction is from areas which are substantially ice-free, “sand-blasting” of the blades could be a problem which needs to be considered. A loss of efficiency and a decreased design life could result if precautions are not taken. Wind driven snow can also be a problem, but to a lesser extent.

Fatigue

Compounded by the cold temperatures, metal fatigue due to the cyclic loadings in high winds, is the biggest issue in adapting large commercial turbines for use in Antarctica. Design modifications to the turbine and tower, including the use of specialist steels and castings, could be required.

CONCLUSION

Large wind turbines (greater than say 100kW) which are capable of withstanding the high wind regimes and cold temperatures in Antarctica are now available “off-the-shelf”, so cost-effective replacement of diesel-burning power stations is possible. However, total power-house replacement will also rely on the provision of efficient energy storage systems and special computerised “powerhouse” management systems.