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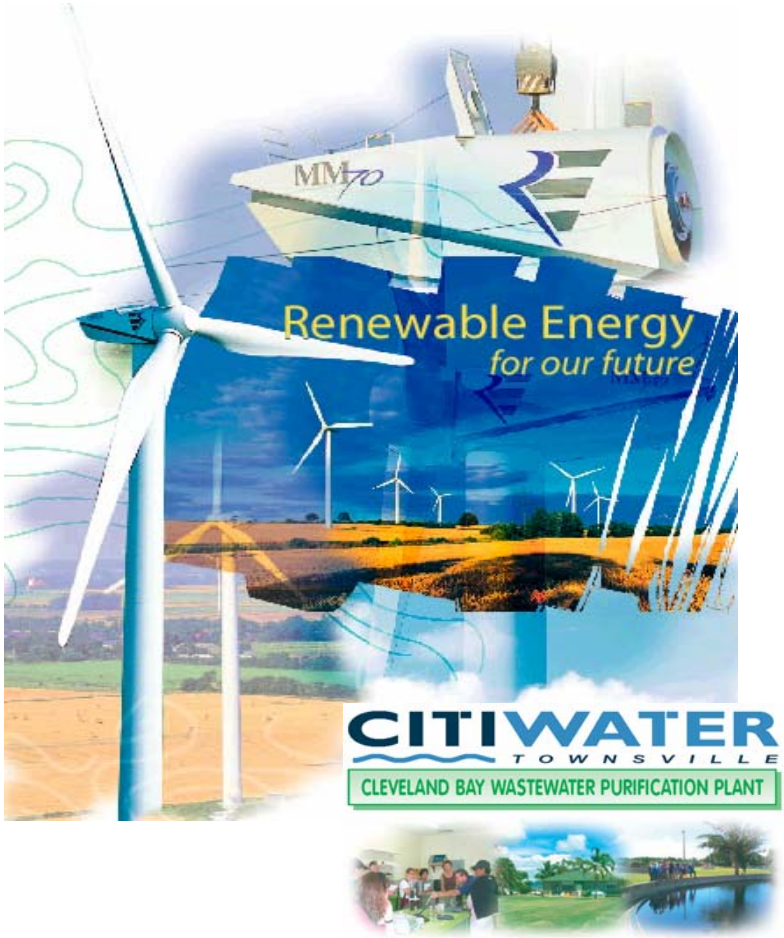
Pre Feasibility Study Report
Citiwater – Cleveland Bay
Purification Plant



PRE-FEASIBILITY STUDY REPORT

Table of Contents

EXECUTIVE SUMMARY

Introduction

This pre-feasibility study has been commissioned by Citiwater to begin the process of assessing an identified part of the Cleveland bay water purification plant for a potential wind energy project. The key goal of this study is to gain a reliable assessment of the wind resource at the identified site.

Basis for the Study

The logical path and the methodology for the conduct of this pre-feasibility are outlined on table 1.

Process

FNQ Solar Power Specialists, with the assistance of Brisbane based Wind Farm engineers, have collected and correlated wind data from a nearby weather station located in Cleveland Bay. This data has been formatted and provided to the CSIRO for independent assessment. Notus engineers have assisted in this process and also provided further system design to verify the CSIRO results.

Outcome

The wind resource assessment has shown that the identified site has a moderate wind resource with mean annual wind speeds of approximately 6.9 meters per second at 65 meters above ground level. Comparative data collected from other, nearby sites, indicates that this data is consistent with long-term averages.

With these wind speeds a REpower MM70 turbine would generate between 4.311 and 4.285 gigawatt hours of electricity per year for each potential turbine site studied.

Recommendations

As the above quoted wind speeds are considered to be in the moderate range, FNQ Solar Power Specialists and Notus will recommend;

1. A joint Citiwater, FNQ Solar Power Specialists and Notus Energy review of the results
2. A further 'Preliminary Study' centered on a small scale, four megawatt project, using primarily Citiwater, FNQ Solar and Notus internal resources.

Conclusion

While the wind resource is pivotal to any wind project other factors also affect the general viability of wind farms. It is in these other factors such as site conditions and grid access that add strong positives to this project. Additionally the opportunity for Citiwater to generate 'green power' and thereby gain substantial collateral advantages continues to indicate the strong potential for the Citiwater Cleveland Bay Water Purification Wind Project.

INTRODUCTION

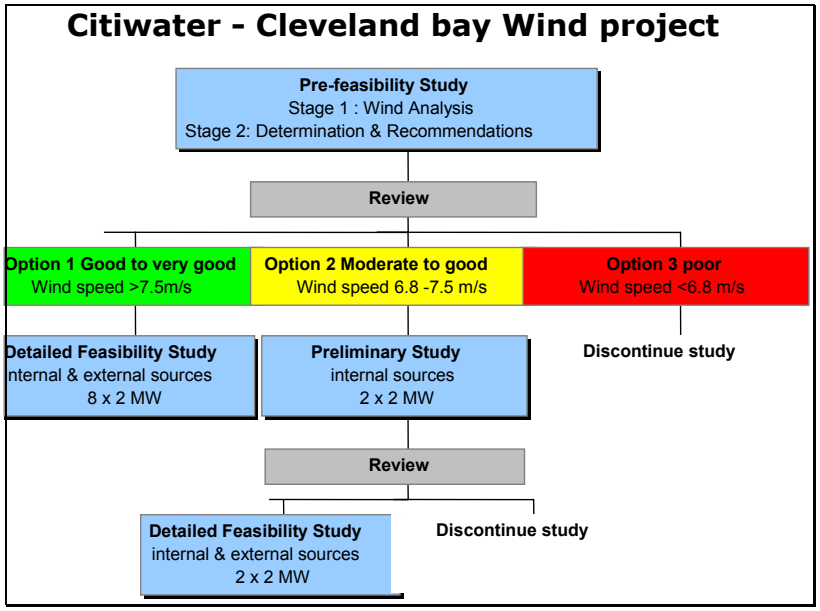
i. Background

This report has resulted as a result of the firm commitment by Citiwater to create a holistic carbon neutral water purification plant.

We have the advantage of prior knowledge of the area due to studies that we have carried out in the same vicinity. This gives us confidence in the re analysis of the data and subsequent reports provided by CSIRO.

As such, FNQ Solar has recommended a feasibility study conducted in stages (Table 1). This first step, the 'Pre-feasibility Study' will focus solely on developing a level of certainty with respect to the wind resource on the site. Based on the results of this pre-feasibility study, contained within this report, FNQ Solar Power Specialists will make recommendations as to the further conduct of the feasibility study.

Table 1 - 'Staged Feasibility Study'



In summary, the goals of this stage of the study are to;

- Perform a detailed, independent assessment of available wind data for the site.
- Use this assessment as a basis for recommendations for further action.

A brief outline of FNQ Solar's commitment in this pre-feasibility study is given here at 1. ii.

ii. Commitment

As described in 1. i. it is the intent of this report to perform those tasks detailed in our quotation as 'Pre-Feasibility Study', Stages 1 and 2.

- Stage 1 – Wind Analysis as detailed in Table 2
- Stage 2 – Recommendations for further action.

Activity	Comments	Conducted by
Compilation of available wind data	FNQ Solar and Notus will collect and assess available wind data for the region. Data will be assembled into useable formats and preliminary analysis performed	FNQ Solar / Notus Energy
Analysis of wind data by CSIRO	CSIRO will be contracted to perform detailed wind resource modelling for the site based on data provided by FNQ Solar / Notus.This third party analysis will serve to confirm results already achieved by FNQ Solar / Notus and provide independent verification for Citiwater management	CSIRO
System Design	The results of the CSIRO modelling will be used to map and optimise the proposed wind park site, resulting in accurate estimates of the energy production potential of the site	FNQ Solar / Notus Energy
Administration		FNQ Solar

Table 2 - Stage 1 – Wind Analysis

A key element of this study is the independent analysis of available wind data by the CSIRO. It is this analysis which will be central to this report.

iii. Methodology

Determining the wind resource is the critical aspect of any wind project feasibility study. While the most accurate method of such determination is to monitor the wind on the actual site for a determined period this is not always possible. In such cases worldwide experience with wind measurements has allowed meteorologists to make accurate determinations as to wind conditions at a particular site based on;

- wind data collected from nearby sites
- the topographical conditions of the site.

These projected wind resources, 'wind resource maps' are today accepted with high degrees of confidence and in fact many wind projects in Europe are installed on the basis of such projections. Australia's leading scientific organisation, the CSIRO, has world leading skills in this field and so has been chosen to perform an independent analysis for this project.

iv. Report Structure

The structure of this report will be;

1. This introductory section
2. Notes on the compilation of data
3. An overview of the key results of the CSIRO analysis (full report attached)
4. Key outcomes from this analysis
5. Notus system design
6. Recommendations

DATA COMPLIATION

As noted above, the preferred method of assessment of a potential wind energy project site is to conduct on-site wind monitoring over a period of at least twelve months. In this case this has not been possible and as such an estimate of the wind speed on the site is required. This estimate is calculated by using wind data from nearby sources.

For Citiwater, wind data has been available from an AIMS site located in the Cleveland Bay area, adjacent to the proposed project site. This data has been collected by FNQ Solar, formatted by Notus and forwarded to the CSIRO for analysis.

The primary data used is two years of data taken from the Cleveland Bay AIMS weather-monitoring site. This data covers the years 2000 to 2001 and is a very comprehensive data set taken at 30 minute intervals over this period. For actual calculations the year 2000 data was used.

For the determination of long term trends for the region further data was collected and analysed from;

- Townsville Airport
- Bowen Airport
- Lucinda Point
- Ayr Research Station

WIND RESOURCE ANALYSIS

i. Methodology

To perform this analysis FNQ Solar Power Specialists has engaged CSIRO to produce a 'Wind Resource map' of the potential project site. CSIRO have used the *WA^{S}P* 7.2 mapping tool, an internationally recognized tool for this type of analysis.

WA^{S}P uses measured wind speed data at a known location and height to generate a wind atlas, which can then be extended to cover a broader region. This is done by analysis of the topographical features of the site including elevation and surface roughness. In this case the Clevland Bay data has been projected over the Purification Plant area as well as the larger portion of the Cleveland bay area.

Figure 1 – Cleveland Bay Purification plant

The analysis by CSIRO produces

- Basic wind statistics
- A 'Mean Annual Wind Speed' map of the area

ii. Basic Wind Statistics

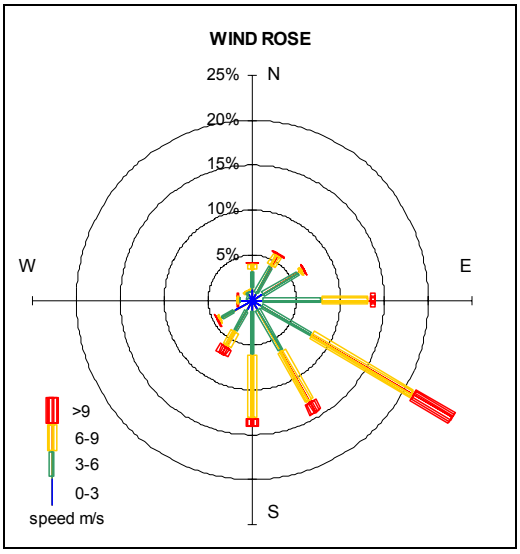
As a first step CSIRO have produced basic wind statistics for the actual Cleveland Bay site from which the data was collected. These basic statistics include;

- 'Wind Rose' a graphical indication of wind direction trends and speeds
- The average wind speed from each sector
- The average wind speed by time of day
- Distribution curve, indicating frequency of all wind speeds

iii. Cleveland Bay Statistics

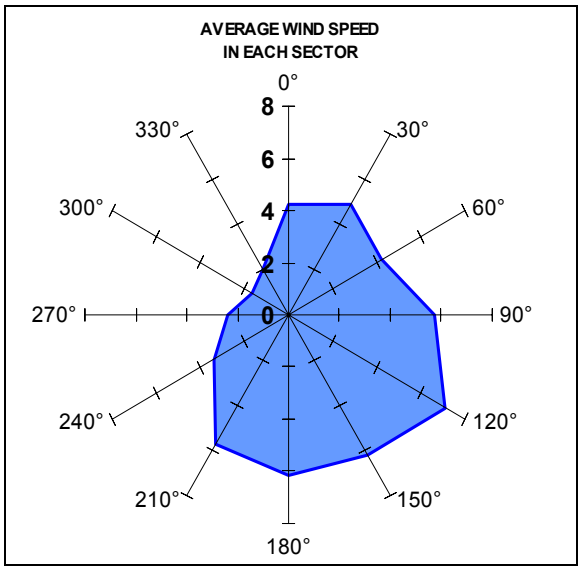
These are the results of the analysis from the Cleveland Bay data

Figure 2 – Wind Direction Rose



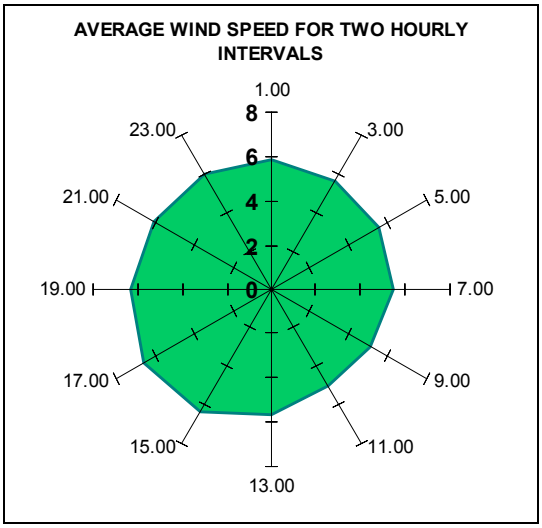
- This graphical indication of wind direction clearly indicates prevailing wind direction from the south-easterly sector.
- Strong wind events up to 31 meters per second (not discernable on plots) were noted from the data.

Figure 3 – Wind Speed by Sector



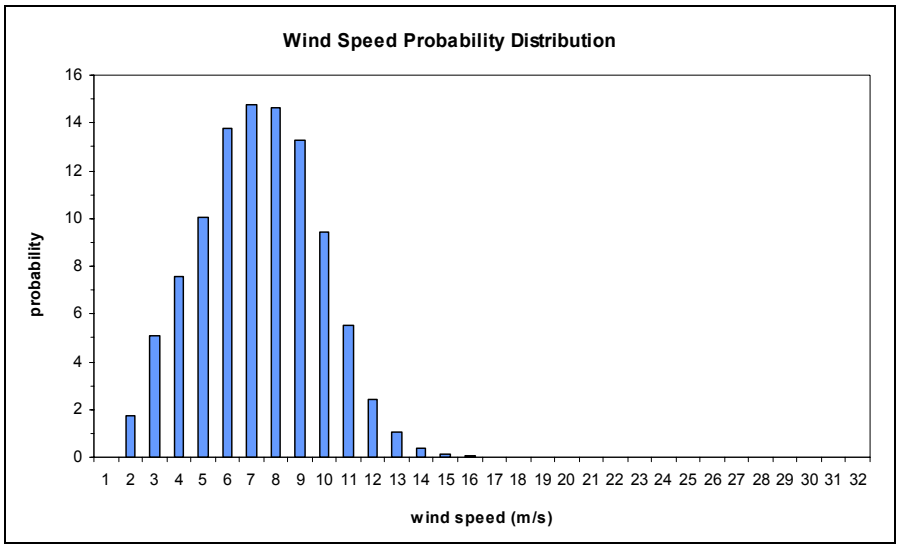
- This graph indicates the direction of the wind and the average wind speed from each direction.
- Wind speed in meters per second is shown on the 0 degree vertical axis as **bold numbers 0 to 6.** These indicate wind speed in meters per second.
- This analysis indicates that not only wind direction but wind speed is most prominent in the south-easterly sector.
- The average annual wind speed for the data set is calculated at 5.8 meters per second at 10 meters above ground level (a.g.l.)

Figure 4 – Wind Speed by Time of Day



- This indicates that a high proportion of wind occurs in mid to late afternoons.

Figure 5 – Wind Speed Distribution



- Finally the data is placed into a distribution graph, indicating the percentage probability of certain wind speeds being experienced at the site.
- While relatively high probabilities exist for wind speeds of between 7 and 9 meters per second, the graph is overall skewed to the left, resulting in lower average wind speeds.

iv. Wind Data Analysis Summary

a) Predominant wind speed is from the south-easterly sector
b) Average wind speed is 5.8 meters per second at 10 meters a.g.l.
c) Strong wind events are possible at the site

v. Wind Data Analysis Conclusions

a) Ideal siting locations for wind turbines will be to the north east of the nominated site. This will enable turbines to receive the predominant winds unaffected by man-made structures and minimise the effects that turbines may have on each other.
b) While the average wind speed calculated is 5.8 meters per second it is measured at 10 meters above ground level and will need to be re-calculated for turbine hub height of 65 meters a.g.l.
c) Class I certified wind turbines (for high wind areas) will need to be used on this site.

WIND RESOURCE MAPPING

The data calculated above is now used to produce wind resource and energy output maps for the surrounding region. This process takes place in a number of steps as described below.

i. Topographical Mapping

This is taken from publicly available topographical maps of the area in question. It can be seen from Figure 2 that the area of the Cleveland Bay plant is, as expected, quite flat. It can also be seen from this Figure 6 that possible turbine sites have been identified by FNQ Solar and added to the mapping. This will be important for later energy calculations.

- Sites 1 & 2 have been chosen, as they are the first sites on land that will meet the prevailing south-easterly winds unhindered by obstructions.

Figure 6 – Elevation Above Sea Level

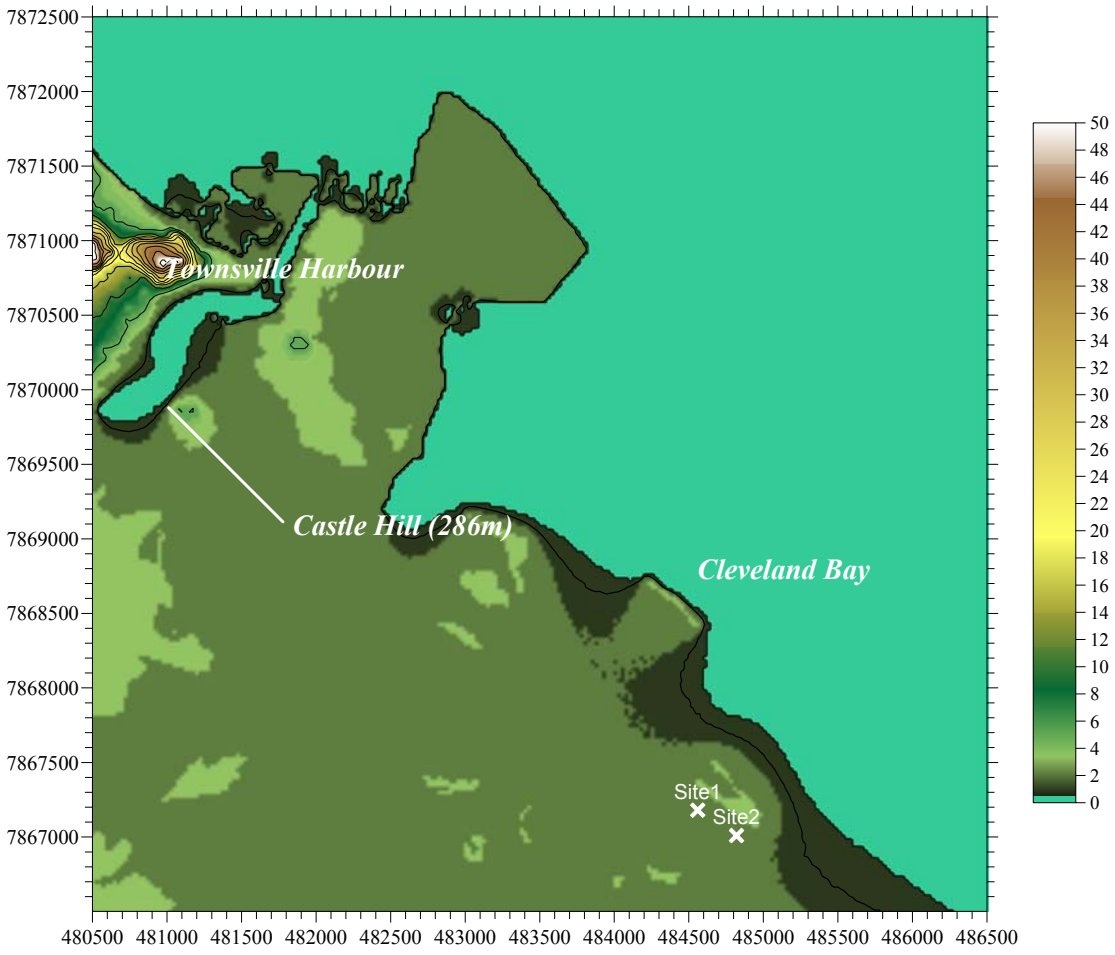


Figure 1 Altitude (m) for the region of interest around the Townsville Harbour area. Potential turbine locations are shown as labelled crosses. The coastline is shown as a black line.

ii. Mean Annual Wind Speed Map

The topographical information above is then combined with the wind analysis carried out in section 3. to develop a 'Mean annual wind speed' map for the region. This is shown below as Figure 7. It can be seen from this mapping that;

- Sites 1 & 2 are indicating wind speeds around 6.9 meters per second.

Figure 7 – Mean Annual Wind Speed Map

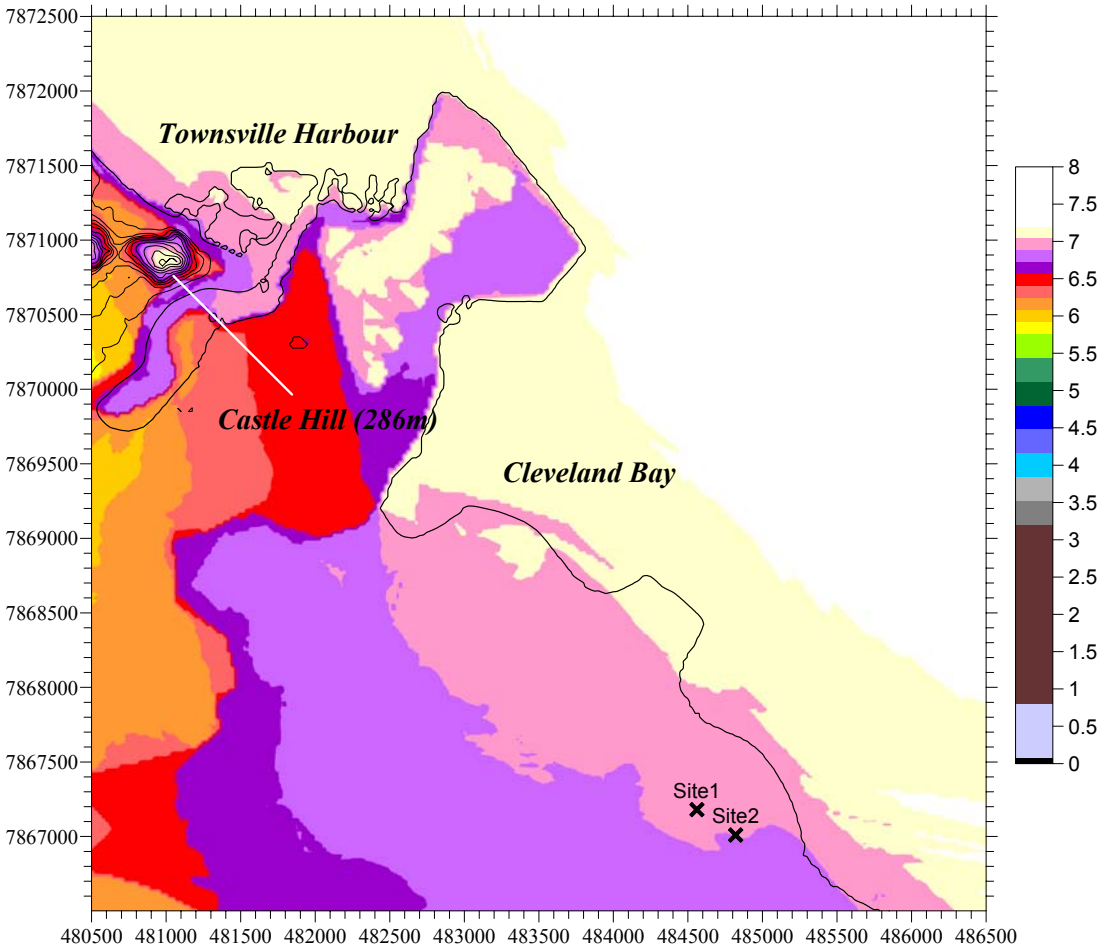


Figure 2 Mean annual wind speeds (ms^{-1}) over the Townsville Harbour area at a height of 65m agl. Potential turbine locations are shown as labelled crosses. The coastline is shown as a black line.

iii. Mean Annual Energy Yield

With wind speed data now available it is possible to calculate the annual energy outputs from the identified potential turbine sites. To complete this calculation data on the power output of the wind turbine is required.

Notus has selected the REpower MM70 as the ideal turbine for this site. This two-megawatt turbine is certified Class I for high wind speeds, essential for this location, and its very high nominal capacity will offer the most efficient power output to cost ratios. The power output curve for the MM70 (which can be seen in detail in the CSIRO report) is then added to the wind and topographical data to produce this map.

It can be seen that sites 1 & 2 are estimated to produce around 4.3 gigawatt hours (GWh) annually.

Figure 8 – Mean Annual Energy Yield

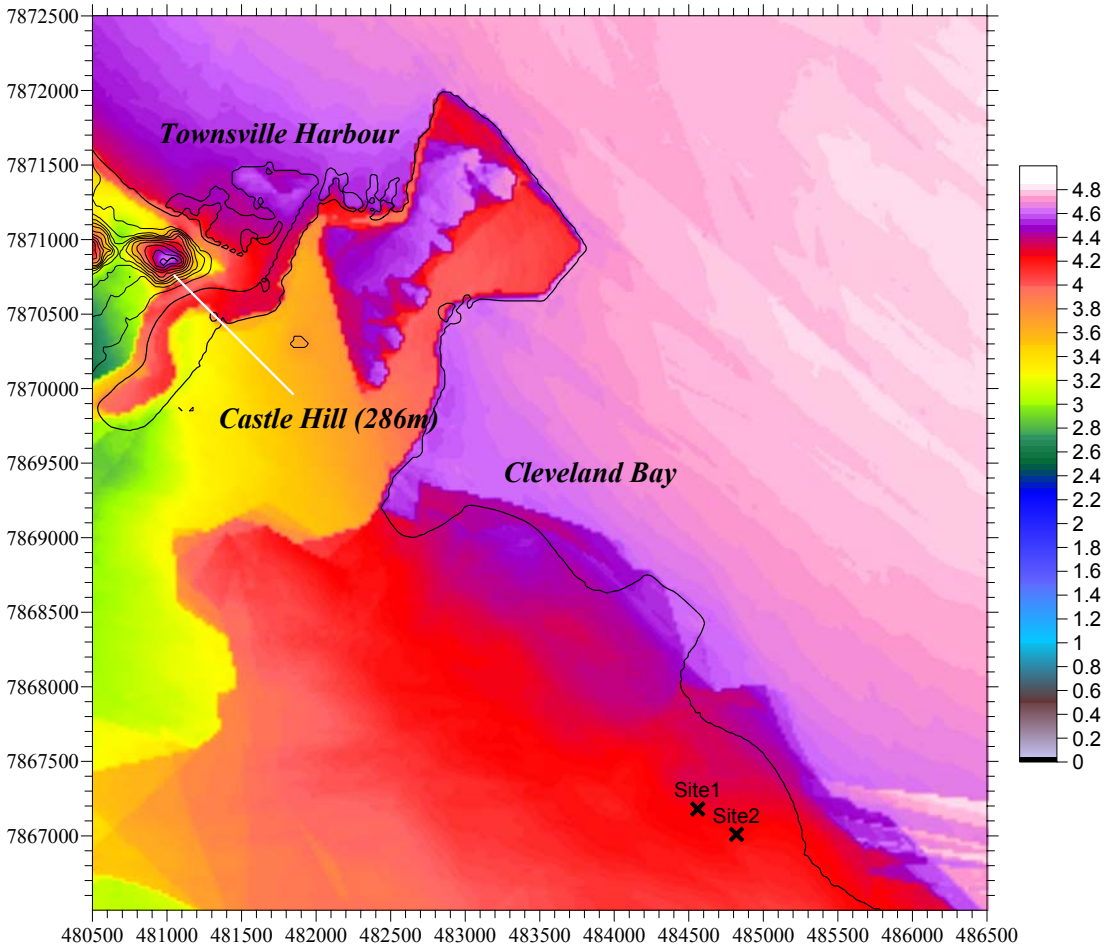


Figure 3 AEP (GWh) for the region of interest around the Townsville Harbour area. A REPower MM70 (2 MW) power curve was used, with a hub height of 65m. Potential turbine locations are shown as labelled crosses. The coastline is shown as a black line.

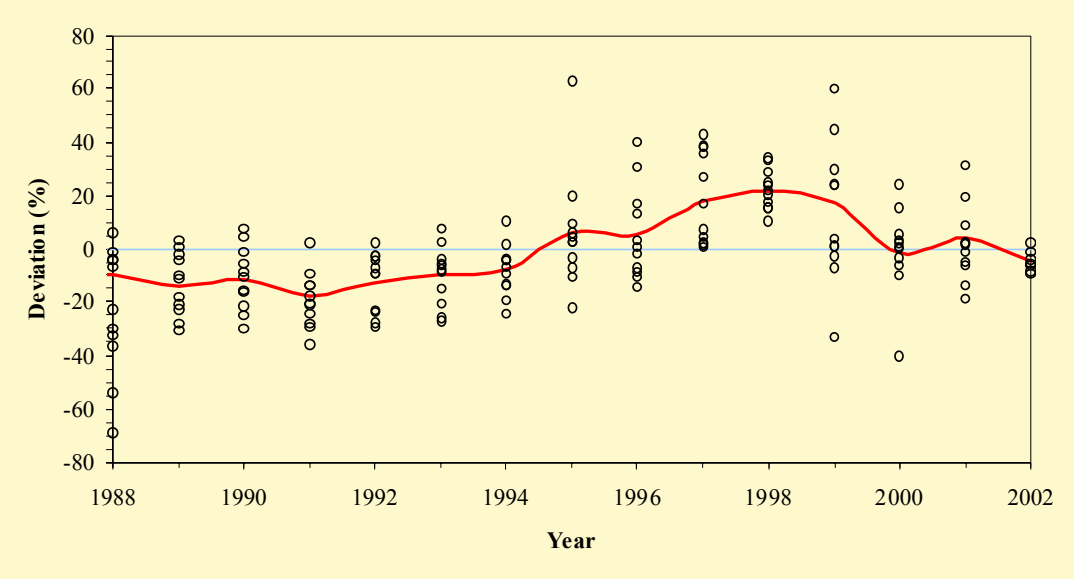
iv. Long-Term Trends

While the results gained above can be viewed with a high level of confidence it is important to realize that they are projections from one year of wind data. Individual years can vary significantly from year to year and so long term trends must be examined to determine if the year in question, here 2000, can be considered to be an 'average' year.

To make this determination long term data has been collected from a number of sources. Primarily a 14 year data set from Lucinda Point and a 15 year data set from Bowen Airport were considered to have adequate consistency in terms of location and data collection methods to present reliable long term trends.

The CSIRO has concluded from these data sets that 'the year 2000 for Cleveland Bay can be considered to be close to the probable long term average for the region'.

Figure 9 – Long-Term Wind Trends



SUMMARY OF ANALYSIS RESULTS

i. Wind Speed

Mean annual wind speed on the site can be generalized as approximately 6.9 meters per second. Actual wind speeds at the identified possible wind turbine sites range from 6.9 to 7.2 meters per second.

In the terms of our quotation, this places the wind speed for the site in the 'moderate to good, 6.8-7.5 meters per second, category although clearly it is at the lower end of this category. Consequently in general terms we will refer to these wind speeds as 'moderate'.

However it must also be considered that the CSIRO report has noted (Section 3) that wind events of up to 31 meters per second have been recorded. This will place the site into the international standard 'Class I' 'high wind speed' site and as such suitably certified wind turbines must be used. For the purpose of this study Notus has used the Class I REpower MM70 turbine.

ii. Wind Turbine Placement.

Based on the CSIRO analysis FNQ Solar Power Specialists have located two possible turbine sites within the specified Plant area.

- Sites 1 and 2 are located at the eastern end of the plant on the open land. These turbines have been chosen due to their absolute exposure to the prevailing southeasterly winds.

iii. Site Specifics

As expected the sites identified as 1 & 2 are the preferred sites in terms of performance. However this recommended that if other sites are available, theses sites should still be kept in consideration, with further investigation.

iv. Energy Yield

CSIRO have utilised wind speed and loss figures, along with the power output figures of the REpower MM70 two-megawatt wind turbine, to produce 'Net Annual Energy' output figures (Table 3). These figures are designed to give a strong indication of the resultant electrical energy generated by a wind turbine at each specified site. At this stage electrical losses created in the wind park electrical system have not been taken into account but will need to be factored into final project financial analyses.

Table 3 – Summary Statistics

Site	*Easting (m)*	*Northing (m)*	*Gross Annual Energy (GWh)*	*Net Annual Energy (GWh)*	*Estimated Wake Losses (%)*	*Mean Speed (m/s)*
Site1	484560	7867180	4.311	4.185	2.92	6.90
Site2	484820	7867010	4.285	4.284	0.04	6.89

RECOMMENDATIONS

The basis of the FNQ Solar quotation for this feasibility study has been to minimise the potential cost to Citiwater, particularly should it prove that the potential for a viable project is uncertain. As such FNQ Solar originally recommended that should the wind resource fall into this 'moderate' wind speed category then we would recommend in the review process a limited, internal, Stage 2 study into a 'small scale, four megawatt (4MW) wind park'.

The primary reason for this choice of project size is the issue of connection of this project to the electricity grid. A project of not more than four megawatts will be able to be directly connected to the Cleveland Bay Plant's own 11kV internal grid system at minimal cost. Larger projects may have to be connected to the Ergon substation. This would involve a significantly higher cost that may jeopardize the possibility for financial viability of this project given the moderate wind resource.

However, it should be made clear that this 4MW recommendation is only a starting point and that FNQ Solar is committed to exploring a number of potential options to determine the best project option for the Citiwater.

As such FNQ Solar will now recommend the following actions for the continuing joint investigation of this project:

i. Commencement of the Citiwater, FNQ Solar/Notus review of the results of the study outlined in this report.
ii. Decision by Citiwater to continue, or discontinue, this feasibility study.
iii. Should the decision to continue be made, the parameters for the continuing study be agreed.
iv. These parameters to include project size and Citiwater financial targets.
v. A continuing study would be formulated as detailed in our quotation.

5.3 Option 2 Preliminary Feasibility Study

Content of Study

The option 2 preliminary study will be a condensed basic study utilising primarily internal expertise to provide Citiwater with a technical and financial analysis of this project on an estimated basis.

Planned Project

- **Wind Turbines –** 2 x REpower MM70 2MW
- **System Capacity –** 4MW peak
- **Grid Connection –** 11kV line

Activity	Comments	Conducted by
4MW System design		Notus Energy
Geotechnical survey	Using existing survey data	Citiwater
Foundation design		Downer Construction
Electrical system design	Generic, not site specific	Downer Construction
Estimate of project costs		Notus Energy
Estimate of energy prices	Based on market information	Notus Energy
In-house financial assessment		Citiwater, FNQ Solar + Notus

FNQ Solar Power Specialists would also recommend the addition of these options for consideration in this next stage of the study;

1. Assessment of the Cleveland Bay Water Purification Plant grid to determine actual carrying capacity.
2. This information to be used to make final determination as to the size of project to be considered.

FINANCIAL ANALYSIS

FNQ Solar and Notus have not quoted to perform a financial analysis at this stage of the process however during initial discussions with Citiwater it has become clear that a preliminary analysis will be essential to assist in the on-going decision making process.

This report will show that;

- Our preliminary analysis indicates that, due to moderate wind speed conditions, we have proven a project can be made on this site by Citiwater
- A number of factors which contribute to the analysis are still uncertain and would need to be clarified during the second stage feasibility study.
- A large scale, 16MW project should be kept under consideration.

CONCLUSION

The commercial viability of any wind energy project is dependant on a very large number of factors. Issues such as capacity and location of the electricity grid, soil conditions, site access and power purchase price all influence system costs and financial returns. However, detailed knowledge of the local wind resource is the critical factor, and the assessment of this wind resource must always be the first step in gauging the feasibility of a wind project.

For the Citiwater Wind project this first step is now achieved. Further investigations of the project, reviewing factors such as those listed above, can now move forward with a solid basis upon which sound engineering, commercial and environmental decisions can be made.

FNQ Solar Power Specialists and Notus look forward to continuing this investigation in conjunction with Citiwater.