Introduction

3.1 Identify a place and renewable energy source(s)

Several questions needed to be answered in order to find a suitable place and renewable energy source(s) that satisfies and make the project viable. First, who will be in need of renewable energy, and will the advantages outweigh the disadvantages of exploring those energy? One answer came to mind: renewable energy source(s) implemented in small or private islands. The system would be most suitable for small islands such as Scotland Island in Sydney that has a diameter of around 1km. My conjecture has proven to be accurate as several articles from different sources has confirmed my claim. “With rising oil prices, fuel import bills now represent up to 20 percent of annual imports of 34 of the 38 small island developing states (SIDS)”, claims Vanya Walker-Leigh (2012). In fact, the biggest expense of those islands are importing all kinds of materials. Although it will stop or reduce the amount of fuel imported, setting up and importing the materials for renewable energy system will be costly. It will however save the island money as well as contributing to a clean environment and less pollution. The scenery of those small islands also shouldn’t be affected by the implementation of non eco-friendly energy source infrastructure. In fact, the implementation of renewable energy systems will reflect a brighter future and will not affect the ecosystem on and around the islands. Furthermore, The high price of importing fuel for electricity uses makes the use of renewable energy system cost competitive. However, the wide variety of renewable energy systems made the choice of energy difficult. While wave & tidal, and hydroelectric were some choices to come to mind, I have decided to give up on them as views and scenery might be affected and won’t be a first choice for inhabitants. On the other hand, given how common solar energy is used, I believe that it is one of the first choice. As more and more people choose to install solar panels on their roof for personal use, people should be more accepting towards those changes in scenery. Another energy chosen for the project is wind energy. The Danish island of Samsø was the first island to go from fossil fuel dependant to 100% renewable with wind energy. On top of that, coastal areas are suitable as it is windier there because of the sudden change in the atmospheric pressure. In fact, “there is an enormous amount of energy to be harvested from wind.” claims Roger Rassool, a particle physicist at the University of Melbourne. In terms of efficiency, “The most efficient forms of renewable energy geothermal, solar, wind, hydroelectricity and biomass.” (New Jersey Institute of Technology’s Online Master of Science in Electrical Engineering). Seeing that both solar and wind energy are efficient, I have decided to pursue the project with both of those energy sources.
The location chosen for this project is Scotland Island, a small island next to Church Point.

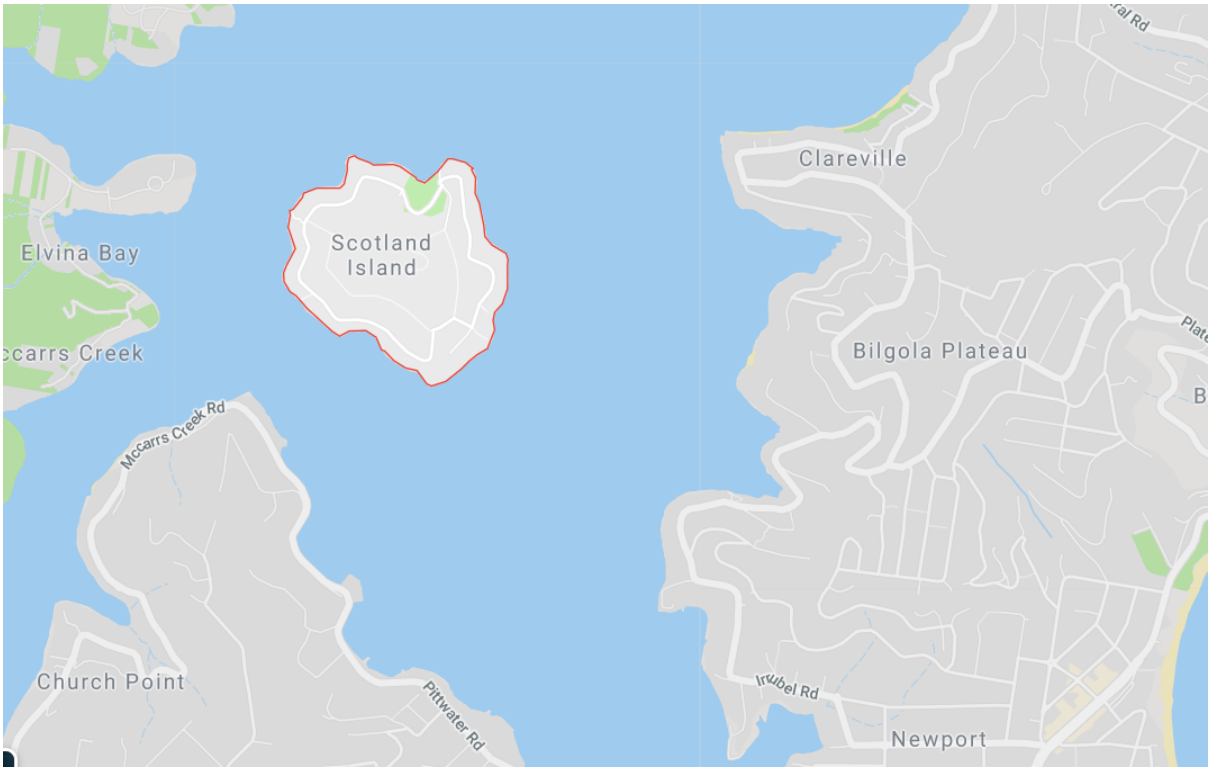

Figure 1 - Scotland Island (Google Maps)

3.2 System Specifications

The system used will need to satisfy several specifications. Firstly, the aim of this renewable energy system generation will complement other sources of electricity such as fuel, which is very common to use on islands. It will considerably reduce the use of non-renewable supply of materials and therefore contribute to the reduction of importing those materials. Choosing to compliment AC grid while not going fully renewable has its advantages. In fact, if a storm is to break own and destroys the newly installed infrastructure, the AC grid can act as a backup generator in case of emergencies. According to the Australian Bureau of Statistics (ABS), the average Australian household uses 117 gigajoules (32,500 kWh) of energy per year (in that case 2015/2016). Taking Scotland Island with its 350 houses as an example, the island would need an average of 11.4 GWh. A large amount of the demand has to be filled with renewable energy systems and the appropriate infrastructure has to be built.
The image below has been found in a study called “Feasibility Study of Energy Storage Systems in Wind/Diesel Applications Using the HOMER Model” by UNSW. We can hear see the average wind resource and has an average of just below 10 m/s. The data was recorded at a height of 46 metres. The highest point on Scotland Island reaches 100 metres over sea level, making the location suitable to implement the system.

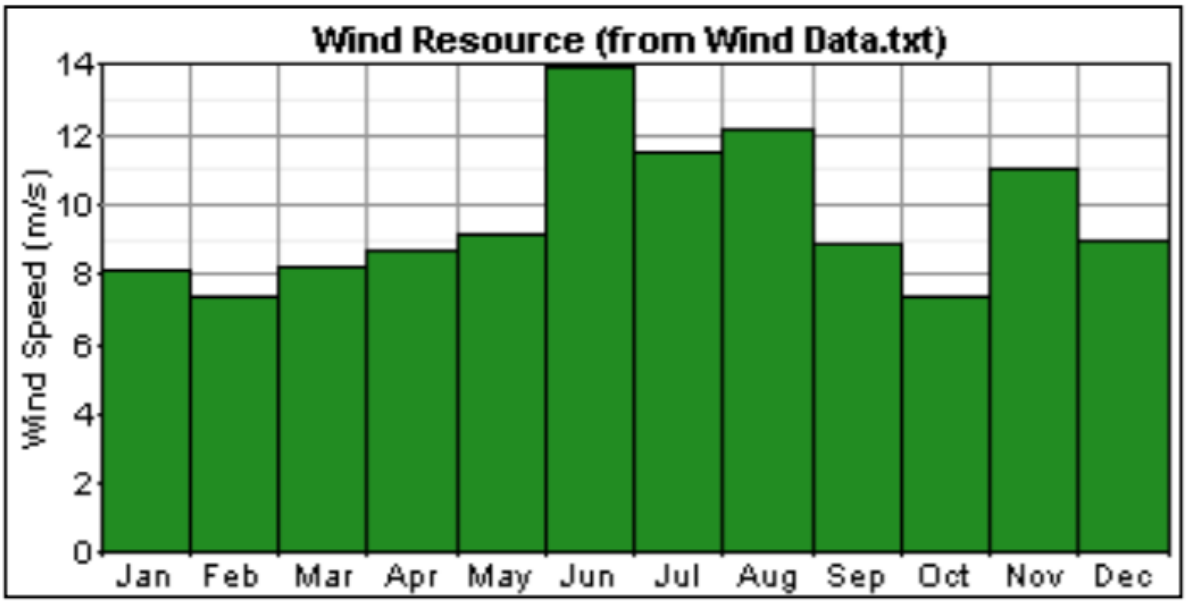

Figure 2 - Wind Resource from HOMER model

On the other hand, tropical islands are very prone to have a high intensity of light with lots of sun, thus suitable for solar energy systems such as photovoltaic panels to be implemented. For example, Australia has a “5 GW Potential resource” per day. The overall demand per day is conveyed in the graph below found in the same study led by UNSW.

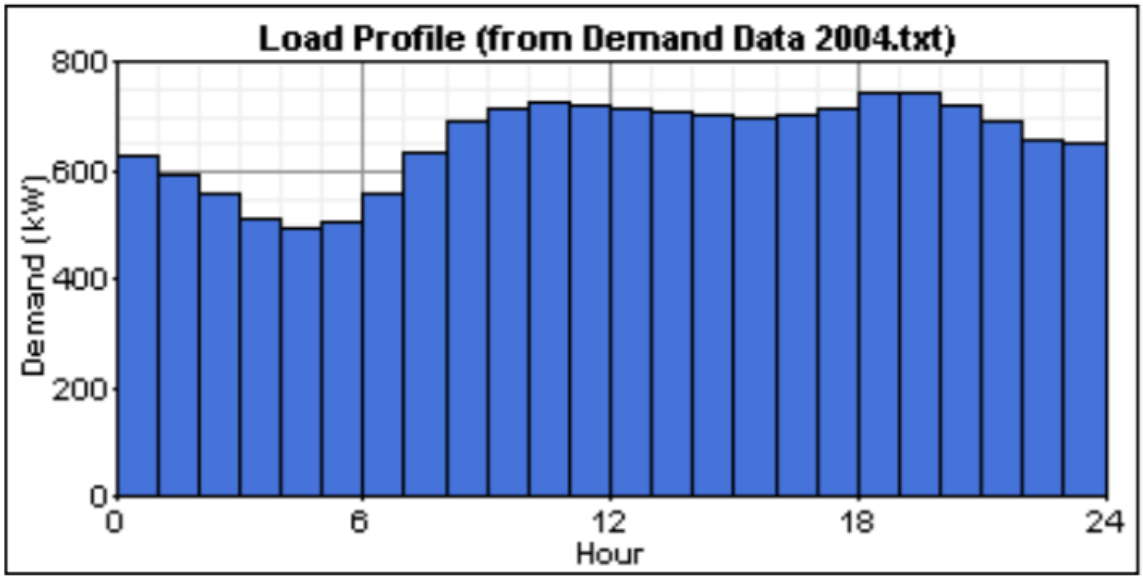

Figure 3 - Demand for electricity from HOMER model

Unfortunately, the resources decreases during winter as the intensity of light might not be as high. While households are more inclined to use more resources during the colder seasons, wind resources is at its highest at that point of time in Australia. Therefore, it is more than feasible to have those two kinds of renewable sources implemented as it will still decrease the majority of fuel consumption.

In the case study, the author claims that using a Fuhrländer 250 turbine will grant us “an expected lifetime of 15 years” (2004, Andrew Stiel and Maria Skyllas-Kazacos). On the other hand, a solar panel usually comes with a warranty of 20 years and decreases the quantity of energy produced every year, “up to 1% per year” (2014, Tom Lombardo).

In terms of size, the renewable energy systems will only need to provide electricity to around 350 households. As stated above, it will be assisting the existing energy source by providing and reducing the use of non-renewable energy. Thus, the system doesn’t have to be as rigorous in terms of producing the right amount of energy.

3.4 Design system topology

Considering the small size of the different targeted islands (1 km diameter approximately such as Scotland Island), the distance from generation to consumption will be relatively short. While solar panels can be installed per household, a wind energy generator centre will be needed on the island. Constructing onshore might raise environmental issues, ruin the scenery and in turn raise complaints from the local. However, onshore centre is preferred as maintenance will be easier and the distance until delivering energy will be shortened. As isolated islands, the wind tends to be stronger and thus its lack will not be a worry. This renewable energy systems will assist and not replace the existing source and will consequently not be as vast as one might think.

Furthermore, vertical axis wind turbine will be preferred over horizontal axis wind turbine. Horizontal axis wind turbine has “higher cost in tower construction to hold the generator, gearbox and the heavy blades”, they also “require additional control mechanism for controlling the direction of the turbine blades” (Kotb B. Tawfiq, 2019). On the other hand, vertical axis wind turbine will always be perpendicular to the wind and a controller is not needed, contrary to the other type of wind turbine.

Calculated earlier, an approximate of 11.4 GWh will be needed to supply electricity to an average of 350 households. As the wind turbine will be acting as a complement to the AC grid, there will be no need for energy storage system and all energy will be fed to the AC grid.

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