A GIS Based Market Assessment Methodology for Small Wind Turbines in Nepal

Alfred Alsop, Scott Strachan, Valerie Belton, Aran Eales

Wind & Marine Energy Systems CDT, Rm 3.36, Royal College Building
University of Strathclyde, 204 George Street, Glasgow, G1 1XW

alfred.alsop@strath.ac.uk

Introduction

Nepal is a landlocked medium development country in South Asia, with Himalayan mountains and valley systems dominating the landscape. With a population of 29.9 Million (based on UN estimates) and an electrification rate of 84.9% there is an estimated un-electrified population of 450,000 people, predominantly in the rural areas of the country. Given the complex geography of the country, and ongoing problems with the national electrical grid (such as frequent load-shedding), the nations goal of universal energy access by 2030 may not be achievable through grid extension alone.

Nepal has seen great success in using off-grid micro/mini-hydro plants for rural electrification in the past, not least because of the abundant and ubiquitous hydro resource in the country, but there are many locations where hydro-power is unsuitable. In these locations it is possible that Small Wind Turbines (SWTs) of capacity in the range 0.5-5kW, may serve as part of the electrification solution, likely in hybrid mini-grid systems with Solar PV units.

The research presented here aims to map the areas of rural Nepal where Small Wind may be a viable technology, and to describe the enabling environment for SWTs in terms of policy and regulatory factors.

Necessary Conditions for SWTs

In order to produce a map of locations suitable for SWT installations in Nepal, we must first consider the necessary conditions for a successful SWT installation. The selected conditions are as follows:

- Sufficient wind resource must exist to allow adequate generation
- Sufficient demand for off-grid electrification must exist
- There must be no obstructions to the turbine, to avoid damage from turbulence
- The land at the site must be suitable for supporting tower and tethers

These are not the only conceivable factors which would contribute to a sites suitability, but rather reflect the most basic criteria on which siting decisions would be made. In order to differentiate between locations in accordance with these criteria, geo-spatial datasets were collected and processed for relevant factors.

Constructing the Inclusion Zone

In order to determine whether or not a location has the need for off grid generation, night time satellite imagery, along with grid line data, was used to construct an electrification map of Nepal. This map assumes that the population within 7.5km of either an existing gridline or a bright area is either currently served by grid electrification or would be best served by grid connection in the future. All other areas are assumed to require off-grid electrification. Figure 1 shows the generated map.

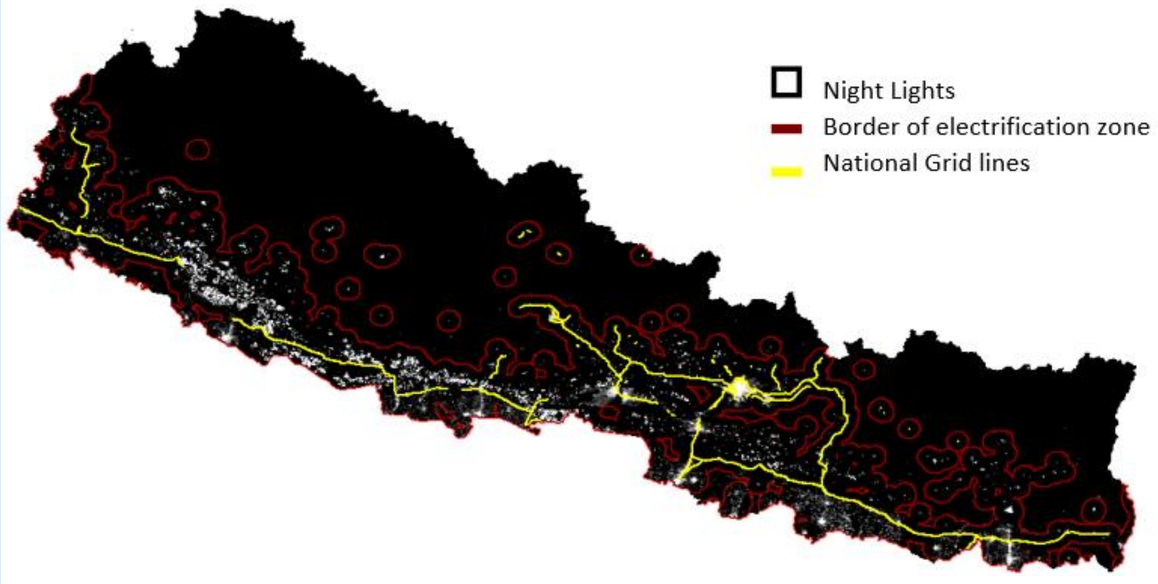

Figure 1: Generated Electrification map of Nepal

A simulated wind resource map, produced by DTU and the World Bank was used to ensure locations experience sufficient wind resource.

Land Cover data, produced by categorising satellite imagery into land-types, was used to ensure suitable land cover in potential sites (eg no wetlands or forests).

A DEM (digital elevation model) dataset for Nepal was used to ensure locations above 4800m were removed (as few people live at these heights and maintenance would become an issue). The height of 4800m was chosen as the highest known SWT is at just above 4800m in Peru.

The Final Inclusion Zone

Combining all the previously discussed criteria, a final inclusion zone was produced. A 1km buffer around this area is included in order to avoid any edge effects caused by the GIS processing. The simulated wind-speed final inclusion zone is shown in Figure 2, below.

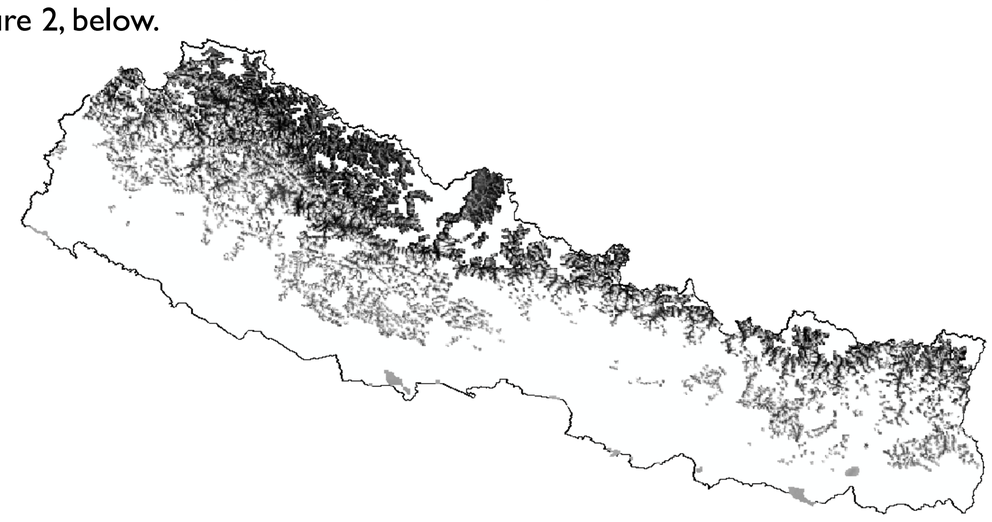

Figure 2: Wind-speed in the inclusion zone in Nepal. Darker areas correspond to higher wind-speeds Blank areas are excluded.

The population calculated to live within the inclusion zone shown in Figure 2 is 3.5 million people, approximately 80% of the 4.3 million unelectrified people living in Nepal. This is the population living in areas expected to show some potential for SWT deployment, and where further investigation should take place.

The economic basis for SWT's should be investigated, the lifetime costs and generation of SWT's should be compared with other off-grid generation techniques in order to determine whether SWTs are economically competitive in Nepal, and if so, where.

Barriers to SWTs in Nepal

There exist a number of regulatory and practical barriers that must be overcome in order to ensure a positive enabling environment for SWTs in Nepal. Some key barriers are:

- Absence of reliable/detailed wind resource maps
- Low consumer confidence in SWTs
- Late maturity of SWT specific standards/certification
- High maintenance requirements and remote installations
- Lack of existing supply chain for turbines and components

At present Nepal has only a very small installed capacity of Small Wind power, around 25kW, but it may only take a few proven high quality installations to increase confidence and boost the industry to more prominence.

Conclusion

Nepal has a large off-grid population, which requires a mix of off-grid generation technologies in order meet demand. Small Wind Turbines may be a valuable part of this mix, in the right context and in the presence of a positive enabling environment. Further research is required to better define the economic case for SWT's and to map the barriers and opportunities to the technology. A National Market Assessment project is planned for SWTs in Nepal, to this end, in April of 2018.