1. Scope of project and description of deliverables

We are proposing a Multi-Criteria Decision Analysis (MCDA) coupled with Geographic Information Systems (GIS) tools to produce suitability maps for the development of wind farms and solar plants in Afghanistan. MCDA consists of methods to enable decision making when multiple objectives are present. The analysis aims at identifying high quality wind and solar zones according to technical, socio-economic, biophysical and environmental criteria. The study will determine and quantify the suitability of each potential location for the development of the energy sources, and estimate its optimal capacity.

Deliverables include:

- Maps of spatial distribution of the electricity generation potential of renewable resources ranked by resource quality;
- Maps of spatial distribution of the electricity generation potential of renewable resources ranked by capacity factor; and
- Maps of spatial distribution of renewable resources ranked by levelized cost of energy for generation.

2. Analysis methodology

The methodology consists of:

1. Identify all technically viable land for renewable energy development. Conduct a resource (potential) assessment, and establish thresholds. For example, wind speed, direct normal irradiance and global horizontal irradiance to establish minimum resource quality, elevation, slope and exclusion categories such as protected areas and water bodies;
2. Create project opportunity areas, by dividing the resource areas into spatial units of analysis of a size comparable to utility-scale wind and solar power plants;
3. Estimate project opportunity area attributes, by calculating the values of multiple siting criteria;
4. Clustering project opportunity areas into zones based on their resources quality;
5. Capacity value estimates, comparing hourly resource data and national demand data;
6. Assign multi-criteria scores to each zone, based on assigning a score from 0 to 1 to each criteria value.

3. What data will be used and data-gaps

Resource data input, in raster format, include:

- Wind: Wind power density (WPD) (e.g. W/m^2), or wind speed (e.g. m/s);
- Solar Photovoltaic (PV): Global horizontal insolation (GHI) (e.g. W/m^2, $kWh/m^2/day$, or $kWh/m^2/year$);
- Concentrating solar power (CSP): Direct normal insolation (DNI) (e.g. W/m^2, $kWh/m^2/day$, $kWh/m^2/year$, $Wh/m^2/day$).

Resource assessment data are used for binary exclusion criteria after applying a threshold. They include:

- Boundaries - Available
- Elevation - Shuttle Radar Topographic Mission 90 and 30 m resolution
- Slope – Can be created from elevation dataset
- Renewable resource quality
- Water bodies – Available

- Land-use/land-cover
- Protected areas
- Population density – Available. We can extract density from our own databases, or it can be obtained from Oak Ridge National Lab if the latter is more up-to-date
- Wind – In the process, Gunjan to confirm
- Solar DNI – In the process, Gunjan to confirm
- Solar GHI – In the process, Gunjan to confirm
- Natural hazards – I am inclined to introduce the natural hazard risks at this stage. An alternative solution would be to apply the natural hazards criteria threshold a posteriori.

Data for definition of project opportunity area attribute include:

- Temperature – Can be obtained from a set of global climate layers (climate grids) with a spatial resolution of about 1 square kilometer
- Land use/land cover (LULC) - Available
- Rivers – Available. If format or definition not suitable it can be obtained from public databases
- Protected Areas – To be obtained. Public databases available, we need to verify availability of data for Afghanistan
- Roads - Available
- Transmission – Uncertain. We have data which are considered highly inaccurate. We need to assess the weight of an approximation on the location of the transmission lines on the final output.
- Renewable energy locations – We have some information; we need to verify availability and accuracy.
- Load centers - We have some information; we need to verify availability and accuracy.

4. Acceptable margin of error

LBNL documents caution about the accuracy of the calculations: "Results and data derived from mesoscale models […] can be inconsistent with ground-based measurements, as well as data from other mesoscale models […] simply due to differences in the numerical model or simulation. The type of analysis applied in this study is a high-level analysis to broadly identify opportunity areas for wind and solar zone development. Appropriate long term ground-level data measurements are essential before embarking on project development."

The objective of this analysis can therefore be better characterized as a robust identification of the most suitable sites, which should be followed by a physical site reconnaissance, and finally by a detailed feasibility study.

5. Timeline

The approximate duration of the project is estimated to be about 3 to 4 months. However, at this stage it is difficult to provide accurate timelines, mainly because:

1) This is a new project where we will use a new, untested technology on which we only have indirect information;
2) We are planning to introduce modifications to include the likelihood of natural hazards among the criteria for the identification of renewable resources zones;
3) The availability and accuracy of several datasets need to be verified; Some of the datasets may not be publicly available anymore, or may be obsolete;
4) We need better information on the audience we are targeting, the type and format of deliverables.