Objective

The Lawrence Berkeley National Lab (LBNL) and the International Renewable Energy Agency (IRENA) will perform multi-criteria geospatial and economic analyses to identify cost-effective, high potential, and high density renewable energy zones for utility-scale wind, solar photovoltaic (PV), and concentrated solar power (CSP) power plants in the eastern and southern African power pools that would facilitate planning of the Africa Clean Energy Corridor (ACEC). The zoning identification process will incorporate existing and proposed geothermal and hydroelectric power plants.

Goals for the zoning methodology:

1) Leverage existing and planned power systems infrastructure (transmission and road networks), particularly those planned for hydroelectric generation
2) Meet country-level technology-specific targets, if available.
3) Establish zones favorability or prioritization scoring based on agreed upon economic and non-economic criteria.
4) Capacity building for adoption of methodology at country or regional level power system planning processes

Methods summary

The proposed zoning methodology framework is a hybrid model based on previous studies. Please refer to the accompanying flow chart figure. Bolded words in the following summary correspond to boxed process stages in the flow chart.

Approach: Analysis begins with a resource (potential) assessment that applies thresholds or exclusion categories to identify all technically viable land for RE development. Where appropriate, resource quality thresholds (e.g. kWh/m²/day), environmental exclusion areas, and other criteria are adjusted to meet country standards and/or ensure that country-level technology targets are met. In the project identification stage, the technical potential areas are divided into “projects,” the size range of which are meant to be representative of typical utility-scale RE power plants.¹ Note that this terminology is not meant to imply that each project area will necessarily be entirely developed. After estimating the additional transmission expansion necessary to point of interconnection and additional length of road access, each project’s levelized cost of electricity (LCOE) is estimated using capital, operations and maintenance (O&M), transmission, and road costs, in the project valuation stage. In the zone identification stage, projects are aggregated by proximity to meet a size range based tentatively on maximum transmission line capacity, but will be adjusted for smaller countries if warranted by the degree of geographic dispersion of resources. A land use discount factor, based on developer experience as reported in previous zoning studies, will also be applied in the aggregation of zones in order to capture the approximate likelihood or percentage of projects that will likely be developed given a high RE potential area. The choice of terminology—projects and zones—used to describe these high potential areas is tentative, and will largely depend on the eventual size of identified areas.

¹ This study will consider only wind and solar projects at this stage
For zone valuation, the LCOE of each zone will be estimated using the same criteria as those used to calculate project level LCOEs. Options for multi-criteria zone ranking are (i) the monetization or valuation of various siting criteria (e.g. slope, land use and land cover preference, distance to nearest load center); (ii) scoring system wherein criteria values (e.g. percentage of slope, number of people per square kilometer, LCOE, capacity value of wind and solar resource) is assigned a score between 0 and 1 and scores are summed—with equal or unequal weights—across criteria; and (iii) a hybrid of (i) and (ii) where some criteria that can be monetized are added to the LCOE on a $/MWh basis and other criteria are given a non-monetary score. Using the selected ranking system, a zone supply curve is built for each country and across ACEC study area for each of the three RE technologies. Finally, sensitivity analyses for several proposed parameters (scoring system weights, LCOE cost assumptions, and capacity value inputs) are conducted in order to identify the most “robust” zones, examine differences in the rank order of supply curves, and inform potential build-out scenario development. This final stage involves re-estimating project and zone costs (LCOE), re-conducting zone ranking, and re-constructing zone supply curves after adjusting parameters.

Limitations

The approach currently does not consider:

- Potential biomass power plants, potential (large or small) hydroelectric generation, and geothermal generation, although some countries may have significant potential for these RE energy sources. Planned geothermal and large hydro will be considered as an input (in the zone ranking and supply curve stages) of this study.
- Transmission upgrades beyond point of connection to main grid. Individual transmission upgrades will need to be estimated through power flow analysis (beyond scope of study).
- Water availability for CSP (assuming wet cooling) due to lack of accurate GIS data on water availability in study region.
- Land restrictions due to land ownership or high political or social conflict areas due to lack of GIS data. Individual utilities or developers will need to assess each zone based on ground-level knowledge.
- Capacity value of wind and solar (to be determined based on data availability).

Definitions and acronyms

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<th>ACCEC</th>
<th>Africa Clean Energy Corridor</th>
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<td>Capacity value</td>
<td>The contribution that a given generator makes to overall system adequacy, as determined by profile of system load. It can be defined as the amount of additional load that can be served due to the addition of the generator, while maintaining the existing levels of reliability.²</td>
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<tr>
<td>CSP</td>
<td>Concentrating solar power (solar thermal electricity)</td>
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<td>Land use discount factor</td>
<td>Percentage of total potential land (or energy projects) likely developed given topological constraints at resolutions greater than that used in the analysis, and other socio-economic or cultural considerations.</td>
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<tr>
<td>Geospatial information</td>
<td>Information with indication of physical location in the form of a vector or raster (grid) with spatial reference, or geographic coordinates of location or extent.</td>
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Power density land use factor
Installable capacity of power generation per unit of land [MW/km²]

Levelized Cost of Electricity (LCOE)
A calculation of the cost of generating electricity at the point of connection to a load or electricity grid. It includes the initial capital, discount rate, as well as the costs of continuous operation, fuel, and maintenance.

Utility-scale
Grid connected generation, typically >200 MW

RE Zone
Contiguous or semi-contiguous area of high renewable energy potential with enough generation capacity to warrant the construction of high voltage interconnection line.

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