AIM International Workshop – Tsukuba, Japan, December 13-14 2013

Global potential of solar and wind energy considering proximity to urban areas based on GIS tools

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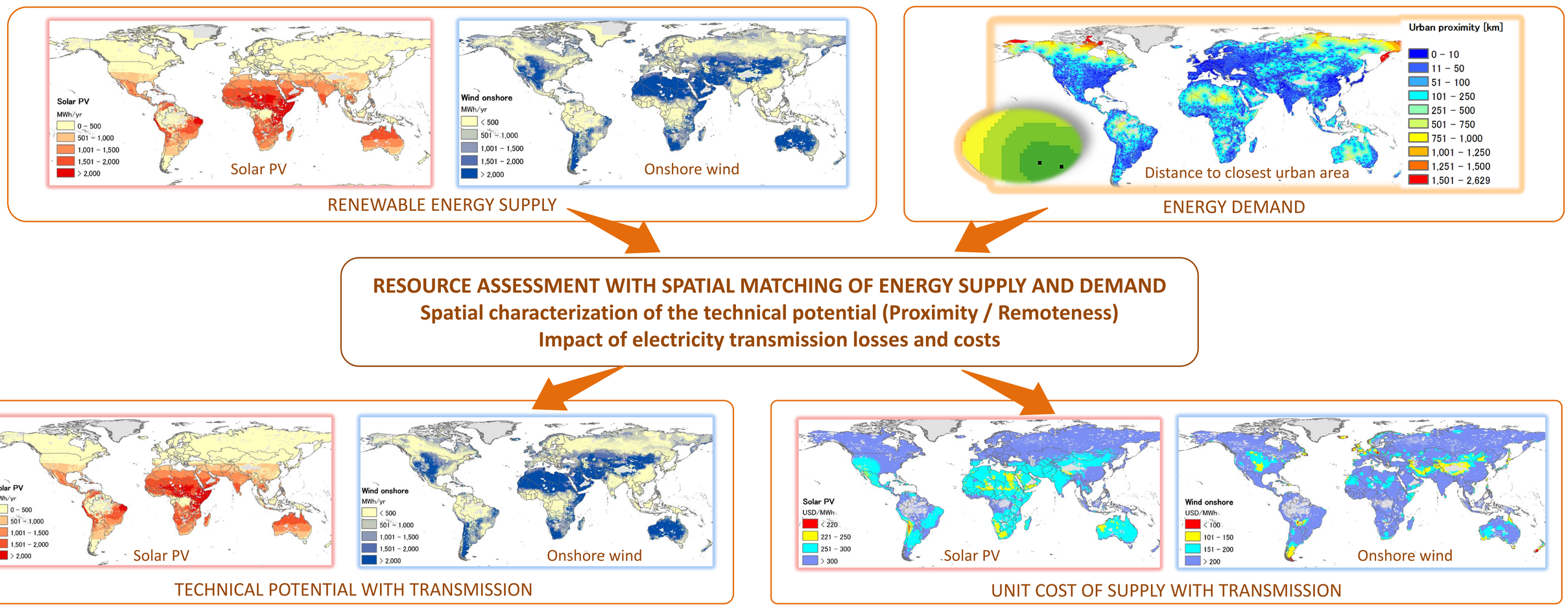
Introducing urban proximity in the assessment of renewable resources

- Matching the spatial variability of resources with the location of energy demand centers is a challenge for introducing large amounts of solar and wind energy in low carbon energy systems.
- This research introduces proximity to urban areas as a new factor in the estimation of the resource availability of solar PV and onshore wind power at global scale.
- Distance along closest path is estimated on a cell by cell basis with a spatial resolution of 0.5 arc-degrees (approximately 1km^2 at the equator).
- Distance from potential energy supply sites to closest urban areas is determined to characterize the proximity or remoteness of renewable energy potential.
- Output losses and additional costs related to electricity transmission are calculated and included in the elaboration of cost curves to evaluate the economic potential of renewable resources.



Impact of urban proximity on renewable energy potential

- Over half of the technical potential is located in remote areas (100km away).
- Most of cheapest solar PV potential (70% of potential below 250 USD/MWh) are located in remote areas. For wind energy, most of cheapest resources (70% of potential below 150 USD/MWh) are in non-remote areas.

- Transmission losses are less than 2% the technical potential for both solar PV and onshore wind energy.
- Transmission costs compared to total costs are over 7% for solar PV, and 6% for onshore wind energy.
- Accounting for transmission costs reduces the economic potential by 65% for solar PV resources below 250 USD/MWh, and by 20% for wind resources below 150 USD/MWh.

- Low cost solar and wind resources in the proximity of urban areas are enough to cover 10% of current electricity demand.
- Higher shares of solar PV and onshore wind in global electricity demand require remote resources.

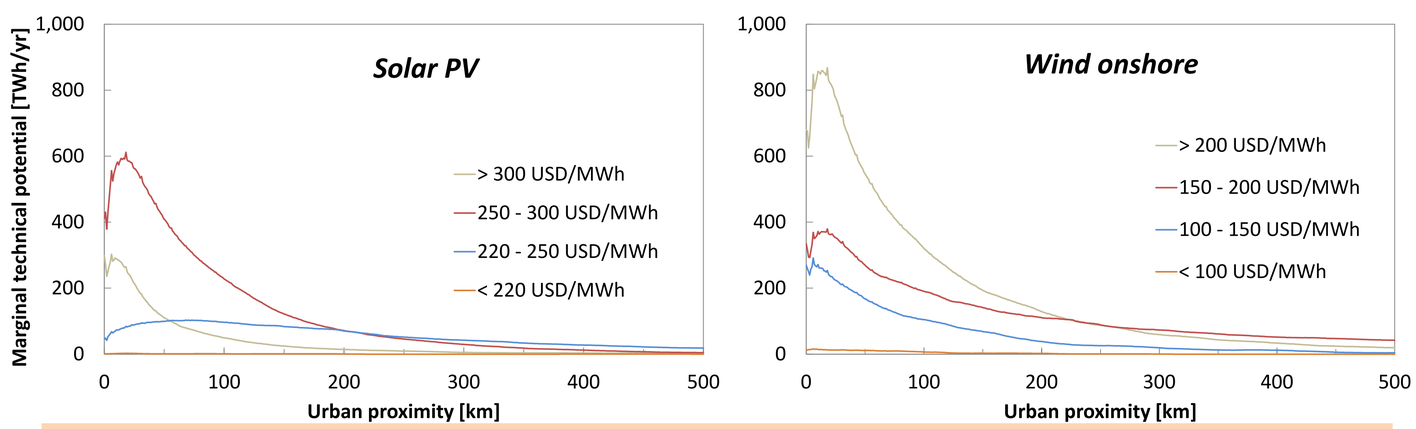


Figure 1 Distribution of marginal potential (w.o.Transmission case) with respect to urban proximity.

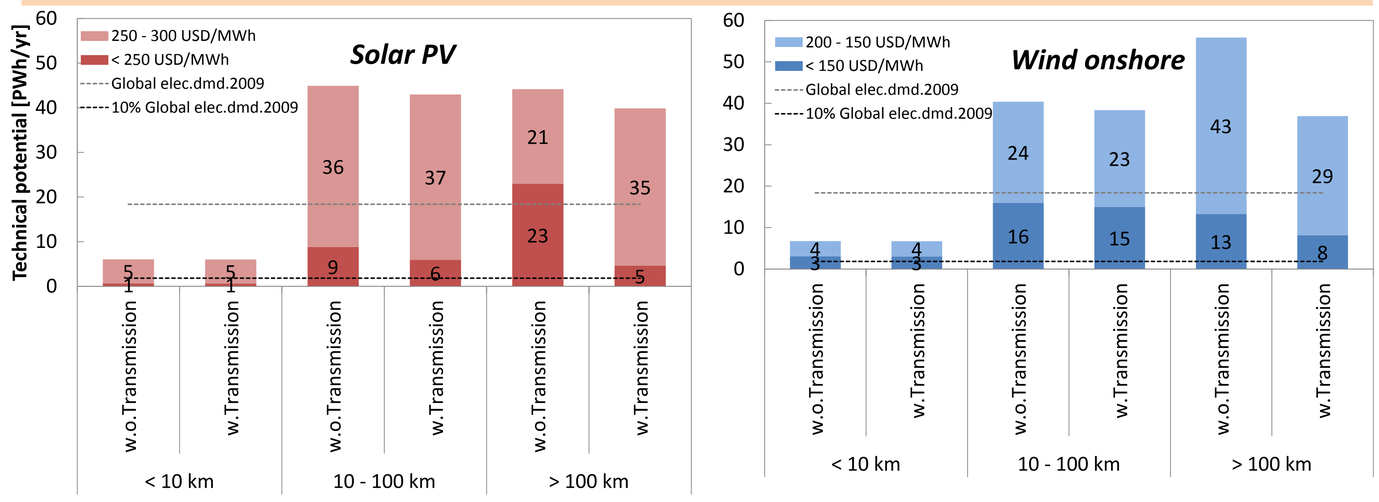


Figure 2 Effect of transmission costs on economic potential for different urban proximity ranges.

Summary and next steps

- The study introduced explicit measurement of effect of urban proximity on technical potential.
- High shares of solar and wind power in electricity supply may require large amount of remote resources, and will have significant impact on economic potential due to transmission costs.
- Proximity is inaccurate given that it is based on latitude-longitude distance rather than actual shortest path.
- Large range of costs for transmission and renewable technologies complicate the assessment of economic potential.
- Several aspects of spatial matching can be evaluated with this methodology, such as the impact of transmission costs on penetration of renewables, and constraining RE supply across country borders, among others. Spatial distribution of energy demand will be characterized in future studies.

References

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Acknowledgement *This study is supported the Ministry of Environment of Japan through the S-6 project ("Research project to Establish a Methodology to Evaluate Mid to Long Term Environmental Policy Options toward Asian Low-Carbon Societies") and by JICA and JST through the SATREPS project ("Development of Low Carbon Scenarios for Asian Regions").*