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The Rethinking the concept of electrification least-cost pathways to increase uptake of Renewable Energies: A case study of Ghana using GIS

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Abstract :

Concerns with increasing global warming has opened-up various discussions and gained mainstream attention on how to mitigate the impact of climate change. About 73% of global Greenhouse gas (GHG) emissions are caused by humans through energy consumption, making the power sector the major contributor of GHG emissions worldwide.

With increasing calls to scale-up the uptake of renewable energies (RE), it is important to reconsider certain factors that inform technology allocation in the supply of electricity. Most often than not, the type of technology is based on where the investor can have the best least-cost option. A review of literature reveals a trend where criteria for a least-cost solution is usually based on the population density of the area, demand pattern, proximity to power infrastructure like roads, substations, etc. and more prominently proximity to the grid, etc., with little or without particular attention to the spatial characteristics of RE energy that is bound by spatial location and spatial extent. Based on this technology allocation criteria, places are assigned either a grid-connected or an off-grid solution. The allocation should however be based on a more sustainable technology rather than a short-term approach.

In as much as these allocation criteria are significant, they are not comprehensive if a country's strategic electrification plan is to increase the uptake of RE in their generation mix. A more localised and disaggregated approach is needed to harness and provide investment especially into power infrastructure to areas that may not fulfil all the conditions for a least-cost solution but have very high RE potential that can be deployed and fed into the national utility grid.

With about 87% of the Ghanaian population without electricity living in rural areas, the present study analysed the general wind energy potential within one of the off-grid districts in Ghana with the highest wind energy generation capacity, e.g., the Kwahu East district to ascertain which technology is most suited for people living in this area considering current geospatial electrification planning methodologies or models and based on selected criteria. This study applied a geospatial approach to analyse and visualise the result of two weighted scenarios that considered either the grid infrastructure and pop density or the RE potential as the main deciding factors.

Outcome of the study showed that, locations that met at least two of the deciding criteria which are proximity to the grid and high population density were assigned a grid-connected system and vice versa for off-grid solution. From the assessment, majority of the people living in the Kwahu East district are assigned off-grid solution even though wind energy generation capacity exceeds 2,000 GWhy-1 per km² which is more suited for a grid-connected system. This obviously highlights the fact that, many places with high RE potentials will remain untapped if current electrification investment and planning policies should continue with current trend. This will result in developing countries like Ghana being unable to meet its energy system decarbonisation target by 2030 as projected.

Biography:

Mary Asare-Addo is an Energy Geographer and a Geographic Information Systems (GIS) specialist. She started her PhD in 2018 with the University of Flensburg, Germany where her research focuses on geospatial mapping of wind and solar energy resources in Ghana as well as developing energy access models for rural and off-grid electrification planning using sustainable energies to increase the uptake of RE in developing countries like Ghana.

Note: - This work is partly presented at Webinar on Renewable Energy and Resources on April 30, 2021.