

A geospatial clustering algorithm and its integration into a techno-economic rural electrification planning model

A. González García; F.J. Domínguez Bravo; J. Amador Guerra; L. Arribas de Paz; M. Torres Pérez; P. Ciller Cutillas

Abstract-

Rural electrification planning is a complex process requiring careful consideration of various factors to ensure efficient and cost-effective solutions. Existing clustering methods in academic literature often fall short in this context, as they typically do not account for geographical barriers, restricted areas, and key electrical and geospatial metrics simultaneously. This can result in clusters that do not meet the energy needs of the study region, potentially causing inefficient energy distribution and increased costs. This study presents a novel clustering algorithm, RElect_MGEC (Rural Electrification Microgrid and Grid Extension Clustering), specifically designed for techno-economic planning in rural areas. The RElect_MGEC algorithm combines density-based and graph clustering methods to group households while considering constraints imposed by geographic barriers, electricity power, and distance from the generation center. The algorithm was implemented within the IntiGIS (Geographic Information System for Rural Electrification) model and evaluated using a real-world dataset of 10,995 unelectrified households in rural Yoro, Honduras. The evaluation involved comparisons with established clustering algorithms, focusing on metrics such as the number of valid clusters, Levelized Cost of Electricity (LCOE), and execution time. The results demonstrate the algorithm's effectiveness in scenarios with equal and varying demands, highlighting its robustness, flexibility, and ability to achieve cost savings within shorter timeframes. Additionally, this approach enables the assessment of distribution infrastructures, such as microgrids and grid extensions, ensuring an effective power generation and distribution. The integration of the RElect_MGEC algorithm into IntiGIS results in an enhanced model that enables a comprehensive and informed decision-making process for rural electrification planning.

Index Terms- Constrained clustering; Density-based clustering; Graph-based clustering; Rural electrification; Geospatial analysis; Techno-economic software tool

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