

Optimizing off-grid generation in large-scale electrification-planning problems: a direct-search approach

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Abstract-

Off-grid systems play a prominent role in rural electrification planning. The problem of optimizing the generation design of a single off-grid system has received a significant amount of attention in the literature, and several software tools and algorithms have addressed it. However, methods and tools designed for individual mini-grids are not directly applicable to regional planning, where it is necessary to estimate the generation cost of potentially thousands of mini-grids. Conversely, most regional planning tools estimate the generation cost of mini-grids with rules of thumb or analytical expressions. These estimations are useful, but they lack the accuracy necessary to develop a rural electrification plan. This paper presents a method to estimate the generation cost of any potential off-grid system in a large-scale rural electrification planning problem, which is currently implemented in the Reference Electrification Model (REM). The method uses a master-slave decomposition that exploits the structure of the problem and combines continuous and discrete variables. The algorithm is illustrated with a case study that shows that a direct application of a discrete model may lead to suboptimal results in large-scale planning.

Index Terms- energy access; rural electrification planning; geospatial planning; off-grid electrification; mini-grid generation; generation sizing; computer model; planning software; heuristic optimization

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