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Optimal electrification planning incorporating on- and off-grid technologies: the Reference Electrification Model (REM)

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Abstract-

In many parts of the world, access to basic electricity services remains a significant challenge. The status quo mode of electrification is central grid extension; however, in many areas, off-grid (OG) technologies like minigrids (MGs) and standalone (SA) systems are more suitable for promoting electricity access under cost constraints. Unfortunately, these opportunities are often overlooked due to the complexities of electrification planning, especially for large areas. Researchers have designed technoeconomic planning tools that can be scaled to cut through aspects of this complexity and be fit to address different places and contexts. This paper describes a computer-based optimization model--named the reference electrification model (REM)--which performs automatic electrification planning and is able to identify lowest cost system designs to most effectively provide desired levels of electricity access to populations of any given size. In doing so, REM determines the most suitable modes of electrification for each individual consumer by specifying whether customers should be electrified via grid extension, OG MGs, or SA systems. For each system, REM supplies detailed technical designs at the individual customer level. We have used this model in real planning activities in sub-Saharan Africa and South Asia. The description of REM's capabilities is supported by case examples. REM stands apart from other electrification planning models because of its high granularity and its capability to provide concrete plans for a wide range of geographical scales. Because of these benefits, REM has the potential to help rationalize electrification planning and expedite progress toward universal electricity access worldwide.

Index Terms- Electricity access; electrification planning; geospatial planning model; off-grid (OG) electrification; optimization planning

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