Abstract

Globally, about a billion people live without electricity. Billions more endure intermittent service at the grid-edge, and hundreds of millions without grid-access solely use a solar lantern. Most of the access-deprived are in the Global South, predominantly in Sub-Saharan Africa and South Asia, and may benefit from the expanding distributed generation. Recognizing the criticality of universal access to electricity in inclusive human development, the United Nations adopted 'affordable and clean energy' as one of the Sustainable Development Goals. To treasure electricityaccess, measuring the same is essential. Electricity-access measurement has evolved from binary to multi-tier, multi-parameter framework. This evolution has facilitated consumer-focused energy-strategy scripting. This study entails electricity availability, consumer aspiration, and overall consumption in an impoverished valley at the gridedge. Results outline demand-response-aided innovative access tier scaling opportunities and underscore the importance of a consumer-focused approach to improve resource utilization. Moreover, supply-reliability transforms from abrupt, complete disruption to gradual, cognisant decay. Worldwide, in off-grid regions, solar photovoltaic-powered mini-grids are increasingly bringing electricity. However, poor load-factor and expensive storage adversely affect viability. Indeed, the presence of sustained productive loads favourably influences the mini-grid economy. This work investigates the role of critical household loads in 88 nation-states to deliver a similar bearing on the mini-grid economy. Results underscore that demand response in a minigrid can improve affordability for all consumers and bring 186 million access-deprived people within affordable access. In remote humanitarian camps, the United Nations High Commissioner for Refugees-managed camp-administrations supply water to camp-residents using polluting diesel generators. Moreover, inadequate cooking energy forces refugees to use unsustainable firewood or skip meals. But, a mini-grid can provide illumination, pump water, power electric-cooking, and support additional camp-essentials. However, the needed high-tier mini-grid remains investment-intensive and impedes the United Nations' plan to run camp operations with solar photovoltaic generation. Power purchase agreements shift the upfront investment to an energy service company; but, energy remains unduly expensive with supply-focused agreement-crafting and simplistic resilience-assessment. This work explores incorporating demand-flexibility & tiered-resilience in power purchase agreements to reduce energy costs. Results show solar photovoltaic can economically power humanitarian settlements and substantially lower the United Nations' energy charges.