

# **Photovoltaic Microgrid Business Models for Energy Delivery Services in Camps for Displaced People**

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## **1 TARGET AUDIENCE**

This research is relevant to the United Nations High Commissioner for Refugees (UNHCR) and other organisations or researchers looking at the provision of affordable and appropriate electricity services in off-grid settings.

## **2 BACKGROUND**

Currently, millions of displaced people, both internally and internationally, live in camps that lack access to electricity services. In the rural context, clean and sustainable energy is successfully being delivered following market mechanisms with the private sector. Renewable energy provision is feasible, thanks in part to the tremendous price reductions seen in wind and solar technologies. The feasibility of private sector provision of energy services in the camp settings, to alleviate these energy challenges in humanitarian response situations, is explored.

## **3 PURPOSE**

To demonstrate photovoltaic (PV) microgrids can provide affordable and appropriate energy to displaced communities.

## **4 METHOD**

This paper presents three case studies of energy delivery PV microgrid models for the provision of electricity for the following demand scenarios: households, institutions, and a combination of the two. For each case study, a technical design was devised and validated with Hybrid Optimization of Multiple Electrical Renewables (HOMER) software. Then, a financial structure for the business model was devised and a risk assessment using Monte Carlo simulations was performed.

## **5 RESULTS**

The proposed PV microgrid business model could provide reliable basic household services for lighting and mobile phone charging with a reasonable return on investment (with an internal rate of return (IRR) of up to 26%) for only US\$ 1.50 per household per month. At the institutional level, a PV microgrid business model servicing the camp operators to power institutional facilities for US\$ 1 per kWh (with an IRR up to 9%) could be by way of a contract with a humanitarian agency. Some potential advantages of this model are that it: mitigates long-term financing responsibility, reduces risk for the private energy companies, and outsources expert management of energy assets, whilst reducing costs and environmental impacts. Importantly, when supplying electricity to the institutional loads in a camp such as: the health clinic, camp administration, and communal area lighting. The microgrid system can be cost-effectively leveraged to supply household electricity for up to 500 households (in our modelling 50% of a camp sector population). Finally, for a PV microgrid build-own-operate (BOO) business model providing services at the household level, the major investment risks identified are: lack of affordability, customer trust and uncertainty of market permanence. For a business model at the institutional level, the risks identified are: national diesel subsidies and lack of access to finance. Nevertheless, the findings of this paper demonstrate a clear opportunity for PV microgrids to improve energy access for internally or internationally displaced people, offering essential electricity services that are comparatively cheap compared to the status quo.

## **6 IMPLICATIONS FOR TARGET AUDIENCES**

The humanitarian system, including camp operators and other sector specialists, are increasingly recognising, and working for, the uptake of sustainable energy. Short-term funding cycles within humanitarian organisations limit their ability to invest in more durable large-scale assets for the provision of sustainable electricity services. Demonstration of innovative PV microgrid business models to power camps can help change the existing paradigm for energy provision in the humanitarian context, potentially allowing for efficient outsourcing of the problem. The method used in this research can guide the process of standardisation and modelling of PV microgrids in other similar contexts, the costs and risk analyses of innovative financing structures for energy delivery business models, and aid in developing contractual terms and coping mechanisms so any identified risks are mitigated.