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Off-grid solar PV power for humanitarian action: from emergency communications to refugee camp micro-grids

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Abstract

The need for new innovative technologies to support humanitarian action is evident today. Efficient and economic technologies properly deployed and integrated should mitigate some of the potential negative social effects of poor refugee camp infrastructure engineering. The body of the paper identifies off-grid solar Photovoltaic (PV) and solar PV hybrid packaged systems that are applicable to emergency relief activities, refugee camp activities and micro-grid development. The paper's concentration on off-grid power, the description of these engineered systems by humanitarian activity and the identification of the different engineered packaged solutions is aimed at stimulating a discussion to help scale more appropriate technologies for humanitarian action. The paper concludes with a discussion of present and future private sector business strategies to support scalability of this new and growing market.

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1. Introduction

The need for new innovative humanitarian technologies to support emergency relief, refugee camp establishment and development assistance is evident today [1,2]. Efficient and economic technologies properly deployed and integrated should mitigate some of the potential negative social effects of inadequate infrastructure engineering [3,4]. In the past, humanitarian energy analysis has focused heavily on fuel wood and cook stove techniques and

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impacts [5,6,7], therefore the authors believe that specific concentration on the off-grid electric power requirements of humanitarian action would add content to the overall development aid discussion. The paper begins with a functional outline of off-grid power applications related to the field of humanitarian action. Following this outline, a review of the off-grid PV power requirements covered in the refugee camp handbooks of the UNHCR Handbook for Emergencies and The Sphere Project will be discussed. The body of the paper then identifies the engineered systems that fit the functions and phases of humanitarian action. We begin with emergency relief ICT power needs and then discuss relief camp shelter, security and health needs. Finally we discuss technologies to support refugee settlements including hybrid solar PV/fuel-driven generator micro-grids for total camp power.

Nomenclature

BoP	Base of the Pyramid
GTIB	Grid Tied Inverter and Battery Controller
ICT	Information & Communication Technologies
kW	Kilowatts
kWh	Kilowatt hours
PV	Photovoltaic
UNHCR	United Nations High Commissioner for Refugees
REA	Rural Electrification Authority

2. Humanitarian action activities and off-grid solar engineered systems matrix

For the humanitarian action phases of emergency relief and refugee camp establishment, and where solar energy is plentiful, packaged off-grid solar PV power systems are key elements in meeting the expedited power needs of the many different field activities encountered by humanitarian workers. For these various field activities, selection of the appropriate engineered packaged system to support the functional needs are important for proper integration of the delivered solution. In order to show the interrelationships of the off-grid solar PV solutions to the power needs of humanitarian field activities we have developed the matrix shown in the Table 1. The various humanitarian field activities include;

- Emergency Relief Communications – the activities (radios, computers, device charging, telecommunications, etc.) are those identified as part of the ICT Humanitarian Emergency Platform [8] Emergency Telecommunications Cluster common operational areas
- Domestic Lighting – this includes camp shelter lighting and task lighting
- Camp Security – security facilities electrical needs
- Medical Facilities – triage and longer term care for refugees
- Information and Communications Technology – camp management and support agency ICT power needs
- Street Lighting – camp lighting for security
- Housing – refugee shelter and camp/relief agency management housing power needs
- Shops – merchandise shops lighting in camp and in the local community
- Schools – refugee temporary and longer term education facility power needs
- Water Pumping – power for refugee camp water power needs
- Telecommunications – camp local and international communication system power needs
- Electric Vehicles – local camp off-road transport vehicles
- Total Camp/Town – camp or local community micro-grid connected power

The different categories of engineered packaged off-grid solar PV systems (excluding unpackaged Component Modular Systems), which will be described in detail in Section 4, include;