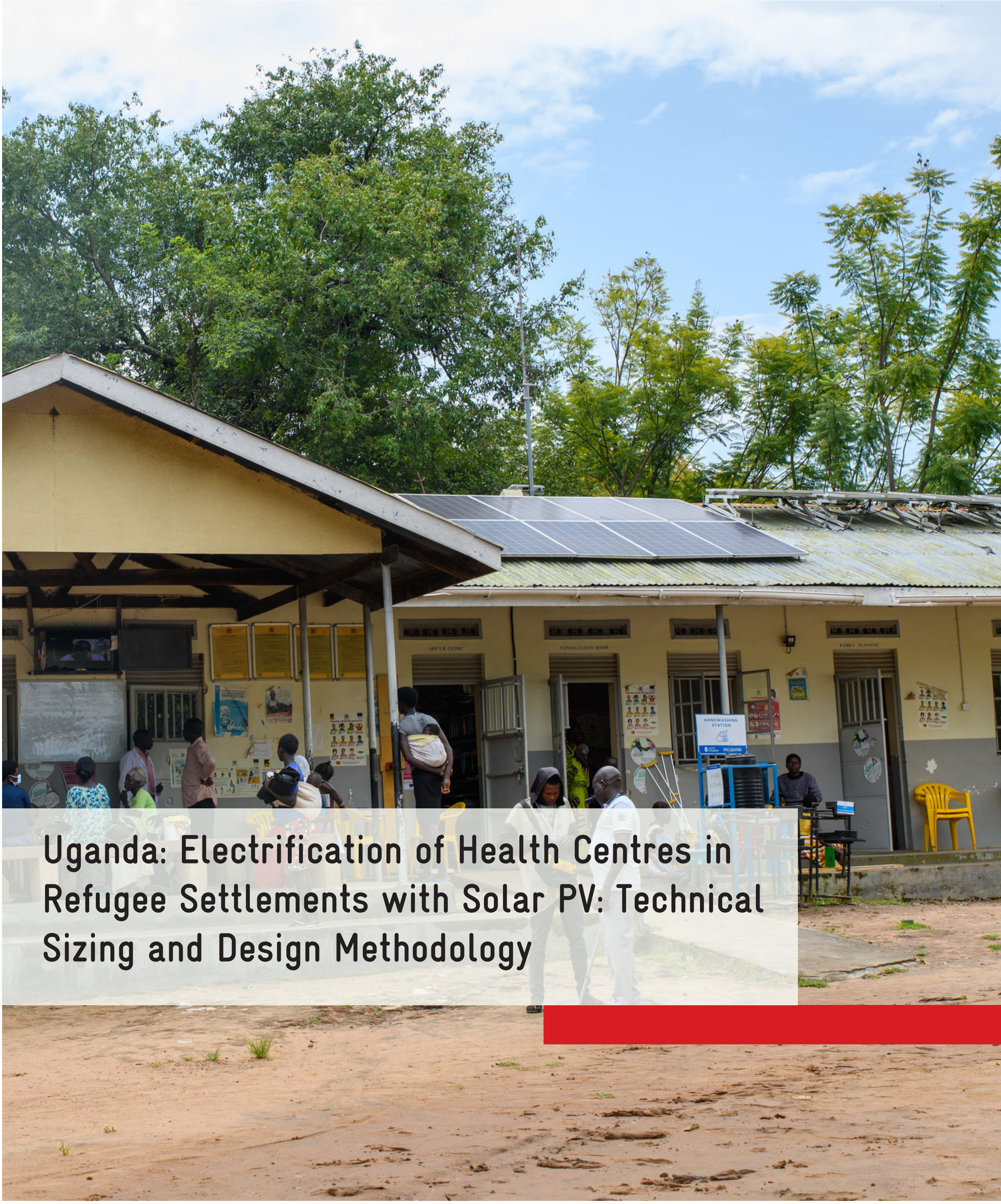

Uganda: Electrification of Health Centres in Refugee Settlements with Solar PV: Technical Sizing and Design Methodology

An Approach to the Design of Sustainable Off-Grid Solar Systems in Rural Health Centres

Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

Energy Solutions for Displacement Settings (ESDS) is a component of the Global Programme "Support to UNHCR in the implementation of the Global Compact on Refugees in the Humanitarian-Development-Peace Nexus" (SUN), which is commissioned by German Ministry for Economic Cooperation and Development (BMZ) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. ESDS supports the Ministry of Energy and Mineral Development, the United Nations High Commissioner for Refugees (UNHCR) and the Office of the Prime Minister (OPM) in addressing the lack of a sustainable energy supply in refugee hosting areas through global advisory services and the implementation of technical measures in displacement settings in Uganda, Kenya and Ethiopia.

Funded by:

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Energising Development (EnDev) is a global multi-donor partnership that facilitates access to modern energy in about twenty countries worldwide. EnDev aims to reach more than 36 million people with access to needs-based, climate-friendly energy supply by 2025. The project is currently funded by four core donors (Germany, the Netherlands, Norway and Switzerland). A number of other government and charitable donors provide additional funding.

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Access to and use of energy is essential in humanitarian response, and for longer term sustainable development. The lack of sufficient quality energy products and services, therefore, grossly limits peoples' opportunities to meet basic needs and strive for self reliance. Shortfalls put people at risk, for instance, in the areas of basic health care, education, and jobs and livelihoods including income generation activities.

While several Health Centres (HCs) in the refugee hosting districts of Uganda have been equipped with solar Photovoltaic (PV) systems with funding from Non-Governmental Organisations (NGOs), UN agencies, and the Government, a number of these systems often fail soon after commissioning. This failure can be attributed to several reasons, including poor sizing, poor quality of equipment, as well as a lack of Operations and Maintenance (O&M).

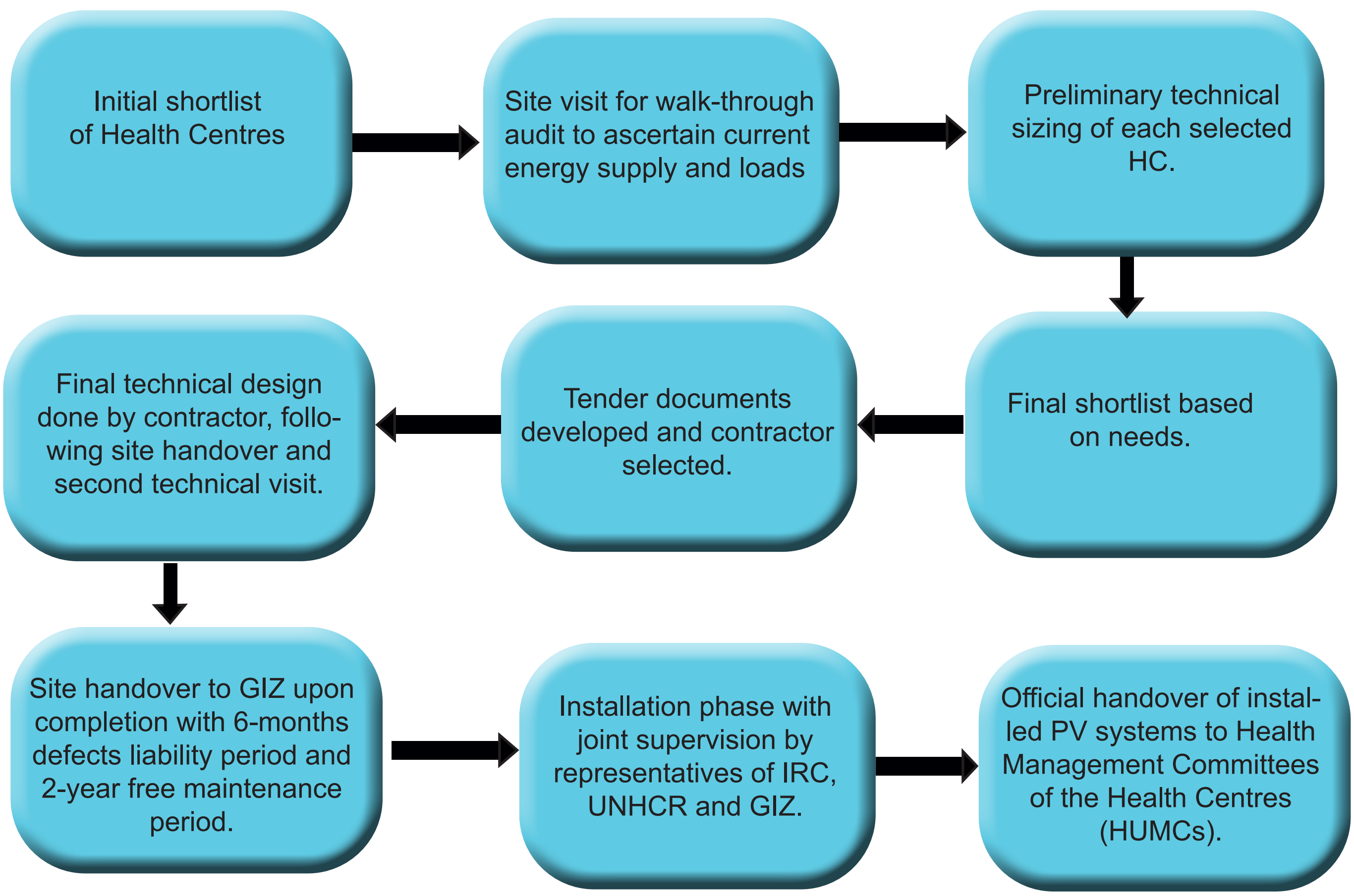
Given this background, the GIZ projects Energy Solutions for Displacement Settings (ESDS) and Energising Development (EnDev) sought to address some of the above challenges by providing and installing well designed solar PV systems for six purposely selected HCs located within Rhino Camp and Imvepi Refugee Settlements in Terego and Madi Okollo districts in 2021.

This document outlines the strategy and sizing process utilized by GIZ engineers prior to initiating the procurement process for the solar PV systems.

The electrification development process:

In the course of project development and the tendering process for the installed PV systems, GIZ adopted the subsequent approach:

Figure 1



* GIZ continues to support HUMC by operationalising income generating activities onsite to finance operation and maintnance beyond the 2-year period.

Project Information:

Project Names:	Energy Solutions for Displacement Settings (ESDS) - Uganda, Energising Development (EnDev) Uganda
Commissioned by:	German Ministry for Economic Cooperation and Development (BMZ), The EnDev Consultative Group
Partners:	Ugandan Ministry of Energy and Mineral Development (MEMD), United Nations High Commissioner for Refugees (UNHCR) and Office of the Prime Minister (OPM)
Duration:	August 2019 - December 2024

Map of Uganda showing location of the health centres: Imvepi (Terego district) and Rhino Camp (Madi Okollo district).

This initial assessment revealed that all the facilities had one, or several but separate solar PV systems spread across the various buildings. Yinga and Ofua HCs had gensets that were used at certain hours of the day, while Olujobo had a system that was meeting most of the energy needs in the Out-Patient Department, laboratory and maternity ward. A new In-Patient Department and maternity wing was under renovation, with a new solar system planned by UNHCR. The next step in the process was the design of a suitably sized solar system at the selected facilities. The design was based on an analysis of all the current and future anticipated loads at the facility.

The analysis included walk-throughs and interviews to record all possible electrical appliances and their usage. A walkthrough energy audit was carried out for all the permanent buildings at the respective health centres to record all possible electrical appliances. It was clear that most of the HCs were offering services beyond their administrative level. For example, HCIIs offering admission services, or HCIIIs performing minor surgery. As a result, the energy needs of these HCs were higher than typical HCs operating at the same level.

Detailed assessment, technical design, and installation process:

A technical assessment was carried out at seven HCs within Rhino Camp and Imvepi Refugee Settlements. The objectives were:

- to establish current and future electrical appliances that require electricity.
- to inspect the electrical wiring of the entire facility.
- to assess the existing solar systems' suitability for their intended purpose thorough inspection.

Site	Assesment			
	Outpatient Dept	In Patient Dept	Maternity	Staff Qtrs
Imvepi HC II	Solar	None	Solar	Pico PV
Ocea HC II	None	None	Solar	None
Siripi HC III	Planned	None	None	None
Ofua HC III	Genset	Genset/ MOPO	MOPO / Solar	Genset
Oduobo HC II	None	Solar	Solar	Solar
Yinga HC III	Solar Genset	Solar	Solar	Solar
Olujobo HC II	Solar	Solar	Solar	Solar

Key: Red=dysfunctional, yellow=moderate, green=functional

Table showing a sample of appliances used for sizing:

Building	Appliance	On site	Units	Load (w)	Total instantaneous Load (w)	Hours Day	Hours Night	Demand Day	Demand Night
Maternity	Suctionmachine	No	1	30	30	1	0	30	0
Maternity	Phone charging	Yes	5	5	25	2	2	50	50
Laboratory	Light bulb	Yes	3	5	15	6	0	90	0
Laboratory	Fridge	Yes	1	240	240	6	6	1440	1440
ART Clinic	TV set	Yes	1	60	60	6	4	360	240
Waiting Room	Security lights	No	2	10	20	0	12	0	240
Staff Quarter	Light bulb	No	25	5	62.5	2	4	250	500
Kiosk	Fridge	Yes	1	120	120	6	2	720	240

The table above shows a snapshot of the sample appliances used for sizing, indicating even appliances that did not exist at the time of the audit. The rest of the sizing was completed using a custom Microsoft Excel tool, to calculate the expected PV and battery capacity.

Some key assumptions were that:

- the area receives 5 sun hours daily.
- the batteries had to deliver 1.5 days of autonomy.

The sizing was done to enable the entire HC, to operate in form of a micro grid. This avoids the scenario where disparate systems are installed on several buildings, often from different providers. Our assessment and interviews revealed that the facility in-charges often do not know to whom to escalate maintenance issues, as often, they do not keep track of which partner/company installed which system. These systems are also prone to overloading beyond their installed capacity, as the medical officers keep moving various appliances to whichever building has a working power system.

Suitable underground cabling was designed to interconnect all buildings, except at two health centres where the distance to the staff quarters was deemed too long and therefore more costly than installing a standalone system. The electrical wiring in each building was also rehabilitated.

For the facilities where the staff quarters were integrated, load limiters were installed to limit the current drawn by the staff, which had, prior, negatively impacted delivery of health services.

Therefore, resident staff could only operate basic appliances like lights, phone charging and radio/TV. This was aimed at not only preventing misuse, but also ensuring that the HC always has priority on the energy being generated.

Energy generation and consumption post-installation:

A total of 24 KWp solar and 178 KWh battery storage was installed across the six health centres. The table below shows recent data collected from the Remote Monitoring System (RMS).

Health Center	Solar Capacity (KW)	Estimated Annual Energy Generation Capacity (KWh)	2021 Energy Consumption (KWh)	2022 Energy consumption (KWh)
Imvepi HC II	3.3	6000	1358	1752
Yinga HC III	2.7	5000	593	158
Siripi HC III	3.3	6000	590	1130
Ofua HC III	6.6	12000	2011	4718
Ocea HC II	4.4	8000	2052	1080
Odoubu HC II	3.3	6000	1108	2112

The estimated total annual energy generation capacity across the six health centres was 43 MWh, although the average annual consumption was only 7.6 mwh in 2021, and this increased to 10.95 KWh in 2022. Ofua and Oduobo HCs saw the biggest increase in consumption, as more electrical equipment was used. In Yinga, the RMS showed a marked decrease in consumption, but this was later attributed to network interruptions that affected consumption. There was also reduced consumption at Ocea.

Interviews from an intermediate outcome assessment indicated a reduction in the number of patients at this HC, for various reasons including voluntary repatriation. Overall, all the PV systems are still being used below the design capacity, and there is room for additional electrical equipment.

At the time of sizing, the facility in-charges had given assurance that some of this equipment (e.g laboratory and maternity ward equipment) would be procured within two years. At Yinga and Ofua, blood transfusion fridges have been tested and the power supply confirmed stable enough for them as per WHO guidelines. Similarly, the laboratory at Oduobo was operationalised following the electrification. A fridge and microscope were also procured.

Conclusion and next steps:

The above process demonstrates an approach that can be used by development partners to adequately size solar PV systems for HCs in rural areas, including refugee hosting areas.

However, some lessons can still be learnt. While it seems prudent that systems should be sized with future energy needs in mind, HCs in humanitarian settings operate under a fluid budget. Consequently, not all aspirational electrical appliances will always be acquired, and often, the power may at times seem more than required. Additionally, providing accurate technical information to health-focused development partners can motivate those that were desirous of funding additional appliances but had reservations regarding the energy capacity.

GIZ has engaged UNHCR and International Rescue Committee (IRC) on this subject, to provide assurance and demonstrate what appliances the designed capacity was based on. It is also often better to plan for the electrification of the whole health facility, as opposed to several partners installing small energy systems to serve the needs of specific buildings or services, like has been the case. A facility-wide energy system provides a buffer that enables use of higher capacity electrical appliances.

Different appliances operate at different times of the day throughout the HC. Therefore, one shared system enables scaling of the energy needs economically. Furthermore, managing operations and maintenance (O&M) for several smaller systems is more challenging since the providers are different and tracking maintenance schedules is also difficult for the health facility managers.

GIZ continues to work with the HUMCs to design and operationalize operation and maintnance strategies that will further ensure the long-term operation of the installed solar PV systems. This includes the health centre canteens that are designed to utilize some of the excess energy from the PV systems installed.

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