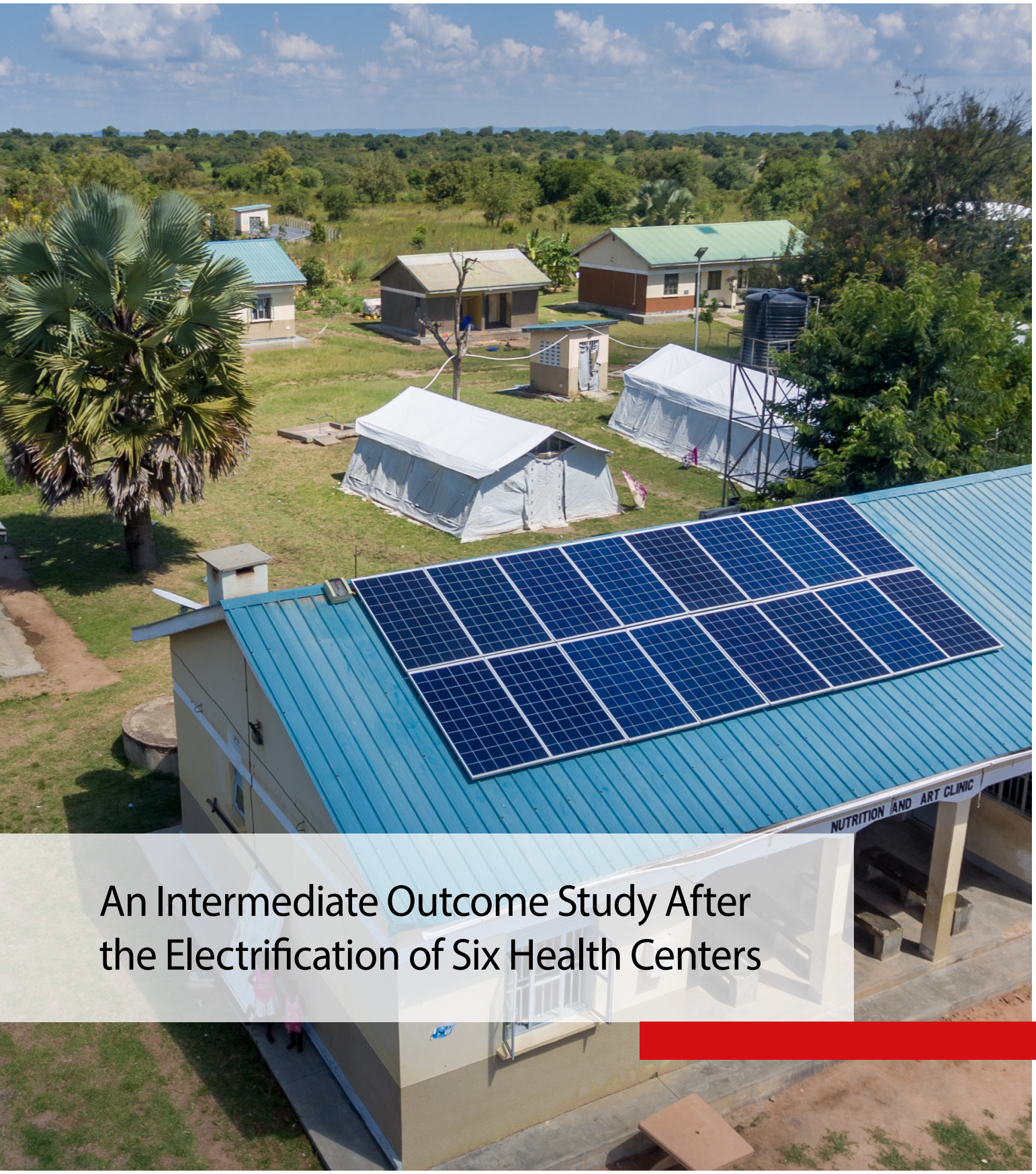

An Intermediate Outcome Study After the Electrification of Six Health Centers

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 Office of 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.

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Energising Development (EnDev) is a global multi-donor partnership coordinated and implemented by GIZ and RVO that facilitates access to modern energy services currently in more than 20 countries worldwide. EnDev is funded by the The German Federal Ministry for Economic Cooperation and Development (BMZ), the Directorate-General for International Cooperation (DGIS) at the Ministry of Foreign Affairs of the Netherlands (DGIS), the Norwegian Agency for Development Cooperation (NORAD), and the Swiss Agency for Development and Cooperation (SDC).

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The Koda Synergies team would like to thank all those who contributed to the successful accomplishment of this outcome study in electrification of six health centers in Imvepi and Rhino Camp Refugee Settlements in Uganda.

Our sincere thanks go to International Rescue Committee (IRC), GIZ, UNHCR who generously supported the study and shared valuable information with the consultants. Thanks also go to; Government representatives in Health care system, District health officers, Hospitals management and all stakeholders for their time and valuable inputs to this intermediate outcome report. Finally, we would also like to congratulate the research team for their commitment. Together with our technical backstopping experts, they were responsible for the successful accomplishment of this assignment. We hope that this report will provide the necessary and effective data on the status of the health centers and the service provisions in the six health centers.

As Koda Synergies
We Say Thank You!

EXECUTIVE SUMMARY

This intermediate outcome report on six electrified health centres is based on a field study conducted in Imvepi and Rhino Camp Refugee Settlements in Uganda by Koda Synergies Ltd in April 2022. It was commissioned by GIZ ten months after the projects Energy Solutions for Displacement Settings (ESDS) and Energising Development (EnDev) had carried out the work of providing sufficient, sustainable, and modern electricity to these health centers. The overall purpose of the intermediate outcome study was to provide information on the status of the health centers and the service provisions approximately ten months after ESDS and EnDev had carried out the solarisation in comparison to the baseline that was conducted prior to in 2021. This intermediate outcome study was guided by a mixed-methods approach, outcome mapping approach, and participatory research process. The study used a mix of participatory tools to collect data from the beneficiary health centers and analyzed the quantitative and qualitative data collected to derive logical conclusions. The analysis was done using SPSS and N-Vivo software. The research team conducted a desk review, Focus Group Discussions (FGDs) with hospital management and community representatives, Key Informant Interviews (KII's) with partner NGOs (UNHCR, IRC, and GIZ), district health officers, government representatives in the health care system and other project stakeholders, observations and individual interviews with project beneficiaries. In order to address gender aspects thoroughly, the study was conducted through gender assessment and reflecting gender analysis in study findings, conclusions and recommendations. A total of 30 patient exit surveys, KII's (19), and FGD's (6) were conducted. Below is the summary of the findings and recommendations.

Key Findings

- The catchment population increased for 4/6 health centres (HC) from 2021 to 2022: Imvepi HC II by (31 %), Yinga HC by (2 %), Siripi HC by (38 %), Ocea HC by (5.7 %)
- The numbers of consultations (patient visits) tend to reduce progressively from 2020 to 2022: Between 2020 and 2021 6/6 HC recorded a decrease of (7 %) Ocea HC II, (12 %) Imvepi HC II, (57 %) Siripi HC III, (36 %) Yinga HC III and (27 %) OfuaHC III – reductions in consultations could be attributed to the existence of COVID 19 which may have limited movement, relocation of populations served to other areas or may be due to other factors like intensified outreach activities among others
- The number of clinicians (in a ratio of full-time clinicians per 10000 population) slightly increased in 4/6 HC: 1.3 ratio increase (from 5.2 in 2021 to 6.5 in 2022) in Oduobu HC, Yinga HC III and1.2 ratio increase in (from 6.1 in 2021 to 7.3 in 2022) in Ofua HC III; 0.4 ratio increase (from 6.5 in 2021 to 6.9 in 2022) in Siripi HC; remained the same in 1/6 HC: 5.2 Imvepi HC II; and decreased in 1/6 HC: 0.4 decline in the ratio (from 6.9 in 2021 to 6.5 in 2022) in Ocea HC II,
- The number of services provided increased in 6/6 HC, i.e., Imvepi HC reported an additional service (nutrition treatment ward) from offering 21 services in 2021 to providing 22 services by the time the outcome study was conducted in 2022, while Ocea HC reported to be

offering 3 additional services (pediatric ward, CD4 cell count lab services, and gene expert for drug resistant TB) from the reported 31 in 2021 to 34 in 2022, Odoubu HC, recorded a substantial increase of 10 health services (pediatric ward, urine microscopy, nutrition and treatment ward, casualty and emergency, ambulance parked onsite, landline supported by HF, cellular airtime supported by HF, blood glucose, hemoglobin, ABO blood group and rhesus blood group) and both Siripi HC and Ofua HC, reported an increase of 6 additional services i.e. (pediatric ward, nutrition and treatment ward, TB ward, Ziehl Neelsen test for TB and gene expert for drug resistance TB) in Siripi HC III, (pediatric ward, gene expert for drug resistant TB, PCR for HIV viral load and EID, serology testing, ABO blood group, Rhesus blood group, cryptococcal antigen) in Ofua HC III. The increase in the provision of some of the health services can be attributed to the availability and improved reliability of solar power, which in turn resulted in increased use of powered hospital appliances such as vaccine refrigerators and powered lab equipment.

- Operation and maintenance (O&M) of the solar PV system in 6/6 HC were low, although the contractor provided training on the basics of the solar system maintenance. The study established that only Ofua HC had a professional technician who could operate fault in the solar system.

- The kiosks intended to generate income and finances for O&M have not yet been installed as previously planned during the project conception and implementation.

Recommendations

- The health unit management committee (HUMC) to consider budgeting for O&M costs to ensure that all facilities' funds are available to cover repairs and spare parts. Maintenance funds should be established upfront and be dedicated only to solar system repair. Mixing maintenance funds with general operating budgets has proven to be an ineffective model.
- For systems incorporating battery banks, regular maintenance of batteries is essential; they should be checked on quarterly basis. Batteries have to be replaced every 4-7 years (depending on proper usage and maintenance).
- The facility should select and train dedicated staff members who will be capable of handling and fixing minor faults and ensure the system is operating normally without having to contact the installation team.
- To enable the HCs to respond to covid-19 and other pandemics effectively, the facilities need to set up permanent structures for isolation wards and ensure they are installed with power.
- To enhance the impact of health center electrification, the installation of PV systems should prioritize HCs that operate at night and those with staff quarters because they are more likely to use the systems effectively.
- The design of the battery facility should consider easy access to each battery for service and the replacement of individual units without disassembling the whole battery system.
- The electrification project should be integrated with approaches that can create long-lasting socioeconomic impact solutions beyond the healthcare facility as the end-users. The construction of the 'energy kiosk' will go a long way in ensuring ownership and accountability by its users are achieved.

ABBREVIATIONS AND ACRONYMS

BMZ	German Federal Ministry of Economic Cooperation and Development
DC	Direct Circuit
DHO	District Health Officer
EnDev	Energising Development
ESDS	Energy Solutions for Displacement Settings
FGD	Focus group discussion
FIC	Facility In-Charge
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GoU	Government of Uganda
HC	Health Centre
HCW	Health Care Worker
HIS	Health Information System
HUMC	Health unit management committee
IRC	International Rescue Committee
KII	Key informant interview
kWh	Kilowatt/hour
kWp	Kilowatt peak
MEMD	Ministry of Energy and Mineral Development
MOH	Ministry of Health
NCD	Non-Communicable Disease
NGO	Non-governmental Organization
NTD	Neglected Tropical Diseases
O&M	Operations and maintenance
OGS	Off Grid Solar
OPD	Out-Patient Department
OPM	Office of prime minister
PPE	Personal Protective Equipment
PREEEP	Promotion of Renewable Energy and Energy Efficiency Programme
PV	Photo Voltaic
RWC	Refugee Welfare Committee
SDC	Swiss agency for development and cooperation
SDGs	Sustainable Development Goals
SOC	State of Charge
TB	Tuberculosis
UGX	Uganda Shilling
UNHCR	United Nations High Commission for Refugees
URTI	Upper Respiratory Tract Infection
LRTI	Lower Respiratory Tract Infection
USAID	The United States Agency for International Development
VHT	Village health team
WHO	World Health Organization

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1. BACKGROUND AND CONTEXT

1.1 Introduction

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) is a German government owned agency, that is involved in implementing technical cooperation measures, mainly commissioned by German Ministry of Economic Cooperation and Development (BMZ).

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", funded by the German Federal Ministry for Economic Cooperation and Development (BMZ).

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In Uganda, ESDS and EnDev under the Promotion of Renewable Energy and Energy Efficiency Programme (GIZ PREEEP), has cooperated closely with the Ministry of Energy and Mineral Development (MEMD), the United Nations High Commissioner for Refugees (UNHCR), and the Office of the Prime Minister (OPM) to improve framework conditions for sustainable access to energy for refugees and host communities, develop private sector models for the solarization of UNHCR infrastructure and provide access to modern energy services and products to Ugandan and refugee households (HHs), enterprises and social institutions through market development for solar PV and energy efficient cook stoves. In the first half of 2021, the partnership provided and installed OGS PVS for six purposefully selected health centres located within Rhino Camp and Imvepi Refugee Settlements in Terego and Madi Okollo districts.

1.2 Context Analysis

1.2.1 Situation Analysis of health Coverage in Uganda

Ugandan health facilities are graded at different levels depending upon the administrative zones that they serve. Health center grade II (HCII) facilities serve the parish level and provide outpatient care, antenatal care, immunization and outreach.[1] It provides only ambulatory services, except in strategic locations (e.g., poor access to HC-III or HC-IV) where maternity services are being provided as an interim strategy. An Enrolled Comprehensive Nurse is key to the provision of comprehensive services and linkages. Health center grade III (HCIII) facilities serve the subcounty level and provide inpatient care and environmental health services in addition to supplying all services of health center grade II facilities. Despite record investment over the past five years, Uganda's healthcare performance is still ranked as one of the worst in the world by the World Health Organization. The country is ranked 186th out of 191 nations. The doctor-patient ratio in Uganda is estimated at 1:25,725 and the nurse-to-patient ratio at 1:11,000.[2] This is way below the WHO recommended doctor-patient ratio of 1:1000. This is a clear indication that the available HCs are in no capacity, both technically or financially, to serve the population with consistent and quality health care.

Uganda's burden of disease is dominated by communicable diseases, which account for over 50 % of morbidity and mortality. Malaria, HIV/AIDS, TB, and respiratory, diarrheal, epidemic-prone and vaccine-preventable diseases are the leading causes of illness and death. There is also a growing burden of non-communicable diseases (NCDs) including mental health disorders. Maternal and perinatal conditions also contribute to the high mortality rate. Neglected Tropical Diseases (NTDs) remain a big problem in the country affecting mainly rural poor communities. Furthermore, there are wide disparities in health status across the country, closely linked to underlying socio-economic, gender and geographical disparities. The major challenges affecting the health system are the lack of resources to recruit, deploy, motivate and retain human resources for health, particularly in remote localities; ensuring quality of the health care services delivered; ensuring reliability of health information in terms of the quality, timeliness and completeness of data; and reducing stock-out of essential/tracer medicines and medical supplies.[3]

1 Saswata B, Omar F, Aubery RJ, Jaffer B, Michael W. Bridging the health gap in Uganda: the surgical role of the clinical officer. Afr Health Sci. 2005 Mar;5(1):86-9. PMID: 15843138; PMCID: PMC1831898. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1831898/

2 https://data.worldbank.org/indicator/SH.MED.PHYS.ZS?locations=UG

3 World Health Organization. (2018). WHO country cooperation strategy at a glance: Uganda. World Health Organization. https://apps.who.int/iris/handle/10665/136975. License: CC BY-NC-SA 3.0 IGO

1.2.2 Displaced population (Refugees)

As of 30 November 2021, Uganda hosts over 1.5 million refugees and asylum-seekers mainly from South Sudan, the Democratic Republic of Congo (DRC) and Burundi, making it one of the top refugee-hosting country in sub-Saharan Africa.[4] This may be due to their open-door refugee policy; the country's government has made welcoming and caring for refugees an important part of its national policy.[5] As of October 2021, the number of refugees from South Sudan were 943,991, those coming from DRC were 449,863, making them the most frequent countries of origin. Those who originated from Burundi are 51,899, Somalia 50,290, Rwanda 25,507, Eritrea 19,468, Ethiopia 3,868, Sudan 3,554 and those from other countries are about 741.The vast influx of refugees is due to several factors in Uganda's neighboring countries, especially war and violence in South Sudan and the DRC, and associated economic crisis and political instability in the region.[6] Refugees in Uganda are either self-settled or live in settlements where basic health and education services are provided by the Ugandan Government and non-government organizations. More than 80 % of refugees in Uganda live in settlements in a refugee hosting district.

1.2.3 Health care service provision for refugees in Uganda

In Uganda, the health care services are provided by the public sector, private not-for-profit, private profit, and complementary and traditional medicine practitioners. The giants in this sector are the public and private health providers who have an almost 50 % share in the health outcomes. However, the private sector health providers are more readily available and provide better quality services than the public sector.[7] Health care provision is decentralized to districts, with each district expected to serve 100,000 people.[8] The main challenges in the health care provision for refugees are financial constraints, distance, safety, policy, and cultural and language discordance.[9] The refugee health needs include ensuring that the population has access to continuous care, providing antenatal care, family planning, preventive care, health education, mental and psychological support, and rehabilitative and palliative care. The top morbidity causes for refugees in Uganda, as reported by UNHCR, is Malaria 23 %, upper respiratory tract infections (URTI) 12 %, lower respiratory tract infections (LRTI) 11 %, skin diseases 10 %, and watery diarrhea 3.8 %[10]. Recently the government of Uganda launched a Health Sector Integrated Refugee Response Plan (2019-2024) that encompasses and advocates for the provision of integrated services for both the refugees and the host communities in all the refugee hosting districts.[11] The plan is to address the refugee and host community health care needs. Despite the efforts from various humanitarian and development partners, significant barriers to the access to modern energy products and services remain. These include lack of organizational structure in energy markets, weak energy business skills among local entrepreneurs, lack of access to key products and services such as spare parts or credit, weak

4 https://www.unhcr.org/uganda.html

5 Uganda stands out in refugees' hospitality | Africa Renewal". www.un.org. Retrieved 2020-03-25

6 https://www.statista.com/statistics/1241293/refugees-in-uganda-by-origin/

7 USAID FROM THE AMERICAN PEOPLE; Uganda's private health sector: Opportunities for growth.

8 F. Ssengooba, SN Kiwanuka, E. Rutebemberwa, E. Ekirapa Kiracho (2017), Universal Health Coverage in Uganda: Looking Back and Forward to Speed up the Progress. Makerere University, Kampala Uganda.

9 http://speed.musph.ac.ug/wp-content/uploads/2019/03/Chapter-6.pdf

10 Uganda adopted legislation that granted refugees free health care within settlements

11 Uganda Launches Health Sector Integrated Refugee Response Plan 2019-2024

business advisory for the energy sector, and an unstable refugee business environment (EnDev Energy Analysis Report for Arua refugee setting, 2018).

1.2.4 Electricity Access Gap in Rural Health Centres

Previous studies conducted by development advisors of GIZ Promotion of Renewable Energy and Energy Efficiency Programme (PREEEP) in West Nile and District Energy Focal Persons between 2013-2016 found unreliable energy access among health facilities and more than 50 % of the sampled health centres had dysfunctional off-grid solar (OGS) photovoltaic systems (PVS).[12]

The energy gap in the health facilities has a clear indication of how they function and the quality, availability and safety of the health care services offered. The lack of sufficient quality energy products and services for cooking and lighting, communication (phone charging), productive uses and for optimal functioning of social institutions grossly limits 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.

Rural health centres play a vital role in the provision of health care services to the local communities which include the treatment of communicable diseases and illnesses, provision of reproductive health services such as maternity services, family planning, antenatal and postnatal care, preventive health care such as immunization, and others. The HC lack the technical capacity to avail all these services to the refugees because of factors such as electricity. HCs in this context have received support in the form of new temporary, semi-permanent or permanent buildings, medical equipment, more staff and additional energy solutions.

1.3 Purpose and Objectives of the Intermediate Outcome Study

The intermediate outcome study aimed to provide information on the status of the health centers as well as service provisions approximately ten months after ESDS and EnDev have carried out the work of providing sufficient, sustainable and modern electricity to these health centers. The purpose of the outcome study was to understand the impact of access to reliable, sustainable, modern and sufficient electricity on social institutions' service delivery and beneficiaries. The study compared and analyzed expected changes at output and outcome level after the intervention was carried out as well as negative or positive unintended results.

12 ESDS and EnDev, Terms of Reference for A Baseline Survey Prior to Electrification of Six (06) Health Centers. 2020, ESDS, EnDev, and GIZ. p. 12.

1.4 Theory of Change

Sharon Tsui (2021) proposed a potential mechanism by which improved energy access in health care facilities could improve health and socioeconomic status. The change theory was developed using the WHO Energy Results Chain Framework for Health Services. It was loosely structured around the intervention types depicted in figure 1 according to the theory. Arrows connect theorized causes to effects, demonstrating a combination of theorized and empirical pathways that these intervention types may take to achieve two types of impact: improved health and socioeconomic status.

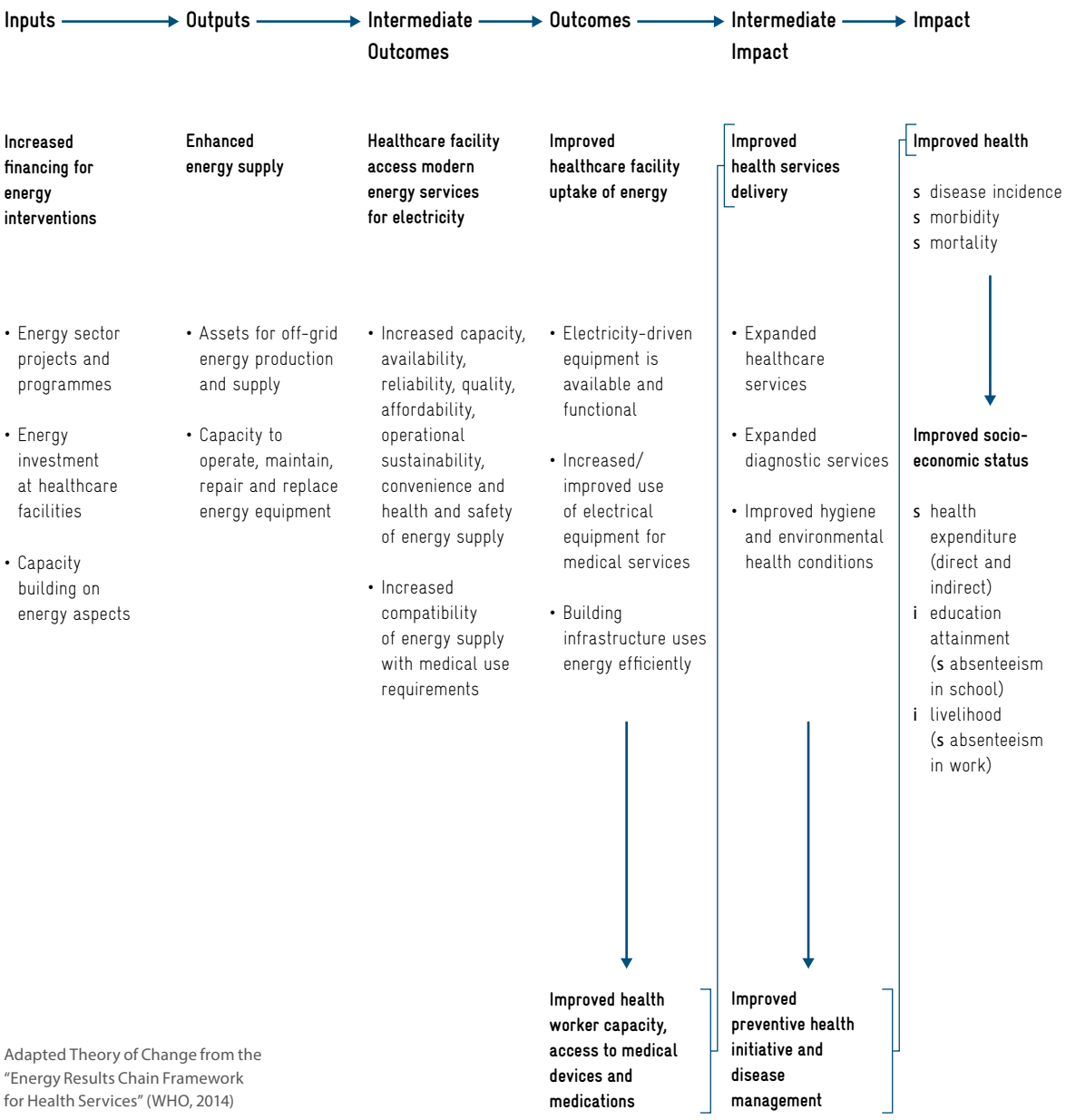

Figure 1: Theory of Change on Electrification of Health Centers and Impacts on Health and Socioeconomic Status

1.5 Expected outputs and deliverables

- Inception report detailing the outcome study design, methodology, sampling methodology & sample frame, survey tools, and work plan, data collection tools
- Draft intermediate outcome study report
- A power point presentation highlighting key findings will be presented at a feedback meeting to be held after completing the draft report.
- Final intermediate outcome study report
- Cleaned data sets

2. METHODOLOGY

2.1 Outcome study approach

The outcome study focused on six health centers, Imvepi HCII, Ocea HCII, Odoubu HCII, Yinga HCIII, Siripi HCIII, and Ofua HCIII. Based on the objective of the study, the intermediate outcome study was guided by the outcome mapping approach and participatory research process. The mixed-method approach involved the use of both quantitative and qualitative data. The method was used to collect data from the beneficiary health centers. The data was collected through the systematic desk/ literature review and fieldwork investigations with particular attention to the data relating to project indicators, i.e., adoption of good health practices, improved services, increased staff satisfaction rates, etc. These were triangulated through health center surveys, focus group discussions, customer satisfaction surveys, and key informants. The team undertook a 3-phase process to conduct this outcome study as follows;

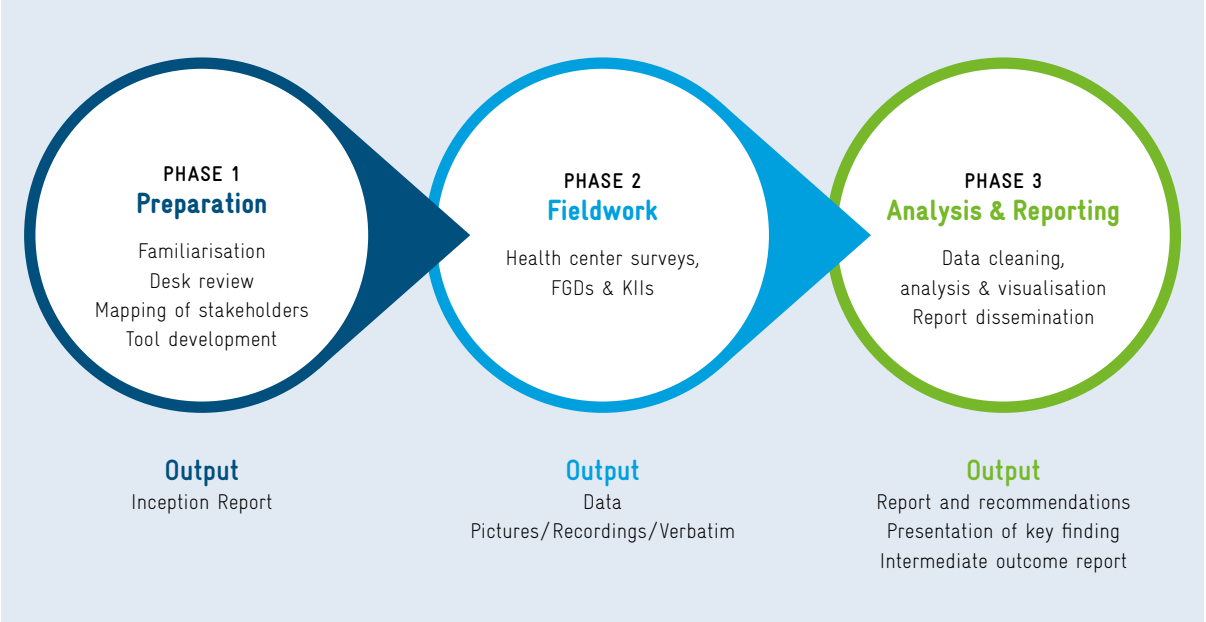

Figure 2: Outcome study process

Desk review of the project document, reports and site visits (observations) were carried out. These methods were used to determine outcome data and to ensure effective measurement of programme results/outcomes and impact of the programme.

2.2 Sources of data and Sampling

Considering the geographical size of the sample population, the consultant used purposive sampling for the six health centers. This approach was taken because of the targeted intervention by GIZ. For this study we selected purposive sample from Imvepi, Ofua, Siripi, Yinga, Ocea and Odoubu Zones of Rhino Camp and Imvepi Refugee Settlements, which are GIZ project sites. Our sampling frame was 6 supported health centers in the target areas. Using this approach, our proposed sample was 62 surveys distributed as; 30 customer satisfaction surveys, 19 in-depth interviews and 6 focus group discussions. Data collection was carried out by use of paper questionnaires and observation.

The additional data collected constituted data collected the previous year, for purposes of this study. Therefore, in this report, the 2021 data represents data from the end of 2020 and 2022 data represents data as at the end of 2021.

Table 1: List of interviewed respondents[13]

Target Group	Members	Tools
Implementers & stakeholders	1. IRC, UNHCR 2. District health officer, Hospital management 3. Health unit management committee 4. Community representatives	• KIIs (19) (2 - Female, 17 - Male) • FGDs (6) (13 - Female, 28 - Male) • Customer satisfaction Surveys (30) (16 - Female, 14 - Male)

13 Total number of interviewed participants by gender (Male 46, female 15)

2.3 Data analysis and reporting

Data collected was recorded and reviewed daily for analysis by the research team. This allowed the research team to monitor the relevance, consistency, and accuracy of all the data collected by the survey team from a logical, contextual and technical perspective.

The consultants team conducted morning and evening debriefs with field teams to address any issues and/or confirm trends in the data. After data collection was completed, the research team cleaned and analyzed data using tools detailed in (Table 2) below.

Table 2: Data analysis framework

Data Collected	Analysis tool	Description
Health center surveys	Excel	• Graphs for key indicators generated using Excel were presented as summarized in the report
FGDs & KIIs	N-vivo	• Content analysis was performed using N-vivo to draw-out thematic connections between respondents and visualize qualitative findings.

2.4 Study Limitations and Enabling factors

The intermediate outcome survey exercise faced a number of challenges as summarized below;

1. Low mobile phone network coverage in some parts of Rhino Camp and Imvepi Refugee Settlements.
2. The poor road network to the beneficiaries' sites and the health facilities were far from each.
3. Long distances to the beneficiaries' sites and a limited time from the project beneficiaries.
4. Rotation of the Health center staff who were part of the project since its conception and implementation.

Enabling factors

1. We got good support from GIZ, IRC, UNHCR, District health officers, and beneficiary hospitals' management and staff in all the target areas.
2. Consultants' fieldwork organizational plan and team were committed.
3. The environment, weather, and community hospitality were ideal for successfully completing the outcome study.

3. KEY FINDINGS

3.1 Introduction

This intermediate outcome study was carried out to provide information on the status of six health centers and the service provisions approximately ten months after the intervention of providing sufficient, sustainable, and modern electricity to these health centers was carried out. The intermediate outcome study was carried out in 2 districts; Terego and Madi Okollo targeting 6 health centers, i.e., Yinga HC III, Imvepi HC II, Siripi HC III, Ofua HC III, Ocea HC II, and Odoubu HC II, which are located in Rhino Camp and Imvepi Refugee Settlements in Uganda. This report will describe the key findings in the health centers' general characteristics, analyze electricity access and its effects on health care services, the synergy between electricity access and healthcare services delivery. For example, during the covid 19 pandemic, oxygen concentrators and extra lighting to isolation ward supported in managing the pandemic in Uganda.

3.2 Analyzing electricity access and its effects on health care services

The health centers included three level II health centers and three level III health centers (Yinga HC III, Siripi HC III, Ofua HC III) and (Imvepi HC II, Ocea HC II and Odoubu HC II) respectively. The main goal of any health system is to provide effective and quality care at any time, and therefore access to electricity is an important enabler of these services. This section summarizes the change in general characteristics of the health centers in terms of structure of the health centers, staffing, the medical appliances and equipment available in the health centers and the health services being provided in each of the six facilities.

3.2.1 Structure of the health centre

Uganda's health system is divided into national and district-based levels. At the national level includes the national referral hospitals, regional referral hospitals, and semi-autonomous institutions including the Uganda Blood Transfusion Services. The lowest level of the district-based health system consists of Village Health Teams (VHTs). These are volunteer community health workers who deliver predominantly health education, preventive services and simple curative services in communities. They constitute level 1 health services. The next level is Health Center II (parish), which is an outpatient service offering immunizations and antenatal care, emergency deliveries, it is run by a nurse. Health center II is intended to serve 5000 people. The health Centers III (HCIII) are supposed to be situated in every subcounty and are intended to serve 10,000 people[14] and provide in addition to HC II services, in patient, simple diagnostic and maternal health services. It is managed by a clinical officer.[15] This intermediate outcome study focused on the 2 district level health facilities, known as Terego and Madi Okollo managed by Ministry of Health (MOH) and one managed by IRC. Regardless of managing authority, all health facilities receive support – technical, infrastructural, human resource, and other – from the MOH, a multitude of implementing partners, and UNHCR.

Table 3: Structure of the health centers

Building /facility	Function	Current energy supply and needs
Clinic buildings	In HC II, one permanent building with multiple rooms. In HC III, one permanent building with isolation wards (tents)	Primary area for energy investment Often multiple power systems.
Staff houses	HC II; Usually 1-4 units HC III ;1 to 28, average 5 houses.	Usually a single PV system for each staff house.
Latrines	Provide service for all visitors	Lighting

14 hopeworldwideuganda.org

15 MHU (2000). "Uganda Ministry of Health: Health Sector Strategic Plan 2000/01 – 2004/05" (PDF). Kampala: World Bank Quoting Ministry of Health (Uganda) (MHU). Retrieved 16 October 2016

3.2.2 Catchment population

The catchment population is the number of people located in a political administrative unit where a health center is located. However, the actual number of patients visiting the HCs is usually lower than the catchment population and here is referred to as the population served. For purposes of this study, the figures used for the analysis for a given year, refer to the total at the end of previous year (e.g. 2021 data in the baseline refers to data as of 31st December 2020).

Table 4 shows the changes in catchment population. For purposes of this analysis, Ofua HC III was not considered during the analysis of the changes in the catchment population because the host community population data which forms part of the analysis was unknown from the baseline assessment. Imvepi HC II, Yinga HC III, Siripi HC III, Ocea HC II, Odoubu HC II had a combined catchment population of 98,764 people and 114,360 people in 2021 and 2022 respectively. The refugee population stood at a total of 74,460 in 2021 and 79,645 in 2022 while host community population stood at 24,304 and 34,715 in 2021 and 2022 respectively. Overall, the total catchment population grew by 16 % during this time. This may have been a result of the refugee influx from Uganda's neighboring countries or an increase in child births which may be attributed to availability of better social services in the catchment area or even a mix of both.

Table 4: General health facility characteristics (data collected from 2021 Baseline Survey and 2022 Outcome Study)

Health Centre	Refugee Settle-ment	Managing Authority	Years of Service	Catchment Population (2021)			Catchment Population (2022)		
				Refugee	Host	Total	Refugee	Host	Total
Imvepi HC II	Imvepi	MOH	27	19,668	3,224	22,892	26,786	3,224	30,010
Yinga HC III	Imvepi	MOH	26	10,813	7.351	18,164	10,360	8,200	18,560
Siripi HC III	Rhino Camp	MOH	28	13,090	5,500	18,590	13,616	12,050	25,666
Ocea HC II	Rhino Camp	MOH	27	18,428	3,729	22,157	16,422	6.741	23,422
Odoubu HC II	Rhino Camp	MOH	30	12,461	4,500	16,461	12,461	4,500	16,461
Ofua HC III	Rhino Camp	MoH	6	26,952	–	–	25,000	21,000	46,000

However, the data gathered during the interim study shows a decline in the number of patients served between 2021 and 2022 at the respective HCs (Table 5). For purposes of this study only data from Ocea HC II, Imvepi HC II, Siripi HC III and Yinga HC III as it was the most complete data set. The average number of patients was analyzed across the 4 HCs of Ocea HC II, Imvepi HC II, Siripi HC III, Yinga HC III, showing a decrease from 39,550 people to 30,114 people between 2021 and 2022 representing an average decrease of 9,436 (24 % decrease in patients served). Based on this data, the average number of patient visits decreased from an average of 2 visits to 1 visit per person between 2021 and 2022. Considering population increment during this period, this trend may be attributed to the fact that the country was under lock down with movement of persons highly restricted and health centers focused more on service to COVID 19 patients compared to other ailments that the population may have suffered. Furthermore, other factors such as intensified outreach activities might have also attributed to decreased patient visits.

Table 5: General health facility patient visits (data collected from 2021 Baseline Survey and 2022 Outcome Study)

Facilities	Settlement	2020	2021
Ocea HC II	Rhino	44,165	47,997
Imvepi HC II	Imvepi	27,732	25,689
Siripi HC III	Rhino	20,968	18,366
Yinga HC III	Imvepi	65,334	28,405
Ofua (Uriama) HC III	Rhino	48,720	30,942
Oduobo	Rhino	-	-

3.2.3 Health care staffing

In order for a health center to operate effectively, it needs a medical officer or a nurse respectively, together with the health team i.e. midwife, nutritionist, pharmacist, lab assistant, HIV counsellor at minimum. According to WHO standards level II health centre are intended to serve 5,000 people while Level III health facility is intended to serve 10,000 people and WHO minimum threshold of the health staff in a health facility is 23 Health care workers. (Clinician, nurses, midwives)[16]. By enhancing energy supply to a health center one is able to improve the operation of health workers making their working environment safer during night hours, extending work hours beyond the daytime, improving lighting for their accommodation and generally improving the environment that they work in. In addition, the health workers are able to utilize more tools and medical appliances to improve on their service delivery.

This study reveals that there is still a severe shortage of staffing required to deliver essential maternal and child health services. None of the health facilities (0/6) met the WHO minimum threshold of 23 doctors, nurses, and midwives per 10,000 population. (Table 6) shows number of full time and part staff available in the 6 health centers during the intermediate outcome study implemented in April 2022. It is notable that none of the health centers (0/6) had a physician specialist. Odoubu HC did not have a part time or full-time clinical officer compared to 2021 when they had 1 clinical officer in the facility as reported by the senior nurse in charge. Ofua HC III reported a decrease in clinical officers from 4 to 3 and an increase from 5 to 8 nurses as compared to 2021. Only Ocea HC II had a decrease in the number of midwives available while Siripi HC III and Odoubu HC II has recorded an addition in the number of the midwives from 2 and 5 in the year 2021 to 7 and 9 in the year 2022. The total number of nurses and midwives ranged from 11 to 16 in the HC II and 11 to 15 in the HC III. None of the facilities had a pharmacist but one HC II and two HC III had a pharmacy dispenser. None of the health centers had a laboratory technologist, Imvepi HC III did not have a laboratory technologist, lab technician or laboratory assistant, the HC also does not offer lab services they mostly refer the patients to other facilities. One HC II (Ocea HC II) had two HIV/AIDS counsellors which was still the case during the start of the project, 2/3 HC III (Yinga and Ofua) had HIV/AIDS counsellor compared to 3/3 HC III who had an HIV/AIDS counsellor at the initiation of the project. All the health centres 6/6 had a translator, security guard and a cleaner.

16 hopeworldwideuganda.org/health-services/

Table 6: Human resource for health staffing (2022 vs 2021 data)

Health Facility Staff	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021
Physician Specialist	0	0	0	0	0	0	0	0	0	0	0	0
Medical Officer	0	0	1	1 (part time)	0	0	1	0	0	0	1	1 (part time)
Clinical Officer	1	1	3	3	0	1	5	1	1	1	3	4
Midwife (enrolled, registered)	4	4	6	7	9	5	6	6	7	2	5	5
Nurse + Nurse Assistant (Enrolled, registered, comprehensive)	7	7	5	6	6	6	5	7	8	12	8	5
HIV/AIDS Counsellor	0	0	2	2	0	0	2	1	0	1	1	1
Nutritionist	0	0	1	0	3	0	1	0	0	0	0	1
Nutrition Assistant	1	1	1	0	0	0	1	0	1	0	1	2
Translator	3	3	3	1	3	2	3	4	2	4	4	4
Pharmacist	0	0	0	0	0	0	0	0	0	0	0	0
Pharmacy Dispenser	0	0	1	1	0	0	1	1	0	0	1	1
Laboratory Technologist	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory Technician	0	0	1	1	0	0	2	2	2	1	1	1
Laboratory Assistant	0	0	1	1	1	1	2	1	0	1	2	2
Records Clerk	1	1	2	1	0	0	3	2	2	2	1	2
Cleaner	5	5	4	4	2	1	9	10	2	2	4	4
Security Guard	2	3	5	5	2	2	7	3	3	3	4	5
Total Full Time Clinician (CO, Nurse, and Midwife) – 2022	12	12	15	16	15	12	17	14	16	15	17	14
Ratio of Full Time Clinician per 10,000 population	5.2	5.2	6.5	6.9	6.5	1.3	7.3	6.1	6.9	6.5	7.3	6.1
Outcome change 2022	0		-0.4		1.3		1.2		0.4		1.2	

During the baseline study conducted in 2021, the ratio of full-time clinician per 10,000 was 5.2 for Imvepi HC, 6.9 for Ocea HC, 5.2 for Odoubu HC, 6.1 for Yinga HC, 6.5 for Siripi HC and 6.1 for Ofua HC. The total number for the clinician during the outcome study are indicated in the table 6 above.

The results show that there was no change in the ratio of full-time clinicians per 10,000 population in Imvepi HC, while Ocea HC reported a 0.4 decline in the ratio from 6.9 in 2021 to 6.5 in 2022, Oduobu HC reported a 1.3 ratio increase from 5.2 in 2021 to 6.5 in 2022, Yinga HC and Ofua HC, also

reported a 1.2 increase in the ratio of full-time clinician from 6.1 in 2021 to 7.3 in 2022, And Siripi HC also reported a 0.4 ratio increase from 6.5 in 2021 to 6.9 in 2022. The findings indicate that the number of clinicians had increased in 4/6 health centres while the number of clinicians in one health facility remained the same and only one facility had reported a decrease in the number of clinicians.

3.2.4 Type of services provided

Essential health services for any health centre include outpatient, inpatient, delivery services, laboratory services, emergencies and referral services. This section summarizes the number of health services provided at each health facility involved in this study.

Outpatient services

Currently, all health facilities (6/6) provide the same range of outpatient health services regardless of the health facility level. All the health centers provided general outpatient services, antenatal care, family planning services, maternal and child health services, HIV Testing and counselling, Prevention of mother to child transmission of HIV, HIV and TB treatment clinic, Homebased care for HIV clients, nutrition screening and delivery services. 5/6 health centers also reported to offer mental health and psychosocial support services apart from Odoubu HC.

Table 7: Outpatient services offered

Services	Health Center II						Health Center III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021
Outpatient												
General Outpatient	√	√	√	√	√	√	√	√	√	√	√	√
Maternal and Child Health (including immunization)	√	√	√	√	√	√	√	√	√	√	√	√
Family Planning (including youth friendly services)	√	√	√	√	√	√	√	√	√	√	√	√
Antenatal Care	√	√	√	√	√	√	√	√	√	√	√	√
Delivery	√	√	√	√	√	√	√	√	√	√	√	√
HIV Testing and Counselling	√	√	√	√	√	√	√	√	√	√	√	√
Prevention of Mother to Child Transmission of HIV	√	√	√	√	√	√	√	√	√	√	√	√
HIV and TB Treatment Clinic	√	√	√	√	√	√	√	√	√	√	√	√
Home-Based Care for HIV Clients	√	√	√	√	√	√	√	√	√	√	√	√
Nutrition Screening and OP Treatment	√	√	√	√	√	√	√	√	√	√	√	√
Mental Health and Psychosocial Support	√	√	√	√			√	√	√		√	√

Inpatient services

There has been an increase in inpatient services across all six HCs, in aggregation from 18 to 26. 5/6 health centers reported to be offering nutrition treatment and had a nutrition treatment ward. All the HC II, 3/3 did not have a TB ward but all the HC III 3/3 had a TB ward and offered treatment for TB.

Table 8: Inpatient services provided (2022 vs 2021 data)

Services	Health Center II						Health Center III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021
Inpatient												
General Medical Ward	√	√	√	√	√	√	√	√	√	√	√	√
Paediatric Ward	√	√	√		√		√	√	√		√	
Maternity Ward	√	√	√	√	√	√	√	√	√	√	√	√
Nutrition Treatment Ward	√				√		√	√	√		√	√
TB Ward		√					√		√		√	√

Inpatient bed availability

There is no comparable data in the baseline report for the number of beds in inpatient and maternity wards. However, interviews indicated that there has been an increase in its capacity. Table 13 presents the number of beds in the two wards. Imvepi HC reported a bed capacity of 18 inpatient and 6 maternity beds, Yinga HC had 32 inpatient and 13 maternity beds, Siripi HC had 11 inpatient and 6 maternity beds while Ofua HC reported 18 inpatient and 11 maternity beds and Ocea HC had 31 inpatient and 10 maternity beds and Odoubu HC had 12 inpatient and 2 maternity beds. The health centers now have the capacity to offer more admission and deliveries. There seems to be a correlation in the increased number of beds and the electrification intervention – either due to a general increase in services offered in relation to the electrification, or due to the increased capacity to handle patients at night. However, at this stage, the exact cause and effect between increased bed capacity and improved electrification cannot be conclusively stated.

Table 9: Inpatient bed availability

Health facility	Imvepi HC II	Yinga HC III	Siripi HC III	Ofua HC III	Ocea HC II	Odoubu HC II
Inpatient Beds	18	32	11	18	31	12
Maternity Beds	6	13	6	11	10	2

Emergency services provision

Having unstable power supply to a health center can result in non-functional laboratory equipment, leading to expensive repairs, high error rates during lab tests, long turnaround times for test results, and wastage of materials that need to be refrigerated. Emergency services is hinged to effective communication, where there is efficient and effective communication infrastructure, the delivery of emergency services usually tends to thrive. With phones able to stay charged overnight, coordination of ambulance services is enhanced as was noted by HUMC.

4/6 Health facilities reported to providing emergency/ casualty services, but Imvepi and Odoubu do not offer this service. 2/6 HC reported to have a supported landline as compared to 2021 when none of the HC had. The number of HCs supported by cellular airtime has increased to 3/3 from 2/3. However, none of the health centers offered blood transfusion as a medical emergency service.

Table 10: Emergency services provided (2022 vs 2021 data)

Emergency Services	Imvepi HC II		Ocea HC II		Oduobu HC II		Yinga HC III		Siripi HC III		Ofua HC III	
	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021
Casualty/Emergency	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Access to an Ambulance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ambulance Parked On-Site	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Landline Supported by HF	No	No	No	No	Yes	No	No	Yes	Yes	Yes	No	Yes
Cellular Airtime Supported by HF	No	No	No	No	Yes	No	Yes	No	No	Yes	Yes	Yes

> In my village, our health centre is now open 24hrs on emergency and the maternal health services have improved. Even in the case of emergencies, we are able to you visit health center and deliver baby confidently."
>
> FGD participant Siripi Health Center

Diagnostic services

Installation of stable power supply at health facilities has been known to tremendously improve the levels of service provision around diagnostics. While all health centers initially provided essential diagnostic services like malaria testing, the installation of solar power boosted the amount of energy that their diagnostic departments can utilize. This is evidenced by the feedback from the lab technicians who reported being able to work on more patients, having extended hours to work as well as being able to safely store their reagents and lab samples without worry of decrease of quality.

Besides Yinga HC III all HCs registered at least 1 additional diagnostic service which may be attributed to the installation of the solar power supply in these health centers.

6/6 HC offer malaria diagnosis, with some facilities offering malaria RDT (Rapid Diagnostic Tests) and others conducting the smear test. None of the HC II were offering TB diagnosis, these services were reported to be offered in all the HCIII. 6/6 HC reported to be offering various HIV diagnosis services as well as Syphilis screening. Pregnancy and Management services were also offered in all the health centers. None of the facilities reported to be offering X-ray services and only one facility (Ocea HC II) offered ultrasound services. Other services include isolation wards and SGBV protection house. 6/6 HC had isolation wards and also had a SGBV protection house for the local community members set aside in case the need to use it arises.

Table 11: Diagnostic Services provided (2022 vs 2021 data)

Services	Health Center II						Health Center III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021
Diagnostics – Laboratory												
Malaria												
Malaria RDT	√	√	√	√	√	√	√	√	√	√	√	√
Smear test			√				√		√		√	
TB												
Ziehl Neelsen Test for TB				√			√	√			√	√
Genexpert for drug resistant TB												
HIV												
HIV RDT	√	√	√		√	√	√	√	√	√	√	√
HIV antibody test by ELISA												
CD4 cell count												
Dried blood spot collection for viral load testing and early infant diagnosis			√		√		√		√		√	
PCR for HIV viral load and EID					√		√		√		√	
Syphilis												
Syphilis RDT	√	√	√	√	√	√	√		√		√	√
Serology testing												

Services	Health Center II						Health Center III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021
Diagnostics – Laboratory												
Pregnancy and Management												
Pregnancy (urine dipstick)	√	√	√	√	√	√	√	√	√	√	√	√
Rhesus blood group			√				√				√	
Glucose/ketone (urine dipstick)	√		√		√		√		√		√	
Blood glucose (glucometer)			√		√		√		√		√	
Haemoglobin (HemoCue)	√		√		√		√		√		√	
ABO blood group			√				√				√	
Other testing												
ALT (liver function)				√		√				√		
Serum creatinine (renal function)												
Full blood count and differential												
General microscopy/ wet mounts			√	√	√	√		√	√	√	√	√
Urine microscopy			√	√			√	√	√	√	√	√
Gram stain							√	√			√	√
CSF/body fluid counts								√				
Cryptococcal antigen				√				√				
Diagnostics – Imaging												
X-ray												
Ultrasound			√	√			√					
Electrocardiogram (ECG)				√				√				

Neonatal care

Electricity access is important to ensure that the incubators are in good working conditions. Infants should be nursed in the neutral thermal environment and have a core body temperature between 36.5 – 37.2 degrees Celsius[17]. As compared to the 2021 study, there is an increase in the services offered now by (14 %), and at least one of the HCs (Yinga HC III) now has an incubator for better childcare services. The importance of these incubators available in the HCs are used in combination with other equipment and procedures to ensure that babies needing extra support get the best possible environment and continual monitoring therefore without electricity, these services cannot be offered in the prescribed standards by WHO. Further, in charge reported an improvement in the patient attendance especially maternity cases this could be attributed to the electrification of the health centers, in that more services are offered. In addition, this study revealed that all the health centers (6/6) now offer all the inpatient services compared to 2021 when Nutrition services and TB treatment were not offered in the 2 HCs, i.e., Imvepi HC II and Ocea HC II. In the case of Ocea HC II, Odoubu HC II, Siripi HC III, and Ofua HC III currently have a pediatric ward. Based on the report from the Imvepi HC FGD group, a participant mentioned that the expectant mothers no longer look for delivery services in far reach hospitals, instead they do now attend the clinics due to enough confidence of available services in case of an emergency, this shows that better access to electricity has positive effects on the number of both the inpatients and delivery services as well as the willingness and confidence of patients to be admitted to the health centers.

Table 11: Number of total health services provided

Year of study	Health Centre II			Health Centre III		
	Imvepi HC II (Imvepi)	Ocea HC II (Rhino Camp)	Odoubu HC II (Rhino Camp)	Yinga HC III (Imvepi)	Siripi HC III (Rhino Camp)	Ofua HC III (Rhino Camp)
2021	21	31	22	39	28	34
2022	22	34	32	39	34	40
Outcome change 2022	+1	+3	+10	0	+6	+6

17 https://starship.org.nz/guidelines/incubator-care-of-baby-in-incubator

(Table 11) indicates the number of total services offered in comparison to the baseline. The study established that service provision has increased in 5/6 HC. Imvepi HC reported an additional service from offering 21 services in 2021 to offering 22 services by the time the outcome study was conducted in 2022, while Ocea HC reported to be offering 3 additional services from the reported 31 in 2021 to 34 in 2022, Odoubu HC, recorded a substantial increase of 10 health services and both Siripi HC and Ofua HC, reported an increase of 6 additional services. While Yinga HC reported to be offering the same number of services during the outcome study as it was in 2021.

According to a discussion with the in-charge Imvepi HC, electricity has greatly aided in the preservation of vaccines/drugs in refrigerators, particularly for immunization and other diseases. As a result, they are able to provide more services than before electrification.

> “First, I want to give vote of thanks to GIZ, our sub county being in a rural setting generally we face problems of power supply. Earlier we had a similar solar system that ran out and power was not steady, however this one that was installed by GIZ up to now we haven’t faced any problem. The whole system is okay and we have power 24 hours a day. We can now do our work in our health center like using the computers, charging our phones and lighting etc. Even now the security has greatly improved because of the security lightings installed. Whenever people come to seek health services, they also charge their phones as they are being served and they are very appreciative because of the availability of solar power.”
>
> KII Sub County Chief Siripi

3.2.4 Medical appliances and facilities

A summary of the medical appliances that were available is presented in (Table 12) below. Siripi HC, 1/6 of the facilities reported to have an electric autoclave, but all the facilities 6/6, had a non-electric autoclave. None of the health centers reported to have and electric dry heat sterilizer. Only one facility, Ocea HC had a non-electric pot for boil, while the rest did not. All facilities 6/6 reported they had refrigerators, Ocea HC is the only facility that have a ECG and ultrasound equipment. All facilities reported to have a glucometer, hemocue, glass slides and coverslips. 5/6 facilities reported to have a microscope apart from Imvepi HC that did not have any. Imvepi HC also did not report any desktop in the facility, unlike the other five health centers that all had a computer for use.

Table 12: Inventory of equipment (data collected from 2022 health facility outcome survey)

Health facility	Imvepi HC II		Yinga HC III		Siripi HC III		Ofua HC III		Ocea HC II		Odoubu HC II	
	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021
Electric autoclave	No	No	No	No	Yes	No	No	No	No	No	No	No
Non -electric autoclave	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Electric dry heat sterilizer	No	No	No	No	No	No	No	No	No	No	No	No
Electric boiler	No	No	No	No	No	No	No	No	No	No	No	No
Non-electric pot for boil/steam	No	No	No	Yes	No	Yes	No	No	Yes	No	No	No
Refrigerator	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Desktop	No	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-
EID machine	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Microscope	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Glucometer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Hem cue	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-	Yes	-
Glass slides and cover slips	Yes	No	Yes	No	No	No	Yes	No	Yes	No	Yes	No
Ultrasound	No	No	No	No	No	No	No	No	Yes	No	No	No
ECG	No	No	No	No	No	No	No	No	Yes	No	No	No
CT scan machine	No	No	No	No	No	No	No	No	Yes	No	No	No
Incubator	No	No	Yes	No	No	No	No	No	No	No	No	No

From table above on the inventory of equipment, there is a notable positive change in terms of equipment acquisition. Prior to electrification interventions UNICEF provided refrigerators for storage of vaccines. Five (5/6) facilities (Ocea, Odoubu, Yinga, Siripi and Ofua) have reported to have acquired desktops which the facilities did not have during the baseline survey. Imvepi HC and Odoubu HC also reported they had acquired glucometer. Yinga HC also reported to have acquired an incubator. Health center level assessment and discussions with in-charge and laboratory staff, indicated that some of the equipment that they had received from other donors and government of Uganda were now possible to be used in health care service such as, vaccine cool boxes, fridges, computers etc.

> "In the last one year we have witnessed delivery of additional equipment's such as oxygen services tanks, computers, microscope and fridges. This equipment has enabled us get diagnosis and treatment in our HC as compared to before we could go to far hospitals, as computers assist to keep track our hospital visits."
>
> FGD participant Ofua level III HC

3.3 Electricity access and health care delivery

Access to energy is essential for resilient health systems; however, strengthening energy infrastructure in rural health centers is still a challenge in Uganda and refugee districts. This outcome study demonstrates the effects of improved electricity access to service delivery in the six health centers supported by GIZ.

> "… Previously our mothers whenever they needed to deliver at night they were told to buy candles but now it's not there. Our mothers are excited, they visit the facility anytime and are attended to promptly because power is available for any other thing that might be needed and I can confidently say that this is the beauty of GIZ solar project."
>
> Chairperson Oduobu Health Center II

3.4 COVID-19 prevention and response, functionality of isolation wards

The COVID-19 pandemic has overwhelmed health systems in both developed and developing nations alike and was a bigger challenge to HC in refugee settings. The Ugandan government, IRC and UNHCR rapidly mobilized to respond to COVID-19 in early March 2020, using their considerable previous experience with other outbreaks, such as Ebola. In line with GoU guidelines, quarantine measures were put in place at all HC at the refugee settlements and isolation wards were installed. Through solarization at Ofua HC an oxygen concentrator was supported which provided assistance to COVID-19 patients as reported by the medical clinical officer in-charge. In addition, all HCs stored vaccines in the fridges due to availability of the power, this in turn assisted the community not to travel far in search of the services.

> “Before installing solar in Siripi HC, and if a health emergency occurs at night, the hospital could refer us to another HC where we could get treatment, and it’s about 52 kilometers away, and sometimes you could be lucky to get a UNHCR ambulance. This solar has greatly improved access to health-care services.”
>
> Siripi HC III FGD Participant

Patient exit survey

The study undertook anonymous feedback of randomly selected 30 patients surveyed from every facility department among the six HC. Figure 3 below shows that 53 % of the patients interviewed were female and 47 % were male, indicating that more women seek health services.

The responses in (Figure 4) indicated that 67 % of the patients reported having good access to medication during emergencies at night. Further, the findings in terms overall quality of care rating from the hospitals, 53 % of the respondents are satisfied, 33 % are very satisfied,13 % receive fair services, and none receive poor services.

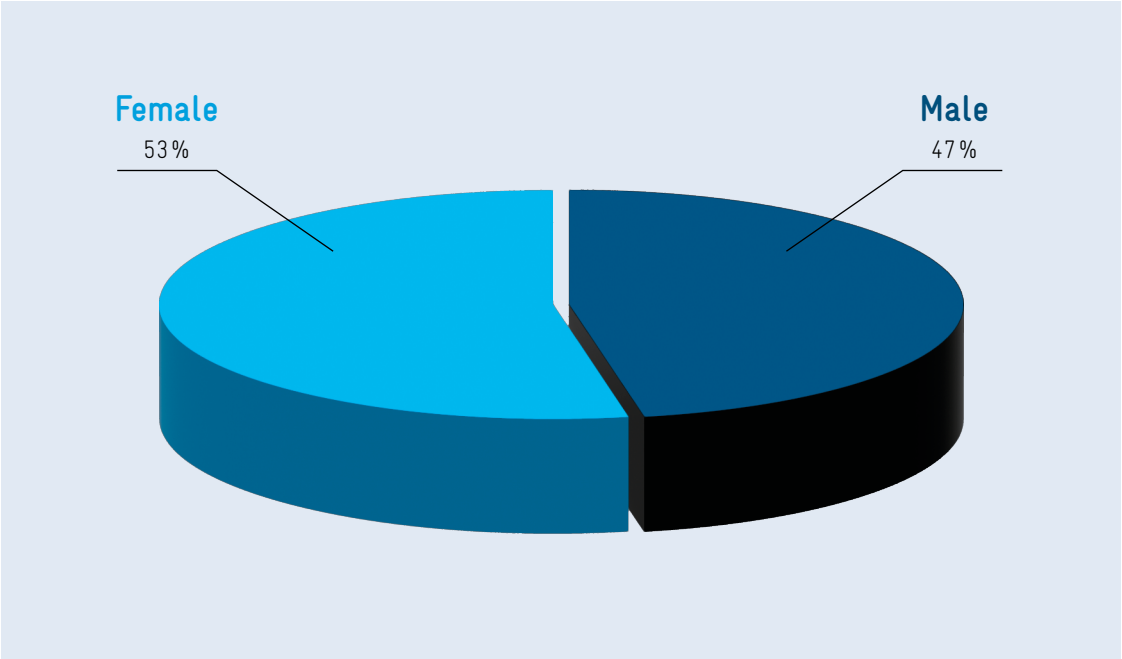

Figure 3: Gender of patients.

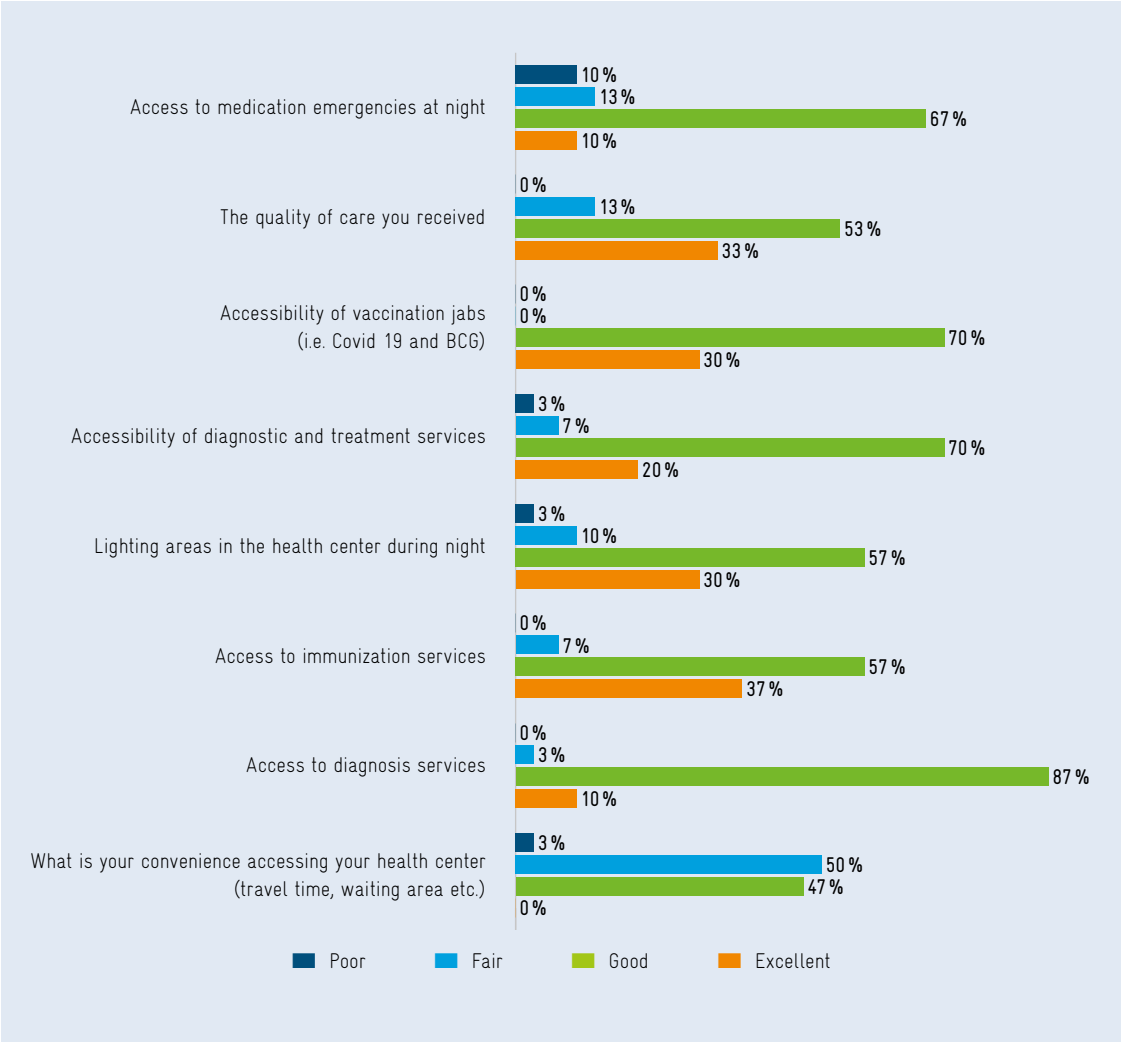

Figure 4: Patient exit survey, outcome study 2022

Among the patients interviewed 70 % reported to be getting good access to both vaccination jabs and diagnostic treatment services. 50 % of the patients reported that waiting time in the health facilities for service is fair, about 3 % said that the distance from the residential areas to clinics is far. In terms of facility lighting at night, 57 % of the respondents reported good lighting in the health centers and 3 %, reported poor lighting at night and further 87 % of the respondents reported to be accessing good diagnosis services in the health centers. Finally, in majority of patients rated the quality of health services are good and excellent.

> Nowadays, we are extremely excited with the services we receive in the health facility, immunization services are available, the good quality care offered by the health workers is overwhelming. Through access to electricity, it has really improved the maternal health, we can safely deliver at night."
>
> Patient at Ofua HC III

3.5 Performance of installed solar PV systems

Solar PV performance is achieved by in depth analysis of the solar generation and load analysis of the utility. For the case of the six health centers' Hybrid systems, the main focus in this report is generation and discharge analysis. The generation explains key indicators on performance of plant system components such as solar, protective mechanism such as surge arrestor and breakers. The battery status explains the health and lifeline of the battery. Based on commercial operation date, generation the inverter and battery storage system are stored in the growatt data. server.growatt.com. The (Table 14) below shows the solar PV generations and consumptions in each health center.

Table 13: Summary analysis of the six health centers.

S/N	NAMEOFPLANT	PLANT SIZE (kWp)	DATE OF OPERATION	DAILY AVERAGE GENERATION (kWh)	DAILY AVERAGE CONSUMPTION (kWh)
1	Imvepi	4.4	Apr-21	6	3
2	Ofua	3.3	Aug-21	2	0.2
3	Siripi	3.3	Aug-21	4	1.8
4	Yinga	2.75	May-21	2.5	1
5	Ocea	4.4	Feb-21	10	6
6	Oduobo	3.3	May-21	7.5	4

Imvepi HC

Imvepi has a plant of 4.4kWp. This plant was put on operation in April 2021, the plant produced a total of 1358.1kWh in 2021 with 556kWh discharged from battery storage. Solar generation has been at a constant of 150-160kWh with the maximum peak being achieved between January and March 2022 as elaborated in (Figure 9 and 10). Daily production and discharge obtain a smooth belly shape with daily peaks being achieved at 10-11 am as illustrated in (Figure 10). The plant consumption on a daily basis is at 3kWh. per day, thus the generated surplus per this system is 1.8kWh, with the design the hospital can have an additional load rated 1.5kWh per day. However, the plant has had a significant drop performance as illustrated by the graphical analysis of (Figure 10). The drastic shift of reduced performance started from September, October 2021 to January 2022 as indicated in the graphical representation (Figure 14 and 15). There were some dates between October 2021 and January 2022 in which the data was not available in this case either there was no power generated or lack of internet.

Ofua HC

This is 3.3kWp plant operationalized on August 2021, the plant potentially generated 604kWh with half of it being discharged by the battery cells. The plant generated average of 2kWh per day and supports a constant load of 0.2KWh

Siripi HC

The plant is 3.3kWp operationalized on August 2021 and has been on optimal performance, the average production per day is at 4kWh, the average consumption in a day is 1.8kWh. 590kWh was generated by the plant from august to De-

cember 2021, the discharge is low at 107kWh, the major loads were effective during the day as illustrated in (Figure 9,10 and 16).

Yinga HC
The plant is 2.75kWp operationalized on May 2021.The plant had a constant performance at inception with increase in generation for consecutive months. The plant had a daily generation curve averaging at 2.5kWh, the consumption averages at 1kWh. However during the month of September and October 2021 the plant underperformed. Between October and November, the performance improved.

Ocea HC
The plant is 4.4kWp, since operationalized in February 2021, the plant has had a constant power generation hitting 675.6kWh at the close of the year 2021, the battery SOC is at optimal level, the power supplied by the solar and the storage system surpasses the load demand as illustrated in graphical analysis fig 5,6 and 15. The plant supports a constant average load of 6kWh, the daily production averages at 10kWh. The belly shaped curve has been achieved with the peak supply being recorded from 10-12pm on the daily basis. The drop of performance is illustrated between May and June 2021. This may be due to change in weather pattern or one of the solar panels failing to maintain its peak power, cleanliness of panels also has performance effects, if there is dust settling on the panels.

Oduobo HC
The plant had excellent solar generation as displayed in appendix 15, the plant is 3.3 kWp operationalized in May 2021, it generates average of 7.5kWh per day with 4kWh being consumed in this facility. The excess surplus can support a load of 3.5kWh rated machine. In 2022 it has had a high peak of 788kWh from January to April 2022. The generation is enough with excess energy sufficient for additional loads.

3.6 Operation and Maintenance energy systems

Solar Now provided training on the basic operation and maintenance of the Solar PV systems in the six HC. Staff trained in each health centers on O&M team was assigned a particular duty of regularly monitoring and addressing the O&M needs of all the solar systems installed. In line with Solar Now contract with GIZ, they will ensure continuous 24/7 operation of the healthcare facility's solar power system, including training of preventive and basic operation and maintenance of selected key staff of the HC, monitoring the system remotely, and carrying out repairs for a period of 24 months after the date of commissioning. Further, Solar Now advised health centers technicians in charge to report any complaint in case of any fault to them. Therefore, maximizing the performance of any PV system is one of the priorities of the users and the installation team and therefore the HC could maximize on performance through routine maintenance to ensure the PV system operates optimally. The whole purpose of conducting a routine maintenance is to minimize downtimes while maximizing return on investment. Further the outcome study has showed that all six health centers had 100% solar PV system functional, with some reporting minor challenges such as; bulbs burnt out in all 6 HC and trunkings from the power room were short exposing the cables.

Further, there were no warning notices or warning labels provided as required in all electrical installations on the doors to the power rooms that houses the batteries, inverters and DC circuit breakers to alert the operator. Dry power type fire extinguishers were absent in the power room. As a measure each O& M team in each HC, should be given a guideline and a checklist on how to operate and maintain the PV system

so that they can gain continuous understanding and know on management of the system. They should also provide clear sustainability measures to be followed by the health centers, however none of the facilities reported to have received any sustainability measures or procedures.

While the solar system is supposed to be monitored and taken care of by Solar Now and its team, it is important for the end user to understand the basic operations of the system so as to utilize it effectively and derive its maximum benefits. From the outcome study, out of all the six health centers, its reported that only one health center had a professional technician who was able to operate and check on the maintenance of the solar, while in the other health centers in case of a fault they had to inform the Solar Now to repair. Therefore, more training on maintenance should be administered to those in charge of the solar PV system.

Secondly, they should come up with strategic energy plan on operation and maintenance of the solar PV system. This project also has a component for income generation from installed electricity using Solar Kiosks to provided services to community through charging phones, lamps, computers etc. and the funds generated would be used to maintain items like replacing bulbs, sockets, exposed wires etc. This activity had not been implemented during outcome study period in April 2022.

Finally, if frequent maintenance of the solar system is not done, while the power usage runs for 24hours, this will drain the battery life and longevity of the Solar PV system. This would mean that battery would have to be replaced more frequently than if it were to be charged and discharged regularly. Thus, the training of the HC staff in this regard would be of importance to ensure sustainability of the Solar system, in doing so, the good functionality status of the solar PV systems at the health center will assist in saving lives, saving the environment and saving money.

> We are ready to use the solar kiosk when installed to charge our lamps, torches and phones. This is a good idea and we work hard to protect so that it can improve our lives. The funds generated can be placed to good use to maintain and repair the solar in case of damage."
>
> FGD participant Ofua level III HC

This study assessed the situation of solar energy project across the six health centers in order to present an accurate picture of the effect of electricity access on healthcare service delivery.

Summary

All the 6 HCs were installed with solar PV systems and they operate at an average of 8 to 24 hours daily. The normal opening hour of a facility for outpatient services is from 8:00 AM and the closing time is 5:00 PM in the evening. In terms of emergency services, it was reported that services may be affected only during rainy seasons when power generation is low. During such conditions, the HCs with backup generators use them to supplement power needs.

This outcome study reveals that during rainy season, the amount of power supply is lower than during the dry season, therefore some of the services that require electricity might not operate during the night of the rainy season. Emergency and delivery services are subject to the need of the patient, and hence require access to electricity on demand. Low supply of power during this rainy season significantly affects the ability of the HCs to provide the required service, therefore there is need for a working standby diesel generator for emergency cases and portable lamp for lighting.

4. CONCLUSION

The study aimed to provide an intermediate outcome-level information on the six health centers and service provision status, which GIZ solarized and electrified in Rhino camp and Imvepi Refugee settlements in the two districts (Terego and Madi Okollo). The findings show that health centers need power for their daily operations, especially in laboratories, operating rooms, maternity, and clinics. These departments require electricity to power the lights, computers, communication, refrigerate vaccines, and use life-saving medical devices, which, when fails, puts lives at risk.

Service provision increased in all health centers i.e., Imvepi HC reported an additional service from offering 21 services in 2021 to providing 22 services by the time the outcome study was conducted in 2022, while Ocea HC reported to be offering 3 additional services from the reported 31 in 2021 to 34 in 2022, Odoubu HC, recorded a substantial increase of 10 health services and both Siripi HC and Ofua HC, reported an increase of 6 additional services. The increase in the provision of health services can be attributed to the availability of solar power, which in turn resulted in more use of powered hospital appliances such as vaccine refrigerators and powered lab equipment.

Operation and maintenance of solar PV systems in the six HCs is low, although the contractor provided training on the basics of the maintenance of the solar system. The study established that only Ofua HC had a professional technician who could operate fault in the solar system. This result shows a need for the health centres to have a professional who will ensure proper maintenance on aspects such as solar panel cleaning, inverters, sockets and bulbs of the solar PV system to ensure its sustainability. Finally, the income generated by energy kiosks constructed in each health facility is intended to be used to either buy repairs or maintenance of the solar PV system. However, these kioks are not yet operational, hence no analysis can be done, as to their effectiveness in financing O&M activities. Therefore, urgent action is required since its of importance to the sustainability of the Solar PV system.

Overall, the outcome study findings show a general improvement in the services provided by the hospital facilities. Solar electrification has a general positive effect on the level of service provision, especially in remote areas as is the case in the 6 health centers. While the results of the study can attribute some improvements to the electrification intervention, a concrete cause and effect cannot be drawn from this study, for this a more detailed random control trial study would need to be conducted comparing the study areas and similar health centers.

5. RECOMMENDATIONS

Operation and Maintenance

- The health centers management should budget for operational and maintenance costs to ensure that funds are available in all the facilities to cover repairs and spare parts. Solar Now and GIZ should advice HC management on maintenance funds tobe established upfront and be dedicated only to solar system repair. Mixing maintenance funds with general operating budgets has proven to be an ineffective model.
- Routine maintenance should be carried out and the health centers should hire a local-professional technician from Arua to perform a semi-annual maintenance check, examine wiring connections, mounting bolts, and inverter operation and be on call to fix the system if it does not work. This service may cost each HC between USD 100 and USD 15
- For systems incorporating battery banks, regular maintenance of batteries is essential; batteries should be checked regularly and every 3 months. If properly maintained, the batteries should last several years before needing replacement
- The health facility should provide training to both the technician and all their staff members on the basics of operation and management of the solar system; the staff members also should be trained on which appliances can and cannot be supported by the solar system.
- All staff members should be trained on energy conservation like putting off power when not in used, putting off security lights during the day.

Health Facility characteristics

- The management should allocate funding for servicing and repairing the available equipments in the health centers and also ensure the equipments purchased are of good quality, durable and are energy-efficient
- The management should provide targeted support for medical equipment innovation.
- The management should prioritize clinical equipment needs and convene health & energy access stakeholders around medical equipment.

Health care service delivery

- To enhance impact of health center electrification, installation of PV systems should prioritize HCs that operate at night and those with staff quarters, because they are more likely to effectively use systems. This is because at night they can make use of ultra sound machines, incubators and lighting in maternity wards to conduct safe delivery, and be able to do laboratory tests and diagnosis using the microscope.

Solar system Design

- Since sterilization autoclaves requires upto 84 kWh/day to perfume optimally, hence high power consumption, then the HC should consider cheaper option such as Electric dry heat sterilizer.
- Provide dry powder-type fire extinguisher for PV solar system installed, especially in the power room.
- All systems should always be made online to allow the plant to record data into the server; this will ensure smooth data verification, monitoring, and troubleshooting. The plants in the remote areas or places with a poor internet connection to be improved by the addition of extra stronger antennas by the installation team.
- Imvepi, Siripi, Yinga, Ocea, and Oduobo plants have good power production; hence more loads can be shifted during the day. The major operations that necessitate higher power consumption can be done during the day to maximize the solar energy consumption produced.
- In practice, the design of the battery facility should consider easy access to each battery for service and the replacement of individual units without disassembling the whole battery system.

Accountability

- The stakeholders in the project should consider creating a specific solar PV management tasked with the responsibilities, accountability, and facilitation of the solar powers within the health centers. This management should be able to coordinate, organize, and be authorized to provide technical support and maintenance services that will benefit project development practices and reduce dependability while increasing ownership.
- The electrification project should be integrated with approaches that can create long-lasting socio-economic impact solutions beyond the healthcare facility as the end-users. The construction of the 'energy kiosk' will go a long way in ensuring ownership and accountability by its users are achieved.

APPENDICES

Appendix 1: Key informants

S/N	NAME	Position	Venue
1.	Kandaruku Stephen	Vaccinator	Yinga HC III
2.	Ajuma William	Lab Assistant	Yinga HC III
3.	Ogwang Jonny	Facility In charge	Ocea HC II
4.	Ateminga Kasim	Enrolled Nurse	Odoubu HC II
5.	Akuonzi Agustio	Medical Laboratory Technician	Odoubu HC II
6.	Dradria Timothy	Enrolled Nurse	Ofua HC III
7.	Candice Ismael	EPI Focal Person	Ofua HC III
8.	Kiloli David	Medical Laboratory Technician	Siripi HC III
9.	Asizuyo Flavia Okoboa	Enrolled Midwife	Siripi HC III
10.	Lekuru Judith	Lab assistant Nurse	Imvepi HC II
11.	Econi Daniel	Enrolled Nurse	Imvepi HC II
12.	Gordon Andima Eneku	Ass. Environment Officer	UNHCR
13.	Emmanuel Kerukadho	Ass. Public Health Officer	UNHCR Kampala
14.	Dr Annupake Gorge	Acting DHO	DHO's Office
15.	Muhamed Annule Marjid	Ass. Health Manager	IRC
16.	Amayo Obami Alphonse	Chairperson Yinga HC	Yinga HC III
17.	Ajeze Wilson	Chairperson	Rigbo subcounty Madi Akollo District
18.	Aea Luke	Sub county chief	Siripi
19.	Steven Oleva	Chairperson HUMC	Siripi HC III

Appendix 2: Health Centers electricity source

Health Centre	Health Centre level	Baseline	Outcome Study	Back up power
Yinga	III	Diesel generator	Solar	Diesel generator
Ofua	III	Diesel generator	Solar	Diesel generator
Siripi	III		Solar	
Oduobu	II		Solar	
Ocea	II	Diesel generator	Solar	Diesel generator
Imvepi	II		Solar	

Appendix 3: Health Facility Observation (data from 2021 UNHCR Balanced Score Card)

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
UNHCR Balanced Score Card: 2021 HF Observation												
Staffing	75%	63%	67%	78%	50%	44%	89%	89%	56%	56%*	No data	78%
Facility infrastructure	90%	81%	90%	90%	80%	95%	80%	100%	80%	86%	No data	86%
Infection control supplies	100%	100%	100%	100%	100%	100%	100%	100%	88%	100%	No data	100%
Lab infrastructure equipment	70%	70%*	No data	100%	No data	90%	No data	No data	No data	No data	No data	No data
Equipment for consultations	77%	77%	69%	92%	100%	100%	62%	100%	54%	92%	No data	85%
Common equipment for consultation	77%	77%	90%	92%	100%	100%	62%	100%	54%	92%	No data	85%
Vaccines	90%	90%	90%	90%	90%	90%	100%	90%	80%	80%*	No data	90%
HIS	60%	80%	60%	80%	80%	60%	40%	80%	60%	40%	No data	60%
General medicine supply management	95%	55%	95%	88%	98%	80%	93%	95%	70%	80%	No data	89%
General medicines	100%	37%	95%	84%	100%	74%	89%	95%	63%	79%	No data	89%
Medicine management protocols	75%	100%	100%	100%	100%	100%	100%	100%	88%	88%	No data	88%

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
General facility protocols	73%	64%	55%	91%	100%	100%	91%	100%	73%	88%	No data	73%
Nutrition	100%	100%	100%	100%	100%	100%	100%	100%	100%	89%	No data	100%
Overall HF Observation	80%	78%	80%	91%	89%	85%	82%	96%	73%	81%	No data	84%

Appendix 4: Immunization (data from 2021 UNHCR Balanced Score Card and 2022 Health Facility Study)

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
UNHCR Balanced Score Card: 2021 Immunization												
Cold Chain	No data	90%	100%	90%	90%	90%	90%	80%	100%	90%	90%	95%
Program quality	No data	100%	95%	89%	100%	95%	89%	95%	89%	79%	84%	89%
Observation of EPI session	No data	82%	87%	96%	100%	89%	96%	91%	91%	100%	87%	91%
Overall Immunization	No data	83%	94%	92%	97%	91%	92%	89%	93%	90%	87%	92%
Health Facility Survey: 2022 outcome study												
Frequency of routine full child immunization services at facility	Weekly		Weekly		Weekly		Weekly		Weekly		Weekly	
Frequency of routine full child immunization services as outreach	Weekly		Weekly		Monthly		Weekly		Monthly		Weekly	
Facility has refrigerator available and functioning for storage of vaccines	Yes		Yes		Yes		Yes		Yes		Yes	
Type of energy source for vaccine refrigerator	Solar		Solar		Solar		Solar		Solar		Solar	
Energy source supply power to the refrigerator 24 hours a day for 7 days in the week	Yes		Yes		Yes		Yes		Yes		No Yes	

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Thermometer available for monitoring refrigerator temperature	Yes		Yes		Yes		Yes		Yes		Yes	
Continuous temperature recorder or logger available for monitoring refrigerator temperature	Yes		Yes		Yes		Yes		Yes		Yes	
Temperature of refrigerator monitored twice daily	Yes		Yes		Yes		Yes		Yes		Yes	
Temperature log has been completed for the last 30 days	Yes		Yes		No		Yes		Yes		Yes	
Temperature has been out of range of 2 to 8 degrees Celsius inclusive in the last 30 days	In range		In range		Out of range		Out of range		In range		Out of range	
Items for immunization available on day of interview												
Auto-disposable syringes	Yes		Yes		Yes		Yes		Yes		Yes	
Sharps container/ safety box	Yes		Yes		Yes		Yes		Yes		Yes	
Vaccine carrier/ cold box	Yes		Yes		Yes		Yes		Yes		Yes	
Set of ice packs for vaccine carriers	Yes		Yes		Yes		Yes		Yes		Yes	
Immunization cards	Yes		Yes		Yes		Yes		Yes		Yes	
Official immunization tally sheet	Yes		Yes		Yes		Yes		Yes		Yes	
Official immunization registers	Yes		Yes		Yes		Yes		Yes		Yes	
Vaccines available on day of interview												
Measles vaccine and diluent	Yes		Yes		Yes		Yes		Yes		Yes	
DPT-Hib-HepB (Pentavalent)	Yes		Yes		Yes		Yes		Yes		Yes	
Oral polio vaccine	Yes		Yes		Yes		Yes		Yes		Yes	
Stock out in the last 3 months	Yes		Yes		Yes		Yes		Yes		Yes	
Measles vaccine and diluent	Yes		Yes		Yes		Yes		Yes		Yes	
DPT-Hib-HepB (Pentavalent)	Yes		Yes		Yes		Yes		Yes		Yes	
Oral polio vaccine	Yes		Yes		Yes		Yes		Yes		Yes	
BCG vaccine and diluent	Yes		Yes		Yes		Yes		Yes		Yes	
Rotavirus vaccine	Yes		Yes		Yes		Yes		Yes		Yes	
Pneumococcal vaccine	Yes		Yes		Yes		Yes		Yes		Yes	
Inactivated polio vaccine	Yes		Yes		Yes		Yes		Yes		Yes	

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Human papillomavirus vaccine	Yes		Yes		Yes		Yes		Yes		Yes	
Stock out in the last 3 months												
Measles vaccine and diluent	No		No		No		No		No		No	
DPT-Hib-HepB (Pentavalent)	No		No		No		No		No		No	
Oral polio vaccine	No		No		No		No		No		No	
BCG vaccine and diluent	No		No		Yes		No		No		No	
Rotavirus vaccine	No		No		No		No		No		No	
Pneumococcal vaccine	No		No		No		Yes		No		No	
Inactivated polio vaccine	No		No		Yes		No		No		No	
Human papillomavirus vaccine	No		No		No		No		No		No	

Appendix 5: Reproductive Health and Obstetric and Neonatal Care
(data from 2021 UNHCR Balanced Score Card and 2022 Health Facility Survey)

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
UNHCR Balanced Score Card: 2021 RH Assessment												
Basic RH protocols	No data	100%	No data	100%	33%	100%	100%	100%	33%*	33%	33%	100%
Protocols	67%	94%	56%	94%	50%	100%	100%	100%	81%*	81%	81%	94%
Detailed RH/HIV protocols	88%	92%	46%	92%	46%	100%	100%	100%	85%*	85%	77%	92%
Referrals	92%	100%	100%	100%	100%	100%	100%	100%	No data*	No data	100%	100%
Maternal nutrition	100%	100%	100%	100%	50%	100%	100%	100%	100%*	100%	100%	100%
RH medicines	78%	89%	100%	100%	89%	61%	100%	89%	89%*	89%	78%	89%
RH equipment	100%	75%	100%	100%	100%	100%	75%	100%	100%*	100%	100%	100%
RH HIS	75%	75%	100%	100%	100%	100%	100%	75%	100%*	100%	100%	100%
ANC observation	88%	88%*	91%	81%	91%	76%	93%	93%*	76%*	76%	69%	81%
PNC observation	92%	92%*	92%	92%	83%	83%	96%	96%*	83%*	83%	71%	92%

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Overall RH Assessment	84%	87%	77%	95%	78%	89%	95%	93%	80%*	80%	76%	94%
Health Facility Survey: 2022 Outcome study												
Interventions routinely carried out by HCWs at facility												
Oxytocin prevention for PPH	Yes		Yes		No		Yes		Yes		Yes	
Partograph use for labour mgmt	Yes		Yes		Yes		Yes		Yes		Yes	
Immediate and exclusive BF	Yes		Yes		Yes		Yes		Yes		Yes	
Hygienic cord care	Yes		Yes		Yes		Yes		Yes		Yes	
Thermal protection for newborn	Yes		Yes		Yes		Yes		Yes		Yes	
Interventions for mgmt. of complications of pregnancy in the last 12 months												
Parenteral admin of antibiotics mums	Yes		Yes		Yes		Yes		Yes		Yes	
Parenteral admin of oxytocic PPH	Yes		Yes		Yes		Yes		Yes		Yes	
Parental admin of MgSO4	Yes		Yes		Yes		No		Yes		Yes	
Assisted vaginal delivery	Yes		No		Yes		Yes		Yes		No	
Manual removal of placenta	Yes		No		Yes		Yes		Yes		Yes	
Removal of retained POC	Yes		Yes		Yes		Yes		Yes		Yes	
Neonatal resuscitation – bag+mask	Yes		Yes		Yes		Yes		Yes		Yes	
Caesarean section	No		No		No		No		No		No	
Blood transfusion	No		No		No		No		No		No	
Antibiotics for preterm or PROM	Yes		Yes		Yes		Yes		Yes		Yes	
Corticosteroids in preterm labour	Yes		Yes		Yes		Yes		Yes		Yes	
Kangaroo Mother Care	No		Yes		Yes		Yes		Yes		Yes	

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Injectable antibiotics – neonatal sepsis	Yes		Yes		Yes		Yes		Yes		Yes	
Availability of functional, basic equipment on day of interview												
Examination light (incl. torch)	Yes		No		No		Yes		Yes		Yes	
Delivery pack	Yes		Yes		No		Yes		Yes		Yes	
Cord clamp	Yes		Yes		Yes		Yes		Yes		No	
Episiotomy scissors	Yes		No		No		Yes		Yes		No	
Scissors or blade to cut cord	Yes		Yes		Yes		Yes		Yes		Yes	
Suture material with needles	Yes		Yes		Yes		Yes		Yes		Yes	
Needle holder	Yes		Yes		Yes		Yes		No		Yes	
UNHCR Balanced Score Card: 2021 RH Assesment												
Manual vacuum extractor	Yes		Yes		Yes		Yes		No		Yes	
Incubator	No		No		No		No		No		No	
Disposable latex gloves	Yes		Yes		Yes		Yes		Yes		Yes	
Blank partograph	Yes		Yes		Yes		Yes		Yes		Yes	
Delivery bed	Yes		Yes		Yes		Yes		Yes		Yes	
Resuscitation table with heat source	Yes		No		Yes		No		No		Yes	
Newborn bag+mask size 1 (term)	Yes		Yes		Yes		Yes		Yes		Yes	
Newborn bag+mask size 0 (preterm)	Yes		Yes		Yes		Yes		No		Yes	
Electric suction pump	No		No		Yes		No		No		No	
Suction catheter	No		No		Yes		No		No		Yes	
Suction bulb, single use	Yes		No		Yes		No		Yes		No	
Suction bulb, multiple use	No		Yes		Yes		Yes		Yes		Yes	
Speculum	Yes		Yes		Yes		Yes		Yes		Yes	
Infant weighing scale	Yes		Yes		Yes		Yes		Yes		Yes	
Blood pressure apparatus	Yes		Yes		Yes		Yes		Yes		Yes	
Cleaning running water	Yes		Yes		Yes		Yes		Yes		Yes	
Hand washing soap/ liquid soap	Yes		Yes		Yes		Yes		Yes		Yes	

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Alcohol based hand rub	Yes		Yes		Yes		Yes		Yes		Yes	
Availability of valid (unexpired) medicines and commodities on day of interview												
Antibiotic eye ointment for newborn	Yes		Yes		Yes		Yes		Yes		Yes	
Gentamicin injection	Yes		No		No		Yes		Yes		Yes	
Ampicillin powder for injection	Yes		Yes		Yes		Yes		Yes		Yes	
Hydralazine injection	Yes		No		No		Yes		Yes		No	
Metronidazole injection	Yes		Yes		No		Yes		Yes		Yes	
Azithromycin cap/tab or oral liquid	Yes		Yes		No		Yes		Never avail.		Yes	
Cefixime cap/tab	Yes		Yes		No		Yes		Never avail.		Yes	
Benzathine benzyl penicillin powder	Yes		Yes		Yes		Yes		Yes		Yes	
Nifedipine cap/tab 10mg	Yes		Yes		No		Yes		Yes		Yes	
Methyldopa tab	No		Yes		No		Yes		Yes		Yes	
Calcium gluconate injection	Yes		Yes		No		Yes		Yes		No	
Magnesium sulphate injectable	Yes		Yes		No		Yes		Yes		Yes	
Skin disinfectant	Yes		Yes		Yes		Yes		Yes		Yes	
IV solution with infusion set	Yes		Yes		Yes		Yes		Yes		Yes	
Sodium chloride injectable solution	Yes		Yes		No		Yes		Yes		Yes	
Dexamethasone injection	No		Yes		No		Yes		Yes		Yes	
Oxytocin injection	No		Yes		No		Yes		Yes		Yes	
Oxytocin stored in cold storage	Yes		Yes		Yes		Yes		Yes		Yes	
Notes	Vaccine carrier		Vaccine carrier		Vaccine carrier		Vaccine carrier		Vaccine carrier		Vaccine carrier	
Qualitative Interview of Midwife												
Equipment that cannot be used because of inadequate electricity in maternity ward							Oxygen concentrator, ECG		TV		Resuscitation table with heat source, oxygen concentrator	
Hours of available lighting in maternity												
Dry season (Jan 2022)	No data		7.5 hr		11 hr		7 hr		10 hr		10 hr	

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Rainy season (Sep 2021)	No data		3 hr		7 hr		4 hr		7 hr		6 hr	

Appendix 6: Diagnostics (data from 2021 UNHCR Balanced Score Card and 2022 Health Facility Survey)

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
UNHCR Balanced Score Card: 2020 Lab Assessment												
General conditions of lab structure	100%	100%	83%	83%	100%	100%	50%	100%	67%	67%	17%	33%
Utilities and lab structure	8%	50%	67%	67%	83%	67%	50%	25%	50%	58%	25%	58%
Biosafety, hygiene, and security	81%	75%	88%	88%	100%	81%	81%	75%	94%	100%	69%	75%
Specimen collection, handling, recording	75%	67%	83%	83%	75%	83%	100%	100%	92%	92%	83%	100%
Equipment and supplies	32%	19%	32%	32%	39%	26%	32%	26%	19%	23%	23%	48%
Reagents and supply	50%	42%	58%	58%	58%	42%	75%	58%	50%	58%	58%	75%
Analysis and test performed	19%	35%	60%	60%	38%	100%	90%	43%	52%	58%	45%	42%
Lab staff and working date	80%	80%	60%	60%	80%	100%	80%	60%	60%	80%	80%	80%
Reporting, surveillance, analysis and communication	82%	76%	88%	88%	82%	65%	94%	100%	76%	94%	88%	100%
Quality assurance	33%	44%	75%	75%	67%	67%	85%	68%	67%	76%	65%	85%
Outbreaks – outbreak participation	100%	75%	100%	100%	75%	100%	100%	100%	100%	100%	100%	100%
Overall Lab Assessment	60%	60%	72%	72%	72%	76%	76%	69%	66%	73%	59%	72%
Health Facility Survey: 2022 Outcome study												
Accredited/certified microscopist at facility	No		Yes		No		Yes		Yes		Yes	
Functional basic equipment for diagnostics available on day of interview												
Light microscope	No		Yes		Yes		Yes		Yes		Yes	
Fluorescent microscope	No		No		No		Yes		No		No	
Refrigerator	No		Yes		Yes		Yes		Yes		Yes	
Glucometer	Yes		Yes		Yes		Yes		Yes		Yes	
HemoCue	Yes		Yes		Yes		Yes		Yes		Yes	

In the last 30 days, have you needed to use any of the electric diagnostic equipment but could not do so because you did not have electricity?	No	No	No	No	No	No
Notes						
In the last 30 days, have you needed to use any of the imaging equipment but could not do so because you did not have electricity?	NA	No	NA	NA	NA	NA

Appendix 7: Blood transfusion services (data from 2022 Health Facility study)

Data Source	Health Centre II			Health Centre III		
	Imvepi HC II (Imvepi)	Ocea HC II (Rhino Camp)	Odoubu HC II (Rhino Camp)	Yinga HC III (Imvepi)	Siripi HC III (Rhino Camp)	Ofua HC III (Rhino Camp)
Health Facility Survey: 2022 outcome study assessment						
Facility offers blood transfusion services	No	No	No	No	No	No
Any interruptions in blood availability in the past 3 months	NA	NA	NA	NA	NA	NA
Facility has functional refrigerator for storage of blood	No	No	No	No	No	No
Energy source used for blood refrigerator	NA	NA	NA	NA	NA	NA
Energy source supply power to refrigerator for 24 hours a day and for 7 days in the week	NA	NA	NA	NA	NA	NA
Has temperature been out of range of 2 to 6 degrees Celsius inclusive in the last 30 days	NA	NA	NA	NA	NA	NA
Facility has guidelines on appropriate blood use and safe transfusion practices	NA	NA	NA	NA	NA	NA
Facility has received training in appropriate use of blood and safe transfusion practices in the last 2 years	NA	NA	NA	N/A	NA	Yes

Appendix 8: Client Interview outcome (data from 2021 UNHCR Balanced Score Card)

Data Source	Health Centre II						Health Centre III					
	Imvepi HC II (Imvepi)		Ocea HC II (Rhino Camp)		Odoubu HC II (Rhino Camp)		Yinga HC III (Imvepi)		Siripi HC III (Rhino Camp)		Ofua HC III (Rhino Camp)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
UNHCR Balanced Score Card: 2021 Client Interviews												
Beneficiaries satisfaction score	83%	83%	94%	83%	83%	91%	94%	74%	89%	89%	94%	91%

General clients satisfaction score	89%	71%	76%	88%	75%	87%	79%	82%	83%	76%	84%	84%
Overall Client Interviews	86%	77%	85%	86%	79%	89%	87%	78%	86%	83%	81%	88%

Appendix 9: Processing Equipment for Reuse (Sterilization) outcome (data from 2022 Health Facility Study)

Data Source	Health Centre II			Health Centre III		
	Imvepi HC II (Imvepi)	Ocea HC II (Rhino Camp)	Odoubu HC II (Rhino Camp)	Yinga HC III (Imvepi)	Siripi HC III (Rhino Camp)	Ofua HC III (Rhino Camp)
Health Facility Survey: 2022 outcome study assessment						
Available and functional equipment used for processing of equipment for reuse on day of interview						
Electric autoclave	No	No	No	No	Yes	No
Non-electric autoclave	Yes	Yes	Yes	Yes	Yes	Yes
Electric dry heat sterilizer	No	No	No	No	No	No
Electric boiler or steamer	No	No	No	No	No	Yes
Non-electric pot w cover for boil/steam	No	Yes	No	Yes	No	No
Heat source for non-electric equipment	Charcoal	Gas	Charcoal, gas	Gas	Charcoal	Gas, solar
In the last 30 days, have you needed to use any of the electric items for processing of equipment for reuse but could not do so because you did not have electricity	N/A	No	N/A	N/A	N/a	No

Appendix 10: Status of Electrification (data from 2022 Outcome study Health Facility Survey)

Status of Electrification	Health Center II			Health Center III		
	Imvepi HC II (Imvepi)	Ocea HC II (Rhino Camp)	Odoubu HC II (Rhino Camp)	Yinga HC III (Imvepi)	Siripi HC III (Rhino Camp)	Ofua HC III (Rhino Camp)
Total Number of Power Sources regardless of functionality (Total number of FUNCTIONING OR PARTIALLY FUNCTIONAL power sources)						
Off-grid solar PV systems	Yes	Yes	Yes	Yes	Yes	Yes
Mobile Power (MoPo)	No	Yes	No	No	No	No
Diesel generators	No	Yes	No	Yes	No	yes
Petrol generators	No	No	No	No	No	No
EPI Solar Refrigerators	Yes	Yes	No	Yes	Yes	No
We Care Solar	Yes	-	No	No	No	No

Status of Electrification	Health Center II			Health Center III		
	Imvepi HC II (Imvepi)	Ocea HC II (Rhino Camp)	Odoubu HC II (Rhino Camp)	Yinga HC III (Imvepi)	Siripi HC III (Rhino Camp)	Ofua HC III (Rhino Camp)
Buildings Wired to Power Sources – Wired For Lighting (functional and dysfunctional)						
Outpatient department	Yes	Yes	Yes	Yes	Yes	Yes
Pharmacy	Yes	Yes	Yes	Yes	Yes	Yes
Laboratory	Yes	Yes	Yes	Yes	Yes	Yes
Inpatient ward	Yes	Yes	Yes	No	Yes	Yes
Maternity	Yes	Yes	Yes	Yes	Yes	Yes
HIV/TB Clinic	Yes	Yes	Yes	Yes	Yes	Yes
Nutrition Ward	Yes	Yes	Yes	Yes	Yes	Yes
SGBV Protection House	No	N/A	Yes	Yes	N/A	Yes
Security Guard House	No	Yes	Yes	No	No	Yes
Staff Quarters	Yes	Yes	No	No	Yes	Yes
Isolation Ward	N/A	No	Yes	No	No	Yes
Latrines + Bathing Shelters	No	No	No	No	No	No
Security lights	Yes	Yes	Yes	No	Yes	Yes
Medicine Stores	Yes	Yes	Yes	Yes	Yes	Yes
Buildings Wired to Power Sources – Wired to Sockets for communication or medical appliances (functional and dysfunctional)						
Outpatient department	Yes	Yes	Yes	Yes	Yes	Yes
Pharmacy	Yes	No	Yes	Yes	Yes	Yes
Laboratory	N/A	Yes	Yes	Yes	Yes	Yes
Inpatient ward	Yes	No	Yes	Yes	Yes	Yes
Maternity	Yes	Yes	Yes	Yes	Yes	Yes
HIV/TB Clinic	Yes	Yes	Yes	No	Yes	Yes
Nutrition Ward	N/A	N/A	N/A	Yes	N/A	No
SGBV Protection House	No	N/A	No	Yes	N/A	Yes
Security Guard House	No	Yes	Yes	No	Yes	Yes
Staff Quarters	Yes	Yes	No	No	No	Yes
Isolation Ward	No	No	Yes	No	No	Yes
Latrines + Bathing Shelters	No	No	No	No	No	No
Security lights	Yes	No	Yes	No	Yes	Yes
Medicine Stores	Yes	Yes	Yes	Yes	Yes	Yes

Appendix 11:Diesel generators coverage, functionality, reliability, and operation details (data from 2022 outcome study).

Diesel Generator	Health Center II			Health Center III		
	Imvepi HC II (Imvepi)	Ocea HC II (Rhino Camp)	Odoubu HC II (Rhino Camp)	Yinga HC III (Imvepi)	Siripi HC III (Rhino Camp)	Ofua HC III (Rhino Camp)
Coverage of power from diesel generator						
Diesel generator wired to	NA	Lab, IPD, OPD, HIV/TB clinic, 3/5 staff quarters	NA	OPD and lab	NA	IPD, lab, OPD, nutrition, isolation tent, security lights, shared staff hall, warehouse for storage of new and old equipment, data center, pharmacy
Electricity from diesel generator is designed for	NA	Backup	NA	All electrical needs of facility (lighting, communication, and other appliances)	NA	Backup
How frequently is diesel generator turned on	NA	NA	NA		NA	
Daytime		(Generator not installed)		As needed (mainly for lab)		As needed.
Nigh time				No		
Functionality diesel generator						
Generator functional on day of interview	NA	No	NA	Yes	NA	Yes
Note		New generator, not connected		Requires car battery to start generator		
Reliability of power from diesel generator						
During the past 7 days, was electricity at all times from the diesel generator available when it is turned on?	NA	NA (generator not connected)	NA	No interruptions	NA	Yes

Diesel Generator	Health Center II			Health Center III		
	Imvepi HC II (Imvepi)	Ocea HC II (Rhino Camp)	Odoubu HC II (Rhino Camp)	Yinga HC III (Imvepi)	Siripi HC III (Rhino Camp)	Ofua HC III (Rhino Camp)
How many days during the past week was electricity not available for at least 2 hours during a time when the facility was open for services and the diesel generator was turned on?	NA	NA (generator not connected)	NA	0 days	NA	0 days
Operational details of diesel generator						
Generator capacity (kVA)	NA	44 kVA	NA	NA	NA	NA
Donor or partner for diesel generator fuel	NA	NA	NA	NA	NA	NA
Fuel available for generator	NA	No*	NA	No*	NA	Yes
Average litres of fuel to keep generator running for service delivery every day	NA	NA	NA	NA	NA	20 liters
Average budget allocated to fuel diesel generator for service delivery (not ambulance) each month (UGX)		NA		NA		NA
Allocated fuel is enough to keep generator working	NA	No*	NA	No*	NA	Yes

Appendix 12: Availability of solar lighting on a typical night in the maternity ward during dry and rainy seasons (data from 2022 Outcome study)

Health Center	Availability of Lighting on a Typical Night in Maternity Ward During Dry Season (January 2021)	Availability of Lighting on a Typical Night in Maternity Ward During Rainy Season (September 2020)	Difference in Hours of Availability of Lighting Between Dry and Rainy Seasons
Imvepi HC II	7pm to 6am (11 hours)	7pm to 6am (11 hours)	0
Yinga HC III	7pm to 6am (11 hours)	7pm to 6 am (11 hours)	0
Siripi HC III	7pm to 6am (11 hours)	7pm to 5am (10 hours)	-1 hour
Ofua HC III	7pm to 6am (11 hours)	7pm to 5am (10 hours)	-1 hour
Ocea HC II	7pm to 6am (11 hours)	7pm to 5 am (10 hours)	-1 hour
Odoubu HC II	7pm to 6am (11 hours)	7pm to 5 am (10 hours)	-1 hour

Appendix 13: HC Energy trend analysis (Sample) - Details visit growatt data server.growatt.com

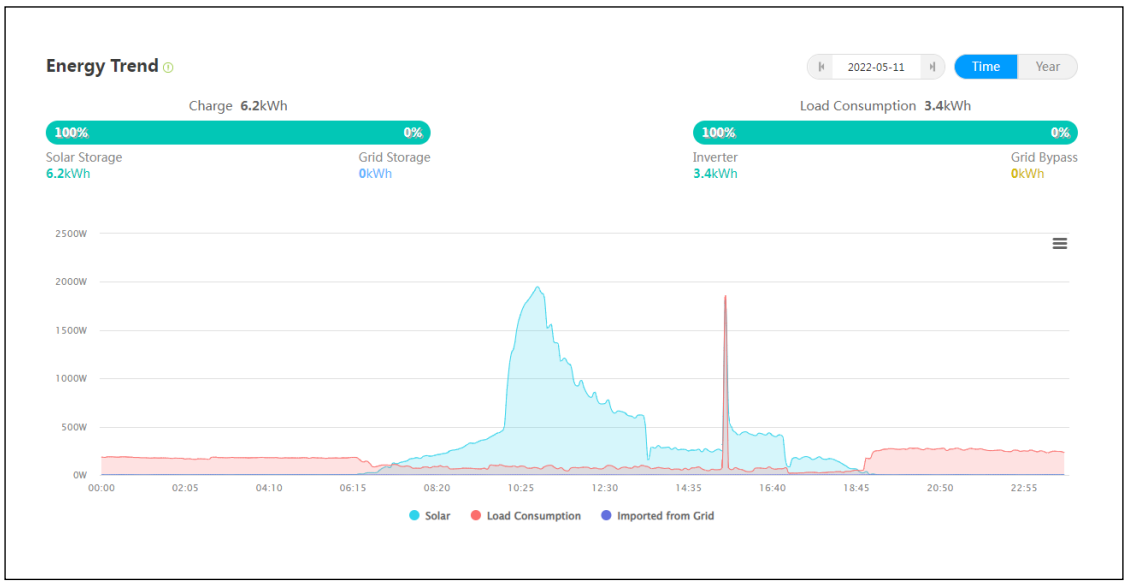

Figure 5: Graphical analysis of daily production on IMVEPI plant

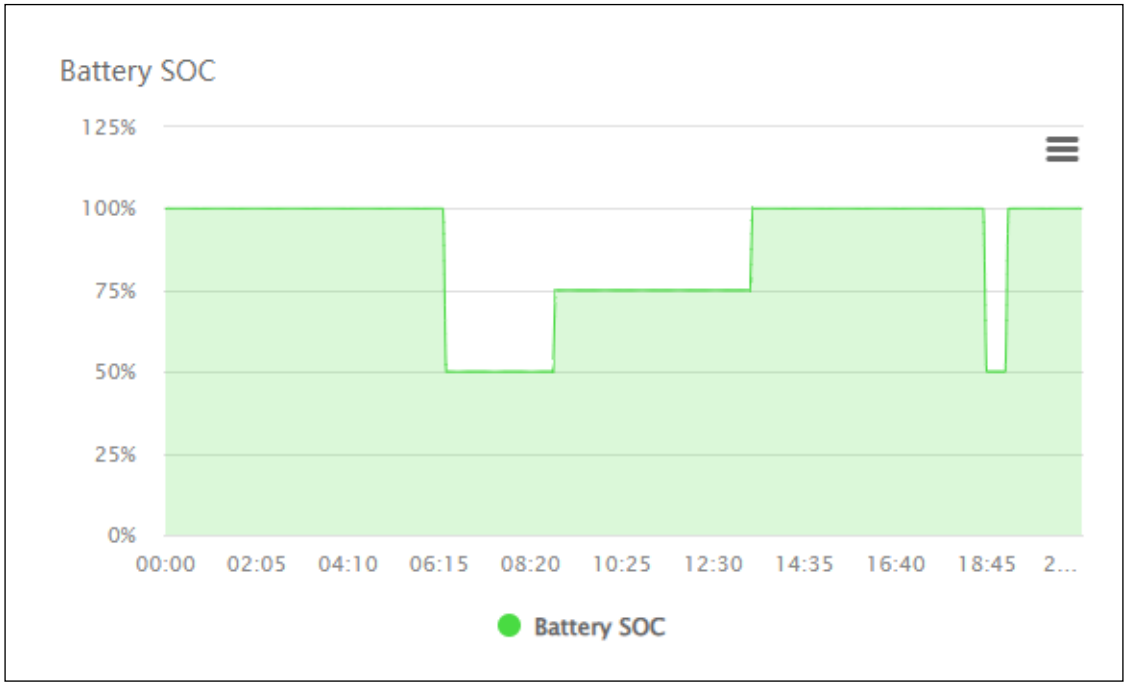

Figure 6: Battery discharge

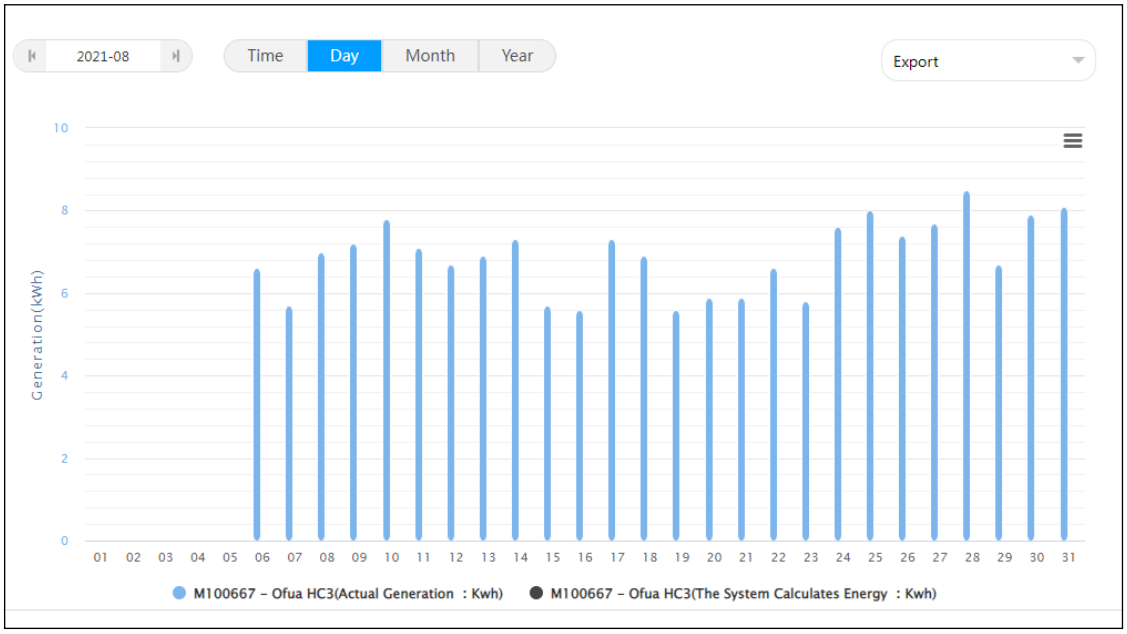

Figure 7: Ofua performance at the operationalisation of the plant

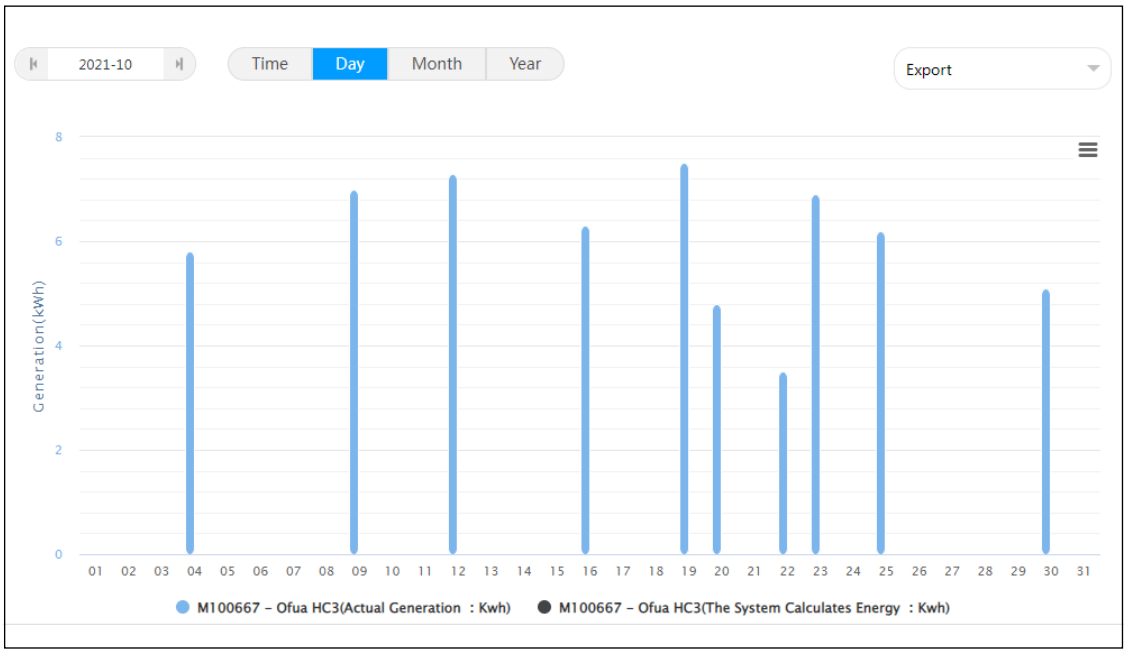

Figure 8: Ofua graphical representation of drop of performance

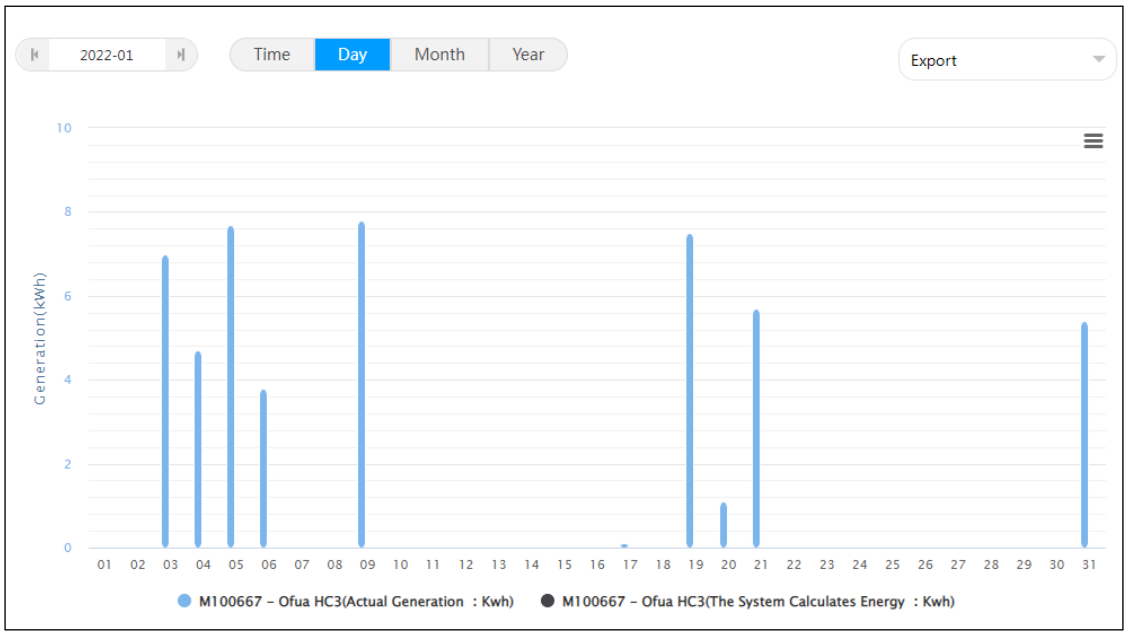

Figure 9: Ofua, low production and missing data

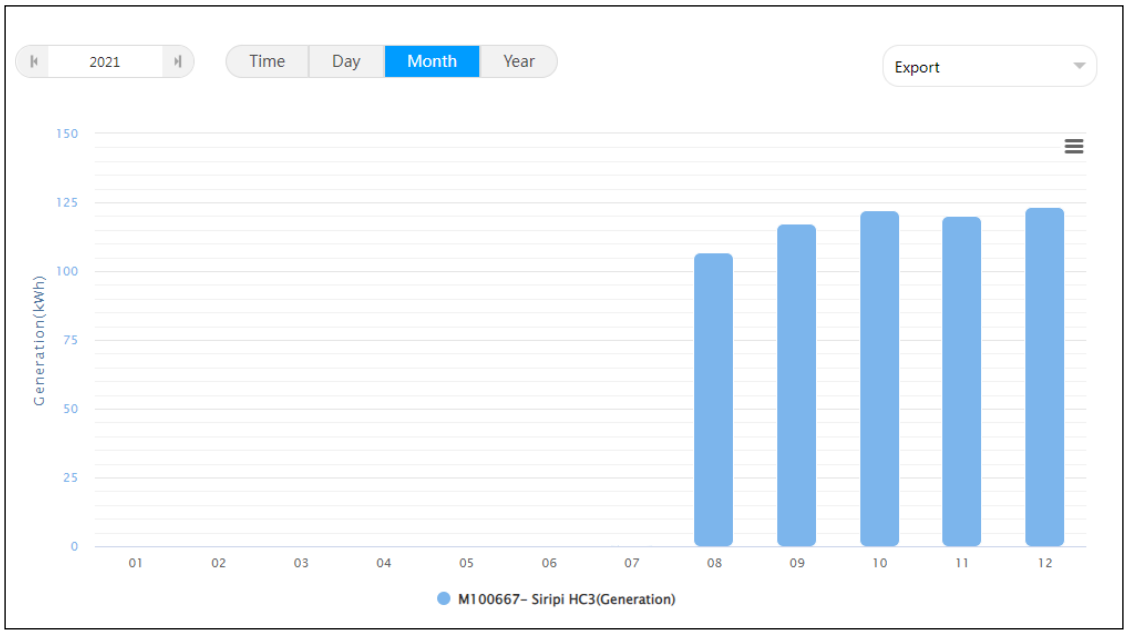

Figure 10: Graphical presentation of SIRIPI performance

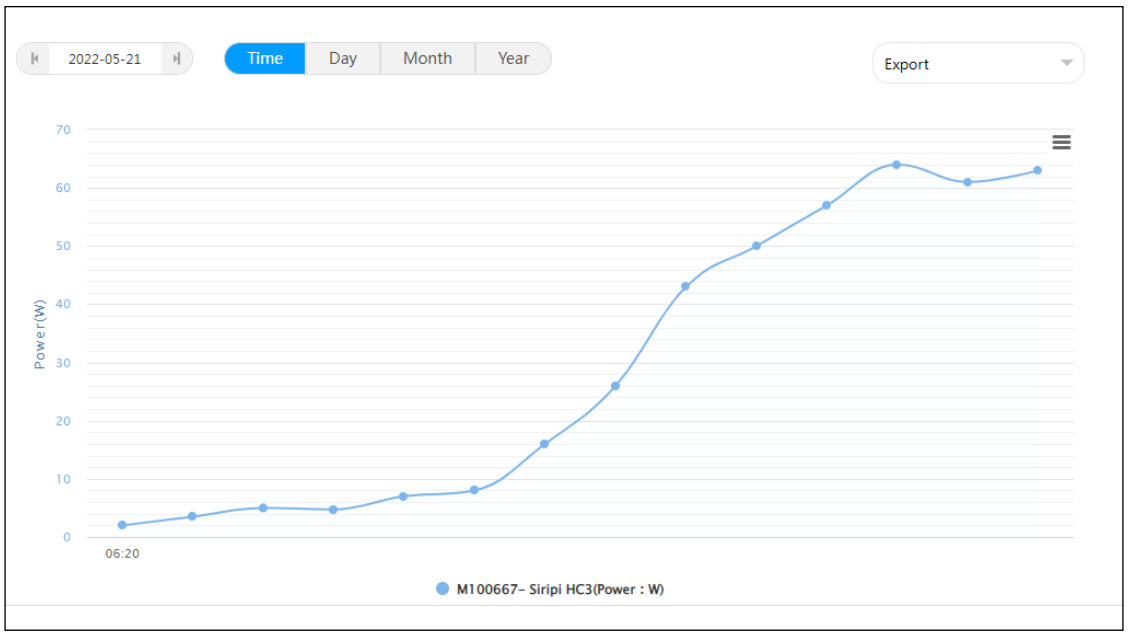

Figure 11: Illustration of effective loads during the day

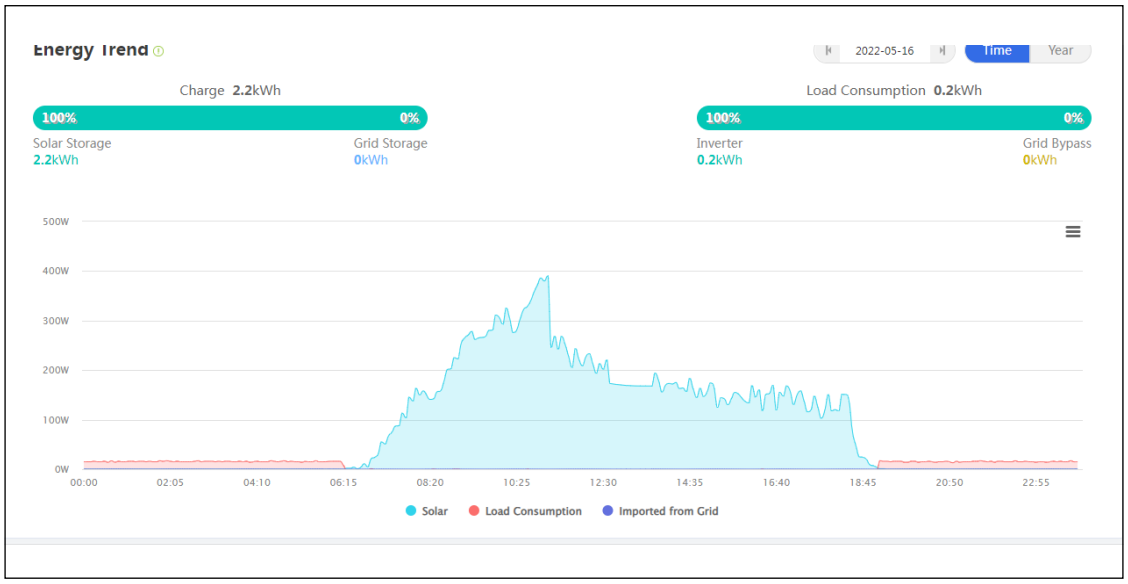

Figure 12: Graphical analysis of solar generation at OCEA health center

Appendix 14: Maintenance Guideline Checklist

The solar PV system operations and maintenance procedures deployed in different schedules shall include condition-based monitoring, curative and preventive maintenance, and panels cleaning. The schedule in the table below indicates the scope of works to be undertaken in an operation and maintenance procedure.

No.	Description	After 3 months	Bi-annually	Annually
1.	Scope of Works			
1.1.	General Housekeeping			
1.1.1.	If ground mounted, visually inspect perimeter fence/gate for signs of damage, corrosion, vandalism etc.		Check	
1.1.2.	If ground mounted, visually inspect entire site for debris/liter. Collect and remove from site (On Demand)		Check	
1.1.3.	If a residential/commercial development record and inform any variance in condition of the site. (i.e. construction works are under way, residential units vacated, signs of squatters etc.)	Check		
1.2.	Software Upgrades (on demand)			
1.2.1.	Upgrade equipment software as required for the following: • Inverters – Solar controllers • Routers - Data Loggers	Check		
1.3.	Inverter Maintenance			
1.3.1.	General Visual Inspection of the inverters and auxiliary equipment for any anomalies	Check		
1.3.2.	Record and validate production values from the Human Machine Interface (HMI) display	Check		
1.3.3.	• Visual Inspection and functionality test of all protective and safety equipment: • Leakage current circuit breakers • Line circuit breakers • Power switches	Check		
1.3.4.	Record and validate open circuit voltages	Check		
1.3.5.	Record and validate short circuit currents	Check		
1.3.8.	Record last logged system errors	Check		
1.3.9.	Thermal Imaging of terminations	Check		
1.3.10.	Clean the inside of the cabinet	Check		
1.3.11.	Test fans for proper operation	Check		
1.3.12.	Visual Inspection of all fuses	Check		
1.3.13.	Thermo-graphic photography of the fuses to check for hot spots	Check		

No.	Description	After 3 months	Bi-annually	Annually
1.3.14	Check torque on terminations	Check		
1.3.15	Check gasket seal	Check		
1.3.16	Confirm warning labels are in place	Check		
1.3.17	Look for discoloration from excessive heat build up	Check		
1.3.18.	Check integrity of lightning arrestors	Check		
1.3.19.	Check continuity of system ground and equipment grounding	Check	Check	
1.3.20.	Check mechanical connection of the inverter to the wall or ground	Check		
1.3.21.	Check internal disconnect for proper operation	Check		
1.3.22.	Verify that current software is up to date	Check		
1.3.23.	Document findings for all work performed	Check		
1.3.24.	Visual inspection of locking mechanism, check for signs of corrosion, vandalism etc.	Check	Check	Check

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