Solar Electric Cooking in Displacement Settings: Lessons from Dzaleka Refugee Camp

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In partnership with;

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Abbreviations

Ah	Ampere-hour
CARD	Churches Action in Relief and Development
DRC	Democratic Republic of Congo
EPC	Electric pressure cooker
ESMAP	Energy Sector Management Assistance Program
FCDO	Foreign, Commonwealth & Development Office
IMF	International Monetary Fund
kg	Kilogramme
kW	Kilowatt
kWh	Kilowatt hour
LPG	Liquefied Petroleum Gas
MECS	Modern Energy Cooking Services
MoDa	Mobile Operational Data Acquisition
MWK	Malawian Kwacha
$	United States Dollar
W	Watt
UNHCR	United Nations High Commission for Refugees
WFP	World Food Programme

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About WFP

The World Food Programme (WFP) is the world's largest humanitarian organization saving lives in emergencies and using food assistance to build a pathway to peace, stability and prosperity, for people recovering from conflict, disasters and the impact of climate change. A member of the UN family, WFP is governed by an Executive Board consisting of 36 Member States, which provides intergovernmental support, direction and supervision of WFP's activities.

About MECS

Modern Energy Cooking Services (MECS) is an eight-year research programme funded by UK Aid (FCDO). We are a geographically diverse, multicultural and transdisciplinary team working in close partnership with NGOs, governments, private sector, academia and research institutes, policy representatives and communities in 16 countries of interest to accelerate a transition from biomass to genuinely 'clean' cooking.

Executive Summary

This report discusses findings from an investigation into the progress of a three-year solar electric stove pilot project trialled in 61 households and a day-care centre in Dzaleka Refugee Camp, Dowa District, Malawi, starting in September 2022. A follow-up study was conducted 18 months after installation. The project was heavily impacted by the COVID-19 pandemic, which delayed the pilot start date, originally planned for 2020. Through household surveys and focus group discussions, the study found that although the Pesitho ECOCA devices were well-received by beneficiaries and several benefits were highlighted, including cost savings and health benefits, only 20% (12 households) of the cookers were still fully operational and in use. A further 29% of the devices were able to provide solar electric charging to beneficiaries' digital devices, such as mobile phones.

Several factors were identified as potentially contributing to the limited lifespan of solar electric cookstoves. These include, but are not limited to, insufficient training in maintenance and upkeep, overburdensome use, inadequate provision of aftercare and technical assistance, and a reported lack of cookstove robustness, particularly with regards to the battery.

In contrast, five of six solar electric cookstoves installed in an institutional setting, a day-care centre, were in regular and consistent use, by a small cohort of trained beneficiaries, who prepared simple foods, for the duration of the installation period, with few reported problems. The devices were extremely well regarded by the staff, with benefits from cooking (porridge and staff food), medicinal (hot water for treatment) and electric device charging perspectives (e.g. charging of e.g. phones).

This study discusses the solar electric pilot project background, focus group discussion, baseline and follow-up survey findings, and concludes with recommendations based on project learnings, for future initiatives of similar character.

1 Introduction

This report presents the findings from a follow-up survey and focus group discussions to learn from the experiences of several households, and a Children's Respite Day-care Centre, that participated in a solar electric project piloted by the World Food Programme (WFP) in Dzaleka Refugee Camp in Dowa District, Malawi. It provides background information on demographics, cooking habits, fuel situation, and sheds light on pilot participants' experience of a novel solar electric cooking system, between the pilot start date and follow-up survey undertaken in January 2024. It further offers key lessons learnt and recommendations for future pilots and projects aiming to implement solar electric solutions in similar contexts.

The pilot project was originally planned for May 2020 but roll-out was delayed until 2022, due to restrictions imposed because of the COVID-19 pandemic. From September 2022, the WFP undertook the distribution of 67 ECOCA cookstoves to households and a day-care centre in Dzaleka Refugee Camp. The primary objective was to pilot the viability of solar electric cooking within a humanitarian displacement setting. The stoves were sourced from Pesitho and acquired, assembled, and installed by a local technical partner. A qualified engineer oversaw the installation, providing them on a complimentary basis to 61 households. Additionally, six domestic stoves were allocated to a Children's Respite Day-care Centre for institutional use.

Pesitho is a start-up founded in 2018 that has set itself the challenge of giving the poorest access to renewable energy and clean cooking. It works in some of the most difficult to serve contexts, such as refugee camps. Pesitho ECOCAs are characterized by their compact, self-contained design and serve as versatile cooking units. They include solar panels, a battery pack, and well-insulated cooking pots designed to retain warmth for extended durations. Notably, these stoves feature two USB ports, facilitating solar charging of devices. Each unit was complemented by a rechargeable torch and lamp. WFP Malawi and WFP Innovation spearheaded the adoption of these cookers in Dzaleka Refugee Camp as a strategic response to energy challenges and deforestation concerns. Most households within Dzaleka Refugee camp heavily rely on locally sourced firewood and charcoal for cooking purposes, as evidenced both in the baseline survey and through this study's findings.

The cookers possess the capability to provide cooking energy for a family throughout a day, contingent upon weather conditions (sun availability) and battery capacity. The preliminary training results indicated the cooker's efficiency in heating water and preparing Malawian food, although the cooking time itself might be comparatively longer than with traditional fuels. It was acknowledged during training that users would need to acquaint themselves with and adjust their cooking methods based on factors such as the cooking pots, battery charge, and fluctuating daily solar radiation. A baseline survey with all households that were to receive the solar electric cookstoves was conducted in September 2022 to understand the pre-existing cooking behaviours and fuel use of targeted households in Dzaleka Refugee Camp. A follow-up initiative to assess the effectiveness of the intervention was undertaken between WFP and MECS in January 2024. The report describes the background to the pilot project and the cooking context, project findings, conclusions and recommendations.

2 Background

2.1 Dzaleka Refugee camp

Dzaleka Refugee Camp is located in Dowa district, approximately 41km from Lilongwe, the capital of Malawi. The camp was established in 1994 by the Government of Malawi and the United Nations High Commission for Refugees (UNHCR) and accommodates people fleeing genocide, violence, and wars, particularly from Central and Eastern African nations such as Burundi, Rwanda, the Democratic Republic of Congo (DRC), Ethiopia and Somalia. Consequently, a range of languages are spoken, although the lingua franca of the camp is Swahili. Currently it hosts over 53,000 refugees and asylum seekers, far more than the 10-12,000 people for which it was originally intended.

Image 2: Map of Dzaleka Refugee Camp and surrounding area (Google, January 2024)

2.2 Pilot Project background

Malawians rely heavily on firewood as a source of household energy, and cooking accounts for over 90% of household energy use in rural areas. Biomass used for cooking on inefficient cookstoves, along with agriculture expansion and tobacco growing, is a key driver of deforestation and the resultant detrimental environmental impacts on wildlife, biodiversity, and climate. In addition, cooking with polluting fuels – which over 90% of Malawi's population rely on for cooking - contributes to household air pollution and associated negative health outcomes (for example respiratory and cardiovascular disease). Firewood collection takes significant time and effort and is associated with the risk of gender-based violence (GBV) and attacks, especially against women and girls. Only around 12% of the population in Malawi are connected to electricity, with 42% of the urban population having access to electricity, and only 4% of the rural population.

Households in refugee settings have additional challenges, including acute financial insecurity, as well as increased risk of conflict with host communities and authorities, as locally sourced firewood becomes scarcer. 26% of those interviewed for the Dzaleka Refugee Camp baseline survey in 2022, reported conflict or incidents when collecting firewood. According to the baseline survey data, a higher proportion of those in refugee households pay for cooking energy (61%), compared to other households surveyed in Malawi (28%). In order to reduce household dependence on wood and charcoal in Dzaleka and reduce the financial burden on refugee households, alternative cooking solutions were considered by WFP, including solar electric.

WFP Malawi decided to trial an innovative new off-grid cooking solution, a solar powered, clean and efficient cooking system developed by Pesitho, a Danish company. The cooking systems also included two USB outputs for electrical devices, to charge home lighting devices (rechargeable 12W LED lamps and 6W torches were also provided by Pesitho) and other devices, such as mobile phones. The units comprised of a 275W solar panel (and a fixed metal frame), an electric cooker base unit (containing a 25.2 V, 24Ah Lithium iron phosphate battery) with USB outlets, and bespoke electric cookpots (6 litre double insulated stainless steel and safety glass 400W powered pots).

Image 3 & 4: Rechargeable torches, security lock and ECOCA cooking pots (JFT, January 2024)

Beneficiaries in Dzaleka refugee camp were chosen according to a range of criteria, which included literacy level (ability to read and write), phone ownership, female-headed households (40%+), household size, adequate space for mounting solar panel frames and storing securely and included both those involved in livelihood activities either under the WFP or UNHCR. A Children's Respite Day-care Centre in Dzaleka Refugee Camp - that caters daily for up to 140 children and young people with special needs - was also chosen to trial solar

electric cooking in an institutional environment, using six domestic sized 6 litre cookstoves. Schools and educational institutions are characterized by a high rate of student absenteeism and daily meals are a strong incentive for attendance.

A training of trainers was conducted by Pesitho in May 2022. Further, a training of trainers was delivered by the WFP in collaboration with Churches Action in Relief and Development (CARD), who was a partner of UNHCR in the camp. Once selected, household heads were invited for a one-day training course that was conducted and delivered by the WFP and Kuunika in May 2022. The units were distributed and installed by a contractor in August and September 2022.

2.3 Follow-up study Objectives

The objectives of this follow-up study were set out to:

- Understand the usage, impact and longer-term adoption rate of the solar electric cooking on refugee households in Dzaleka Refugee Camp.
- Understand the cooking habits and practices of beneficiaries, and the impact of solar electric cooking combined with increased access to electricity.
- Determine any changes in fuel use behaviour and cooking habits between baseline and follow-up surveys.
- Draw lessons from the implementation and applicability of the solar electric pilot project in a refugee setting.

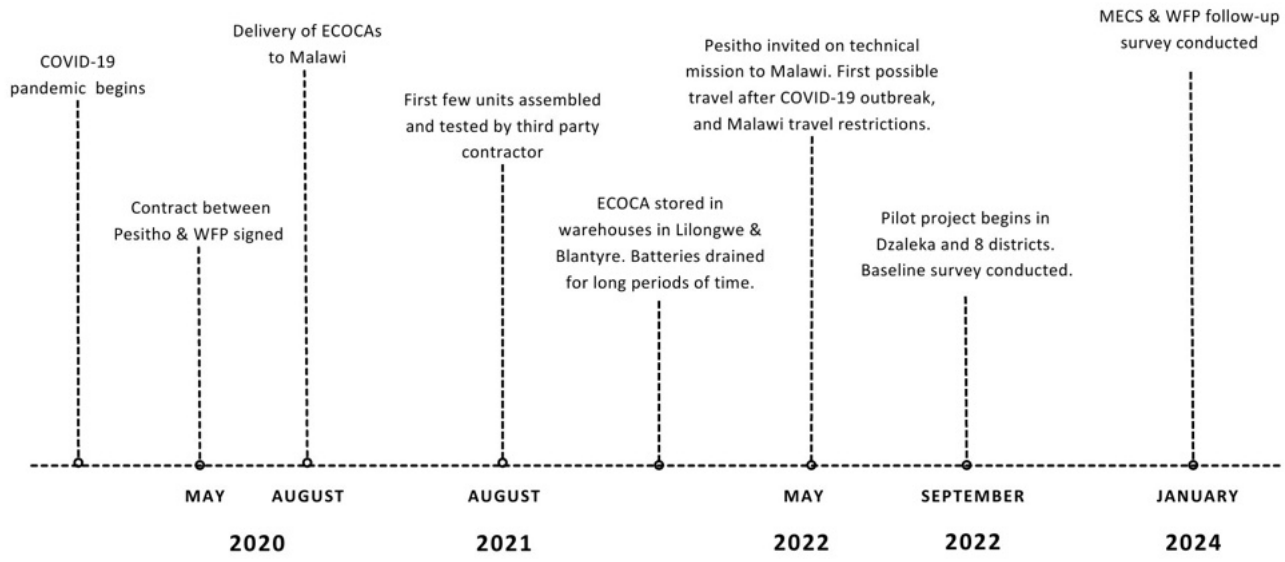

Figure 1: Timeline of WFP ECOCA project

3 Methodology

The following research methods were used to collect data for this study:

3.1 Household survey with 59 pilot study participants

The follow-up study targeted households that had received the Pesitho ECOCA cookstoves and who had participated in the baseline survey conducted in September 2022. Five teams, each consisting of an enumerator and a translator, undertook the surveys over two days, January 22nd and 23rd, 2024. The surveys were overseen by the WFP and MECS representatives. The enumerator teams conducted door-to-door visits across Dzaleka refugee camp with 59 households, each targeting around six households per day. Guided by the objectives, the survey enquired on aspects of cooking behaviour including cooking fuel use, duration of use and experience with ECOCA cookstoves, mealtimes and frequency, benefits, and challenges with various stoves, as well as simple demographic information.

The survey was written in English and administered through a tablet using MoDa (Mobile Operational Data Acquisition), which is WFP's propriety data collection platform. The interviews were primarily conducted in Chichewa, the most common language spoken in Malawi, and translators assisted with Swahili, the lingua franca of refugees in Dzaleka, French and Kinyarwanda/Kirundi. Questions, for example household cooking fuel use, were repeated from the survey undertaken at the start of the pilot, so comparisons were possible with the baseline data.

Image 5: Enumerator team undertaking household survey (JFT, January 2024)

3.2 Focus Group Discussion

Focus group discussions were carried out at the Central Community Centre and the Children's Respite Daycare Centre, in Dzaleka Refugee Camp, to gain further qualitative insight into beneficiaries' usage of the Pesitho ECOCA cookstoves and cooking behaviours since the distribution. The participants were split into two groups, those who had had the cookstoves installed in their households, and participants who used the six cookstoves that were installed in the Children's Respite Centre. A series of questions guided the two discussions, although open conversation and group participation was encouraged. The household discussion was attended by 18 participants (all of whom had been involved in the survey), and another discussion was attended by the four cooks who had been cooking at the Children's Respite Centre and who were part of the baseline survey. The four cooks were not interviewed as part of the household survey group but handled separately due to the different cooking context. Participants were not renumerated for their time, although sodas and snacks were provided free of charge for their participation.

Image 6: Household focus group discussion (JFT, January 2024)

4 Findings

The household survey and focus group discussion gathered information on beneficiaries' responses to the pilot solar electric study, as well as demographic information. Findings and analysis are presented below. However, the overall sample size is only 59 households for the survey (pilot size), and segments even smaller. This should be considered when interpreting the findings.

4.1 Participants

There was a total of 65 beneficiaries who received the solar electric cookstoves in the original pilot. Most of the beneficiary households were from Central Africa, namely DRC (48%), followed by Rwanda (27%) and Burundi (24%), and one participant from Somali (1%). There were a wide range of different household sizes, with the largest hosting 14 people and the smallest 3. Average household size was 7 and there was an average of 4 children per household. Most respondents were educated to at least primary school level, with a third having secondary school level or above. Seven respondents had never been to school.

Of the 65 beneficiaries, four were part of the Children's Respite Day-care Centre, and were not included in the household surveys, and are discussed below in Section 5. The follow-up household survey was able to reach 59 of the original 61 beneficiary households (two had been relocated). 83% of the follow-up study respondents were the main household cooks, who were the main targets of the intervention. Of these the majority were female, although around 20% of households had male cooks. In circumstances where it was not possible to reach the cooks, the survey would be performed with another member of the same household.

Image 7: ECOCA beneficiary giving feedback in her compound (JFT, January 2024)

4.2 ECOCA stoves

All households surveyed were provided with a solar electric ECOCA stove at the start of the pilot. The stoves were distributed in September 2022, with the pilot running up to 3 years. The cooking system was permanently installed into the houses by means of an embedded fixed metal frame to support the solar panel and wires that pass underground to a secure covered kitchen, or cooking, space, with a detachable fitting to the battery pack and cooking unit. This provided added security, both from theft, and the elements.

Images 8 & 9: The solar panel frame, cooking unit and pot | A charged cooking unit in the household (JFT, January 2024).

Although the ECOCAs were primarily designed for cooking, they also offered provision for charging rechargeable LED lamps, torches and other devices, such as phones. For the follow-up survey, nearly all households retained the cookstove hardware, apart from in two instances, where some or all of the equipment had been stolen. However, out of all the ECOCAs distributed only 12 stoves (20% of participants) were still in use for cooking by the follow-up survey, in January 2024. Most of the remainder malfunctioned (see below) and were not able to be repaired by the beneficiaries themselves. One ECOCA was not used because the beneficiary did not like the way it cooked.

		ECOCA no longer used for cooking		
	ECOCA Cooking	**ECOCA Broke**	**ECOCA stolen**	**ECOCA not used**
No. of households	12	44	2	1
% of households	20.3%	74.6%	3.4%	1.7%

Table 1: ECOCA usage

However, it became apparent during follow-up data collection that the charging functionality remined useful to many households (see section 4.7) even when the cooking aspect stopped working, even though of the 12 that continued to use them for cooking 9 (75%) did not use the USB outlets. One respondent noted that "the solar is used for cooking only, I don't know how to use it for charging and lighting", so the functions were not universally used, and that aspect of the training had not been passed on to the cook or user.

4.3 Demographics

It was suggested during the initial pilot training feedback that literacy levels and cooking behaviour were an important part of adjusting to the ECOCA stove's nuances. It appears that there are no clear features to distinguish between those who managed to maintain and keep using their cookstoves and those that were not able to at the demographic level. Equally, the small sample size means no conclusions can be drawn with certainty. However, among the ECOCA users that continued to cook on the devices the main respondents tended to be younger (33% were under 30, compared to 15% of inactive ECOCA users). The ECOCA users were more likely to report as unemployed (33% compared to 2%) or receiving aid (17% compared to 15%) as their primary livelihood activity. There was an even spread of educational attainment (from those who had never been to school to those with higher education levels).

It was observed during focus group discussions that specific individuals were trained during the initial training rather than groups, or main household cooks. It is likely that this was rather a single beneficiary or household head who were predominantly male (64%), rather than the main cooks of which 82% were female. There was little by way of supplementary training, or resources to reinforce the initial training to extend knowledge within households. As one female participant noted: "I am the only one who understand how it operates".

Demographics	Baseline	ECOCA	ECOCA (Inactive)
Age			
Average	42 years old	30-40 years old	40-50 years old
Median	44 years old	40-50 years old	40-50 years old
Minimum / Maximum	24 youngest / 74 oldest	20-30 / over 50	Under 20 / over 50
Gender %			
Female:	36%	48%	72%
Male:	64%	58%	28%
Livelihood activity %			
Casual work:		50%	83%
Aid:	100%[1]	17%	15%
Unemployed:		33%	2%
Education %			
Never been to school:	8%	17%	11%
Primary:	40%	50%	47%
Secondary:	38%	25%	32%
Tertiary:	11%	8%	11%

Table 2: Demographics of beneficiary respondents for baseline and follow-up surveys

[1] 71% of the targeted beneficiaries are participating in livelihood activities supported by WFP. 28% were participating in livelihood activities supported by UNHCR. Soya beans and beans production is the most common livelihood activity.

Image 10: Beneficiaries discussing the ECOCA pilot project (IKG, January 2024)

4.4 Cooking behaviour: frequency and time spent

Detail was observed about the times of day that beneficiary households cooked during the follow-up survey. Mealtime hours were reported as such:

Breakfast – 06.30am – noon
Lunch – noon – 3pm
Dinner – 4pm – 9pm

Breakfast was by far the least popular meal, with only 12% of households preparing breakfast. 63% of households cooked a single meal, for these lunch and dinner were equally popular. 25% cook both lunch and dinner. Only two households (3%) cooked three meals a day.

Meals per day	Follow-up survey households (HHs)			
	No. of HHs	% of HHs	ECOCA	ECOCA (Inactive)
Breakfast only	0	0.0%	0	0
Breakfast, Lunch & Dinner	2	3.4%	0	4%
Breakfast & Lunch	2	3.4%	0	4%
Breakfast & Dinner	3	5.1%	0	6%
Lunch & Dinner	15	25.4%	25%	26%
Dinner only	18	30.5%	25%	32%
Lunch only	19	32.2%	50%	28%
TOTAL	**59**	**100**	**100**	**100**

Table 3: Type of meals per day

Beneficiaries reported on the number of meals cooked per day for baseline and follow-up surveys. Most households cooked one meal a day and there was an increase in this number (+8.9%) and a near corresponding decrease in the number of households that cooked two meals per day (-10.7%). Few households cooked more than two meals a day (+1.9%).

Meals per day	Baseline	Follow-up survey (%)		
	Overall	Overall	ECOCA	ECOCA (Inactive)
Single meal	53.8%	62.7%	75%	60%
Two meals	44.6%	33.9%	25%	36%
Two+ meals	1.5%	3.4%	0%	4%
Average (meals per day)	1.5	1.4	1.3	1.4

Table 4: Number of meals per day

Those who still used the ECOCA for cooking were predominantly single meal households (75%) and lunch was the favoured meal, (cooked by 75% of households). Those who cooked two meals cooked dinner and lunch. All households cooked staples (such as nsima and rice), although the ECOCA was also used for boiling water, porridge and cooking vegetables. There didn't appear to be any trend of specific foods being favoured for cooking with the ECOCA in households who cooked a wide range of dishes, although some noted that it was reserved for certain types of foods (such as boiled foods, beans, rice and potatoes), as with some foods "ugali became difficult to prepare in ECOCA". The insulation was also highlighted in a focus group discussion:

"you can keep food warm, since the pots act as a food warmer". One participant noted that "it was difficult to cook food fast" and the initial training feedback noted that in general food took longer to cook using the ECOCA stove.

However, overall, there were reported time savings with ECOCA users, potentially due to reduced time spent collecting firewood or other fuels, and cooking with electric could start instantly. It also "offered time to do other things as you were not required to keep monitoring stove from time to time". This included being able to cook two dishes simultaneously, or to undertake processes such as heating water, which can influence cooking time.

Time spent cooking	Baseline survey (%)	Follow-up survey (%)		
		Overall	ECOCA	ECOCA (Inactive)
60 minutes or under	35.4%	30.5%	42%	28%
Up to 120 minutes	21.5%	45.8%	42%	47%
<120 minutes	43.1%	23.7%	17%	26%

Table 5: Time spent cooking

In total, surveyed households for the follow-up survey spent around 108 minutes cooking on average per day, with most beneficiary households (60%) spending more than 60 minutes cooking daily. Households that used ECOCA for cooking spent slightly less time (at an average of 95 minutes) compared to other households (who spent 110 minutes cooking). They were also more likely to report spending 60 minutes or under cooking.

4.5 Cooking fuel use

It is essential to acknowledge that this study faces limitations due to the dynamic and changing national, regional, and macroeconomic landscape during the period spanning between the time of the baseline survey and the start of the solar electric pilot in September 2022, to the follow-up survey, in January 2024. Notable factors related to seasonal and temporal changes in fuel prices, currency fluctuations (e.g. the Malawian Kwacha devaluation in November 2023), and firewood availability due to ongoing deforestation around Dzaleka. These contextual variables are all likely to have impacted on the observations over the time periods. Interpretations of the data and comparisons between the baseline and intervention data should therefore be undertaken with caution and understood in such context.

Fuel use was monitored in both baseline and follow-up surveys. Charcoal remained the most popular cooking fuel, used in 88% of households during the follow-up survey, down from 95% in 2022 (a change of -7%). Firewood was used in 48% of households, down from 64% of households in 2022 (-16%). Despite the appearance of a decrease in overall use of all traditional fuels, it may be explained by other factors such as, greater reliance on a single fuel between households and potentially fewer meals being prepared, as charcoal prices became more expensive (commented on by 45% of beneficiaries), and the reduced access to firewood locally.

Cooking Fuel	Baseline survey (%)	Follow-up survey (%)		
	Households	Overall	ECOCA users	ECOCA (Inactive)
Charcoal	95%	88%	83%	89%
Firewood	64%	48%	50%	47%
Solar electricity	0%	20%	100%	0%
Residues	8%	2%	8%	2%
Biogas	2%	0%	0%	0%

Table 6: Cooking fuel use

Table 6 shows that in January 2024, 46% of households used charcoal as the only fuel, and many households used it as part of a fuel stack together with firewood (32%). Most households used biomass with a traditional mud stove, 88% of households. Additionally, 20% used three stone/open fire, and 12% improved fixed brick stove, with one household reporting using a smart home burner. Biogas was no longer used.

There appears to have been a slight shift towards households relying on fewer fuels, rather than a broader fuel stack. Solar electric was in use in 20% of households, and there was negligible use of other alternative cooking fuels beyond wood and charcoal. Evidence suggests the ECOCA did not necessarily displace fuel but added to the fuel stack: "Whenever one wants to cook different foods the time, you had to combine with other cooking methods as ECOCA stove could only manage one pot."

Around 26 households (44%) had a national grid electricity connection, whereas 33 (56%) had no domestic access. 7 households (~60%) that used the ECOCA had an electricity connection as well although no households reported using grid electricity as a cooking fuel.

Fuel stack (No. of fuels used)	Baseline Survey	Follow-up Survey		
	Households (%)	Overall (%)	ECOCA	ECOCA (Inactive)
1	39.1%	49%	0%	62%
2	53.1%	42.5%	58%	38%
3	7.8%	8.5%	42%	0%

Table 7: Cooking fuel stack

In addition to solar electricity, all 12 ECOCA households used charcoal as a fuel, and 6 of those (50%) used firewood as part of their fuel stack.

Fuel combinations	Baseline %	Follow-up %	Change %
Charcoal only	34.4	45.8	11.4
Charcoal & Firewood	51.6	32.2	-19.4
Firewood & solar electric	0.0	8.5	8.5
Charcoal & solar electric	0.0	5.1	5.1
Charcoal, firewood & solar electric	0	5.1	5.1
Charcoal, residue & solar electric	0.0	1.7	1.7
Firewood only	4.7	1.7	-3.0
Charcoal, firewood & biogas	1.6	0	-1.6
Charcoal & residue	1.6	0	-1.6
Charcoal, residue & firewood	6.3	0	-6.3

Table 8: Household fuel combinations, Highlighted cells, Ecoca users

4.6 Fuel cost and savings

The data relating to fuel prices was challenging to interpret, due in part to inconsistencies in data collection and ambiguous language regarding quantities used, weights and timescales. Traditional fuels such as charcoal and firewood have a lot of variability in quality, weight and burning time. Without weighing scales or other equipment it was difficult to get accurate figures. However, using the most popular term (bag) and most common reported weight (50kg) it was estimated that in January 2024, the cost of charcoal was on average 14,000 MWK per bag, calculated to approximately 280MWK per kg. Several households used one bag each month, which on average was 3,500 MWK per week.

The baseline survey found that households spend on average 1,940 MWK per week, or 7,760 MWK per month on charcoal. In addition, the variables mentioned above (e.g. currency devaluation, fuel availability and seasonal price fluctuations) mean both sets of figures must be treated with caution.

It was not possible to verify or quantify the fuel savings, however respondents repeatedly noted that they were able to save money using the ECOCA device, through savings on charcoal, candles and charging of e.g. phones and torches. To share an example, one respondent was recorded stating “it saves money for buying charcoal and they use the money to buy other things. In the past if they didn't have money for charcoal they would not eat”. It also had a wider impact on the household, “it reduced the burden on children who are sent out to collect plastics bottles for cooking”.

Image 11: A bag of charcoal in a beneficiary's house (JFT, January 2024)

4.7 Inactive ECOCA Stoves

The majority of households (80%) no longer used their cooking units for cooking, reporting malfunctions either with the cooking pot, solar panels or battery, or due to theft. Table 9 describes their reported length of use, before the malfunctions appeared. However, several households continue to use the ECOCAs for charging (& lighting) solely.

Use of Ecoca for cooking	Number of households	% of households
Less than one year	13	22%
Still in use	12	20.3%
Less than one month	10	16.9%
More than one year	8	13.6%
Less than 6 months	8	13.6%
Less than 3 months	8	13.6%
Charging & Lighting (incl. cooking)	29	49%
Charging & Lighting only	17	29%
Grand Total	**59**	**100**

Table 9: Length of use of ECOCA for cooking

The follow-up survey indicated there were several recurring issues that were not resolvable by the beneficiaries. Below are the main identified issues:

4.7.1 Battery

Several households continued to use the units for charging and lighting, using the USB ports available (29% of households). In these cases, the units still turned on but were unable to generate sufficient power to cook with or had connective pot malfunctions. It was hard to assess where the issue was from a technical standpoint and there was no engineer to verify. However, many beneficiaries considered that battery maintenance and capacity was an issue, even in the case where the cookers were still being used. Complaints fell into three broad categories: 1) catastrophic failure with the battery unit or solar charge, where the unit no longer turned on; 2) The battery unit continued to turn on, but it no longer generated enough power to use the cooking pots, but was capable of charging lights and phones; and 3) the cooking pots continued to work but slowly, were inconsistent or lost charge quickly.

This may have been due to the size of the battery and duration for which it was designed, where participants desired longer charge and cooking periods and larger solar panels, or more likely a combination with the maintenance and upkeep of the battery, which was inconsistent among beneficiaries. There was conflicting advice and/or understanding as to best practice in terms of maintenance. Some thought that the system should be fully charged before being used, or that the system should not be plugged in while cooking, or that it was best to cook while the sun was shining. The battery management aspect of the training (and aftercare) perhaps did not reinforce sufficiently the measures needed to preserve battery health. One respondent noted that “at the beginning it was not difficult but as time went by started facing some challenges which made it difficult to use. The battery life was short”.

Image 12: A fully charged ECOCA cooking unit (JFT, January 2024)

4.7.2 Cooking pots

The cooking pots were observed to be kept in good condition in appearance. Where there was insufficient power to cook with, it was difficult to determine whether there was any fault with the pots, elements or connections. In one or two cases the heating element was reported as getting damaged, as in the response of one participant: “the pot got stuck to the connecting coil from the battery unit. In the process of removing the stuck pot it got broken and it has never heated the pot again”. Two pots were provided to beneficiaries, so at least one required storing (e.g. in boxes and cabinets) and the pots would be moved frequently to cook. During the data collection, it was observed that it was not uncommon for beneficiaries to move the entire ECOCA unit (back and forth from e.g. the package or cabinets). The frequent movement of the base units and pots might as well have led to some of the pot or unit damage.

Image 13: ECOCA cooking pot begin stored in a cupboard (JFT, January 2024)

4.7.3 Solar panels

The solar panels were the most visible aspect of the ECOCA system to neighbours and the wider public, as they were elevated high and prominently placed to have good exposure to sun, and therefore often visible from outside the house compound. The panels were placed on a metal frame, which was moulded to the ground. Despite this there were only two reported thefts: “the solar was stolen in less than a month. Still waiting for police report which CARD office was handling”. However, there were other reported security risks, such as vandalism. To mitigate against theft, some were fitted with extra wires (e.g. chicken wire netting) for protection from stones and other disturbances. They also required cleaning from time-to-time to protect from dirt and to ensure efficient energy generation. Protective wires, that covered the panels, could have significantly reduced the power output and energy available. Pesitho advise not to cover the solar panel at all.

Image 14: A solar panel installed in a beneficiary compound (JFT, January 2024)

4.7.4 Maintenance and repair

Due to the terms and conditions of the lease agreement (the contract between beneficiaries and WFP for the cooking units), individuals were not to use local technicians to address any problems. They were instead reportedly instructed to report any issues to Churches in Action for Relief (CARD), a Dzaleka Refugee Camp based organisation subcontracted to deal with maintenance and repair, who would use qualified technicians through the private sector company Kuunika. This created a bottleneck for repairs and complaints, and several participants highlighted that the organisation was unresponsive: “When it comes to repairs it is bit of a challenge as it seems no repairs were being done by anybody”. Few beneficiaries consulted other locally available technicians (“we were advised not to take it to any local technicians”) due to the lease agreement terms and relied on reporting to CARD and for them to further handle the repair.

4.8 Overall experience of the ECOCA by Dzaleka Refugee Camp Users

Question	Score (NPS & average)	
	ECOCA	ECOCA (Inactive)
On a scale from 1-10 how strongly would you recommend the Pesitho Solar Cooker (ECOCA) to a friend?	-8 (NPS)	19.5 (NPS)
On a scale from 1-10 what is your satisfaction with the Pesitho Solar Cooker (ECOCA) battery?	6/10	n/a
On a scale from 1-10 how would you rate your experience with the ECOCA?	7.6/10	7.4/10

Table 10: Overall experience of the ECOCA by beneficiaries

All the recorded continued users (20%) used the ECOCA often, at least once a day, when the sun was sufficient to charge the unit. A common complaint was the battery life and capacity, and this is reflected in the low average score (6/10) relating to the battery experience. This is exacerbated during rains or bad weather, when it was difficult to charge consistently. The rainy season, where the sun is less consistent, was noted as enduring from November to March: “it was very easy to use, but the device varies in its performance depending on seasons. For example, hot season it works well.”

Overall satisfaction with the cookstoves by those who still use it was higher (7.6/10), and comments were made on the cleanliness, comfort of use, and lack of smoke as well as cost savings and convenience, mentioned above. Interestingly, the ECOCA non-users overall scored the ECOCA performance almost equal to current users, with a total of 7.4/10, despite no longer using the ECOCA. However, looking at the breakdown of why beneficiaries were no longer using the ECOCA, 77% were no longer using the ECOCA due to various malfunctions, which had not been repaired. However, during the FGD, the beneficiaries elaborated on their satisfaction and challenges with the ECOCA: “Neighbours think the stove is good and would recommend if they did not breakdown so frequently.”

Another respondent highlighted that: “At the moment it is very difficult to continue as the equipment is currently not in use due to broke down. If a similar electric cooking device was to be given which is durable and better lasting battery life, I would continue”. However, during the FGD one beneficiary was noting that “Yes, as it is cost saving and clean form of energy” responding to if they would like to continue with electric cooking. Both during the quantitative survey as well as the focus group discussion the importance of less smoke and cleanness of the ECOCA was highlighted, with beneficiaries reporting on e.g. reduced eye problems”. However, from the study it was evident that beneficiaries had not themselves invested in an alternative electric cooking device since their ECOCA broke, even though 44% had access to grid electricity. It was considered expensive to cook using electricity.

Participants were asked whether they would recommend the unit to friends, on a scale of 1 to 10, using a net promoter system (NPS) – which considers the upper (promoters) and lower percentiles (detractors), to place a figure between -100 to +100. The score for continued users was -8, indicating that the consensus was negative. Anything above 0 could be considered slightly positive, with over 50 considered excellent. For those who no longer were able to use the ECOCA for cooking, the large majority, they rated it at 19.5, which indicates an overall positive consensus, and many would likely recommend the ECOCA.

Image 15: The day-care Centre beneficiaries and cooks (JFT, January 2024)

5 ECOCA in institutional use

Six ECOCA cookstoves were placed in a Children's Respite Day-care Centre to assist with the cooking for infants and young children (~140), and staff members (13). The Centre provides one meal of porridge made from a mix of grains, pulses and legumes each day for attendees. It was served around 11am, Monday to Friday.

The solar panels and fixings were fitted in the centre grounds of the Centre, which was fenced and had a security guard present. The ECOCA battery units and cookstoves had a dedicated kitchen space, which was allocated for the placement of the cookers, and the connecting wires were hardwired to this location. The cookstoves and battery units themselves were kept in a locked storage cupboard when not being used or charged and during closing hours of the centre, to avoid vandalism or theft. The Centre did not have an electricity connection when the stoves were first installed, although it was later connected to the national grid.

Four female cooks were responsible for the upkeep and care of the ECOCAs, although one individual took care of their day to day use in the centre. One of the units failed due to a reported battery issue, and it was reported, but not replaced or repaired. The remaining 5 ECOCAs were in regular use from the date of installation (September 2022) until they were removed in January 2024 due to a request from the centre's managing organisation, reporting non-usage. The trial ended early due to the site management's decision, although the devices were in good working order when removed.

5.1 Cooking behaviour

The ECOCA stoves were predominantly used for making tea and heating water for bathing the kids. Porridge was occasionally made in the ECOCA but the size of the pots, designed for household use (6 litres), meant that large scale cooking of porridge needed to be spread across the 5 working units, and presented challenges, although they would be used when there were no alternatives, or all the units were fully charged. For institutional scale purposes this provoked issues: “the pots are a bit small for use at the centre”. The staff also used the units to cook a range of foods, including Irish potatoes, green beans, porridge and rice, for themselves and family (i.e. for domestic scale consumption).

Image 16: Dedicated space for ECOCA with wiring in Day-care Centre (JFT, January 2024)

5.2 Maintenance

The ECOCA in the institutional setting were treated in a consistent manner that may have contributed to their being no reported problems with 5 of the 6 devices. The cooks made sure the cooking units were fully charged before being used for cooking, and mostly made sure they were not plugged in while being used. They were cautious of water damage on the bases of the units. The battery units were charged (solar) and discharged (cooking and charging) on a regular basis, although it was reportedly challenging to fully charge the ECOCA during periods where there was less sunshine. They were stored securely and were well protected in a storage cupboard when not being used. The cooks used them for only a selected number of foods described above and avoided using them for foods that required vigorous stirring and did not use them to fry food. They noted that the ECOCA was “very easy to take care of”. They were used during daytime hours only.

5.3 Fuel, convenience and safety implications

Using the ECOCA enabled the institution to have regular access to hot water, which was used both for food and drink purposes (tea & porridge) but also for providing medical care (e.g. washing wounds). Over the course of the time during which the ECOCA were present, (approximately one year), it may well have led to considerable cost savings (through fuel saved from water heating) or at least added a considerable co-benefit, e.g. providing tea or hot water to the Centre's community. The cooks reported being able to save time by doing other tasks during the day, while cooking occurred.

It was also considered to be a safe way to cook, as it was unlikely to burn children, as the pots were insulated and covered. The alternative fitted biomass stove, had a large pot that was often uncovered that could be hazardous to children, being firewood or charcoal powered and producing smoke and soot compared to the ECOCA, which had "no side effects in terms of silt and smoke".

The charging benefits of the stove were particularly useful in the Centre, which did not have an electricity connection when they were first installed, so staff used them frequently to charge their phones (they did not receive accompanying lamps).

Image 17: Solar panel stands in Centre after removal of ECOCA (JFT, January 2024)

6 Discussion

The introduction of the ECOCA demonstrates that beneficiaries largely embraced using solar electricity for cooking and adapted to a novel form of cooking. Only one beneficiary reported ignoring the device because they did not like the way it cooked and the remainder used it for varying lengths of time. However, only 20% of the devices were still in use (and used regularly) in households by the time the follow-up survey was undertaken, some 18 months after installation. The average overall reported experience with the ECOCA was 7.5/10, and interestingly there was negligible difference between those for whom the ECOCA no longer worked (7.4/10) and those who continued to use it (7.6/10). In fact, those who no longer used the ECOCA for cooking were more likely to recommend it to a friend. That said, it is unfortunate that more ECOCAs were not still being used, and so many ceased working. There appeared to be a few possible reasons for this.

From a technical standpoint, without further investigation by a qualified technician, it was not possible to determine the issues that led to the malfunction of the cooking aspect of the ECOCA, and whether that was due to the battery, cooking pots and solar panels, or the ways in which they were used, kept or maintained. The battery was most commonly reported as having issues, and in some cases, the unit no longer switched on at all, although it was estimated that in approximately 29% (17) of households, they were still being used for charging.

The cooking pots were observed to be in good condition (each household received two pots originally), however there may have been issues within the mostly concealed connector that fitted to the battery unit, or other issues that created an unstable connection. The solar panels had fewer reports of damage although they were subject to attempts at vandalism and required cleaning to operate at full capacity. This might have been made more challenging given their elevated positioning, although they were still in reach. Equally, practices regarding their upkeep, such as partial covering for protection, might not have been up to standard to ensure the longevity of the equipment and contributed to failings.

The way in which the ECOCAs were used was reportedly inconsistent, and although training was conducted, it appears that the main cooks of the households, a key audience, might not have been targeted for the initial training. The beneficiaries (who agreed the lease of the equipment) were predominantly male (64%) in the baseline survey. The follow-up survey, which targeted the main cooks, found that cooks were predominantly female (82%). There were no observable additional training materials available to the beneficiaries, apart from an English technical manual and given the highlighted challenges with language and literacy, this is unlikely to have been adequate. It is likely that the use was inconsistent in and between households and that information was not accurately conveyed even within a household, as a participant stated, noting she was the only one at home who knew how to use it.

Another factor that may have impacted the cookstoves longevity might have been the foods being cooked. A popular dish in the region (nsima/pap/ugali) and among beneficiaries requires vigorous stirring with a stick, and this may have strained the pots which were centrally connected to the units. Additionally, depending on the cook it requires a higher heat than many other dishes, which mostly require only to reach boiling point (potatoes, rice, porridge, etc). What is clear is that in the institutional setting, where the ECOCA was often used for heating water and simple boiled foods (rice and beans) and frying was not permitted, according to the institutional cooks, their average lifespan was significantly longer (only one of five devices malfunctioned).

A key oversight of the household pilot project was the ongoing provision of aftercare. Numerous beneficiaries reported the issues to CARD, as advised. It is unclear that all the issues were able to be dealt with, or the required level of funding available to the aftercare provider. A technical understanding and relationship between the technicians from Kuunika (trained by Pesitho, the manufacturers of the ECOCA) and the on-site aftercare centre CARD was not well-established or appears to have broken down between the installation and the time of the survey, as many reported cookstove issues were not resolved. The financial and logistical arrangement between the various parties was not clear, however at a point, all aftercare stopped, and the ECOCAs were no longer able to be used when they appeared defective, even though in some cases it may have been a straightforward, though specifically technical, issue of re-booting the device.

From a fuel and cost perspective, although it was not possible to quantify accurately, or verify, there were numerous reported fuel and cost savings, and the charging and lighting co-benefits were welcomed. Several participants noted the value of the ECOCA in supporting the household budget and time resources. According to the metric measuring time spent cooking, those still using the ECOCA were able to save time when cooking, perhaps by simultaneous cooking. ECOCA households were the only ones to use more than two fuels, as part of their household stack.

*Image 18: The ECOCA in a beneficiary's kitchen (JFT, January 2024***).**

7 Conclusion

This follow-up study has helped to provide insights into the opportunities and challenges with trialling solar electric cooking in a refugee setting. The Pestiho ECOCA solar powered electric stoves were well-received amongst the beneficiaries, despite some behavioural change required to cook certain foods. The ECOCAs scored similarly well on the user experience (with an average of 7.5/10) for both those who continued to use the devices and those for whom they no longer worked. They were embraced, noted to be a clean way of cooking, and reportedly led to cost savings amongst its users.

However, there were significant issues with the longevity of the appliances in domestic households. During the follow-up study, conducted 18 months after installation, only 20% of the devices were still working to their full capacity, i.e. beneficiaries were able to cook using the stoves. This is likely due to a combination of limited training in maintenance and upkeep, overburdensome use, inadequate provision of aftercare and technical assistance, and a reported lack of cookstove robustness, particularly with regards to the battery. A further 29% continued to use them for charging and/or lighting, as the cooking element no longer functioned.

In contrast, in an institutional setting – a day-care centre – most ECOCAs (5/6) were in regular and consistent use for the duration of the trial. A small cohort of cooks, attended training, used the devices uniformly, including from a battery charging and discharging perspective, for a range of simple boiled foods and stored them in a secure covered environment. This likely contributed to their lifespan. They were extremely well regarded by the staff, with benefits resulting from cooking (porridge and staff food), medicinal (hot water for treatment) and electric device charging perspectives (phones, etc).

More investigation into the technical issues experienced by several beneficiaries is needed to identify the causes of the ECOCA malfunctions, and help to better target interventions pre-, during and post- solar electric cookstove installation. Further, it could help improve the experience and strengthen future interventions. Further research would be needed to quantify any fuel cost savings, beyond anecdotal evidence, to support the potential for fuel savings from solar electric cookstove use, reported by beneficiaries during the survey and focus group discussions. Finally, it must be noted that the stoves were distributed free of charge and for low-income beneficiaries to access solar electric cooking, a considered financial model would need to be developed to fund the upfront capital cost of the solar electric equipment.

7.1 Reflections from Pesitho

This solar electric project was conceived in 2020 and the ECOCAs were procured by WFP Malawi under a "procure and supply" model in mid-2020. The device was a prototype in early innovation developed by Pesitho and first deployed in Uganda in 2019. In Malawi, Pesitho were not involved in the implementation phase, although did support the training of the local contractor (Kuunika) and WFP staff. However, the operational timeline for Malawi was significantly impacted by the COVID-19 pandemic: the ECOCA stoves were delivered in 2020, but only distributed for the pilot project in 2022.

As a result, the batteries may have suffered as a result of potentially unsuitable long-term storage (~2 years) in WFP warehouses, with low or no charge, leading to batteries with reduced capacity being delivered on implementation in 2022. Pesitho always recommends budgeting for and being included in the implementation phase (as occurred in earlier trials in Uganda), as well as user training (considered one of the most important aspects) and aftercare, including ongoing cooking advisor training, which in this case did not occur.

The ECOCA technology has been through several development cycles since the early model used in Malawi. As there were no other engagements in Malawi, there were difficulties establishing synergies. However, Pesitho is interested in expanding in the market and seeks further collaboration in both household and institutional cooking solutions.

7.2 Reflections from WFP

WFP implemented this project as a pilot, which has yielded valuable learnings which are elaborated further in the recommendations of this report.

First of all, there were several external conditions and challenges, mainly caused by COVID-19, which unfortunately delayed the distribution of the Pesitho stoves, after their arrival to Malawi. As a result, the Pesitho ECOCAs were stocked for a period of 21 months in the WFP warehouse, before it was possible to securely distribute them. Besides the delay in reaching the beneficiaries of the Pesitho ECOCAs, there is a risk that this delay might have impacted the longevity of the batteries.

Further, reflecting on the project design, WFP would like to highlight three main points. The first point is related to the maintenance agreement for enhanced aftercare and warranty period with Kuunika and Pesitho, covering comprehensive service, maintenance, warranty, and repairs, which should have been laid out for the full 3-year period of the pilot, to ensure the continuous usage of the cookers during the pilot project period, however, this was not done because of budgetary limitations.

Secondly, based on the learnings from this study, it became evident that the training provided was not comprehensive enough to meet the needs of the users. Further, since it was up to the household to decide who should attend the ECOCA training, WFP saw that 64% of the trained were male, whereas the main cooks were pre-dominantly female (82%), meaning some main cooks were depending on another household member to train them, in which it is expected some information might have been lost. Therefore, additional technical support should have been made available, to ensure rightful usage and enhance the longevity of the ECOCAs.

The final point is related to the beneficiary selection, which was done based on specific defined criteria. However, looking at the continued sustainability and usage of the ECOCAs WFP is considering that one of these criteria should have been that the beneficiary would be willing and able to pay for the continued maintenance and repairs of the ECOCAs after the 3-year period of the pilot.

8 Recommendations

Based on the findings and conclusions outlined in this report, the following recommendations are to be considered for future projects of similar character, or as further actions.

1. Improve the robustness and battery capacity of appliances

To improve the longevity and reliability of the Pesitho ECOCAs, it is essential to enhance the robustness and battery capacity of these appliances. Findings from the study indicated that only 20% of the household devices were fully operational 18 months post-installation, with the main issue reported due to battery malfunction. Considering the context of where these stoves are being used, stoves need to endure the rigors of daily use, and optimizing the battery life to ensure that they remain functional and effective for a longer period, to enhance user satisfaction and device dependability. However, it is worth noting that the Pesitho ECOCA piloted in Dzaleka Refugee Camp is an early model and due to COVID-19 the batteries were stored in a warehouse for approximately 2 years before being distributed. These considerations have already been taken into account by Pesitho in designing newer models.

2. Plan and mitigate for seasonal fluctuations in solar radiation

Given the variations in solar radiation throughout the year in Malawi, it is critical to tailor the solar panel systems accordingly to cope with these changes. This involves sizing solar arrays appropriately to guarantee sufficient energy is captured, and further appropriate sizing of storage (batteries) needed, particularly during periods of low sunlight. Such adaptation will ensure that the cooking needs of refugees in Dzaleka are consistently met, regardless of seasonal changes, thereby improving the practicality and attractiveness of the solar cookstoves, as well reducing the usage of charcoal and stove stacking. Training should also reinforce the need to avoid even partial covering of the panel (e.g. with security wire) to avoid efficiency loss.

3. Enhance targeted training to ensure appropriate usage

The study highlighted inconsistencies in appliance use and maintenance between different users, affecting the effectiveness and lifespan of the ECOCA devices. By implementing targeted training programmes that address the specific needs and roles of users (separate training modules for cooks and general beneficiaries for example), better understanding and practices around the operation and care of the cookstoves might be achieved. This approach will likely reduce misuse and prolong the functional life of the appliances.

4. Improve after-care and maintenance support

Enhancing the aftercare and maintenance framework is vital for sustaining the functionality of Pesitho ECOCAs. Feedback and communication would be better secured with establishment of Pesitho local production and/or service, with trained technicians and direct communication on repair cases. Establishing a well-structured support system that includes comprehensive service instructions and scheduled maintenance can significantly extend the lifespan of these devices. Regularly accessible technical support not only aids in immediate problem-solving but also boosts user confidence in adopting and continuing to use these new technologies.

5. *Provide adequate long-term sustainable technical support, (e.g. locally available trained engineers) and consider extended warranty periods.*

For the solar powered cookstoves to be a viable long-term solution, ongoing technical support is imperative. Ensuring the presence of trained local engineers and extending warranty periods can provide the necessary support infrastructure to support the transition towards solar powered cookstoves. This setup helps in promptly addressing any operational issues, minimizing downtime, and maintaining high service standards, thereby increasing the reliability and user trust in solar cooking solutions such as the Pesitho ECOCA.

6. *Improve communication and ownership channels*

Communication gaps and unclear responsibilities can undermine the effectiveness of technology deployment in humanitarian settings. By improving the channels of communication and clearly defining ownership responsibilities between organizations and recipients, the overall management and upkeep of the cookstoves can be enhanced. Clear communication and established responsibility are crucial for fostering a sense of ownership among users, which in turn encourages better care and maintenance of the appliances. This combined with the sustainable aftercare and maintenance should be able to increase the uptake of solar electric cooking pilots.

7. *Explore institutional successes and potential to scale*

The positive reception and effective use of the Pesitho ECOCAs in an institutional setting, such as a day-care centre, provide valuable insights that can be scaled and adapted to other contexts. Exploring these successes further can help in understanding the critical factors that contributed to their longevity and satisfaction among users. To increase the usage of solar powered cooking in the day-care centre, it is however recommended considering the potential for larger pot sizes, which could facilitate communal cooking purposes, expanding their applicability and impact.

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WFP World Food Programme

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