

ECOCCA

Willingness-to-Pay among Vulnerability Groups in Uganda



LEARNING REPORT February 2022



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Previous deliverables of the learning collaboration include:

- ECOCA impact pilot: Real Time Evaluation Report Uganda, 2019
- ECOCA impact pilot: Real Time Evaluation Report Myanmar, 2019
- ECOCA impact pilot: Learning Study – Consolidation of findings across pilot contexts, 2019

The two private Danish foundations; the **Novo Nordisk Foundation** and the **Hesse Ragle Foundation** have also contributed financially to the implementation of the willingness-to-pay pilot.

This pilot project has been implemented under extremely difficult circumstances. While any application of innovation is likely to involve uphill learning curves, challenging the patience and endurance of participants, this project was implemented from late November 2019 to September 2021. The implementation team has thus suffered through COVID-19 lock down implications of three nations, including queuing in international shipping systems, seizing of workspaces as temporary quarantine centres, technology transfer through virtual trainings of Ugandan and refugee youths, limitations on gatherings complicating sales, travel restrictions, and not least risk of infection.

Nevertheless, our long-term and competent local partners, **Caritas Uganda** and **Community Integrated Development Initiatives (CIDI)**, have showed dedication, agility, perseverance and have honoured their commitments. Without them, this pilot would never have been completed. A great thank you to fields offices, project coordinators, support staff and directors, especially Mr. David Adong with Caritas Uganda and Mr. David Katende with CIDI, who have both out done themselves to make this happen. Finally, Caritas Denmark is highly appreciative of our private sector partner, developer of the ECOCA technology, Pesitho, who has been committed to our joint learning ambitions throughout the pilot implementation and ensured transfer of technical competencies even under these difficult circumstances.



Executive summary

With our Ugandan partners, Caritas Uganda and CIDI, Caritas Denmark has completed a learning pilot aiming at establishing willingness-to-pay for subsidized ECOCA, a solar-powered electrical cook stove, among three different vulnerability groups in Uganda. This report summarises the learning compiled from the sale period (April-August 2021) and the subsequent repayment period to the time of the learning report completion (February 2022). Documentation of learning from the pilot is still ongoing and is expected to be compiled in brief updated learning sheets for sharing among interested stakeholders.

During the sales period 307 subsidized ECOCA were sold to refugees in the Bidibidi Refugee Settlement in Yumbe District, 135 to the members of the adjacent host community, and 100 to members of three farmer cooperatives in Rakai District. The beneficiaries were provided with an option of full up-front payment or repayment over 1-5 years. While the beneficiaries in Yumbe (refugees and hosts combined) had a relatively even preference between the 1-year (43%) and the 2-year (41%) repayment plans, 96% of the Rakai beneficiaries chose the 1-year repayment plan. The 3-year repayment plan was selected by only two individuals (both refugees), and the 5-year repayment plan by none at all. The remaining beneficiaries chose the full up-front payment.

The repayments exceeded the commitments by the beneficiaries at the initial stages and have for the well-organised Rakai beneficiaries continued to be timely. For the Yumbe beneficiaries, on the contrary, commitments started to dwindle by close of October, and reached by close of January 2022 a level that caused for follow-up actions to be implemented by the local partners. At the time of the report writing, dialogues with up to half the Yumbe beneficiaries are undertaken to identify any need for reverting the choice of repayment modality to a longer-term period with lower monthly payments.

Impact of ECOCA access on household firewood collection and energy expenditures is included in the learning report as a means of explaining motivation for willingness-to-pay. Though the collection of this data met some challenges, it was a clear trend that the extent to which beneficiaries replaced their energy usage from wood fuel to ECOCA differed. The data indicated that some households used the ECOCA as a primary source supplemented by wood fuel rather than as a complete replacement, resulting from for instance large household sizes and suppressed energy demand. In average, the time spent on firewood collection among those collecting firewood prior to their ECOCA purchase reduced with 39% among the refugees, with 58% among the host population and with 67% among the Rakai beneficiaries. At the same time, the average weekly household cooking fuel costs reduced with 63% among the refugees, with 72% among the host population and with 71% among the Rakai beneficiaries.

Looking at the energy savings achieved in relation to weekly costs on lighting and phone charging, the trend is very convincing. Across all three vulnerability groups, the costs are entirely or practically diminished, comprising a 100% reduction for the refugees, 88% for the Yumbe host population, and 99% for the Rakai beneficiaries. Adding together reductions in weekly costs on both cooking fuels, lighting, and phone charging,

all three vulnerability groups in average are experiencing considerable improvements in their household finances. The total household energy savings (cooking, lighting, and charging combined) achieved added up a monthly saving of UGX 82,836 for the refugees, UGX 98,354 for the Yumbe host population, and UGX 122,417 for the Rakai cooperative members. With monthly ECOCA repayments ranging from UGX 0-64,000, all repayment modalities are fully accommodated by the average savings made from the ECOCA usage. After ended repayment period, the full saving will be available to the beneficiary households.

Adding to these savings, 17% of the refugees, 29% of the Yumbe host population, and 39% of the Rakai cooperative members were using their ECOCA for income generating activities, such a charging of mobile phones. In average for those gaining an income from these activities, the income amounted per month to UGX 30,970 for the refugees, UGX 17,078 for the Yumbe host population, and UGX 17,714 for the Rakai cooperative members.

Overall, Caritas Denmark assesses the ECOCA to be a highly beneficial and appropriate technology for our Ugandan target group, and the subsidised price appears generally affordable. Programmatic adjustments and follow-ups have been identified, aiming at improving the household level impact from ECOCA access and nurturing the repayment rates from Yumbe specifically back on track.

Background

Responding to the urgent wood fuel dependency and deforestation crisis evolving in various setting across the world, especially in and adjacent to refugee settlements expanding due to the increasing global refugee influxes, Caritas Denmark in 2018 took the first steps towards identifying a solution. Caritas Denmark was well positioned to embark on this quest with strong partnerships with competent local organisations based in some of the crisis hot spots, offering a complete understanding of the local challenges and needs, and as a Danish organisation with easy access to one of the most cutting-edge resource bases within green technology.

The Danish, newly founded, company Pesitho was identified as the most promising technological partner for the initiative, as they were in the process of developing an innovative solar-powered electrical cook stove with potential to relieve vulnerable households of wood fuel dependency and reduce deforestation. Based on consultations with Caritas Denmark's partners in Uganda and Myanmar, Caritas Uganda and Caritas Myanmar (KMSS) respectively, Caritas Denmark provided inputs to Pesitho in the prototype developing stage to ensure that the product would reflect the needs of the target groups in these two settings. This resulted in the version 1.0 ECOCA.

Impact pilot in two settings

With funding from Danida, Caritas Denmark purchased the first 100 version 1.0 ECOCA that were shipped to the two selected destinations; the Bidibidi Refugee Settlement in Yumbe District in Northern Uganda (38 ECOCA for refugee households, 12 ECOCA for host community households) and two IDP villages in Kayin State in South Eastern Myanmar (25 ECOCA for IDP households in each village). From February to May 2019 an impact pilot was completed in these two settings, assessing the appropriateness of

the equipment and the outcomes experienced by the households from accessing an ECOCA. Considering the adaption challenges experienced globally of many previous cooking technologies, in both settings the most vulnerable households were selected as recipients of ECOCA to ensure that the findings would reflect those with the lowest adaption capacity, thereby disclosing this challenge entirely. A Real Time Evaluation was done in both settings in March/April 2019 by Caritas Denmark staff, and an end of project evaluation across settings were completed in June 2019 by a team of Danish graduate students from Aarhus University. The pilot was highly successful and testified to significant livelihood improvements among the 100 participating households. These three learning reports are available on the Caritas Denmark website.

Based on learning from the impact pilot, Pesitho developed the ECOCA version 2.0, offering solutions to the challenges encountered with version 1.0, such as constraints in preparation of beans. The version 2.0 model is designed for local assembly, easy serviceability, and usability. It comprises 8 submodules that can be assembled using two types of simple hand tools with assembly time of only 8 minutes, requiring only limited technical expertise, as the submodules cannot be assembled wrong. The equipment includes two Printed Circuit Boards (PCB) that enables local service technicians to assess any technical defaults using the Pesitho smartphone application. The version 2.0 model is digitalised which allows flexibility in terms of adjusting cooking programs, allowing for more cooking options, reflecting the relevant cooking cultures. The capacity of both solar panel and battery is slightly higher and a display has been added that indicates the remaining level of battery available.

The challenges remained that 1) the technology requires local capacity facilitating technology adoption, manual digital tracking¹, maintenance, and supply to ensure sustainability and last mile distribution, and 2) the market price of the ECOCA significantly surpasses the expected ability and willingness to pay among the most vulnerable population groups, who Caritas Denmark is seeking to reach.

Comparing the findings from the two impact pilot settings it was clear that the beneficiaries in Uganda were experiencing the most significant livelihood improvements from ECOCA access due to the more restrained access to wood fuel in this setting and due to a more prevalent utility of the possibility to generate income from the electricity access provided by the equipment. For this reason, Caritas Denmark prioritised to focus resources on pursuing the initiative in Uganda.

[Local capacity supporting last mile distribution](#)

In collaboration with Pesitho, and Caritas Denmark's Ugandan partners; Caritas Uganda and the national NGO CIDI, Caritas Denmark established an ECOCA cooperative (Ecoop) in Yumbe adjacent to the Bidibidi Refugees Settlement as a local ECOCA technology

¹ Pesitho is in the process of adding automated digital tracking to the equipment allowing for extension of use-period whenever monthly repayment is made, thereby reducing the frequency needed of Trackers physically having to move to the beneficiary homes for activation. This system is expected to be finalized together with Pay-as-you-go enabling of the ECOCA, and planned to be released by June 2022.

resource centre to ensure anchoring of product knowledge with those who live in the area where the ECOCA is being used. Ecoop was capacitated to assemble imported ECOCA components, sell ECOCA to beneficiaries, install ECOCA in beneficiary households, provide cooking guidance for easy technology adoption, maintain equipment, and monitor usage (tracking). The combination of having the local production physically placed in the vicinity of the users with staffing from the refugee settlement and host community, allows a close and quick response time to any service needs beneficiaries might have. At the same time both sales and service people are well known, speaks the local languages, and local employment opportunities and skills development is facilitated.

CIDI is supporting the operation of Ecoop, and Caritas Uganda is monitoring beneficiary repayments and coordinating the usage monitoring by Ecoop. A separate learning study on the Ecoop institutional capacity and potential for creating decent green youth jobs (SDG 8) is expected to be completed in 2022/23. This local capacity build in Yumbe supported the implementation of this willingness-to-pay pilot regarding the beneficiaries located in Yumbe District. Ecoop assembled, sold, and installed the equipment. The Ecoop Cooking Advisors facilitated beneficiary adoption of the new technology and the Ecoop Trackers followed-up payments and collected user data for documentation of carbon emission reductions. As a small part of the pilot beneficiaries is located in Rakai District, a sort of satellite hub was created in Rakai in the sense that resource persons within the involved farmers cooperatives were trained to undertake the support functions of installing and maintaining ECOCA, providing cooking advisory services to the members households purchasing the equipment, and tracking usage.

[Subsidizing the ECOCA price](#)

Even with the necessary local capacity in place, the ECOCA price remains a challenge in reaching the massive populations, who could benefit from the equipment. Carbon credits has so far been identified as the most promising means of subsidizing the ECOCA price, an avenue that Pesitho is now pursuing. The preliminary financial assessment of this subsidy stream conducted by Pesitho led to development of a business model where $2/3^2$ of the ECOCA price would be financed by carbon credits (partially supplemented by donor funding or other soft finance in a start-up phase, particularly when targeting population groups where documentation of carbon credit reduction could be impeded by e.g. repatriation). Determining the applicability of this model as a sustainable market-driven impact strategy therefore depends upon the extent to which the beneficiaries themselves would be able and willing to finance the remaining $1/3$ of the ECOCA price. This business model reflects the assumption that partial user payments increase the likeliness of the product ending up with those really needing it and who therefore will prioritise to maintain it well and make the most use of it.

Caritas Denmark therefore in late 2019 prioritised with funding from Danida and the Danish Novo Nordisk Foundation to conduct a comprehensive willingness-to-pay pilot

² At the time of finalizing this report, a new carbon credit calculation methodology had been introduced, which might reduce the share of the product costs that can be subsidized by carbon credits. The implications are still unknown, but it might involve a longer-term or even permanent need for partial donor subsidy.

exploring this potential. Learning from this pilot was enabled, captured, and documented by Caritas Uganda and CIDI, and compiled, analysed, and presented in this report by Caritas Denmark. Delays occurred in 2020 particularly induced by COVID-19, but also resulting from changes in Ugandan import legislation. While preparations were ongoing throughout this period, the actual sales took place between April and August 2021.

The objective of the study is to establish if beneficiaries are able and willing to pay a subsidised price (approximately 1/3 of the actual product price) and how long a repayment period is preferred. The emphasis of the study is therefore not only if beneficiaries agree to purchase the equipment, but also the extent to which they honour this commitment by continuously making the monthly repayments as per their selected repayment models. Finally, a narrow focus of impact on household economics and energy consumption is included, adding to the findings of the broader impact study from 2019, representing here a much larger number of informants. The household level impact provides a good indication as to the likeliness of the households being motivated to continue repaying their monthly instalments.

Pilot methodology

Identification of vulnerability groups

Caritas Denmark is through our local partners implementing both a humanitarian response programme as well as a development programme in Uganda. Beneficiaries of these two programmes represent significantly different vulnerability groups, with different challenges and different opportunities and abilities. However, wood fuel dependency is a key barrier to livelihood improvements across all selected vulnerability groups, though it impacts them differently. Some have easier access to wood fuel than others, some have higher income than others and some are more exposed to food insecurity and assaults in relation to collection of firewood. Furthermore, deforestation is occurring across the country and thereby affecting populations of both programme areas, though the near depletion of trees particularly surrounding the refugee settlements are very serious, adding further pressure on wood fuel dependent households. The ECOCA was therefore expected to have relevance among both target groups, while the ability and willingness to pay were likely to differ. For this reason, a total of four different vulnerability groups were identified to be included in this pilot of 575 available ECOCA:

1: *The refugees of the Bidibidi Refugee Settlement*, located in Yumbe District, representing beneficiaries of Caritas Denmark's humanitarian programme. This vulnerability group is expected to comprise the poorest and most vulnerable, whereby their ability to pay is likely to be very low. However, this segment is currently facing the alternative of paying not just for batteries or other means of household lighting and phone charging, but also for wood fuel for cooking. Therefore, they are likely to have a high willingness to pay if the amount to be paid is not higher than the costs saved. Small instalments over longer period of time are expected to be most suitable. **315 ECOCA available for test for this vulnerability group.**

2: The host community of the Bidibidi Refugee Settlement are also part of the beneficiaries of Caritas Denmark's humanitarian programme due to the *Ugandan Refugee Act 2006*, requiring 30% of humanitarian interventions to be targeting the host communities. This target group is less vulnerable but still comprises a very poor population affected by the high population increase in the area due to large influx of refugees. They – in theory - have the option of collecting firewood without charge on their own land, whereby they might be less willing to pay for an ECOCA. Some representatives of this segment might however see the income potential of the ECOCA as an attractive investment, not least considering the time saved on firewood collection. Access to alternative means of electricity is limited in the area, as not many solar powered product providers are available. **135 ECOCA's available for test for this vulnerability group.**

3: The members of three farmer cooperative in Rakai, supported by Caritas Denmark's development programme. This target group has achieved higher income levels than the typical rural household, and representatives of this segments are already making small business investments and make regular savings. Wood fuel as a natural resource is less scarce in their area of residence, compared to the areas adjacent to the refugee settlements. Their drivers for buying an ECOCA are likely to be the convenience of not having to collect firewood and the quality of life improvements as well as income opportunities arriving from the ECOCA. They are expected to prefer fewer instalments, however, the total amount that they are willing to pay is not necessarily higher. **100 ECOCA's available for test for this vulnerability group.**

4: Caritas Uganda staff and relatives, reflecting the Ugandan middle-income class. The local partner staff as a target group is included in this pilot to provide the opportunity for a fall-back strategy, in case willingness to pay is not established in either of the above described target groups. While it is not the aim for Caritas Denmark in the long-run to enable ECOCA access for the Ugandan middle-income class, it could be an alternative strategy to reach the vulnerable target group through reducing the price by reaching scale from selling ECOCA's to middle-income class. Therefore, a few units are included in the project for this target group. **25 ECOCA's available for test.**

[Selection criteria among the vulnerability groups](#)

In Yumbe District, where the Bidibidi Refugee Settlement is located, a total of 450 subsidised ECOCA's (as mentioned above) were offered for sale for anyone, who could document that they were either a refugee or belonging to the host community. Initially, the sales were restricted to residents of zone 2 (which is Caritas Uganda's main zone of operation) in the settlement and the adjacent host communities, but this restriction was lifted as the sales slowed down. Five awareness raising meetings were held in the settlement (zone 2) by the local partners to inform residents of the possibility to purchase ECOCA's, the inherent advantages and the sales conditions.

In Rakai District, it was initially the intention that the 100 ECOCA's for the third vulnerability group would be offered to members of only one of the farmers cooperatives that Caritas Denmark's development programme in Uganda is supporting. Nevertheless, the members of this cooperative are in close interaction with two other farmer cooperatives in the same area that the programme is also supporting. Rumours travelled fast, and the two remaining cooperatives requested also to be included in the

pilot and have the opportunity for their members to purchase ECOCA. Hence, a third of the 100 ECOCA were offered to the members of each the three farmer cooperatives in Rakai, on a first come first serve basis. Nevertheless, each cooperative would reserve four of their available 33-34 ECOCA for sale to the most vulnerable cooperative members, categorized as; the elderly, disabled, or youth/child headed families.

Available repayment schedules and marketing conditions

These vulnerability groups were all offered the option among five different repayment plans, with the expectation that their choice would differ. The repayment plans reflected in the below table were presented as an introductory price with limited units available for sale. It was clearly communicated that it was unknown when ECOCA again would be for sale and that the price offered might be higher in the future. The total price is higher the longer the repayment period chosen to cater for the additional costs of offering credit, in order to ensure financial sustainability of the repayment models.

Up front	1 YEAR	2 YEARS	3 YEARS	5 YEARS
\$0 per month Total: \$175	\$16 per month Total: \$192	\$8,5 per month Total: \$204	\$6 per month Total: \$216	\$4 per month Total: \$240
UGX 0/month Total UGX 700,000	UGX 64,000/month Total UGX 768,000	UGX 34,000/month Total UGX 816,000	UGX 24,000/month Total UGX 864,000	UGX 16,000/ month Total UGX 960,000

Within all the repayment plans, the monthly instalments remain the same throughout the repayment period and during all seasons of the year. Long-term learning from this study will suggest if seasonal variances are more advisable, reflecting agricultural seasons or typical household income or expenditure patterns such as payments of school fees. Beneficiaries were however given the flexible opportunity to pay in advance on their monthly instalments as savings for coming months of lean season or other household financial restraints. When payments are received, the Tracker (see section on Local Capacity for Last Mile Distribution) visits the household and prolongs the ECOCA operation period with yet a month. This means that the equipment stops operating if instalments are not made, for the purpose of motivating timely instalments. Beneficiaries were clearly explained that in case of defaulting payments, they would be given 10 days before the equipment would be re-collected. In such event, the Trackers would during the 10-day period dialogue with the household and propose a switch to a longer-term repayment plan with smaller instalments. This arrangement provides the beneficiaries with the opportunity to be released from the financial obligation of continuing the repayment should they wish to. Thereby it can be assumed that all beneficiaries continuing their repayments experience a satisfactory value for money. At the same time, the arrangement is expected to result in a high recovery rate, which is significant for the financial sustainability of the business model.

When the beneficiaries sign their sales agreement, they are informed that the subsidised price is offered in exchange for the rights to the carbon reduction that the ECOCA usage is achieving, as this is used to finance the subsidy. Also, they are informed that the Tracker during the monthly visit will gather the data from the inbuilt data logger, showing their user patterns and that this data will be used both for carbon reduction documentation and for further refinement of the technology. Occasionally the Tracker

will also ask questions about their user patterns and cooking energy consumption to generate learning on ECOCA adoption specifically and generally on e-cooking as a new alternative to wood fuel for cooking.

The monthly payments are made through an Airtel³ account, and beneficiaries are informed of whom to contact in case of technical difficulties, and whom to contact in case of complaints or dissatisfaction with the product, services, or staff. The purchase involves a 5-year service agreement, including free of charge repairs (except cases resulting from misuse of the equipment). Battery replacement that is expected to become necessary after approximately 5 years will be the responsibility of the beneficiaries who will be offered to buy a new battery paid in instalments to ensure affordability (the total battery price is currently USD 169, but might be less in 5 years). It is the intention of Pesitho to set up an e-waste arrangement where a substantial discount is offered for those returning an old battery.

When purchasing the ECOCA, the beneficiaries are given the opportunity to also purchase a solar panel stand, as it was a key learning from the impact pilot that if the solar panel is not fixed to a permanent stand, it tends to be locked inside the house when beneficiaries are not at home, which reduces the availability of cooking energy from the ECOCA. The option involves a locally available structure that can fixture the panel to an iron roof, or two different tailor-made models (one in iron and a cheaper version in wood) that allows the panel to be fixtured on a pole for homes without iron roofs.

For easy adoption of the innovative ECOCA technology, the beneficiaries receive cooking advisory services that is included in their purchase. A cooking advisor instructs the household members who will be using the ECOCA on how to use the different functions and how to cook the most typical local dishes. The instructions take place in the beneficiary homes during cooking and is repeated to the extent necessary. A cookbook is also provided for this purpose. The cooking advisor further explains how the solar panel needs to be kept in the sun and the dos and don'ts related to the equipment.

[Methodology for data collection](#)

The baseline data for this willingness-to-pay pilot learning report was collected during the ECOCA sales (April-August 2021), where all beneficiaries were asked questions mainly regarding their household energy consumption and costs. Two months after the ECOCA installation in the respective households, the Trackers during their monthly visits repeated majority of the baseline questions, allowing for comparison on household energy consumption and costs with and without ECOCA, and collected information regarding income generating activities originating from the ECOCA access. By the time of the learning report writing, the two-month tracking data was available for all households, except for 8 ECOCA that have been purchased by one of the local partners for donation to People with Special Needs (PwSNs). This is the main data on which basis the findings of the report are derived. Additionally, 21 qualitative semi-structured interviews (15 in Yumbe and 6 in Rakai) were conducted to provide a better

³ One of the major telecom providers in Uganda.

understanding of the trends that the data are showing, and 33 testimonies were collected from randomly selected potential beneficiaries who chose not to purchase an ECOCA. The latter was done as a means to inform analysis of the constraints or concerns that the target group could experience when considering ECOCA purchase.

The findings of this learning report might result in follow-up activities by Caritas Denmark and partners, should the findings indicate need for further efforts by the cooking advisors or other strategic adjustments, enabling improved impact. During the monthly Trackers' visits one year after the installation, the same data collection will be completed by the Trackers, allowing for an assessment of the extent to which the impact is maintained or even improved, following potential follow-up activities. This one-year progress data collection will result in a progress learning sheet that will also be shared with the stakeholders (expected by September 2022), who have requested sharing of this learning report.

Methodology for data analysis

The ECOCA technology applied for this pilot had gone through upgrades and redesign (see section 'Impact Pilot in Two Settings') resulting in a version 2.0 that had not previously been field tested. Consequently, during the pilot period minor technical challenges did occur requiring some adjustments allowing for optimal use. Therefore, the equipment was not fully operational throughout the entire pilot period, which affected some of the pilot result. During the non-operational periods that occurred at different times for the respective 575 units, the users were exempted from meeting their monthly instalments. As it was possible to identify these households in relation to the monthly repayments, the repayment data was still applicable. Also, the household data collected by the Trackers two months after installation could for the part of the target group (those located in Rakai District) be filtered so that those households who had non-operational ECOCA's during the time of the Tracker visit could be deducted from the data. For majority for the target group though (those located in Yumbe District) this was unfortunately not possible, which means that an unknown percentage of the households did not have operational equipment when they were answering questions regarding the impact of the ECOCA on their energy consumption. To some extent this has affected the presented impact data negatively, though it is still possible to identify the impact trends. In the analysis scenarios in this report where results might have been affected, it is clearly stated.

The technical challenges were isolated to the newly designed PCB boards, whereas other the remaining components had a stabile performance.

1. Quality from sub-supplier: Most faults on the product was due to quality in mounting of certain components on the Pesitho PCB board from suppliers. This has led to a stricter factory test procedure including a newly designed test-bench for PCB-boards.
2. Fuse design error: Due to a missing limitation (software) to the power draw from the pot in a scenario with a fully charged battery and rated power on the PV array, the fuse design (fuse type and socket) was inadequate dimensioned.
3. Software deficiency: Some scenarios in different use cases were not handled appropriately by the software. These have been added and fixed during the pilot.

4. Electrical loads: High electrical load happens in events where the user is cooking and intensively stirring in the pot (especially when mingling), creating a sudden circuit break that could not be handled by certain components. Electrical load is handled during design upgrades to the PCB board.

With technical back-stopping from Pesitho, Ecoop corrected the errors as they occurred, and in February 2022 Pesitho developed a more long-term solution regarding the fault occurring from electrical loads. This upgrade is being added to all already installed ECOCA's during March-April 2022 at the initiative and expense of the Pesitho.

Pilot findings

During a period of approximately 100 days, all the 575 ECOCA's⁴ were sold to the four respective vulnerability groups, namely 307 to refugees in the Bidibidi Refugee Settlement, 135 to the members of the adjacent host community, 100 to members of three farmer cooperatives in Rakai, and 25 to the staff and relatives of Caritas Uganda. Willingness-to-pay at the offered price and market conditions is thus confirmed, also among the vulnerable groups, making the business concept fallback position involving the middleclass irrelevant. Data related to the 25 ECOCA's sold to Caritas Uganda staff and relatives will hence not be included in this learning report analysis.

Among the 542 households from the vulnerable groups who purchased an ECOCA, 31% were women. This average is more or less reflected among the refugees (30%), while there are significant differences looking at the Ugandan households in Yumbe and Rakai, respectively. Among the host communities in Yumbe who purchased an ECOCA, 19% were women, while 41% of the farmer cooperative members in Rakai who purchased an ECOCA were female. This difference can possibly be explained by gender equality being a strong focus in the programme support to the Rakai cooperatives, and by female headed households being over-represented among the refugees in Yumbe, compared to the host community. The sex of the person purchasing the ECOCA does however not testify as to which household members, who are using the equipment for cooking. For instance, among the refugees 54% of the main users were females and 71% among the Yumbe host community. In this regard distinction was not made as to what was perceived as the main usage (cooking, IGAs, lighting etc.).

Baseline wood fuel consumption for cooking

Prior to the ECOCA purchase, 37% of the households in the Bidibidi Refugee Settlement and the adjacent host community (31% of the refugee HHs and 50% of the host community HHs) did not collect any firewood but purchased all their wood fuel for cooking. In comparison, in Rakai only 1% reported not to be collecting any firewood with an average 17 hours spent per week for those who did (when counting the hours spent by all household members). Similarly, the 63% of the Yumbe target group who did collect firewood spent in average 18 hours per week on this activity. There was some difference between the hours spent by refugees (19,3 hours) and hosts (14,2 hours). Among the 542 respondents only two reported not to have any weekly expenditures on wood fuel. Hence, almost all the households collecting firewood are

⁴ Except 8 ECOCA's that had been purchased by CIDI for PWSNs on another project.

also buying wood fuel, or at least paying for access to collect firewood. The latter is a very prevalent practice in Yumbe, where refugees are often demanded in kind or cash payment by the host community members to be granted access to collect firewood on their land.

Comparing the average weekly costs on cooking fuel for refugees compared to host community in general, refugees spent UGX 12,795 on firewood, UGX 9,142 on charcoal and UGX 85 on other fuels such as briquettes (total of UGX 22,021 on cooking fuels per week), while the host community members spent UGX 11,000 on firewood, UGX 13,296 on charcoal and UGX 411 on other fuels (total of UGX 24,707 on cooking fuels per week). In Rakai, the households spent an average UGX 13,985 on firewood, UGX 5,374 on charcoal and UGX 1,834 on other cooking fuels (total of UGX 21,193 on wood fuel) per week prior to their ECOCA purchase. The Yumbe host community who has the highest weekly expenditure on wood fuel was the same population group who spent significantly less time collecting firewood compared to the other two groups. The local partners explained that the majority of families in the Yumbe host community who did not collect any firewood are households with few household members or households based in the more urban settings, while the larger households in the rural settings with farmland typically both collect and purchase. While firewood and charcoal prices might differ between the two different geographical settings, and both distances and scarcity determine the quantities of firewood that can be collected in an hour, implying some insecurity as to the actual volumes consumed, the baseline scenario regarding time and money spent on wood fuel appears to be relatively comparable among the three different vulnerability groups. It is important to note though that this baseline data might not be representable generally for these vulnerability groups as the data reflects only those households who purchased an ECOCA and thereby might comprise different characteristics than those who did not.

Baseline costs on lighting and phone charging

In average the weekly expenditure on lighting among the refugees was UGX 2,827, including UGX 226 spent on kerosine/paraffin, UGX 159 on candles, and UGX 2,441 on batteries for torch lights. This expenditure was lower than the average weekly lighting expenditure among the Yumbe host community, who spent UGX 3,322 in total, including UGX 696 spent on kerosine/paraffin, UGX 253 on candles, and UGX 2,373 on batteries for torch lights. The lower lighting expenditure among the refugees might be explained by the fact that usage of kerosine/paraffin is prohibited due to fire hazards in the settlement, where most homes have grass roofing. This has led to several actors distributing small solar lamps to the refugees.

In Rakai where most of the beneficiaries have iron roofing, the weekly expenditure on kerosine/paraffin was as high as UGX 3,775. With a weekly expenditure of UGX 371 on candles and 2,729 on batteries, the total weekly lighting expenditure for the target group was UGX 6,875.

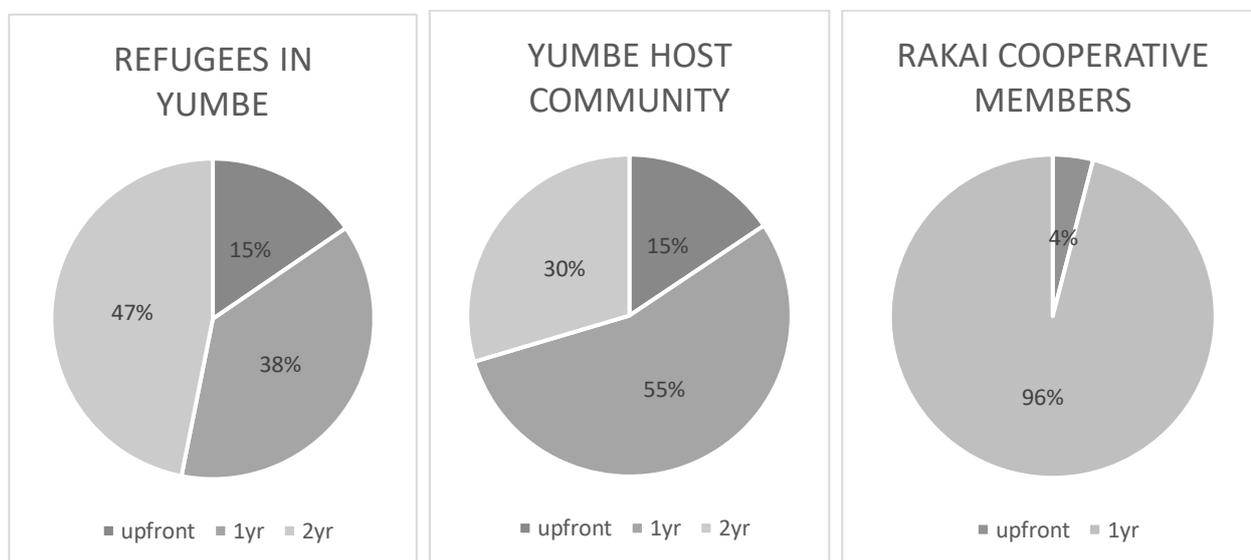
A similar trend applies for phone charging, on which the refugees spent UGX 2,479, the Yumbe host community members spent UGX 2,333, and the Rakai beneficiaries spent UGX 6,403. Hence, the baseline expenditures on lighting and phone charging are almost 2.5 times higher for the Rakai target group (total of UGX 13,278) compared to the

refugees and host community of the Bidibidi Refugee Settlement (total of UGX 5,413). This could very likely reflect a suppressed demand among the Yumbe beneficiaries compared to the Rakai beneficiaries who are considered more financially empowered, whereby the relatively high expenditure among the Rakai beneficiaries might not necessarily imply a higher level of motivation regarding their willingness-to-pay for an ECOCA.

Repayment plans selected

From April to August 2022, 542 subsidised ECOCA's were sold to the three vulnerability groups, who as expected had different preferences in their choice of repayment plans. Almost half of the refugees selected the 2-year repayment plan (47%), while preference among both the Yumbe host population (55%) and the Rakai beneficiaries (96%) was given to the 1-year repayment plan. Relative high percentages among the Yumbe target groups could manage the full upfront payment (approx. 15% of both refugees and hosts), while only 4% of the Rakai target group chose the upfront payment though this involves a lower total cost. The very uniform approach to repayment plan selection among the Rakai beneficiaries might however merely be a reflection of the high degree of social cohesion and unity prevalent in the Rakai cooperatives, where members tend to replicate each other's decisions providing a sense of reduced risk.

While none of the beneficiaries in Rakai selected any of the 2-5 years repayment plans, the beneficiaries in Yumbe (refugees and hosts combined) had a relatively even preference between the 1-year (43%) and the 2-year (41%) repayment plans. The 3-year repayment plan was selected by only two individuals (both refugees) in Yumbe, and the 5-year repayment plan by none at all.



Figur 1. Selected repayment plans

Repayment success

During the first months of the pilot implementation period the repayments superseded all expectations. In Yumbe, by June 2021, 65% of the households who had purchased an ECOCA at the time (two months after sales were initiated) had paid several months in advance, and by August 2021 more than half (51%) of the 442 Yumbe beneficiaries

had paid up their full share of the product price, though majority of these beneficiaries had chosen 1-2 years repayment plans. Among the households who had fully operational ECOCAs⁵, there was no delayed payments and no arrears at any time during this period in Yumbe, which is a clear indication that the beneficiaries are satisfied with the ECOCA performance. By close of October 2021 however, 26% of the Yumbe beneficiaries had delayed their monthly payment. Over half of these beneficiaries had delayed payment due to the technical difficulties that were being addressed during this month, which according to their sales contracts suspended their payment obligation. Among the remaining defaulting households (12% of the total Yumbe beneficiaries) some had relocated to other villages in the settlement and awaited that the Ecoop Trackers would identify their new locations before making the monthly payment, while others were experiencing difficulties in affording their monthly payments. The main explanations provided for the latter were increased cuts in the WFP food rations and COVID-19 induced financial struggle such as school teachers not receiving salaries during the prolonged school lockdown (ending January 10th 2022). These households were given a 10-days extension to meet their payments, which many managed. Nevertheless, from November 2021 the repayment rate for the Yumbe target group collapsed and reached by close of January a level as low as 28% (of beneficiaries still repaying) who had met their full monthly obligations. This left to implementation of a follow-up intervention by the local partners meeting with each beneficiary household in arrear to identify reasons for their defaulting payments and agree upon a realistic payment strategy, including the option transiting to longer-term repayment plans with lower monthly instalments. At the time of the learning report finalisation, these follow-ups were still ongoing.

The 96 households in Rakai who chose not to pay the full price upfront paid averagely UGX 130,056⁶ in their first instalment instead of the UGX 64,000 owed according to their selected 1-year repayment plan. This equals an average of more than one monthly instalment in advance. The first defaulting beneficiaries were encountered in Rakai in August 2021, when 13 of the 96 households did not make their timely payment. 10 of the 13 households did not make the payment as per agreement with the project partners as their ECOCAs were among those experiencing technical difficulties (described in section 'Methodology for Data Analysis'). The remaining 3 households had difficulties meeting their monthly payment due to financial constraints resulting from the COVID-19 imposed lockdown (2 cases) and health implications (1 person). They had all recovered their arrears within 10 days and it was therefore not relevant to propose a longer-term repayment plan (see section 'Available Repayment Schedules and Marketing Conditions'). Following these incidences and up to the time of the report writing, defaulting repayments were only recorded in Rakai among those experiencing technical difficulties and hence were excused from timely payment.

Cooking fuel savings motivating willingness-to-pay

The reductions in household usage of cooking fuels are generally lower than anticipated, when looking at hours spent on firewood collection. In Yumbe the average time spent on firewood collection among those collecting firewood has reduced with 39% among

⁵ Technical difficulties occurred for some of the equipment during different times of the pilot period see section on 'Methodology for data analysis'.

⁶ This figure is beyond the UGX 50,000 that the farmer cooperatives charge their members as commission (more on this in the next section 'ECOCA demand').

the refugees and with 58% among the host population. At the same time the percentage of households that do practice firewood collection has increased from 69% to 80% among the refugees and from 50% to 61% among the host population. This trend will need to be explored further by the project to clarify whether it is reflecting a seasonal pattern, external circumstances such as COVID-19 restrictions, cuts in food rations etc. or if there can be some unforeseen behavioural practice resulting from ECOCA usage. In Rakai, on the contrary, the number of households collecting firewood remains more or less stagnant (one less collecting), while the average time spent on firewood collection among those collecting has reduced by 67%.

The picture becomes somewhat more nuanced when looking at the weekly household cooking fuel costs. As reflected in the below table, the host communities in both Yumbe and Rakai have achieved a 72% and 71% reduction in weekly cooking fuel expenditures, respectively, while refugees reduced this expenditure by 63%. There are large differences in reductions within all three target groups, indicating different categories of success in technology adoptability. Also, the differences are likely to be influenced by the operation of a portion of the ECOCA's being challenged by technical difficulties (See section on Methodology for Data Analysis), meaning that some of the beneficiaries in Yumbe had non-operational equipment at the time when the follow-up data were collected two months after installation. In Rakai, it has as mentioned been possible to remove the follow-up data from the households experiencing technical difficulties from the data analysis, thereby providing a more real picture of the household impact from ECOCA usage.

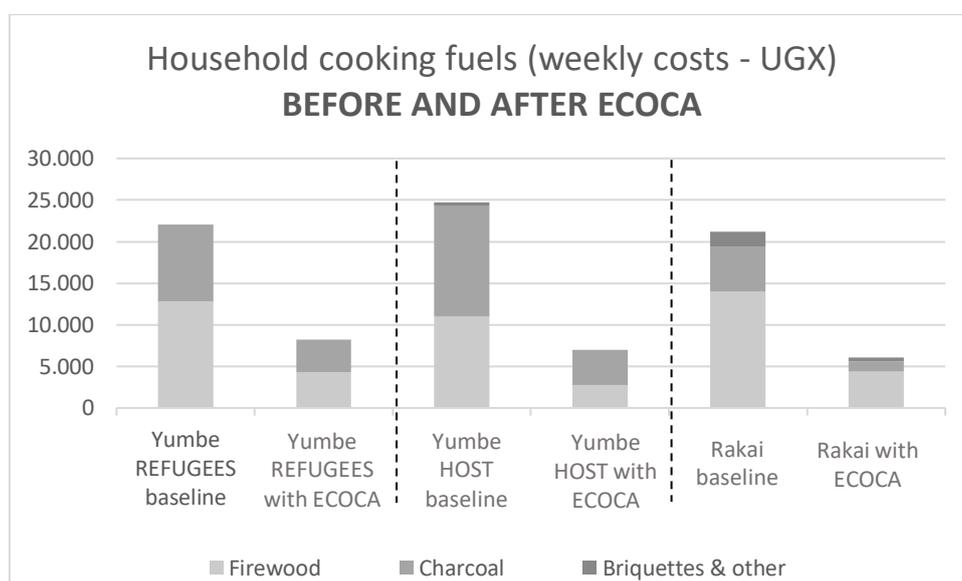


Figure 2. Cooking fuel expenditures

The differences within the vulnerability groups can for instance be seen among the refugees, where a “super user” category can be identified reflecting 12% of this target group who has managed to **eliminate their cooking fuel expenditure entirely** and at the same time averagely spent only 3 hours weekly on firewood collection. While the data does not reveal the number of household members that the ECOCA's in these “super user” households are supporting or clarify the extent to which these households

are enjoying the same number of meals, the baseline data for this specific category testifies to impressive reductions. In average this specific category used to spend over 11 hours weekly collecting firewood and had an average weekly cooking fuel expenditure of UGX 24,000, adding up to a monthly saving of UGX 104,000 on cooking fuels alone, which is significantly more than the monthly ECOCA repayments (UGX 0-64,000 depending on modality chosen).

In Rakai, the reductions achieved appears to be more evenly distributed among the beneficiaries. Here only 3% have eliminated their cooking fuel expenditures entirely, while majority (72%) have reached a lower level of cooking fuel expenditures than the average of UGX 6,086. This shows that it is the remaining 28% who accounts for the above average consumption. Paying a closer look at this section of the beneficiaries, it is clear that the average baseline cooking fuel expenditures for these households were only slightly higher compared to the overall average Rakai baseline (UGX 23,313 compared to UGX 21,190) and the time spent on firewood collection more or less the same. Still, this high consuming group that might not at the time of the data collection have achieved so impressive reductions in their wood fuel consumption, in average experienced a monthly saving of UGX 62,942 on their lighting and phone charging costs combined, which alone is almost enough to cover their monthly ECOCA repayments (which is UGX 64,000 for all of these households). This might explain the successful repayments even among less benefitting households.

[Explaining cooking fuel trends](#)

As mentioned in the methodology section, qualitative interviews were conducted with 21 ECOCA beneficiary households in order to get a more in depth understanding of some of the trends that the quantitative data is showing. While the qualitative data is too limited to deduct statistics, it does suggest some explanations for the wood fuel reductions that among some of the households within all three vulnerability groups are lower than anticipated. First of all, it suggests that particularly the Yumbe households have a larger household member base (above 10 household members of which at least 4 are adults) than the ECOCA version 2.0 technology is intended to accommodate (up to 7 household members), which implies that the equipment by some households in this vulnerability group are not intended to replace their wood fuel consumption entirely, but rather is seen as a primary source to be supplemented by fuel based cooking.

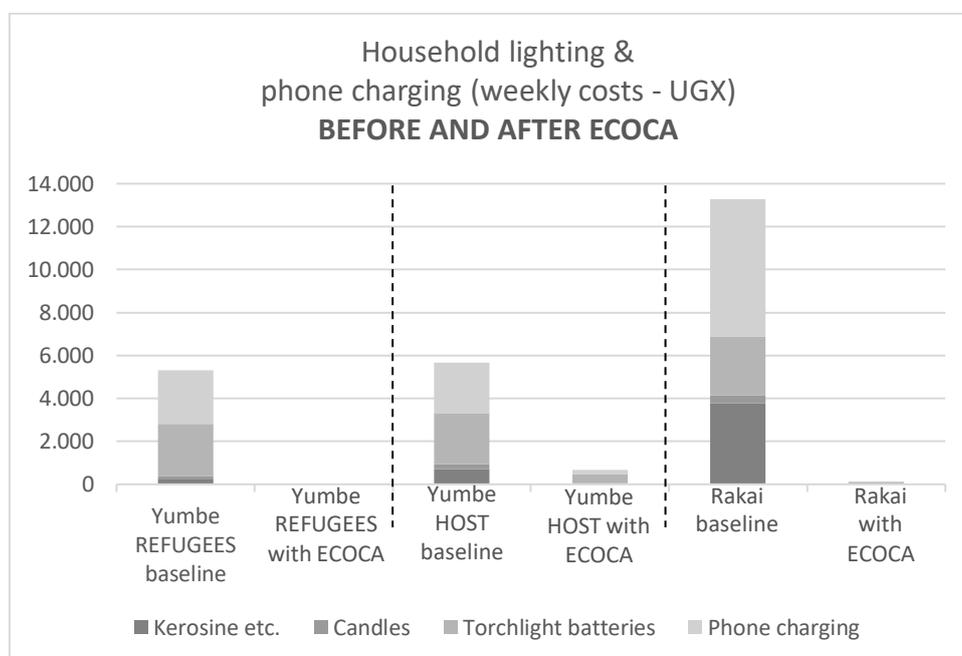
Furthermore, as the Rakai beneficiaries live in houses with iron roofing, it was possible for this vulnerability group to have their solar panels permanently fixated on their roof. This is rarely the situation with the Yumbe beneficiaries. Learning from the initial impact pilot in 2019 in the same geographical location suggested that fear of theft concerning the solar panel results in beneficiaries keeping the solar panel indoor at night and sometimes when leaving the premises during the day. Therefore, as part of the willingness-to-pay pilot the Yumbe beneficiaries were offered to purchase a solar panel stand as an add on to their ECOCA purchase. Two different options had been designed; a cheap version made of wood (UGX 65,000, approx. USD 18) and a more expensive, but safer version made of metal (UGX 140,000, approx. USD 39). Nevertheless, no beneficiaries in Yumbe chose to purchase a solar panel stand possibly due to economic restraints. Of the 15 Yumbe beneficiaries responding to the qualitative interviews, only

four felt safe leaving the solar panel out during the day when leaving the house. Still, none of the respondents had purchased a solar panel stand, though ten mentioned that they planned to do so at some point. By the time of the report writing, still none had purchased a solar panel stand. In average, the 15 respondents in Yumbe kept their solar panel indoor during almost three hours every day during sun light, which clearly reduces on the capacity of the equipment, increasing the need to supplement the cooking with use of wood fuel. Hence, to reduce the wood fuel usage further, it will be key to find a means of securing the solar panel that correspond better to the needs and affordability of the Yumbe beneficiaries.

Another interesting information arriving from the qualitative interviews was that majority of the Yumbe beneficiaries appears to be using the ECOCA to boil water for both tea and particularly drinking water, though water purification through boiling was a rare priority beforehand in this setting⁷. Some households now boil more than 10 litres of drinking water per day, which significantly reduce the capacity left for cooking, resulting again in higher need of supplement with wood fuel. Boling of drinking water might hence have been a suppressed demand among this population group that is now to some degree addressed as it with the ECOCA has become more accessible. This challenge could be mitigated by ensuring access to other means of water purification.

Lighting and charging savings motivating willingness-to-pay

Looking at the energy savings achieved in relation to weekly costs on lighting and phone charging, the scenario is unambiguous. Across all three vulnerability groups, **the costs are entirely or practically diminished**. As illustrated below, the reductions comprise 100% for the refugees, 88% for the Yumbe host population, and 99% for the Rakai beneficiaries, respectively.



⁷ According to the initial ECOCA impact study baseline survey, and KAP survey 2019.

Figure 3. Expenditures on lighting and charging

Adding together reductions in weekly costs on both cooking fuels, lighting, and phone charging, all three vulnerability groups in average appear to be experiencing considerable improvements in their household finances. The total energy savings (cooking, lighting, and charging combined) achieved added up to 70% for the refugees, 75% for the host population and 82% of the Rakai cooperative members. In Uganda shillings (UGX) this translates into a monthly saving of UGX 82,836 for the refugees, UGX 98,354 for the Yumbe host population, and UGX 122,417 for the Rakai cooperative members. With monthly ECOCA repayments ranging from UGX 0-64,000, all repayment modalities are fully accommodated by the average savings made from the ECOCA usage. After ended repayment period, the full saving will be available to the beneficiary households.

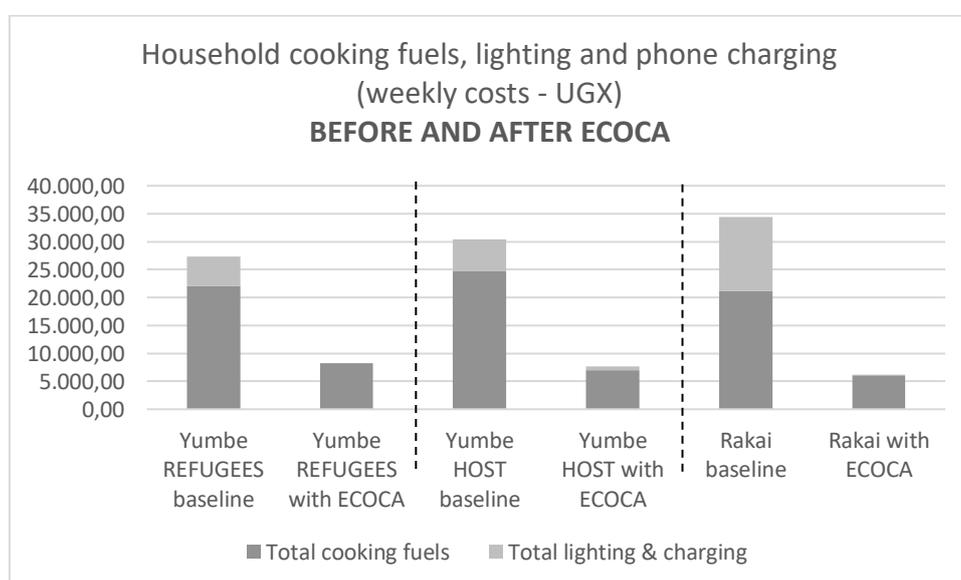


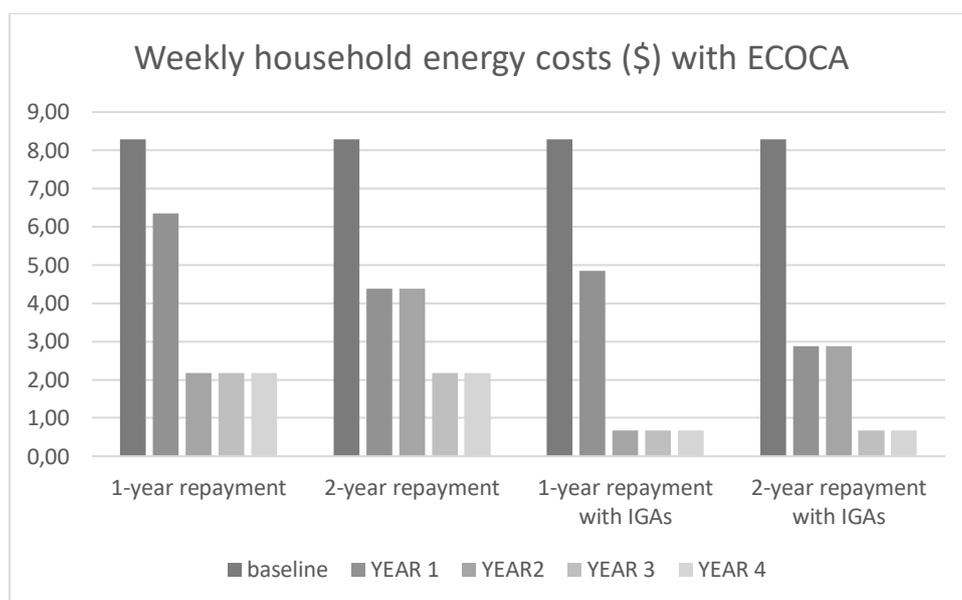
Figure 4. Total energy expenditures

Income generation motivating willingness-to-pay

Two months after their individual installation date, 17% of the refugees, 29% of the Yumbe host population, and 39% of the Rakai cooperative members were using their ECOCA for income generating activities. In Yumbe, the income generating activities only included charging of mobile phones, while the Rakai beneficiaries had extended this service to also include charging of radios. In Rakai there was also one case of a household boiling drinking water and eggs for sale. The incomes of the households from these activities differed from UGX 500 to UGX 50,000 per week. In average for those gaining an income from these activities, the income amounted per month to UGX 30,970 for the refugees, UGX 17,078 for the Yumbe host population, and UGX 17,714 for the Rakai cooperative members. The most prevalent explanations provided for not utilising the ECOCA for income generation were that the intention with the purchase was domestic use or concerns that such activities would reduce on the cooking capacity.

With the different points of departure reflected in the baseline data, especially with regards to the weekly expenditures on lighting and phones charging, with the relatively

uneven reductions achieved both between and within vulnerability groups and with only some of the beneficiaries having initiated income generation using their ECOCA, the household benefits from ECOCA usage clearly differ. Nevertheless, looking at the average weekly household energy expenditures across all the 542 beneficiary households, it is clear as illustrated below (includes ECOCA repayment costs and expenditures on cooking fuel, lighting and charging, deducted incomes if any) that the household finances are significantly improved with ECOCA access during the repayment period and particularly after ended repayment. There seems however to be a number of programmatic adjustments that could further increase household reductions on wood fuel usage, which should be pursued to support this learning.



Figur 5. Energy expenditures per repayment plan

ECOCA demand

With willingness-to-pay confirmed among 542 beneficiaries, represented by three different vulnerability groups, and energy savings established as fully covering monthly ECOCA repayment costs, a very high demand is the logical expectation. Nevertheless, learning from promotion of other cooking products seems to be that this cannot be considered a safe assumption. The ECOCA does however significantly distinguish itself from other cookstoves, being the only electrical off-grid cookstove powered entirely by renewable energy, and it is possible that the provision of electricity access is a game changer. For this study we have not prioritised to document the extent of the demand within a specific target group, as this would have been a rather comprehensive exercise. Nevertheless, the project learning does offer indications as to the demand among the different vulnerability groups.

Regarding the Rakai cooperatives, our Ugandan partner CIDI reports that in average in each of the three involved farmer cooperatives almost 100 more members wished to purchase an ECOCA but did not have the opportunity due to the limited quantities offered for sale. These three farmer cooperatives have in total a member base of 828 farmers, of which 100 already purchased an ECOCA. With close to 300 additional

farmers expressing also to be willing to pay for the product (at the offered price and conditions), this would equal a demand among almost half of this target group. Also, the fact that the Rakai beneficiaries paid the first instalment to their respective cooperatives long before the equipment had in fact arrived indicates a serious wish to buy the equipment. The three cooperatives agreed among them to add a commission of UGX 50,000 (approx. USD 14) on top of the subsidized price offered by the project to be paid by their members purchasing ECOCA's to utilize the opportunity to create an income source for the cooperatives, which testifies to an ability and willingness of this vulnerability group to pay slightly more than the 1/3 of the product price. The commissions to the farmer cooperatives were paid prior to the first instalments. It is important to stress in this regard that the Rakai target group are less poor and vulnerable than the Yumbe target groups, whereby this finding does not necessarily indicate that an increased market price would be affordable to all the targeted vulnerability groups.

The sales of 442 ECOCA's to the two vulnerability groups in Yumbe; the refugees and the host population, took approximately 100 days, facilitated by two Sales Agents from the ECOCA Cooperative (Ecoop). Excluding weekends, this means that in average one Sales Agent sold approximately three ECOCA's per day, which is relatively decent considering how expensive a product this is for those buying it. Nevertheless, the patterns of purchase were very uneven.

The arrival of the equipment in Uganda was much delayed and in the meantime the word of mouth had spread. Ecoop and the local partners were contacted by many individuals eager to buy the product. Therefore, they noted down those among the interested buyers who lived up to the selection criteria and thereby were eligible for purchase once the equipment had arrived. At the time when the 450 ECOCA's were ready for sale in Yumbe, 315 individuals had been noted down. The existence of this "waiting list" surely meant that the sales in the beginning of the 100 days were faster, as many beneficiaries interested in purchasing the product were already identified. At the peak, the demand was so overwhelming that Ecoop, to avoid long queues (conflicting with COVID-19 restrictions on gatherings) had to send beneficiaries interested in buying home and schedule a time for them to come back and purchase their ECOCA. However, during the end of the 100 days, the demand was so slow, particularly among the refugees, that beneficiaries from other zones of the settlement were allowed to purchase an ECOCA so that the pilot could be completed. It is worth noting that in both settings, numerous individuals not eligible for purchase according to the selection criteria (individuals from other zones of the settlement, from neighbouring districts, government officials and for the case of Rakai; farmers not members of the targeted cooperatives) expressed interest in purchase.

Ecoop, CIDI and Caritas Uganda have provided a number of explanations that could shed light on why the demand slowed down in the end. First of all, they believe that demand would have been higher if product promotion and more sensitization had been prioritized so that more people would be aware of the option and understand the advantages offered by the product. Further, they suggest that those who purchased ECOCA's under the pilot are reflecting the most risk willing, curious, and agile segment

among those who knew about the opportunity. The partners report that a prevalent attitude was that people wanted first their friends and neighbours to prove the efficiency of the equipment before daring to buy it themselves. Also, many were sceptical based on their experience with other technologies that have previously been available and did not meet their needs and/or fulfilled the promises made with regards to warranty and guarantee. Some interested buyers did not have Airtel accounts and could hence not access the repayment modalities. Finally, the uncertainties involved in the COVID-19 lockdowns made many hesitant towards making investments and the government seizing the Ecoop premises as temporary COVID-19 quarantine centre impeded access to the facility, scared off some potential buyers and effectuated rumours that ECOCA were no longer for sale at the facility.

For the purpose of gathering more knowledge on the demand, sample testimonies (27 in Yumbe and 6 in Rakai) were collected among those who had the opportunity to purchase an ECOCA but did not. This information provides an indication as to the prevalence and types of concerns and barriers that prevented potential beneficiaries from purchasing an ECOCA. Approx. 1/3 of the Yumbe interviewees heard about the possibility to obtain an ECOCA directly from the Ecoop Sales Agents, approx. 1/3 through community sensitization meetings with the local partners, and approx. 1/3 heard about the possibility at church, from neighbours or friends. In Rakai all the interviewees were informed of the possibility at a meeting between CIDI and the three involved farmers cooperatives, except one who did not participate. He instead heard about the possibility in the local town, where venders were talking about the innovative technology and from a co-member from the cooperative. All 33 interviewees reported that they found the opportunity appealing, though they had different reasons for not purchasing the product. Some provided more than one explanation.

In Yumbe, eight interviewees generally found the product to be too expensive, and 11 reported that they at the time did not have the financial means to make the first instalment. There was one overlap between these two categories. Six interviewees were of the perception that the ECOCA would not meet their needs or felt that the information provided was insufficient. Of these, two were concerned with the capacity of the battery, two found the cooking pots too small considering their household size, and one was afraid that children might get electrical shocks. Another four interviewees explained that they would need to make consultations with their household members and that household heads were unavailable to make decisions due to travelling, sickness etc. Finally, one was concerned that she would not learn how to operate the equipment.

In Rakai, five of the six interviewees reported that they had tried to purchase an ECOCA, but the stock was finished. The sixth interviewee explained that he at the time of the purchase opportunity was about to move out of his parents' residence and was concerned that having an ECOCA installed in his parents' home for a short period after which he would bring it with him for his new residence, would create tension between him and his parents. All six interviewees in Rakai are looking forward for the next opportunity to purchase an ECOCA.

These 33 interviews suggest that the demand proportionally is higher among target groups resembling the Rakai interviewees than among the refugees and host population

in Yumbe, where ability to afford the ECOCA instalments at least is perceived to be lower. Still, the fact that hardly any of the beneficiaries, including the 442 beneficiaries in Yumbe, selected the long-term repayment plans with the lowest monthly instalments (0,5% chose the 3-year repayment plan, 0% chose the 5-year repayment plan) indicates that the beneficiaries did not consider the monthly repayments to be out of reach. They could have chosen to pay \$4 or \$6 per month, but they chose \$8,5 and \$16 per month, respectively. This implies that these market conditions still leave room for the even more vulnerable and poor households among the different vulnerability groups to also access an ECOCA, which considering the documented energy savings would in fact offer a significant monthly saving. However, as energy consumption seems to be reflecting energy accessibility and affordability, it might be the case that the energy savings achieved by even more vulnerable households would be less as they are likely to have a lower baseline resulting from less financial capacity. Further studies could reveal if those who perceived the ECOCA to be unaffordable with time – if neighbours and friends continue to appreciate the equipment – would reconsider and make use of the longer-term repayment options with lower monthly instalments, or if 3-5 years simply is too long a time perspective for such vulnerable population groups enduring a high level of uncertainty in their daily lives, which for some even involve a potential option of repatriation.

Conclusion and issues in need of further study

This willingness-to-pay pilot verified both ability and willingness to purchase ECOCA's at the subsidized price among three different vulnerability groups in Uganda. This was verified at the sales point by 542 households and confirmed through the monthly user instalments, which comprised successful repayment rates throughout the full period for part of the target group and for at least six months for the remaining target group. The price level generally appeared appropriate, though one vulnerability group chose to pay a higher price in favour of their respective farmer cooperatives, testimonies by representatives of the other vulnerability groups at the same time revealed that some did not purchase the product as they found it too expensive. The latter though somewhat conflicting with the fact that the low repayments over longer periods were not prioritized, why this issue would benefit from further pursuit.

The technology was appreciated by the users, though technical challenges occurred. The risk of similar or other occurrences of technological challenges persists, which can be expected with pioneering technology, but this underscores the importance of local capacity and spare parts availability as part of scale-up planning. As potential future technological challenges might be of a different nature, a significant learning in terms of sustainability is that the technology developer, in this case Pesitho, should continue in one way or another to have a stake in the operability of the equipment. This could for instance be by part of the product payment coming from carbon credits, as these are only issued if the equipment is operational.

Significant reductions on household energy expenditures were documented across all three vulnerability groups, including expenditures on cooking fuels, lighting, and phone charging. The least vulnerable vulnerability group, who had the highest baseline, experienced the most comprehensive reductions. This trend however might have been

influenced by some of the equipment with the other two vulnerability groups not being operational at the time of the interviews. The extent to which the beneficiaries managed to utilize the full potential of the equipment differed possibly between and definitely within the vulnerability groups. The main challenges identified that appears to have impeded optimal usage of the equipment included that the ECOCA capacity by some is catering for more than the 7 household members that it is intended for, by some is used for water purification and by some reduced by the practice of keeping the solar panel stands indoors for safety reasons.

- **These challenges are expected to be attempted mitigated in 2022 by exploring the reluctance towards procurement of solar panels stands, by ensuring that the cooking advisory services received by the beneficiaries are sufficient, and by supplying alternative means of water purification devices⁸ to document a potential effect on the ECOCA user behaviours.**
- **As the ECOCA energy use is documented in an in-built data logger, Caritas Denmark will work with Pesitho to explore whether other challenges such a cloudy weather can account for some of the wood fuel supplements still in practice by majority of the beneficiaries.**

A number of knowledge gaps has been identified during the data analysis, which will be included in the next data collection among the 542 households which is scheduled for one year after installation (meaning April-August 2022). These include:

- **Why some households not collecting firewood at the time of the baseline had initiated this practice two months after installation.**
- **Why more beneficiaries are not utilizing the option of gaining an income from their electricity access, such as charging of phones.**
- **How many household members the ECOCA averagely is accommodating.**
- **Finally, how the above-mentioned programmatic changes for optimisation of ECOCA usage (regarding cooking advisory services, solar panels and water purification) have influenced user patterns.**

In 2022, it will further be key to monitor closely the repayment rates and to document learning on handling of defaulting households.

The precise ECOCA demand as a percentage of a given target group was not established under this pilot. It could have been an important learning in relation to planning of scale-up stages. In 2022, Caritas Denmark expects to offer sufficient ECOCA's for sale to cover the entire demand of the three farmer cooperatives in Rakai, which will contribute to the verification of the expected demand among this and similar target groups with the same vulnerability characteristics.

⁸ Caritas Denmark is in 2022 piloting the water purification device, the "Sawa", developed by 4LifeSolutions in Yumbe and joint marketing of these two products have previously been discussed.

In a longer perspective, key learnings will be the extent to which the most vulnerable households will endeavour to purchase ECOCA and what will be the decisive motivation in this regard, the extent to which the technology meets the duration expectations, and the extent to which carbon credits will be a feasible means of product subsidy meeting the now established willingness-to-pay of the beneficiaries.