



IMPACT ASSESSMENT

ENERGY FOR RURAL START-UPS PROJECT

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ACRONYMS

BG	Benzene Generator
CACH	Caritas Switzerland
DG	Diesel Generator
EEU	Ethiopian Electric Utility
EMIT	Entrepreneurship for Market Inclusion and Transformation
EneRSU	Energy for Rural Start-Ups
ETB	Ethiopian Birr
Green REAP	Green Rural Entrepreneur Access Project
KII	Key Informant Interview
KW	Kilo Watt
KWH	Kilo Watt Hour
MSME	Micro Small and Medium Enterprises
NEP2	(Ethiopia) National Electrification Programme 2.0
NGO	Non-Governmental Organizations
NPS	Net Promoter Score
PBX	Power Blox (Product)
PBX, AG	Power Blox (Company)
PI	Public Institutions
PUC	Productive Use Cases
PV	Photovoltaic
SME	Small and Medium Enterprises
SPV	Solar Photovoltaic
TOT	Training of Trainers
TV	Television
TVET	Technical and Vocational Education and Training

EXECUTIVE SUMMARY

Background and objectives of the Energy for Rural Startups Project

Caritas Switzerland (CACH) and Power-Blox AG piloted the Energy for Rural Startups (EneRSU) project in Oromia region. EneRSU has three outcome areas: a) provide electrification for rural communities to improve lives, livelihoods and promote diversified income; b) enhance renewable energy curriculum in collaboration with local universities and TVETs and c) networking and scaling the project. The project was implemented over two and a half years, implementing 87 installations for 24 productive use cases (PUC) and public schools and health centres (PIs) in Borana, East Borana and Bale zones. Some PUCs had installations in multiple locations. Curriculum enhancement with the University of Borana, was completed in March 2024, and the training of trainers (TOT) delivered in mid-to end March 2024.

As part of the pilot, EneRSU worked with other CACH projects in an integrated manner:

Green Rural Entrepreneur Access Project (Green REAP): A graduation out of poverty project implemented in Borana Zone, Oromia. The project supports ultra-poor women and youth through climate change adapted and an evidence-based poverty graduation model that trains, coaches, and mentors project participants to shift out of extractive livelihoods and to get into environmentally sustainable micro-enterprises. EneRSU worked with one group of ultra-poor women of the Green REAP project providing one PBX cube at 25% of its original cost, with no advance downpayment.

Entrepreneurship for Market Inclusion and Transformation (EMIT): This is also based on the graduation model, EneRSU integrated with one group of EMIT project participants from Moyale, Ethiopia. The project applies a push and pull approach. The push approach involves training, capacity building, grant disbursement, monitoring, and providing mobile phones and cash boxes. The pull approach involves establishing market linkages for 1,000 business groups (each group has 3 members). The project also manages 147 self-help savings groups. The EneRSU project worked with one EMIT business group, providing the PBX at 50% of its original cost (thus at same conditions as other PUCs/PIs), with an advance downpayment amount of ETB 20,000.

The impact assessment conducted by Altai Consulting is the first under this pilot phase. Therefore, the assessment is directed at understanding the extent to which the pilot project proved concept against intended objectives. Understanding which use cases show signs of success, highlight lessons from the integrated projects, and how EneRSU and similar future projects can be scaled. Also central to the impact assessment was identifying emerging outcomes and EneRSU's contribution.

Approach and methodology of the assessment

The impact assessment applied an outcome harvesting approach to identify intended and unintended outcomes as well as the extent to which EneRSU contributed to identified changes and the level of significance of those changes to project participants and stakeholders. The assessment team built a framework based on the impact assessment objectives and the OECD-DAC criteria¹ (relevance, effectiveness, impact and sustainability), and added scalability as a criterion. The framework enabled the design of the evaluation criteria and data collection tools.

The assessment drew from EneRSU's monitoring data and primary data collection as follows:

- An outcome harvesting workshop with EneRSU staff to identify emerging outcomes, intended and unintended.
- 22 mixed methods interviews with a sample of 15 PUCs (others in multiple locations) and 4 PIs.

¹ The criterion 'Efficiency' was not included in this study as it largely focused on the pilot phase of EneRSU.

- 17 qualitative interviews with stakeholders, including PBX-Ag, Ministry of Water and Energy and Ministry of Health at national level, signatory offices² at zonal and regional level, participating TVET and Universities, one private sector actor in the renewable energies space and CACH project staff.
- Five Focus Group Discussions (FDGs), three with community members, one with PUC members in Hora Kore, and one with GreenREAP business group.

Overall, the assessment found that EneRSU generated significant positive change at the outcome and impact level for project participants and their communities. It also provided an understanding of factors to consider in future similar access to energy projects in terms of scalability and sustainability of change.

Relevance: The extent to which the PBX technology, the project approach and interventions, are relevant in their ability to respond to community, PUC and PI needs and priorities.

The EneRSU project pilot strongly aligns with national and regional priorities for productive use of energy. The pilot strongly aligns with the National Electrification Plan (NEP 2.0) strategy targeting 35 percent of planned connections in rural remote areas in Ethiopia through off-grid means³. It also aligns with sectoral plans; for the health and education sectors to improve service provision, and in enhancing livelihoods generation and rural development through the productive use of energy, aligning with the objectives of the job creation and cooperatives office, particularly for empowering youth and women.

There is growing interest in the PBX in communities in which the pilot was implemented. Anecdotal evidence from interviews with participating PUCs and PIs, as well as signatory offices suggests that there is rising demand for the PBX. For MSMEs, there is demand for energy sources that have low to no operation and maintenance costs, lasts long hours in a day, and can support income generating activities. For households, there was interest in affordable light sources that can illuminate the entire house and last more than two hours in the evening. These qualities were associated with the PBX in comparison with locally available energy sources that could not adequately meet these demands such as dry cell batteries, solar lanterns, solar home systems, diesel and benzene powered generators.

Effectiveness: The level of contribution of project activities towards intended outcomes and the interventions that are most effective at delivering change for PUCs, PIs and local communities.

Project participants experienced significant positive changes which they attributed to the project. There were slight variations in experiences of change, for instance, participants who felt that they were able to make savings on their consumption of fuel/energy were likely to have switched from sources with expensive O&M such as diesel generators compared to participants who were using simpler, less expensive options such as Pico lanterns. Health facilities and businesses earning on average above ETB 1,000 daily and conducting mobile charging services were more likely to have invested in new electrical appliances.

² Oromia Water and Energy, Oromia Bureau of Skills and Job Creation, Oromia Region Co-operatives, Sinana Agricultural Office, Borena Zone Water and Energy, Borena Zone Finance and Development Bureau

³ Ethiopia Customs Handbook, 2022.

PUC and PI outcome harvest statements (n=21)

Outcome change statements	Percent of PUCs and PIs that “strongly agree” to change	Percent of PUCs and PIs that rate the change as “high” significance)
I was able to electrify my household	90%	90%
The quality of my personal life improved	86%	90%
I benefited from starting a new business using the PBX	81%	90%
I extended the hours of operation of the business	81%	86%
I benefited from increase in income generation using the PBX	76%	90%
I benefited from diversifying in new income sources using the PBX	76%	86%
I made savings on my consumption on fuel/energy	62%	71%
Increased investment in electrical appliances	48%	67%

Sixty-six percent of PUC and PIs rated 9-10 out of 10 on the extent to which EneRSU contributed to the most significant changes that they had experienced; 23 percent rated 8 out of 10.

Use case comparison

	PUC	Health Facility	School
Baseline	Kerosene, petrol, candles, torchlight, dry battery cells, solar home system, Pico solar system	Diesel generator	Pico solar system with batteries
Saving on O&M costs	Dry cell batteries 1,000 p/m Repairs 500-5000	8,500 p/m Repairs 500-5000	
Payback period With subsidy	9 months	7months	10 months
Avg. PBX income generated	600 ETB minimum daily income	15,000 ETB per month on lab services (public) 2,000 ETB daily (private health center)	200 ETB daily

Health centres reported substantial savings in terms of monthly fuel costs at average of ETB 8,500, and maintenance and repairs at average of ETB 5,000 per diesel generator malfunction, when they started using the PBX. Installation of the PBX in participating schools contributed significantly to teaching and learning. The PBX contributed to improved teacher’s approach to teaching by enabling access to new curriculum textbooks and teaching material using their phones. Schools generally consumed much less power than the available capacity because of the limited uses of energy within the school itself.

EneRSU strongly demonstrated the potential of off-grid energy in livelihoods development and economic empowerment. All PUCs reported new and increased income generation and diversified income sources. PUCs charged between 100 ETB – 250 ETB per lamp per month to connected households, and billed ETB 20-30 for charging of smart phones for six hours. PUCs also used the PBX for businesses such as barber shops, and in one case, medical services. The private health provider

for instance, was able to increase his daily income from ETB 600 before the PBX to ETB 1,500-2,000 on acquisition of the PBX.

Integration with EMIT and GreenREAP demonstrated the potential models in which the technology can be extended to reach ultra-poor households and enhance their income generating activities. Project participants from EMIT and GreenREAP, similarly benefited from diversifying income and expanding their businesses as other EneRSU participants. Integrated project participants reported increased savings post PBX installations, about 1.7 times what their counterparts under EMIT/GreenREAP were saving without the PBX.

Impact: The type of change or outcome that has been observed in the targeted communities that relate to the intended objectives of the EneRSU (positive and negative).

The assessment applied different sets of metrics⁴ to understand impact of the PBX on project participants. One metric was on the impact of the PBX on the quality of participating PUC and PI lives. The majority of PUC participants (83%) felt that the PBX had “*very much improved the quality of their life,*” while public institution respondents felt that the PBX had “*very much improved their lives and the lives of teachers/ health staff*”. None of the PUC or PI respondents felt indebted by the PBX payback or negatively affected by the cost of acquiring the technology. In comparison, in a performance assessment report by 60_Decibels on why off-grid energy matters, the benchmark stands at 62% users reporting significant life change for using the solar home systems.

PUC and PIs were satisfied with the quality of power, functionality and ease of using the PBX.

The PBX has a Net Promoter Score⁵ of 86, within this score, 86% of PUCs and PIs rated 9-10 that they would recommend the PBX to a friend and 14% rated 7-8 out of 10 that they would likely recommend the PBX. The global benchmark for NPS is 43, and for solar home systems, in comparison, is 50 in the 60_Decibels⁶ report. PUC and PI experience of the PBX was mostly positive related to power consistency, capacity and ease of use.

PUCs and PIs faced few technical and external challenges with the PBX. There were five instances reported of PBX technical malfunction out of 87 total installations, all of which were resolved, and in one case, the PBX replaced. External factors such as cloud cover affected the charging rate of the PBX (two instances reported). PUCs were also concerned over the lack of quality electrical supplies in the local market such as extension cables and connection wires that they required.

All 22 PUC and PIs interviewed said that they could not find an alternative source of power that was comparable to the PBX in the local market. Respondent comparisons were based on qualities attributed to the PBX, no maintenance and operational costs, long and consistent uptime, what is available such as solar lantern and battery cells which could not support productive use, diesel and benzene powered generators which had high maintenance and operational costs, and solar home systems which respondents associated with poor quality and high malfunction rates.

The pilot contributed to community access to affordable and clean energy source, particularly for light and mobile phone charging. Households living in close proximity to participating PUCs and PIs were able to access light at ETB 100-250 monthly for powering one lamp between 6pm to mid-night. This was a significant improvement for the household which probably relied on dry cell batteries, kerosene or solar lanterns for their lighting needs. Other households accessed enough power to also conduct new businesses such as tailoring businesses. Households also used the power for TV and to

⁴ The assessment used similar metrics used by 60 Decibels in their report: 60_Decibels, 2024, Why off-grid energy matters

⁵ The Net Promoter Score is worldwide as a proxy for gauging customer loyalty and satisfaction by assessing the extent to which a customer/end-user would recommend the product/service to a friend on a scale of 0-10. The NPS is calculated by percent of users rating 9-10 out of 10, minus percent of users rating 0-6 out of 10 that they are likely to recommend the product.

⁶ 60_Decibels, 2024, why off-grid energy matters: an impact performance report.

charge their mobile phones, leading to an improved quality of life. Some PUCs also managed to hire new employees because of the PBX.

Community members accessed services within their villages at reduced cost. Participating PUCs provided mobile charging services at 20-50% less compared to providers using diesel generators because they had no operational costs. Community members also saved between ETB 50 - 400 in transportation costs to access the same services.

Improved education and health service delivery. Some of the benefits to community members was accessing 24-hour health services and laboratory and other diagnostic services because participating health facilities were able to expand operating hours and invest in more equipment. In addition to improvement in delivery of teaching, adults interested in literacy classes were also able to access them for free during the evenings from participating schools, and students could study in the evenings.

Sustainability: The extent to which the program interventions and results are likely to be sustained after the completion of the program; the financial viability of the technology and the operating model in the local context.

PUCs and PIs were able to generate income from the PBX and payback subsidized cost of the PBX⁷. All⁸ project participants were able to payback (50% of subsidized cost of the PBX at 44,800 per PBX) within 10 months and were reporting gross profits. However, project participants expressed the need to extend the payback period to at least two years to enable easier payback. As the PBX will last eight to 15 years with no operational costs/maintenance costs, PUCs and PIs will recover the invested money and make profits from the technology as they have completed payments. Schools were the most challenged in paying back as they relied on community contributions. At the same time, EneRSU system utilization data indicated that the demand for energy within the schools was less than what was supplied in number of PBX cubes. Even though schools struggled to payback, they managed to raise over ETB 80,000 in downpayment representing between 50% - 80% of the required amount.

Community members were difficult to convince to purchase the PBX as they are used to associating NGOs with a grant model. The required downpayment in some cases may have been a deterrent in purchasing the PBX. EneRSU was accommodative of participating PUCs and PIs, allowing between 10% to 30% downpayment, and in one case, waived downpayment for ultra-poor women in the GreenREAP project. Suitable mechanisms should be used to make the technology affordable to rural households.

Scalability: Identifying what types of PUCs/Pis have most successfully adopted the PBX; what project activities have been crucial towards achieving intended change/outcomes. Aim to identify what approaches can be used to efficiently scale future iterations of the project

EneRSU subsidies on solar panels and electric appliances and lease-to-own options made the technology accessible for PUCs and PIs. The subsidy was necessary during the pilot because of the limited quantity of PBX that were purchased for the proof of concept, it is anticipated that the price of the PBX significantly drops with bulk purchase. However, the lack of foreign currency in Ethiopia and substantial differences in parallel forex exchange rates would increase the landing price of the product if a purely commercial model with distributors is used. These factors currently necessitate a blended financing approach with a first-loss partner, to reach rural off-grid communities.

MSME and healthcare use cases are potentially anchor clients for the technology. Both in terms of load demand and ability to generate income using the PBX, MSMEs and health facilities seemed better fit for the PBX through a business model. Health facilities compared to schools had more

⁷ EneRSU provided 100% subsidy on solar panels and electrical supplies, and 50% subsidy on the cost of each PBX cube. In addition, EneRSU covered for the cost of importing the PBX, transportation, training and installation.

⁸ One school paid up to 90% of the cost as a downpayment and did not complete the remaining 10% due to challenges in raising the funds.

expensive energy sources at baseline- fuel and benzene generators compared to Pico solar systems with batteries that the schools were using. Public health facilities participating in the project also benefitted from partner financing which schools participating in the project did not have. In the case of MSMEs, location of the businesses determined the amount of revenue the business could generate. Businesses that were closer to households had more customers. Schools said that they struggled to generate revenue from the PBX because they were located far from where most houses were.

Recommendations towards scaling

Enabling Environment: Government stakeholders such as the Ministry of Water and Energy/Ministry of Finance/Zonal and regional offices/other ministries would ensure supporting policies and their interpretation that stimulate demand and access to renewable energy sources including providing tax relief and subsidies.

PUC/PI: Anchor load clients, potentially MSMEs and health centres (private and publicly owned who have finance partners. Other clients like schools can participate but will not likely be substantial up takers.

First-loss partner(s): Cover administrative costs, logistics and implementation, as well as set up of post-sales support mechanisms. The First-loss partner may also take on downpayment risks enabling inclusion of ultra-poor households, or start-ups that may not have the finances for a downpayment but demonstrate capability for paying back with their business proposal/business opportunity. These could be donors, angel investors, responsible government agencies.

Financiers: Willing to advance downpayments for the cost of the PBX technology, solar panels, and whatever capital is required for the businesses. These could be financial institutions, other granting partners (as with the case of health institutions and livelihoods projects). The financier partners would provide suitable financial products targeting PUCs and PIs with the aim of reducing/meeting capex. It is important that interest rates are zero to very low to avoid indebting participating PUCs and PIs. A payback period of two years is advisable in comparison with other projects and recommendation from PUC and PI respondents.

Electrical appliances suppliers/solar panel suppliers: Potentially with local presence, should be able to provide these appliances also on a lease-to-own basis, or at discounted prices, and importantly guarantee quality products and sustainable after-sales services.

Intermediaries: Mobile-phone applications/mobile money providers facilitating access to support/ financial transactions.

EneRSU would continue to provide a project management or a business manager role, linking all the actors together and overseeing implementation.

1. INTRODUCTION

1.1. CONTEXT AND PROJECT BACKGROUND

Caritas Switzerland (CACH) in partnership with Power-Blox AG (PBX) piloted the Energy for Rural Start-ups (EneRSU) project in Ethiopia. The project aimed to demonstrate the use of PBX technology in addressing rural off-grid households' energy needs and access to productive use energy and its potential impact on improving livelihoods for rural households as well as improving public service delivery for education and healthcare in rural off-grid communities.

Figure 1: EneRSU Theory of Change

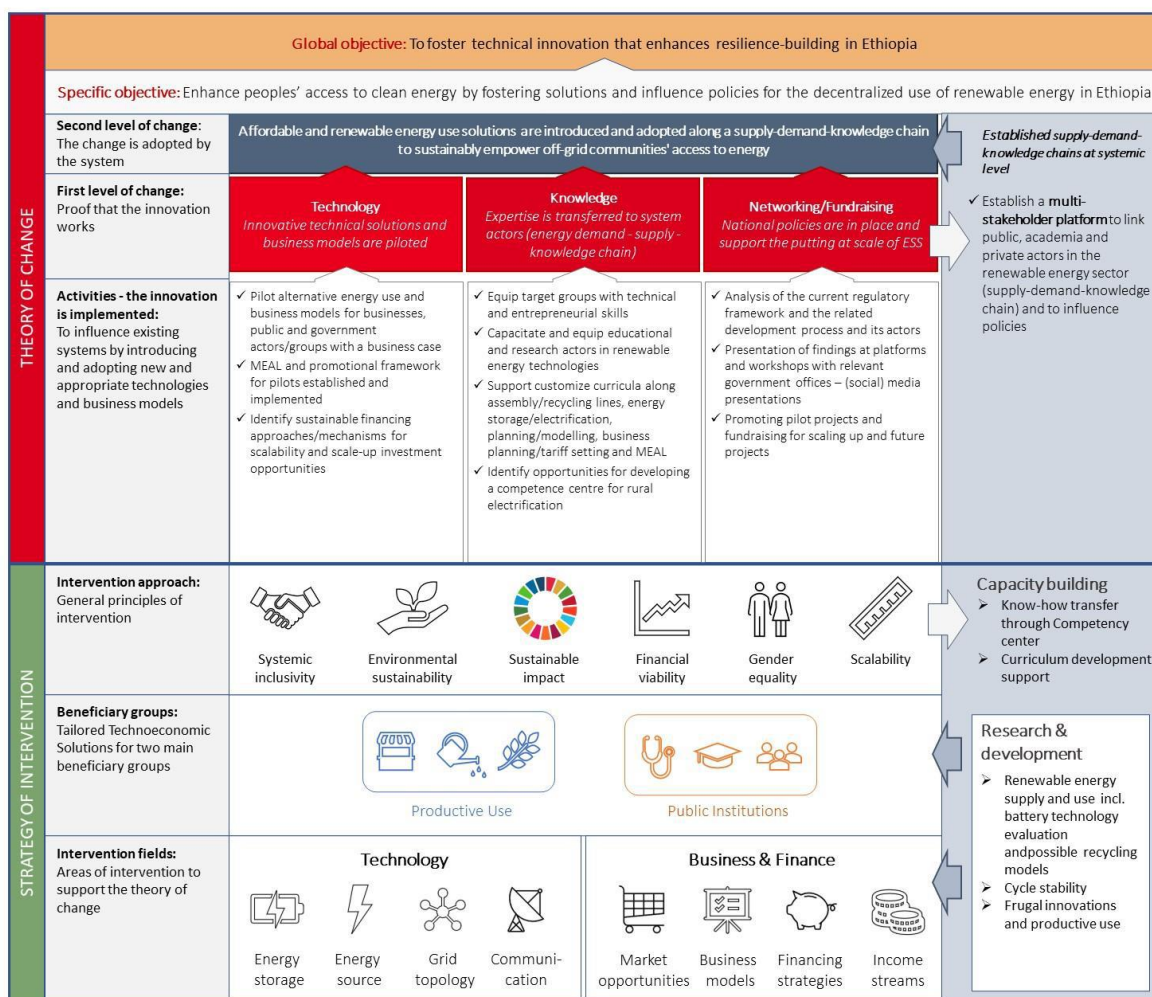
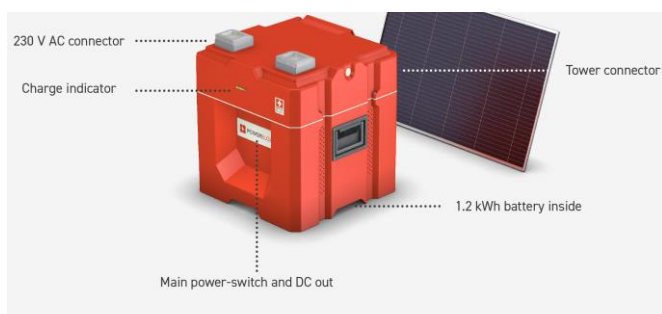


Figure 2: PBX Cube and charging system



The project used the PBX-200 system copyrighted and produced by Power-Blox AG. This is a “plug and play⁹, renewable energy source that requires no configuration, specific know how nor maintenance. It consists of intelligent energy cubes with an integrated lithium battery (LiFePO4). Each cube provides 200 Watt of alternating current (AC) and can be powered by a solar unit to supply a household or small commercial business with electricity. It leverages swarm battery

technology addressing the gaps that solar home systems and other energy source alternatives accessible for off-grid rural communities have:

- An easy installation and user-friendly technology that does not require technical expertise from the user.
- An expansible energy source that can be flexibly adjusted to meet increasing energy needs or scaled down with decreasing energy needs and can meet energy needs for a variety of productive use cases.

The pilot’s objective was to showcase the financial viability, benefits and sustainable impact of PBX electrification through selected productive use cases (PUC) including cooperatives and small and medium size enterprises and public institutions (PIs) including health centre, schools and a mosque. The pilot project was implemented in Bale, East Borana and Borana Zones of Oromia as in the Table below:

Table 1: EneRSU implementation sites and impact assessment sample

Woreda	Kebele	PUC	Number of sites	of PI	Busine ss Type	Sampled
Mada Walabu	Hora Kore	Ramadan, Tahir, Sultan & Their friends small shop MSE	4 locations	-	Commodity Shop	Yes 2 locations
		Rabla, Tayiba, Munisa and their friends Café & Breakfast	3 locations	-	Restaurant	Yes 1 location
		-		Mosque	Religiou s education	Yes
		-		Bidimo Primary School	Educati on service	Yes
	Danisa Karkaro	Ramadan, Abdulbari & their Friends Retail Trade in Radiation Emitting Equipment's & Radioactive	2 locations	-	Retail trade in radiatio n emitting equipm ent and radioactive sources	
		-		Danisa Kerkero	Educati on service	Yes

⁹ Ready to use, already assembled power source in a box.

Woreda	Kebele	PUC	Number of sites	PI	Business Type	Sampled
				Primary School		
Goba	Rira	Harana Rira Multi-purpose cooperative	1 location	-	Honey production	Yes
Sinana	Shalo	Bale Sanbe Irrigation Cooperative	8 locations		Irrigation	Yes 1 location
Arero	Hirmaye	Jalala Tokuma Mini Grid MSE	4 locations	-	Mini Grid	Yes 2 locations
		Dureti Oblo Mobile Charging MSE	3 locations	-	Mobile Charging	Yes 2 locations
		Dhadacha Oblo Restaurant MSE	2 Locations	-	Restaurant	Yes 1 location
			1 location	Faris Mini Clinic	Health Service	Yes
	Bobila	Bakalcha Bari Mini Grid MSE	4 locations	-	Mini Grid	Yes 2 locations
		Milka'ina Bobila Barber MSE		-	Barber	Yes
-			Bobila Junior School	Education service	Yes	
Taltale	Dibe Gaya	Dida Kiya & Bati Mobile Charging & Barber MSE		-	M.Charging & Barber	Yes
		-		Dibe Gaya H/ Center	Health Centre	Yes
	Kulcha	Amanuel Kusiya & Charika Mini Grid MSE	1 location	-	Mini Grid	Yes
		Gulufa, Sachama & Yando Mobile Charging MSE	2 locations	-	Barber	Yes 1 location
		-		Kulcha Health Center	Health Centre	
	Gandhile	GREEN REAP Business Group		-	Mobile Charging	Yes FGD with group
	Bule Korma	Odo, Dida & Adi Mobile Charging & Barber MSE		-	Mobile Charging	
		-		B/Korma Health Center	Health Service	Yes
Moyale	Dambi Hara	Bakalcha Bari Restaurant (EMIT)	1 location	-	Mob. Charging	Yes

EneRSU integrated with two other CACH projects in Borana and Moyale:

Green Rural Entrepreneur Access Project (Green REAP): This is a graduation out of poverty project implemented in Borana Zone, Oromia. CACH intends to graduate ultra-poor women and youth out of poverty and to enhance the resilience of target communities to climate change. The project uses climate change adapted and evidence-based poverty graduation model that trains, coaches, and mentors Green REAP project beneficiaries to shift out of extractive livelihoods and to get into environmentally sustainable micro-enterprises. EneRSU worked with one group of ultra-poor beneficiaries of the Green REAP project providing the PBX at 25% of its original cost.

Entrepreneurship for Market Inclusion and Transformation (EMIT): This is also based on the graduation model and is implemented in five kebeles in Moyale. The project applies a push and pull

approach. The push approach involves training, capacity building, grant disbursement, monitoring, and providing mobile phones and cash boxes. The pull approach involves establishing market linkages for 1000 business groups (each group has 3 members). The project also manages 147 self-help savings groups. The EneRSU project worked with one EMIT business group, providing the PBX at 50% of its original cost (thus at same conditions as other PUCs/PIs).

1.2. IMPACT ASSESSMENT OBJECTIVES

This impact assessment was conducted to identify intended and unintended changes and emerging outcomes of the project. The assessment focused on the financial viability, likely sustainability and scalability of EneRSU initiatives, the demand and absorptive capacity in local communities, and the PBX's relevant utility as compared to other renewable energy solutions in the market. The assessment addressed the following specific objectives:

1. Document direct effects on the benefiting public institutions (health centres, schools and the mosque), PUC business owners and their households, and Borana University.
2. Identify the most promising productive use cases (PUCs) and models of supporting public institutions (PIs) for replication/scaling. To the extent possible, determine local readiness, ability and pathways to make investments in the new technology and business case models.

Each objective had specific evaluative questions that were incorporated into an evaluation framework.

1.3. APPROACH

A qualitative approach was adapted for this impact assessment guided by an evaluation framework fitted to respond to the assessment's objectives. The evaluation framework was shaped by an initial outcome harvesting workshop held with the CACH EneRSU implementation and project team. The evaluation matrix¹⁰ was built around the criteria: *impact, effectiveness, sustainability, relevance, and scalability*. Each criterion builds on the impact assessment objectives, see Annex B mapping the impact assessment objectives to the evaluation criteria.

Impact: The extent to which the intervention has generated or is expected to generate significant positive or negative, intended or unintended, effects for EneRSU's direct and indirect beneficiaries and communities in which targeted PUCs and PIs operate. Since the project is a pilot of two and a half years, impact criterion only focused on emerging changes and initial outcomes. Under impact, the assessment also borrowed from 60 Decibels¹¹ benchmark metric as follows:

- *Quality of life metric:* Used to assess how meaningful or transformative the PBX was to the general wellbeing of PUC owners and those running PIs. It was measured by the percent of PUC and PIs saying their quality of life has 'very much improved' because of access to the PBX, against other response options 'slightly improved', 'no change', 'got slightly worse', 'got much worse'.
- *Net Promoter Score (NPS):* Used worldwide as a proxy for gauging customer loyalty and satisfaction. We measured PUC and PI satisfaction with the PBX by asking them to rate how likely they are to recommend the PBX to a friend or family member on a scale of 0 to 10. 0 is least likely, and 10 is most likely. The NPS was determined by categorizing PUCs and PIs into

¹⁰ The evaluation matrix references OECD-DAC evaluation criteria including only criteria that was relevant for EneRSU's interests in the impact assessment. For instance, Efficiency was omitted as the project is a pilot implemented in a short period of time with specific intention to only prove the new technology is a potential solution for off-grid PUE use.

¹¹ 60_Decibels, 2024, *Why off-grid energy matters: An impact performance report*. 60_Decibels provide benchmarks of impact performance, enabling organisations to understand impact relative to peers and set performance targets. In this specific report they focus on off-grid energy.

Promoters - the percent of PUC and PIs rating 9 or 10 out of 10 minus Detractors (the percent rating 0 to 6 out of 10). Passives are considered those rating 7 or 8 out of 10.

- *Access to alternatives*: This was measured as a percentage of PUC and PIs saying they could not easily find an alternative to the PBX to give an idea of how critical access to the PBX was for PUC and PIs.
- *Challenges experienced while using the PBX*. PUCs and PIs were asked about their experiences using the PBX and challenges they have faced in its utilization.

Effectiveness: The assessment used an Outcome Harvesting approach to identify changes. Analysis moved from outcomes/impacts to inputs/activities to try to understand what caused the change and whether EneRSU contributed to it or not. Under effectiveness, the assessment examined the extent to which EneRSU achieved, or is expected to achieve, its objectives. The impact assessment considered the level of contribution of the project to outcomes and the relative significance of the objectives and changes realised. EneRSU project teams were engaged in an outcome harvesting workshop to identify changes, these were then used in data collection tool design to triangulate the extent to which identified change was experienced by PUC and PI, as well as the communities around them; level of significance of the changes, and what contributed to the changes. Annex A contains the outcome harvest database collected from the impact assessment.

Sustainability: The extent to which identified benefits of the pilot intervention are likely to continue in the medium to long-term. The assessment examined project sustainability considering financial, economic, social, environmental, and institutional capacities of the systems needed to sustain benefits, with considerations that this was a pilot phase.

Relevance: The extent to which EneRSU's concept, objectives and design respond to beneficiaries', communities' and relevant institution needs, policies, and priorities now and in the future.

Scalability: The extent to which the technology (and project) is scalable to reach more rural households, productive use cases and public institutions, as an alternative off-grid electrification option for communities with no access to national power grid.

1.4. DATA COLLECTION AND ANALYSIS

The assessment used data collection methodologies including outcome harvesting workshop, key informant interviews, focus group discussions and document review, explained in this section. These multiple sources of data supported the comprehensive analysis and response to assessment questions.

1.4.1. OUTCOME HARVESTING WORKSHOP

The evaluation team engaged CACH project team in an outcome harvesting workshop to identify outcomes emerging from the EneRSU project. These were later used to inform the approach and methodology and provided a starting point for outcome harvesting at the beneficiary/community level. Annex A has an updated outcome harvest database completed with information collected from various stakeholders of the project.

1.4.2. KEY INFORMANT INTERVIEWS

Evaluators used computer-assisted personal interviews¹² to engage with 15¹³ PUCs and 4 PIs to better understand their experience of using the PBX technology and what changes the project had contributed- positive and negative. This represented 79% of total PUCs and PIs participating in the pilot phase. PUC and PIs were selected based on an agreed criteria with EneRSU at inception phase, which considered an initial outcome harvesting workshop identifying sites that show the greatest change, PUC/PIs that were able to repay relatively quickly and those that have struggled to repay, alignment with CACH EneRSU planned site visits to the locations and availability to coordinate data collection activities (locating and introduction to PUCs and PIs, support in mobilizing FGDs participants), uniqueness of use case (integrated with other CACH programs, only type of business etc), closeness with other implementation sites (two schools relatively close to each other), site security situation and accessibility. In total 23 interviews were conducted with PUC and PI respondents.

Key informant interviews were also conducted with signatory offices, other actors working within the energy sector, EneRSU and its private sector partner to respond specifically to questions on relevance of the pilot project, effectiveness and contribution to change, sustainability and general attitudes towards the new technology. Respondents were mostly selected purposively given their interaction with EneRSU or roles and responsibilities within the institutions they were representing. Respondents' recommendations were also collected with regards to scalability of the project. In total 14 interviews were conducted with stakeholders.

List of interview respondents is included in Annex C.

1.4.3. FOCUS GROUP DISCUSSIONS

Four FGDs were held with community members living around PUC and PIs. Respondents were selected using convenience sampling with the support of EneRSU project team. One FGD was also conducted with PUCs within Bidimo township. FGDs contributed to the understanding of the community's experience of project benefits by their access to PUC and PI services, participation in acquisition of the PBX, as in the case of schools. Insights from the FGD were triangulated with identified outcomes that related to the community.

1.4.4. DOCUMENT REVIEW AND SECONDARY INFORMATION SOURCES

The review of existing data, especially EneRSU project monitoring data and baseline report data was used to triangulate primary data collected during the impact assessment. Documents shared by CACH were used to enable Altai Consulting to have a strong understanding of the project, its processes and be prepared for interviews with stakeholders and direct beneficiaries. Additional research was used to complement our understanding of specific projects and to provide more macro-level context information (political, economic and social).

¹² Researchers used interview tools coded on KOBO consisting of open and closed questions to interview PUC and PI respondents. This provided an opportunity to collect quantitative information including metric-based questions, as well as to explore experiences through open-ended questions. The timing of the impact assessment was also limited, and use of CAPI was useful in working within available data collection time available.

¹³ These included some PUCs with multiple site installations.

Figure 3: A teacher at Danisa Primary school using TV to teach learners



Danisa Kerker Primary School is one of the public institutions use cases. Four PBX were installed in the school and they use it to power a 32-inch TV to support learning through audio-visual content. Teachers were also able to charge their mobile phones more frequently and download new school curriculum textbooks which is only available to them in soft-copy. The school was able to introduce evening adult learning classes because of the access to light and provides the lessons for free to the community. Learners can also study at the school's library from 6pm to 9pm.

2. IMPACT ASSESSMENT FINDINGS

KEY TAKEAWAYS

- EneRSU has strong relevance within the context of providing energy solutions especially for productive use for rural off-grid communities and government objectives, such as Ethiopia's National Electrification Programme 2.0 (NEP2) at national and local level.
- The PBX technology demonstrated strong use case for micro and small enterprises increase and diversification of income, and extending energy as a service to rural households who struggle with access to affordable electricity for mobile charging, entertainment and lighting uses.
- Financial limitations and Ethiopia's lack of forex are major factors that will affect scalability of the project.

EneRSU has three outcome areas: a) provide electrification for rural communities to improve lives, livelihoods and promote diversified income; b) enhance renewable energy curriculum in collaboration with local universities and TVETs and c) networking and scaling. Following a lengthy project design and planning phase, CACH imported PBX in May 2023 and quickly distributed and installed them at beneficiary sites. Since the arrival of the PBX, EneRSU has completed 87 installations reaching 24¹⁴ PUCs and PIs in Borana, East Borana and Bale. In addition, in collaboration with the University of Borana, curriculum enhancement was just completed in March 2024, and the training of trainers (TOT) delivered in mid-to end March 2024.

For the first outcome area, CACH covered partial cost of the PBX on behalf of PUC and PI, supported PBX installation, and training. CACH also supported primary beneficiaries with additional supplies to facilitate power connections, in some instances, they also supported with electrical appliances such as dividers and bulbs.

In the second outcome area, CACH worked with the University of Borana and finalized an updated curriculum. ToT was also conducted with three technical and vocational education (TVETs) in the target region.

This section highlights key findings by evaluation criteria and evaluation questions.

2.1. RELEVANCE

Relevance: *The extent to which the PBX technology, the project approach and interventions, are relevant and effective in their ability to respond to community, PUC and PI needs and priorities.*

The section seeks to provide answers to the following questions:

- Demand/interest and attitudes around the technology at local level, demonstration of demand at a wider scale.
- Is the PBX technology financially and operationally viable in targeted PUCs, PIs? Does it meet local demand and capacity for investment in the technology (or similar solutions)?
- What other renewable energy solutions exist in the local market? How do these compare in terms of operability, sustainability and financial viability compared to the PBX?

The main source of information used to respond to this criterion are project monitoring data review, key informant interviews with primary beneficiaries and key stakeholders and FGDs with community groups.

¹⁴ Some PUCs have installations in multiple locations not counted in the 24.

EneRSU is strongly aligned to national and regional government priorities for rural electrification and livelihoods creation. There is increasing demand for technologies like the PBX. While the community and stakeholders agree that the benefit of the PBX is much higher compared to its price, stakeholders feel that the technology is expensive and unaffordable for rural off-grid communities.

2.1.1. DEMAND, INTEREST AND ATTITUDE TOWARDS THE TECHNOLOGY

The EneRSU project pilot strongly aligns with national and regional priorities for productive use of energy. Over 80% of the rural population does not have access to electricity. According to the National Electrification Plan (NEP 2.0) 35% of planned connections in rural remote areas will be through off-grid means¹⁵.

“One of our plans is to electrify our rural population, in 10 years period of time... the off-grid technology, includes mini-grids, standalone solar, and solar system. All in all, this is dependent on the population settlement, the demand and the opportunity to grow, in terms of socio-economic development.” Ministry of Energy, National Level Representative.

This project greatly supports the national and regional efforts and objectives of government to supply renewable and environmentally friendly energy. Government has set direction to expand solar energy especially in lowland areas where it is possible to generate immense energy from solar. In lowland area there is better potential for solar energy than highland areas.” District agriculture office

Micro and small enterprises, schools and health centres located in off-grid communities were relevant use cases for the PBX technology. Two-thirds of Ethiopia’s health posts are located in off-grid areas. Health posts require energy for cold storage, running diagnostic appliances and lighting. Primary schools in off-grid areas also require electricity to support learning, for example through audio-visual equipment, preparing examination and printing them. Job creation is part of the government’s plans to boost the Ethiopian economy and create opportunities for jobless youth. The job creation regional office particularly appreciated the potential of the PBX in creating income generation and livelihoods diversification opportunities.





“We have provided vocational training so that they have the skills and competence to create job opportunities and/or increase their employability... we encouraged and supported them to create enterprises from which they drive income and are able to create job opportunities for their members and other people. Thus, this project (EneRSU) is in line with our objectives as well as national objectives, supporting our effort to create jobs for young people” Job creation office, Oromia region

“EneRSU has aligned with and supported the objectives of our office. Our priority is agricultural cooperatives and also benefiting young people and women so that they can boost their economic opportunity. In this line, the project has highly contributed to this effort in that some cooperatives, women, and young people have economically benefited from the project by participating in different income-earning activities.” Cooperative office, Oromia

Despite the intention at project design, the PBX seemed less supportive for agricultural use cases in the pilot. Agriculture is considered the base of Ethiopia’s economy, contributing 85% of employment. The energy requirement for the agricultural sector was mainly for irrigation. The project piloted with the PBX-200 which gives 200 watts per cube and is best suited for Tier 2 and Tier 3 use, see Table 2. Farm irrigation systems would require Tier 4/Tier 5 to run.

¹⁵ Ethiopia Customs Handbook, 2022.

Table 2: PBX power capacity and suitable uses

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5*
Power	≥ 3W	≥ 50W	≥ 200W	≥ 800W	≥ 2kW
Energy	≥ 12Wh	≥ 200Wh	≥ 1kWh	≥ 3.4kWh	≥ 8.2kWh
No of PBX-200 and Households	1 x  10 to 50 HH	1 x  2 to 10 HH	1 x  1 HH	4 x  1 HH	10 x  1 HH
Application	Private Household	Private Household SME	Private Household SME Farms	Private Household SME Farms Schools Health Centers Civil Services	Private Household SME Farms Food processing Cooling Schools Health Centers Civil Services

Source: CACH/PBX project presentation

In conversations with the PBX developers, it was understood that they are in the process of piloting PBX use case in the agricultural sector. Initial assumption is that the PBX can be used together with other sources of energy to increase power available to meet required load. Other agricultural energy needs mentioned in the impact assessment included cold storage especially for milk and other perishable produce, and processing/value addition, such as flour milling. PBX-Ag has developed PBX-400 which responds to the need for sustainable power sources for refrigeration. The ePBX-400 can support the initial high-power fridges need to power and can operate an energy efficient fridge. PBX-200 which was piloted for EneRSU was not designed to primarily provide power for irrigation and cold storage.

There is growing interest in the PBX in communities in which the pilot was implemented. PUCs and PIs as well as signatory offices reported that communities around them had growing interests for the PBX. There was growing demand by households for more affordable and durable light sources, while business owners desired the PBX for the income generation benefits and fuel cost savings.

- *“Shortage of solar power hampers us to supply to other households.” PUC interview*
- *“There are many households who request us to get solar power for light. But we are unable to supply (because of limited capacity to extend services for households that live at distant considered far from the source)”. PUC interview*
- *“More than 800 households within the kebele aspire to get the PBX let alone us.” Source?*

The curriculum enhancement and training component will remain relevant in the expansion of the pilot and if the technology demand and supply increase. The training focused on how to operate the PBX, the PBX functions including battery durability, recharging time, solar handling and the PBX capacity, all of which stakeholders felt were important for the users to know. The training also incorporated business skills. Meanwhile the curriculum integrated solar and renewable energy topics into the electrical course. TOTs would then disseminate the training further to project participants. There was a feeling that the training should have also incorporated training in troubleshooting and responding to malfunctions of the technology. Since the project kicked-off, there have been five documented malfunctions, some of which were fixed through the project team, and in one case, the PBX was taken back and not replaced. In later extensions of PBX technology, PBX-Ag plans to deploy a smartphone app that shows details of a PBX malfunction and connects the user to a local support team.

“In my opinion, the content lacks “how to maintain the product in case of malfunctions”. I feel this because, after the project phase-out, the beneficiaries need to know how to maintain the product in case of downtime. This is the question raised by beneficiaries when I was training them.” TVET Representative

Stakeholders particularly felt that it was necessary that any new technology should have skills available locally to respond to any repair and maintenance needs, as well as have spare parts locally available. This was one of the biggest concerns besides PBX pricing.

2.1.2. ALTERNATIVE RENEWABLE ENERGY SOLUTIONS IN THE MARKET

The functionality of the PBX cube makes it highly competitive against the currently available alternative power sources in the target communities. Noteworthy, the majority of households in Ethiopia’s off-grid communities have no access to renewable energy sources. The majority rely on biomass for their energy needs, predominantly, for cooking. The concept of productive use of energy is nascent, and where commercialised, non-sustainable energy sources like diesel or benzene generators are used. Solar home systems and Pico solar systems are the most common renewable energy sources currently present in the community.



Pico solar systems: Pico-systems use solar panels to recharge and provide between 3Wp to just under 10Wp. They usually have more than one light bulb, mobile charging ports (can usually not charge smart phones), and recorded music player. They are usually in easy-to-use kit with plug-and-play type of assembly.

Solar home system (SHS): Are made up of a solar PV panel, battery and LED lights which provide light and power. SHS are often defined as 11Wp and larger, while systems between 3-10 Wp are referred to as ‘multi light and phone charging kits’. SHS can be sold as a kit (already assembled) or in separate parts assembled at site. The latter was more common in the target communities.

Pico solar systems and SHS are available in the market and cost less at initial purchase price compared with the PBX. In addition, the government’s customs relief for stand-alone solar products and components introduced in 2010, specifically targets these types of solar systems and appliances. Communities reported that they had bad experiences with the solar systems ranging from poor quality light, less functional hours in a day, short life span; against which they compared the PBX favourably.

“Previously when we used battery cells for light in the evening, we spent 30 ETB in three days... The PBX has higher power than the smaller solar panel that we were used before. The PBXs supply light for households in the night up to 12:00PM. But the smaller solar panels do not go for more than two hours. The battery cells also do not serve more than two hours a day. The PBXs are used for mobile charging, supply light for households and supply power for DSTV show. But the smaller solar panel is only used for light power for few hours a day. the PBX supplies brighter and quality light for longer hours in the evening.” FGD with PUC in Bidimo town.

Diesel generators: produce electricity by burning diesel fuel. They use a combination of an electric generator and a diesel engine to generate electricity. Diesel generators convert some of the chemical energy, contained by the diesel fuel, to mechanical energy through combustion. Generators used in residential settings can range anywhere from 8 to 30 kW while generators used for commercial settings can range anywhere from 8 KW to 2,000 KW. Direct beneficiaries felt that the PBX was a good replacement for the diesel generator against the increasingly expensive costs of fuel and the maintenance and repair required for their generators. In the long run, the cost of the PBX for them, was a lot cheaper trading off with the high O&M costs. The PBX required no operation costs following installation, and provided longer up-time hours, and cleaner energy.

“In the absence of the PBX, public institutions such as health centres used generators. Some well-to-do individuals and business centres also used the generator to get electric power. However, the generator is not environmentally friendly and is expensive to regularly use. The health centres often face difficulty covering the fuel costs of regular use of the generator. Likewise, business centres and individuals have been challenged to cover the increasing cost of fuel. Further, the sound from the generator is disturbing for patients in the health centre as well as other ordinary people. On the contrary, the PBX is saving expense on fuel costs; it is simple to operate and user friendly... it also reduces environmental pollution.” Job creation office, Oromia region

The PBX is considered more durable and climate friendly. This is well aligned with requirements for a modern source of energy and towards achieving global development goals concerning clean and renewable energy.

“...it is good for the environment, people used to use firewood as light source, now the PBX is being used by 10-15 households. At night people are gathering at the DSTV, watching TV, leaving their houses and therefore not using firewood at that time.” Ministry of water and energy, regional level

“Before the Powerblox, the community used to have small Pico solar bought from Moyale. But most of these solar are fake, and cannot sustain long which most of the time, damages charger cables.” TVET Representative

2.1.3. PBX FINANCIAL VIABILITY

The total cost of the PBX at ETB 89,600 is considered too expensive for targeted rural communities. EneRSU subsidized the PBX at 50%, and provided 100% subsidy on solar panels and electric appliances, bringing the cost of one PBX installation to ETB 44,800 from an estimated total cost of about ETB 126,000. In addition, EneRSU supported the administrative and logistical costs of importing the technology, delivering it to project participants and the cost of installations.

Table 3: Cost of the PBX

	Cost (ETB)	%Subsidy extended to EneRSU participants
PBX purchase	89,600	50%
Solar panel	12,040	100%
Electric appliances	25,000*	100%
	Total cost per PBX 126,640**	Subsidized cost: 44,800***

* Average based on total amount EneRSU contributed to electric appliances over total installations.

** Assuming one PBX, one solar panel and average cost in electrical appliances. Cost of importation, transportation and installation is not included in this estimated landing price.

Stakeholders, including signatory offices, PBX AG, participating CACH integrated projects, agreed that it would not be financially viable to provide the PBX through private sector commercial channels without the support of a finance partner because it would be too expensive, and due to market challenges discussed in later sections. At the same time, it was necessary to provide the technology at cost to users to prevent market distortion and overreliance on aid.

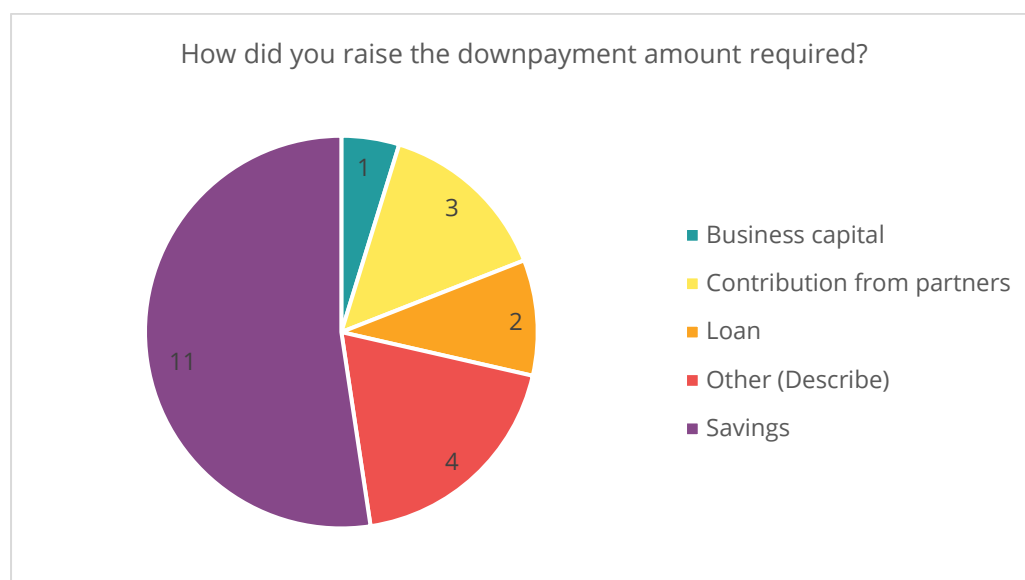
“Thus, in order to extend the energy coverage to a wider community, off-grid technology should be accessible at an affordable price, and there is also a need to arrange modality such as cost sharing and credit access to reach the poor members of the community. In this regard, the support of partners is very crucial.” Cooperative office, Oromia

“Relatively, the PBX is expensive, where our businesses are with capital of 10,000-11,000 birr, but PBX is more than 80,000 birr which it is difficult to cover many households. If you want to support more than 3000 households, it is hard to imagine with PBX, maybe you be forced to reduce your beneficiaries.” GreenREAP

The lease-to-own model illustrated relative affordability of the PBX through tranche payments.

The pilot demonstrated that at subsidized cost and with a flexible repayment plan, a proportion¹⁶ of targeted rural communities could afford the PBX. PUCs and PIs paid a downpayment of between 10% to 30% of the subsidized amount before installation. Half the PUC and PIs, 11 out of 22 that were interviewed used savings to pay for their downpayment, all the 11 were businesses.

Table 4: Number of PUC/PI source of advance payment



**Sources described as 'other' included support from another NGO and sale of assets and community contributions.

A review of PUC and PI payback data illustrates that most business cases were able to payback for the PBX through income generated using the energy it produces¹⁷. In an interview with the PBX developer, he pointed out that the payback period in similar pilots implemented in other countries was two years on average. Compared, in Ethiopia 92% of project participants managed to payback in an average of 10 months, with variances between types of project participants. Respondents said that it might have been easier to provide a longer payback period. Thirteen out of 22 PUCs and PIs interviewed (59%) said that they relied on other sources of funds to finance the tranche payments for the PBX because they were not raising enough income from the PBX alone per month to afford the monthly repayment targets.

¹⁶ PUCs and PIs with access to downpayment amount.

¹⁷ The data only considered cost of payback and no other business costs to determine profitability.

“I am selling my livestock to pay the debt, because the income it generates can't pay my down payment. This is because we are in remote area and there are not many customers who can charge mobile phones here or households who can pay for electric service that we could provide.” PUC respondent

One privately owned and operated health centre was able to pay upfront for the technology from business capital. Another public health centre participating in the study was able to make repayments within two months relying on performance-based financing from a different project.

School public service use cases relying on the community for part of the payback, struggled more than other use cases. All participating PUCs and PIs managed to payback for the PBX, with schools missing monthly payback targets more often compared to the rest of the use cases. Public schools in Ethiopia offer free education funded by the government and usually have no income generating activities. Participating schools were able to establish a new income source using the PBX. However, the schools reported that the remoteness of the school from households limited the potential to increase their revenues. Community members appreciated the benefits of access to renewable energy sources such as the PBX. However, respondents noted that community members were reluctant to participate given past failed solar projects. If a community member was not directly benefiting from the energy resource, they were also less likely to contribute. Community members felt that there were competing priorities for the community with the government-related payments they had to pay.

Public health centres on the other hand, funded the PBX costs through other projects supporting them¹⁸. The hospitals are also able to charge for some of the services they provide such as laboratory and some outpatient services.

“By now community contribution for government is the highest.” School FGD, Danisa Kebelle

2.2. EFFECTIVENESS

Effectiveness: *The level of contribution of project activities towards intended outcomes and the interventions that are most effective at delivering change for PUCs, PIs and local communities.*

This section also broadly responds to understanding the technical suitability of the technology solution within use cases and the effects of an integrated program approach used with the Green Rural Entrepreneur Access Project (Green REAP) and Entrepreneurship for Market Inclusion and Transformation (EMIT) programs on how direct project beneficiaries have experienced change.

This impact assessment is primarily positioned to support the theory of change first level of change ‘proof that the innovation works’, therefore this section seeks to provide answers to the following questions:

- What aspects of the project have contributed towards identified effects or outcomes? Which interventions have been most impactful, or significant in achieving this change?
- What other external factors and actors may have contributed to identified changes?

The main source of information used to respond to this criterion are review of secondary sources such as project baseline and project monitoring data and key informant interviews with primary beneficiaries.

2.2.1. HARVESTED OUTCOMES

To understand the contribution to change and the most impactful interventions, the impact assessment first used outcome harvesting to identify change.

The table below summarizes PUC and PI experience of some of the changes identified through an outcome harvesting workshop with EneRSU project teams, and the extent to which participating PUCs

¹⁸ For example, Cordaid's performance-based financing project

and PIs felt that the change made a significant difference for them (high, medium and low). All the outcome change statements referred to the pilot period following installation of PBX cubes.

Overall, project participants identified strongly with the identified outcome statements, all of which were considered of high significance. There were slight variations in some of the responses, for instance, participants who felt that they were able to make savings on their consumption of fuel/energy were likely to have switched from sources with expensive O&M such as diesel generators compared to participants who were using Pico lanterns. PI representatives were less likely to have benefited personally. Health facilities and businesses earning on average above ETB 1,000 engaged in mobile charging services were more likely to have invested in new electrical appliances.

Table 5: Outcome harvest PUC and PI experiences of change (21 respondents, 18 PUCs, 3 PIs)

Outcome change statements	Percent of PUCs and PIs that “strongly agree” to change	Percent of PUCs and PIs that rate the change as “high” significance)
I was able to electrify my household	90%	90%
The quality of my personal life improved	86%	90%
I benefited from starting a new business using the PBX	81%	90%
I extended the hours of operation of the business	81%	86%
I benefited from increase in income generation using the PBX	76%	90%
I benefited from diversifying in new income sources using the PBX	76%	86%
I made savings on my consumption on fuel/energy	62%	71%
Increased investment in electrical appliances	48%	67%

The next sections summarize findings of immediate change experienced by PUC and PIs related to the above outcome statements. Change experienced by communities living around PUCs and PIs are discussed under section 2.3 on impact.

2.2.1.1. Public Institutions Use Case

Baseline: From EneRSU’s baseline conducted in 2022, 82% of PIs did not have energy. On average 12% of the health centres were connected to benzene and diesel operated generators which generate 247.425KWH of energy per day when it is operated 9hrs per day on average. The report also found that 71% of the current energy sources being utilized by PIs were at standstill because of complexity of the operation and maintenance of generators and the rising cost of fuel.

Health centre use case

EneRSU’s pilot aimed to test the potential of renewable energy in reducing operation and management costs for PIs and contributing to improved service delivery. EneRSU enrolled four health providers, three are publicly owned and one is privately owned and operated (therefore categorized as a PUC).

The health centres reported substantial savings from the switch from diesel generators to the PBX. From the project’s monitoring data, on average, the health centres save around 8,500ETB per month from fuel savings, which they have been able to channel back and reinvest for improved services or expand into other services.

The health centres have experienced increased income through increase in operating hours and diversification of income sources. Unlike the generators which provided nine hours of power, the PBX provided up to 24 hours daily usage. Additional income is generated from lighting supply to nearby households, mobile charging and expanded diagnostic services¹⁹.

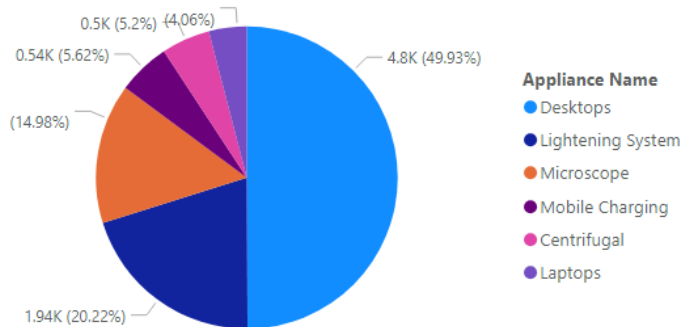
“The community can access treatments at any time since there’s no fixed time for closing clinics. I have doubled my income, before the PBX I generated 600 ETB per day and now I make about ETB 1500 to 2000 per day... I saved cost for diesel and money for mechanics and I received the money from the 10 bulbs I supply for the neighbour at 250 per bulbs which is equal to 2500 per month”

Interview Private Health centre

“We can get up to 120,000 from all outpatient services we provide. For example, we get 15,000 ETB per month from lab services...” PI Interview Health centre

Figure 4: Example of health centre daily energy usage

Sum of Average Daily Energy Usage Appliances [Wh]
BY APPLIANCE NAME



Health centre staff were reportedly more motivated to work because of improved services (availability of power with less downtime to operate lab equipment) and access to mobile phone charging within the centre.

“It changed a lot. Our institution workers charge their phone at the institution and there is no need to go to town to charge mobile phones. Our workers are now happy than before, because of the services that the PBX gives us, especially the service improvements.” PI interview

Health centres experienced more power consistency using the PBX. Health providers using the PBX mentioned that they did not experience frequent technical malfunctions and downtime while using the PBX as they did with generators.

“PBX has high quality. The generator we used before creates technical malfunction always. But PBX consistently supply electricity without interruptions.” PI interview, health centres

One public health centre acknowledged that the PBX installation **increased** the facilities ability to **access more funding from performance-based grants by other donors** through improving their service delivery and range of services they were able to provide without disruptions. Health centres managed upfront payment of between 10% to 50% for 3-4 PBX cubes, completing payments in seven-to-eight-month instalments.

School use case

¹⁹ Health centers operate centrifuges and microscopes using the energy supply.

EneRSU enrolled three primary schools and installed a total of 12 PBX cubes. Two of the schools have three PBX cubes each, while one has installed five PBX cubes. Both schools engaged during the impact assessment said that they were using Pico solar lamps before they purchased the PBX cubes.

The PBX contributed to improved teacher's approach to teaching by enabling access to new curriculum teaching material. Unlike the Pico solar lamps, the PBX cubes made it possible for teachers to charge their phones frequently and use (downloaded) soft copies of textbooks to teach the learners. Before the PBX, teachers had to travel to the nearest town to charge their phones and only on market days. Curriculum textbooks were only accessible to these schools in soft copies as hard copies were not distributed. Teachers were also able to incorporate more audio-visual material to their teaching methods using televisions installed at the school. Schools were able to print examination papers, use computers and also provide lighting and other services to nearby community (and in one case, to another school).

“Teachers could not access new curriculum textbooks to teach students before the school secured the PBXs. Recently only soft copies of textbooks are distributed to schools (we do not have hard copies of textbooks). Once the school secured the PBXs since teachers have smartphones, they charge it well and teach students using the soft copy textbooks from their smart phone. Teachers said that we would not have taught our students well had we not got the PBX. The school also teaches students using television since the school has got PBX. The PBXs contributed a lot for the school. The school also started evening teaching program for adults (10-women and 20 men are attending adult literacy program) after the PBXs were installed. The library of the school also started to serve its students up to 9:00PM in the evening after the PBX has been installed within the school.” FGD, School

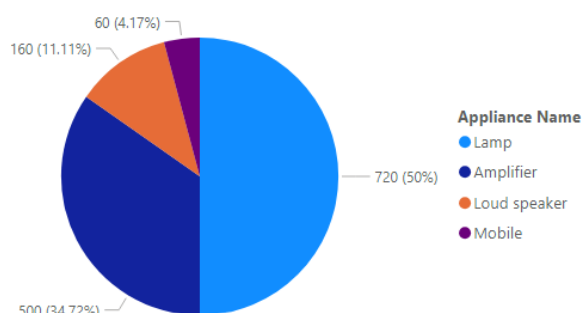
The PBX increased opportunities for revenue generation for the schools. Schools were able to generate income from surplus power from the PBX. They mainly provided household connections for lighting use and entertainment (TV, DSTV), mobile charging services, printing. School principals mentioned that the significant distance between the school and the community impacted negatively on the amount of money they were able to generate from the PBX. It was more difficult for instance, to connect households and provide lighting service, customer traffic was also low because households lived far from the school. This generally led to below optimal use of the PBX power available.

Schools provided additional education services using the PBX. Schools introduced free adult literacy classes in the evenings which they did not offer before because there was no light in the school after daylight. They also established libraries for students that were open until 9 pm to enable students to do after school studies.

One out of three schools participating in the project had not completed their payment, having already paid an advance payment of 90% for two PBX cubes installed. Two schools completed their payment within average 10 months payback of about 20,000 per month. All three schools were able to pay upfront payments of over ETB 80,000. Suggesting that perhaps at a minimum, schools could potentially afford two PBX cubes at subsidized cost, or one PBX cube at market price. Nevertheless, it would be important to guide users in estimating the amount of power they would require to meet their energy needs.

Religious institution use case

Figure 5: Average daily usage of appliance (religious institution use case)



One mosque participated in the project and purchased two PBX cubes. The mosque uses the PBX to provide light to nearby households, power their amplifier and loudspeakers during prayer times to reach more people and also to charge mobile phones for mosque staff. The mosque reported that they generated income from the energy supply to households of about 600 ETB monthly.

The mosque completed instalment payments within six months with a downpayment of 26,000 ETB contributed by the community. The rest was paid in 3,600 ETB monthly payments.

2.2.1.2. SMEs

Baseline: 40% of the smallholders/cooperatives were not using energy sources while the remaining 60% were using other non-clean forms of energy such as diesel generators. In addition, 20% of respondents at baseline said that they spent on average 288,000 ETB annually on fuel (diesel).

EneRSU's objectives for micro and small businesses was to demonstrate the potential of productive use energy in creating livelihoods opportunities and promoting diversification of income sources. The pilot focused on honey processing, mobile charging shop, barber shop, café and restaurant, DSTV house and household electrification use cases²⁰.

The EneRSU pilot strongly demonstrated the potential of off-grid energy in livelihoods development. This was evident in both job creation and diversification of income sources. In the impact assessment interviews with PUCs, over 80% of PUCs strongly agreed that the project had (highly) contributed to their increase in income and diversification of income sources. All the business cases reported that they experienced a rapid increase in their revenue from the PBX as they were able to expand their business and venture into other services. The performance of the MSMEs remained highly dependent on their context, for instance, businesses likely did better because there was little or no competition for the services they were offering and were in close proximity to community households and customer traffic.

"We are working at local area where there is no other competing business so that it's very easy for me to implement them" PUC interview

"We pay 12,620 ETB per month for the service. We received up to 15,000 ETB per month from the four PBX cubes. The difference is our profit. We finished the payment this month and from now on 15,000 per month is our revenue, except the payment we pay for two employees we have hired." PUC interview

Other business opportunities were accelerated with access to energy. Supplying households with power was a new business case in most of the locations where PBX installations were done. In addition, some of the households purchased power from the PUCs to run new businesses such as DSTV houses and tailoring businesses.

²⁰ One private health post was included and has been discussed under section 2.2.1 under healthcare use case.

“One PBX operates in another area to reach out to the community there. This PBX delivers power for a person who delivers football watch via DSTV.” PUC interview

“Local community pays 100 ETB per lump per month for light energy. Those who engage in sewing clothes pay 500 ETB for solar energy they get from the PBX. There was no light energy supplier in the past.” PUC interview

“I was surprised at the battery capacity; you can easily move it to events for more than 3 days. They are renting the PBX for about 2000-2500 per day at weddings.” Ministry of energy and water Oromia office

Businesses extended their hours of operation using the PBX. Businesses were able to operate for longer hours. Businesses that provided nearby households with light provided the service from 6pm to 12pm. Restaurants reported that they were able to operate up to midnight with light from the PBX, and additionally provide TV watching and mobile charging services. This was not possible before using the Pico lights, torch light with battery cells. However, business owners shared that in some instances the PBX cubes were not enough to meet energy demands. This limited the ability to scale their business, and also caused business losses.

“Due to energy shortage in market days, barber shops and sewing machines do not get energy. To solve such a problem barber shops, charge their machines in advance and work for some time in a market day. Absence of energy hampers our business” PUC FGD in Bidimo

“There are four households who quit getting solar energy from the PBXs since the PBXs cannot supply light energy up to 12:00PM. Primarily the agreement was to supply light energy from 6:00PM to 12:00Pm in the night. However, the PBXs could not supply energy as per the agreement. Due to this, four households stopped their contract.” PUC FGD in Bidimo

“... I tried to engage in barber shop business, the power from the PBX burnt my barber machine several times and I stopped operating the business. This is the negative impact that I observed” PUC FGD in Bidimo

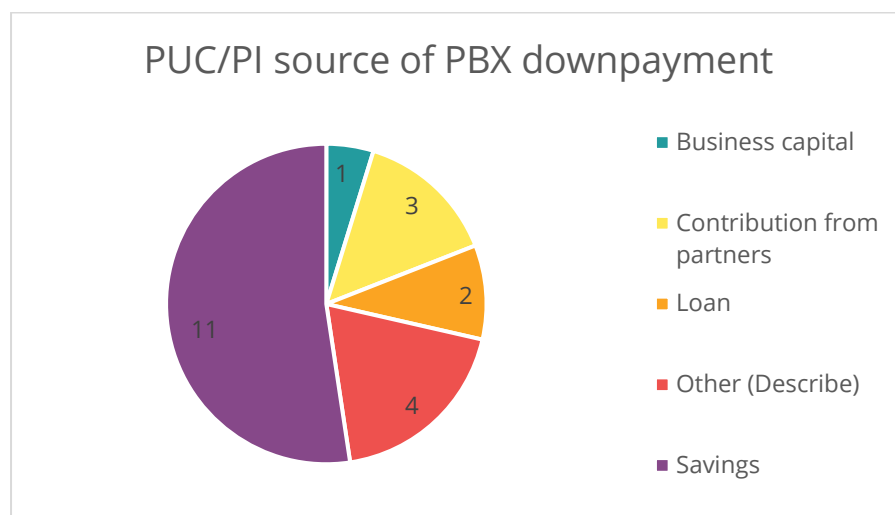
Businesses saved on their daily consumption of fuel. About 60% of MSME’s “strongly agreed” that they made savings on fuel. MSMEs were using diesel-powered generators, Pico solar and solar home systems, others did not have any source of energy, while others were using battery cells and kerosene. Businesses using energy sources that were dependent on expensive fuel to run, such as diesel generators, experienced cost saving benefits from saving on fuel consumption as well as associated maintenance costs.

There was a shift towards a clean source of energy. One of EneRSU’s objectives was to replace unsustainable non-environmentally friendly energy sources with clean affordable sources. In only one case was the business still using the diesel generator after acquiring the PBX. They used it in a different business. The rest of the businesses either sold their previous energy source, lent it out or was just no longer using it. For the hotel and restaurant use cases, while the PBX was useful in diversifying income and increasing operating hours, the businesses continued to rely on firewood and charcoal for their main business - cooking.

“I use the PBX for light in my restaurant in the evening and I also charge my mobile. I run my restaurant until 11:PM in the evening by using the solar light from the PBX. I also get light energy from the PBX in my home. Since I am member of the women cooperative, we generate income via supplying solar energy for 24 households. We have four members in our cooperative and we have four PBXs. Unlike the men cooperative, we do not supply solar light for swing and barber. We installed two of the PBXs in one place and the other two PBXs in another place.to reach the community well. Two of the PBXs supply solar light for 12 households and the remaining two PBXs supply solar light for 12 households. We have already completed our debt for the four of the PBXs. We use charcoal and firewood for cooking.” Women FGD

The PBX was affordable to MSMEs who had savings for the initial payment. MSMEs mainly used savings for the initial payment of the PBX. The rest of the instalments were paid in tranches using mostly money generated from the PBX. Although businesses were mostly able to pay back the full amount of the PBX, they also reported that they frequently had to top up for the instalment payments from other sources of income besides what was generated from the PBX. PUCs agreed that the instalments would be easier to payback with an extended payback period of up to two years and a lower downpayment at 10% of cost. In the absence of savings, it would be difficult for MSMEs to raise funding for the downpayment, as was the case with GreenREAP beneficiaries, and some initially recruited PUCs.

Figure 6: Number of PUCs/PIs source of PBX downpayment



Cooperatives/business groups strengthened small business owner’s ability to afford the PBX. EneRSU additionally supported small businesses to group up and pool funds towards the PBX. To some extent, this helped business owners access the PBX, as they divided the downpayment amount among business partners. EneRSU also enrolled cooperatives. The impact assessment spoke to one business cooperative who participated in the project. In their experience, the cooperative raised the downpayment amount for 8 PBX cubes using business capital and had some members contribute for household connections at a smaller fee to afford the PBX (four households contributed 10,500 ETB each towards payment of one PBX). Even though the cooperative was able to make payments back within six months, they preferred to have an extended payback period of 3 years.

“Others cooperative group members were first formed on this PBX solar system. First it was not for us, but the formed group could not pay for the PBX and we got the chance contribute and own it” PUC interview

“We paid within 6 months all the payment. But for the future it will be better if paid within three years of instalment” Cooperative interview

“To add, such a project is very crucial to rural cooperatives. Access to energy for rural cooperatives enables them to provide their members with access to electric light at an even lower cost and also enables them to have additional income for their association and a high dividend for the members.” Cooperative office, Oromia

PUCs reported that the project had significantly contributed to an improvement in their lives and the lives of the community. Over 80% of PUCs said that the quality of their lives ‘very much improved’ because of the project (see impact section). Quality of life was mostly referencing access to energy in the household for community members as well.

“Previously we were idle in the evening since we do not have light. But now we can either run businesses like shops or café or enjoy watching television in someone’s house. We are able to get mobile charging everyday which helps us to get information and get communicated with relatives and

businesses. One of the participants is able to use ventilation with the solar energy. The participant witnessed as such ventilation has helped him to get relief from the suffering of hot climate.”

2.2.2. CONTRIBUTION TO CHANGE

PUCs and PIs said that their most significant change was because of access to the PBX, attributed to EneRSU’s intervention (see annex A). When asked to rate level of contribution to EneRSU for the most significant change, 66% of PUC and PI rated 9-10 out of 10, 23% rated 8 out of 10. For all the outcomes they identified, the majority of PUC and PI respondents rated “3 - high” to the level of contribution they felt that EneRSU contributed to the change. This section examines the extent to which EneRSU activities and approaches contributed to the changes discussed in section 2.2.1.

2.2.2.1. Lease-to-own model

EneRSU’s lease-to-own model was the most suitable for the selected use cases. MSMEs and health centres in general were able to raise the downpayment for the PBX and payback PBX loans in an average of 10 months. However, the 50% discount on PBX cost was crucial to make the technology affordable during the pilot as low quantity of PBX cubes were purchased. When the quantity purchased is higher (over 2000 pieces) then the price significantly drops.

Primary beneficiaries preferred a longer payback period and a reduction of the expected downpayment amount. Even though PUCs and PIs (particularly health centres) were able to payback balance amounts within 6-10 months, majority said that they paid back for the PBX from income it generated (64%), and 57% said that they relied on other sources to make the payments in addition to revenue generated from the PBX installations. Respondents agreed that with a longer payback period and reduced downpayment, it would be easier to afford the PBX. Most PUCs relied on savings to pay the downpayments while PI use cases relied on community contributions/partner contributions for the downpayment. Without the support, they would not be able to afford the technology.

Schools were the most challenged to meet their payback schedules. School principals reported that even though the school is able to raise some revenue it was not able to before, the amount raised through the PBX is not enough to meet expected payments for the PBX. Schools relied heavily on the community to support payments. Contributions were organised from the Kebele office, who created awareness within the community and the school principal collected community member contributions for the PBX. Repayment has been slow since the community members are also poor and have competing priorities. In some instances, community members were expected to contribute up to 3000 ETB and in some instances 600ETB towards the PBX. Stakeholders were optimistic that with an extended payback period (perhaps to a year), the schools would be able to fully payback the owed amount.

“The actual price of four PBXs is 356,000ETB. However, Caritas covered half of the price of the PBXs. The local community and the school are expected to pay a total of 178,000ETB. With community contribution some amount of money was paid as down payment. The remaining will be paid via instalments. The monthly payment has been 10,000 ETB from community contribution and from its income generation. The school generates 3000 ETB per month from the PBXs’ income and the remaining from community contribution. The school in the future is expected to pay some 50,000 ETB both from its income generation as well as from community contribution (the community will contribute 30,000 ETB and the school contributes 20,000 ETB from PBX income generation). The payment is interest free.” PI Interview, School

“Our people are pastoralists and their income is lower. On the contrary, our people are requested to contribute up to 3000 ETB individually. It will be challenging for our people to contribute such amount of money for PBXs.” FGD, School community

For the public health centre use cases, one of the health centres used performance-based financing²¹ to purchase the PBX. The privately owned clinic owner however had enough savings to purchase the PBX and paid the 50% cost upfront in one instalment; indicating that commercial health centres may have the capability of affording PBX cubes if access is facilitated. A lease-to-own model would still be applicable to ease the burden of upfront payment, which is expensive especially for users within Tier 3 and Tier 4 who require up to four PBX cubes to meet their energy needs.

“They gave us training, they installed the system in all 13 rooms at our health centre, they extended instalment payment time for us. The advance payment expectation is 30% but they accept only 10% from us... Cordaid (Performance based finance). They check our performance and support us financially. So Cordaid has contribution in financing the whole process.” PI health centre KII

2.2.2.2. Installation and technical support

EneRSU staff supported installation and technical support for PUCs and PIs. The instalments required additional electrical accessories like electrical wires, bulbs, switches and other electricals, which the project provided in addition to the installation. These were necessary for the functioning of the PBX installations. It was difficult to find quality electrical material in the market.

Out of 87 total installations, only five instances of malfunction/issues have been reported on the PBX, and 15 days total downtime recorded. The PBX functioned largely as expected with low malfunctions or technical issues, easy ‘plug and play’ functionality. The issues reported were mainly related to PBX overload/need to recharge, slow charge during poor weather/cloud cover, missing/damaged connection wires. The project staff were able to troubleshoot issues, although more serious issues would require the manufacturer’s support. When asked about the sustainability of the project, respondents felt that accessing spare parts and technical skills to maintain the PBX would be the biggest challenge as these are not locally available.

As projected during the design phase, the PBX is most suitable for productive use cases falling into Tier 2 and Tier 3 (Table 2: PBX power capacity and suitable uses). Beyond these Tiers, the PBX becomes too expensive, and other more powerful PBX or other technology may be more suitable than the PBX200. These includes use cases such as irrigation and cold storage. PUCs also mentioned that they experienced overloads/ran out of charge when they had multiple appliances using the connection for instance, on market days when they had a surge in mobile charging customers, they had to scale back on other activities such as sewing/barber shop to meet energy needs with the number of PBX they had.

“... the negative changes I observed is that when we started the project, they told us that the PBX can be used for fridges but after I bought fridges, its power is not enough for fridges.” PUC Interview

2.2.2.3. Integrated Projects

EneRSU integrated its interventions with two CACH projects, where they provided beneficiaries with PBX cubes in two locations:

From the integrated projects, the impact assessment found:

Business training seemed to be a significant enabling factor for the success of MSMEs and generally supporting income generation through the PBX. For sustainability of one of the most significant outcomes of the project- income generation and revenue diversification, the new or pivot businesses need to be sustained. In all use cases, primary beneficiaries were able to generate income from the PBX which they used to pay back for the technology. This is important because the technology is too expensive to only purchase for household use. Nevertheless, the businesses operate in an

²¹ PBF is an initiative of Cordaid that supports health centres improve quality of their services, funds and rewards them based on performance.

ecosystem and external factors inevitably affect the performance of the business, including entrepreneurship skills and business management skills. EMIT and GreenREAP beneficiaries received greater support in terms of business training, mentorship and coaching and savings and loans groups. When compared to other PUCs, even though their income generation is lower than others, they demonstrated signs of expanding and growing their businesses quite quickly, as well as growing their savings, where other PUCs reported that they struggled to save.

“We consider this integration to be successful. In our assessment, the beneficiaries under EMIT have experienced greater benefits compared to those under EneRSU. This is primarily due to their deeper understanding of business operations, facilitated by entrepreneurship, financial, and business training.” Emit

“After we owned this product we are very happy and even diversified our business from tea shop to mobile charging. We are satisfied by the services it provides us. We use the income from the business for food consumption three a day (breakfast, lunch and dinner). We also buy uniforms, exercise books and pens for our children from the income that we get from the business” EMIT PUC

EneRSU’s approach suited beneficiaries who already had an ongoing business or had access to finance the downpayment. Beneficiaries were asked to make a downpayment between 10-20% of half the cost of the PBX and pay the remaining balance within six months. Data indicates that this model was only possible for beneficiaries who could raise the first downpayment amount, such as beneficiaries participating in the EMIT project, who had already run their businesses for a while and had savings that they could use. In one instance, a beneficiary sold one of their cattle to raise money for the downpayment (non-EMIT, non-GreenREAP beneficiary).

“The PBX is expensive. Our beneficiaries engage in businesses that require a capital of 10,000-11,000ETB, but the PBX is more than 80,000ETB, which is difficult to cover for many households. If you want to support more than 3000 households, it is hard to imagine with PBX, maybe you would be forced to reduce your beneficiaries.” GreenREAP representative

*“The PBX has a payback requirement, which poses challenges for beneficiaries under GreenREAP. They lacked the capacity to meet this payment. On the other hand, beneficiaries in EMIT might have the ability to pay, but it could still be challenging unless they do it through the saving-group level.”
EMIT representative*

The addition of the PBX to existing businesses significantly increased income streams. The PBX proved a strong case for diversification of income streams. For EMIT beneficiaries, provision of the PBX significantly increased their revenue streams and enabled them to expand their business. The energy-based businesses that the PBX supports were complementary to the core businesses that PUCs were already providing.

“It complements in the sense that EneRSU has expanded the business opportunity, if PBX was not introduced, these energy related business opportunities would not exist. It gives them additional livelihood from what they had started.” GreenREAP Representative

“They charge 20 ETB for smart phones and 10 ETB for other phones. Sometimes they rent out the PBX to government offices when there are campaigns and they need a power supply. This has been another source of income. As a result, they have started paying their loan. Cash flow from the restaurant contributed to their improved financial situation. The agreement reached was that they would make an initial payment of ETB 20,000 and gradually pay the remaining ETB 24,800 over a span of 6 months.” EMIT Representative



Introduction of the PBX for EMIT and GreenREAP projects also boosted the performance of the beneficiaries compared to their counterparts in the same projects. Representatives of the projects reported that the groups were substantially saving more money than their counterparts – 27,000 ETB compared with 16,000 ETB average of the other project participants.

2.2.2.4. Curriculum Development and Training

The curriculum enhancement support conducted in collaboration with the University of Borana is still in its nascent stages and is considered relevant to the context. Curriculum enhancement was targeted at capacity building through establishing a know-how transfer through competency centre through curriculum development and support. In collaboration with the university, the existing curriculum was enhanced by embedding topics around renewable energy and solar energy, integrated with Borana's electrical engineering courses or offered as a single course. A business course is also to be embedded within the existing curriculum.

“The curriculum is very relevant... what we used to teach was types of renewable energy which are known, there was no designing a system or implementation. Thus, adding the designing system and practice how it works is important... developing entrepreneurial skills, on how to develop business plan are important. We have agreed on the components, but not exclusively on PBX, we might use it as an example when we teach solar home system.” Representative Borana University

A ToT on renewable energy and solar energy was offered to various representatives from regional signatory offices. The University engaged instructors and TVET teachers as electrical students have not yet graduated from the university²². It is anticipated that the TOT would cascade training to beneficiaries who would then take more responsibility for the maintenance and operations of their PBX cubes. The training provides basic training on the PBX to enable installation and minor troubleshooting. In case of major malfunctions or technical issues, these have to be reported to the centre²³.

“For the training to be effective it should be given repetitively so that the community can easily understand the product and its function and use it more effectively. “TVET rep “As our office, we have

²² Borana University is only three years old and has not yet graduated its first cohort.

a plan to continue providing training for beneficiaries after the project ends. But as the TVET office, we need budget and logistical services (at least one motorbike) from the project for more follow-up and guidance. In addition to this, we need a similar product at our office so that we can provide more training.

Investing in technical know-how and local support is critical for scale up and sustainability. PUC and PI respondents were confident in the training they had received about the use of the PBX. On the other hand, their greatest concern was the potential malfunction or technical issues that they may experience with the PBX in the long-run, which they felt they were less capable of addressing without the project's support.

"In my opinion what needs improvement is that the CARITAS project should support TVET with logistical support so that our office can easily follow up and support the PUC groups. In addition to this, the project needs to train us on how to maintain the product in case of malfunctions, because I was trained only on how to handle the product instead of how to maintain it during downtime or malfunction, or else the project needs to hire someone professional in the area so that he can continuously follow up the product and maintain it in case of malfunction." Head of Taltale District TVET rep

2.2.2.5. External factors and actors contributing to change

External actors were most relevant for financing the purchase of the PBX, especially in raising the downpayment. PUC and PI respondents contributed the changes they experienced to accessing the PBX, which they felt would not have been possible without the project. Other stakeholders, such as health institution funding partners, played key roles in enabling initial downpayments for the PBX. In one case, the PUC attributed their significant change to a supporting donor who assisted with access to finance to acquire the technology.

Kebele administration and regional signatory offices played strong supporting roles. PUCs and PIs often mentioned the involvement of the kebele administrations in their participation in the project. Kebele leaders also helped to bring the community together to contribute to the school use cases. Signatory offices participated in the joint monitoring of the project, planning and set up of the project and providing business training to beneficiaries.

2.3. IMPACT

Impact: *The type of change or outcome that has been observed in the targeted communities that relate to the intended objectives of the EneRSU (positive and negative).*

Section 2.2.1 has examined the changes (outcomes) that have been observed in PUCs, PIs since the project started. This section responds to the evaluation questions:

- What changes (outcomes) have been observed in communities since the project started? (both positive and negative) and who in communities have been most greatly impacted (i.e. businesses, households, men, women, youth)? Why?
- Are identified outcomes similar to those observed on other projects? If so, what are the contributing factors (i.e. partnerships, business models, approaches, technologies) that are similar or different to the EneRSU project?

2.3.1. IMPACT AT PUC/PI LEVEL

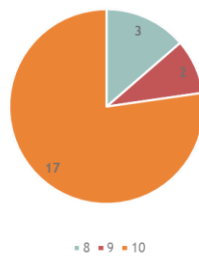
2.3.1.1. Quality of life metric

The PBX was rated highly transformative to the general wellbeing of PUC owners. 83 percent²⁴ of PUCs agreed that using the PBX had “very much improved the quality of their life,” the rest, 17% (3 PUCs) said that the PBX had “slightly improved the quality of their lives.” Public institution respondents felt that the PBX had ‘very much improved their lives and the lives of teachers/ health staff’ because they were able to access mobile charging services closer to them at no cost, and other living close to the institutions were connected to an energy source for light and TV viewing. Two PIs, one public school and a mosque said only ‘slightly improved’ as they were not directly benefiting (their households were too far to get connected) from the PBX installed in the institution.

None of the respondents said that there was ‘no change’, or that the quality of their lives ‘got slightly worse’ or ‘got much worse’. According to the 60_Decibels report, these responses co-related with increased indebtedness. None of the PUC or PI respondents felt indebted or negatively affected by the cost of acquiring the PBX.

2.3.1.2. Net Promoter Score (NPS)

Count of How likely is it that you would recommend the product (Powerbox) to a friend?
(Answer: Scale 0-10) N=22



PUC and PIs were satisfied with the quality of energy, functionality and ease of using the PBX. Based on 60_Decibel’s NPS metric, EneRSU has an NPS of 86²⁵, within this score, Promoters (rating 9-10 out of 10) made up the majority at 86%, Passives (7-8 out of 10) made up 14% and Detractors (percent rating 0-6 out of 10) at 0%. Passives are considered those rating 7 or 8 out of 10. PUC and PI experience of the PBX was mostly positive related to power consistency, capacity and ease of use.



“The light we get from PBX is good and covers a wider area of our home. But the power from battery cells covers smaller area and is not bright.” PUC interview

“It is of very high quality when we compare it with diesel generator. It operate 24 hrs. Once charged it stays 3 days.” PUC Interview

²⁴ In comparison, 60_Decibels impact performance report reported 64% of lantern users and 62% of solar home system users reported significant change to their well-being.

²⁵ In comparison, 60_Decibels impact performance report has an industry standard NPS benchmark of 43, solar home systems were reported to have an NPS of 50.

2.3.1.3. Challenges experienced while using the PBX

Customer's satisfaction is influenced by factors including challenges experienced when using the technology, challenges were low among PUC and PIs. This included lack of electrical supplies such as wires in the local market, fluctuations in how long it takes to charge the PBX in varying weather, and using the PBX to power refrigerators for business and health clinics.

- Technical challenges: There were five instances reported of PBX malfunction, all of which were resolved, and in one case, the PBX replaced.
"Some time the PBX was get contact/electricity shock which caused malfunction to power extension and chargers" PUC interview
- External factors: Once PUC reported slow charging of the PBX during cloud cover, while one PUC reported that they were unable to find proper quality wire to replace a broken connection to the PBX for over five months.
- Mismatched expectations of the PBX: in three cases, PUCs said that they expected the PBX to support their use of refrigerators but they were not able to. One mini-grid business had four PBX cubes installed; total 1,600 watts capacity, another business had one PBX installed; 200 watts, while the health clinic had two PBX cubes; 800 watts capacity. An average refrigerator would require between 350 to 800 watts to operate, dependent on how energy efficient the model is.

"It depends on the season during drought season the power supply has consistency for 24 hours and recharged next day but during rainy season it is difficult to get fully charged the PBX and it's difficult to charge many mobile phones." PUC Interview

"Yes, the negative changes I observed is that when we started the project, they told us that PBX can be used for fridges but after I bought fridges its power is not enough for fridges." PUC Interview

2.3.1.4. Access to alternatives

All 22 PUC and PIs interviewed said that they could not find an alternative source of power that was comparable to the PBX in the local market. Respondent comparisons were based on qualities attributed to the PBX, no maintenance and operational costs, long and consistent uptime, what is available such as solar lantern and battery cells which could not support productive use, diesel and benzene powered generators which had high maintenance and operational costs, and solar home systems which respondents associated with poor quality and high malfunction rates.

"No. We do not find similar products in the market. The solar apparatus in the market are with smaller capacity and are expensive." PUC interview

"This is great difference between the power I used before because I use generator for power but the cost of diesel is very high and it is difficult for me to buy diesel always but now, I use PBX power without any cost." PUC Interview

2.3.2. COMMUNITY-LEVEL IMPACT

Household access to a clean and affordable energy source. Most of the PUC and PIs were able to provide electricity to households living in close proximity. From the 22 PUCs and PIs interviewed in the impact assessment, more than 260 houses benefited from lighting and electricity services from the PBX on an energy-as-a-service model, with about 500²⁶ light bulbs powered in total across Bale, East Borana and Borena zones. The household purchased electricity at the rate of 100ETB monthly payment for one lamp. The household received light from 6pm to 11pm-12pm. Some households also used electricity to

²⁶ EneRSU PUC and PI's appliance tracking records

power televisions and charge small phones (not smart phones). In the absence of the PBX, households used torch lights with battery cells, having to replace the batteries every three days. Others used firewood as a source of light, while others used Pico solar lamp, whose light, they reported was not bright enough. One PBX cube can provide power for lighting purposes for up to 50 households.

"We use firewood in our day-to-day life for cooking and lighting systems at night in our hut. But recently the government instructed us to separate the kitchen from our living hut. After the separation, we started using a small Pico solar system which costs 200 up to 300ETB charged by sunlight and hand torches." FGD with women around PI

"We provide electric service for our village. We have installed electric service for more than 35 houses including four restaurants. We also charge mobiles for local people." PUC interview

"The light energy from the PBX is cheaper than buying battery cell or smaller solar apparatus. The only challenge for households is the initial cost for installation of the line. Paying 100 birr monthly per lump for light is simple." FGD Bidimo

Improved community access to services. Mobile charging, barber services, sewing, DSTV are some of the services that have been brought closer to the community as a result of the PUCs and PIs ability to provide these services using the PBX. In addition, because the PBX does not have operational and maintenance costs, PUCs and PIs have been able to offer services at reduced prices compared to businesses offering the same services but using more expensive forms of energy like diesel generators. For instance, the cost of charging a smart phone used to cost 30-50ETB, and the community member has to pay for transportation to the centre to access the services, only available on market days. PUC and PIs charge 20 ETB for a smart phone and 10 ETB for a feature phone (non-smart phone). Watching football games from DSTV places used to cost 25ETB per person per game from diesel generators, with the PBX the service is provided at 5ETB per person per game.

"In the past, we were paying 20 birr to charge a mobile at once since it was charged with diesel generators. Transport cost was also another expense for us to charge our mobile. But now we pay ten birr to charge our mobile within our locality. Previously, we used battery cells for light in the evening. Three battery cells were used for three days which cost us thirty ETB. But now we pay 100ETB for light from the PBX and get light up to 12:00PM" FGD women, Danisa Kebele

"Previously, I had to wait two or three days to charge my mobile. But now, there is no waiting to charge my mobile since there are three or four places to charge our mobiles. Previously, there was no barber in the locality and people shaved with razor blades. But now there are barbers due to the introduction of the PBX" FGD with women in Bidimo

Improved education and health service delivery. The communities around schools were able to access new opportunities as the schools started to offer evening adult literacy classes for free. Learners could also study in the evenings in the school libraries which were open until 9pm for studies. Teachers were able to access new curriculum textbooks through their mobile phones for their lessons and incorporated audio-visual material in their teaching methods. Health centres increased their hours of operation providing 24 hours services to community members. They were also able to offer diagnostic services that were not available in close proximity to the community.

"It really improved how we work and what we do. It helped the community through the smooth services that we provide. It minimized waiting time for patients." PI interview

"Girls are able to study more hours in the evening since they spend the whole day in household chores" PUC Interview

Increase in communication and entertainment. With access to energy, the community's lives improved gaining longer hours of phone charge to support communication needs including connecting with family, business, work and school, using laptops, desktops, printers. Community members also appreciated access to entertainment at restaurants, DSTV houses, the health centres also provided television for their patients.

“There was no DSTV before the PBX was introduced within the locality. But now there are some three DSTV houses for youths. Hence youths have got recreational places due to the supply of energy from the PBXs.” FGD with school

Increased livelihoods opportunities for community members and a chance to improve their lives. Some PUCs were able to hire staff with the increased business using the PBX. Some community members were also able to start their own businesses through purchasing energy from the PUCs or renting the PBX cubes.

“New businesses like barber and sewing clothes started due to the introduction of the PBX in the locality. Bidimo FGD

“Young people, including some women, have more economically benefited than other members of the community as they engaged in different income-earning activities associated with the project. Thus, they have more experience with economic change than other community members, such as households that only get access to electric light and other related services” Job creation office, Oromia

“The four people we hired get 2,000 ETB salary per month, they even bought smart phones due this project” PUC interview

“Before I sold my cow to feed my family and buying them school uniforms, books and clothes for my family but now I use the income we gain from the project and saving money from project income.” PUC interview

Some PUCs provided light outside of their business premises which in turn lit up streets at night. Having better lit streets was felt to enhance the safety of children and women protecting them from potential dangers associated with darkness.

“They have also lit the street, extending the light bulbs to the outside” Cooperative office Oromia.

“Regarding protection, having accessible light in the area enhances safety for children and women, shielding them from potential danger.” EMIT Representative

Contribution to environmental protection. Although the pilot is at small scale, it provided proof that providing more affordable environmental forms of energy could replace more harmful unsustainable forms of energy. The PBX replaced harmful forms of energy used by PUC and PIs such as diesel and benzene powered generators- to the extent that the PBX was able to meet the PUC productive use for energy needs satisfactorily. Some of the PUCs still used their diesel generators alongside the PBX, while in the case of restaurants, they continued to cook with firewood and charcoal, a use case that the PBX was not intended for.

“There is a difference between the one I used before because unlike the PBX the kerosene has negative effects on our eyes and the quality of power is very low.”

2.3.3. SIMILAR PROJECTS AND EXPERIENCES

This section describes experiences of other projects and how they compare with EneRSU's achievements.

The EneRSU pilot project is one of its kind piloting productive use energies using the PBX technology. Power-Blox AG has conducted pilots in other countries including Uganda and Mozambique, predominantly through an energy-as-a-service²⁷ model rather than the lease-to-own model currently piloted in Ethiopia. In these countries, as with the implementation in Ethiopia, PUCs experienced increased income and were able to diversify revenue streams using the PBX. Health

²⁷ PBX installations are centralized and households are supplied with energy through a metered model, paying tariffs for the use of energy.

institutions were able to improve the quality of service to patients with access to light, and children were able to study in the evening, which they were not able to do before.

Lessons learned from Uganda on the PBX, for instance, were used to improve the product and the model of delivery. These included for instance, changing the PBX light signal system to indicate when charge is running low and the PBX needs to be recharged, or when the PBX was full. Adjustments were also suggested for the model to make it more affordable to PUCs by increasing payback time and maintaining flexibility on the initial downpayment. Participating PUC and PIs in Ethiopia appreciated the alarm system. They also provided similar feedback, asking for longer payback periods, even though 92% of PUCs and PIs in Ethiopia managed to payback within an average of 10 months. In other country pilots, the payback period was much longer, two years.

Other renewable energy projects implemented in Ethiopia were mostly targeting solar home systems and solar products to provide energy for cooking solutions, agriculture and lighting. From conversations with community members and stakeholders, and literature review community attitudes towards solar projects is currently negative as they are seen as less effective in terms of production of energy (strength and duration within the day), durability, and associated maintenance and operation costs depending on the product. Solar home system projects face numerous challenges as last mile connection options. These include low penetration of SHS due to last mile distribution complexities related to importation, spare part availability, logistical challenges. Technical difficulties such as the poor quality/substandard solar equipment in the market that are not durable, lack of financing to support acquisition, unrealistic expectations of the technology and a lack of awareness amongst targeted groups about solar technology. Some of these challenges, such as import and logistical challenges to get PBXs to site, lack of finance, substandard electrical supplies and appliances, compare similarly with the likely challenges the PBX faces. However, the PBX has illustrated better reliability and durability associated with good quality equipment.

Projects primarily struggle with providing productive use energy sources that are technically simple to use, affordable in the short and long-term and can adequately meet the energy needs of the consumer. Although the impact assessment was limited in the information gathered due to limited KII reaching out to implementers, and the amount of information available through literature, we understood that finding the perfect solution for households in off-grid areas was a big challenge. It was impossible to address multiple use cases with a single solution. Areas that were commonly tested include renewable energy for cooking solutions, and agricultural solutions especially irrigation. Section 2.5.5 highlights some ongoing projects.

2.4. SUSTAINABILITY

Sustainability: *The extent to which the program interventions and results are likely to be sustained after the completion of the program; the financial viability of the technology and the operating model in the local context.*

This section responds to the following evaluation questions:

- How economically sustainable are the individual PUCs and PIs? Which are more viable models and why?
- How likely are the changes observed in the project to be sustained once the project is completed? What could be done to better sustain changes in the long-term?

EneRSU was implemented as a pilot project to test the viability of the model to reach set objectives. Sustainability is assessed with this understanding of the project to highlight factors that may enable or hinder sustainability in the long term should the project be scaled in the future.

2.4.1. ECONOMIC SUSTAINABILITY

The project provides sufficient evidence that the technology works and is technically suitable for off-grid communities where access to technical know-how and costs of operation and maintenance significantly impact on the cost of doing business. It also provides a strong case for productive use of energy especially for micro and small businesses and health facilities and its impact on livelihoods development and service improvement. The benefits realized far outweigh the cost of the product.

The assumption that PUCs and PIs will be able to make profits from revenue generation from the PBX once they cover the repayment costs of purchasing the PBX is valid. It does not however consider other expenses of running a business. It was difficult for the assessment to calculate the profitability of the businesses. Several factors however determine the economic sustainability of the PUC and PIs:

- **Ability to raise a downpayment amount.** The cost of the PBX increases with the increase in demand for energy. PUCs and PIs operating within Tier 2 and Tier 3 would be the most suitable use cases. The costs of the PBX would be extremely high for any use case requiring higher energy which may not be economically viable. Additionally, different use cases may require different models. For instance, MSME's used savings, two secured loans for the downpayment, while one health centre relied on a funding partner, while the other had enough savings to pay for the 50% upfront.

Two health facilities interviewed in the impact assessment, one public (purchased 3 PBX cubes) and one private (purchased 2 PBX cubes), were still using the diesel-powered generators they owned alongside the PBX, but at reduced usage, suggesting that their power requirements were higher than the PBX supply. Compared with MSMEs, which had varied system utilization dependent on the number of PBX cubes they were able to afford and power demands of their businesses. Businesses in locations that seemed to have higher customer demand for power-dependent services reported that they experienced power shortages on busy days such as market days when the volume of customers increased. Some businesses also reported that they sometimes ran out of power and had to cut short supply to households before the agreed daily cut-off time at midnight.

Schools had the least system utilization ratios reported because of the limited appliance and uses of energy within the school itself.

- **Ease of repayment.** Schools struggled to make repayments because they were dependent on the community to contribute to the repayments. The schools are also able to generate income from the PBX but given that they are public schools with limited revenue sources, likely the money raised is used in competing school operational costs. An examination of PUC reports on weekly and monthly income showed that they were barely making margins after the payback amount was deducted, suggesting smaller tranches would be more affordable for PUCs even though they managed to pay back in under a year.

2.4.2. ACCESS TO ACCESSORIES AND SPARE PARTS

The greatest concern among PUCs, PIs and stakeholders was the lack of spare parts. While the issues reported remained very low, PUCs and PIs were aware that the life span of the PBX was 8 to 15 years and they were concerned about how sustainable it would be in the future to get the PBX fixed. In addition, the lack of technical know-how increased concerns over maintenance and repair and the cost of it.

“Two or three of the PBXs have shown an anomaly. So, we put them aside until the electrician from caritas checks them.” District Agriculture officer

“Lack of closer follow up, lack of technical assistance and advice, lack of timely responses to the problems of the PBXs and lack of accessories may hinder the sustainability of the project.” District agriculture office

PUC and PI participants were also concerned with the availability of quality electrical accessories. This was especially related to wires to facilitate household connections to the PBX, phone chargers and power extensions which were reported as largely unavailable in the local market, and if available, of poor quality.

“We are unable to get the electric cable for the solar PBX from market since it was cut in the last five months.”

2.4.3. STAKEHOLDER ENGAGEMENT AND OWNERSHIP

There is a general feeling within regional government stakeholders that there has not been adequate ownership of the project with the government and stakeholders. This would affect the sustainability of the project since there would be no one accountable to ensure the project gains were protected.

“One of the factors that challenges the sustainability issue is the lack of proper handover of the project to the government. No preparation has been made to ensure the sustainability of the change after the end of the project. As far as I know, there is no body who are ready to take over. For us (his office) this is not our priority issues” Job creation office, Oromia

2.4.4. DEMAND AND SUPPLY

Demand for the PBX was on the rise. Stakeholder concerns were whether these demands can be met given that the PBX is expensive and is currently imported. On the other hand, project staff felt that the projected demand may be misguided as there was no strong indication that the community would be able to afford the PBX/willingness to purchase the PBX. To achieve a discounted price for the PBX, a tipping point of over 2000 PBX cubes must be ordered, which seems too ambitious without expanding project investors and ‘first loss’ funders.

“There were only a limited number of direct beneficiaries. Thus, there is a mismatch between demand and supply: high demand but a lower supply of PBX. This hinders progress and limits the change to a small population and geographical space. Many of the community members need to have the PBX and feel a sense of exclusion for not having it.” Cooperative office, Oromia

2.4.5. MARKET DISTORTION

Respondents felt that the current profits that the businesses were realising may not be sustainable in the long run as competition grows. The businesses are currently operating in low competition, and in most cases, as sole providers of the services in the areas.

Community members were also difficult to convince to purchase the PBX as they are used to associating NGOs with a grant model. Stakeholders agreed that it was more sustainable to apply the current purchase model, even though it has subsidy. Suitable mechanisms should be used to make the technology affordable to rural households without distorting the market.

“In addition to this, in the past NGOs provide materials for free. Our community has the experience and understanding that NGOs provide different types of materials for free than via payment. Since our community has the experience of getting equipment for free, it will be challenging to let them contribute to get the PBX.” School FGD

2.4.6. CONTINUED BUSINESS SUPPORT

Continued business support is required to help the MSMEs remain in business and be able to scale and diversify income. EnerSU’s internal monitoring system reported that there is still

underutilisation of energy produced from the PBX per location installations. Business support will also help protect livelihoods gains made from the project.

“In this specific project (EneRSU), the direct beneficiary may sustainably earn income as long as they invest the income from the project to diversify their livelihood and grow their investment.” Job creation office

2.5. SCALABILITY

Scalability: Identifying what types of PUCs/PIs have most successfully adopted the PBX; what project activities have been crucial towards achieving intended change/outcomes. Both aim to identify what approaches can be used to efficiently scale future iterations of the project.

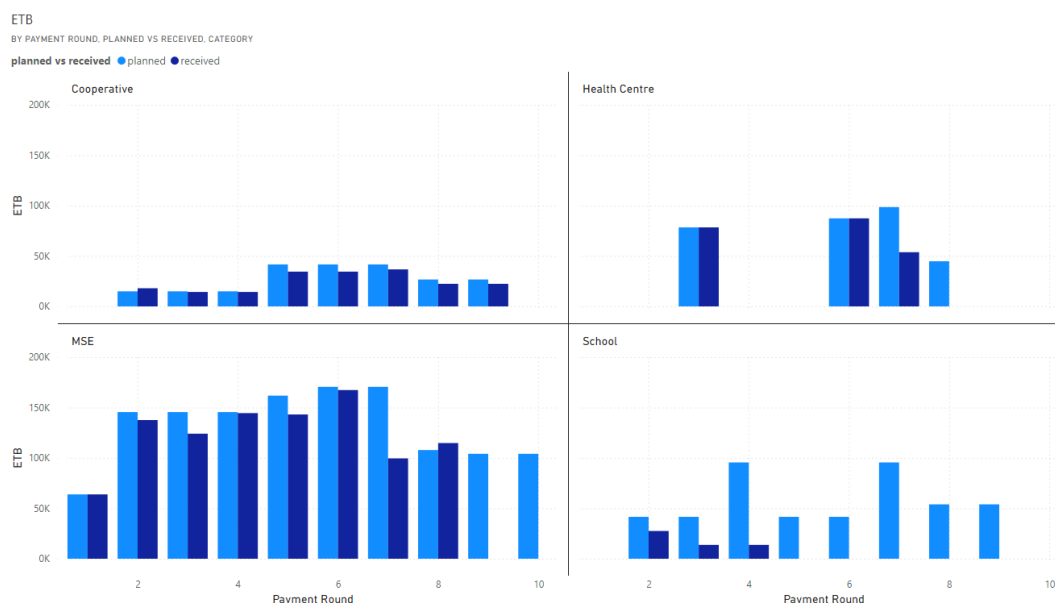
This section addresses the following questions:

- What aspects of the project model have been most successful? Could these be scaled?
- Which PUCs, PIs have the most viable business models, or are performing best? Why is this? What can be learned from this for future programming

2.5.1. AFFORDABILITY OF THE PBX

The 50% subsidy on price and lease-to-own option provided by the project made it accessible for PUCs and PIs. Without the subsidy, the PBX would be considered too expensive for most rural off-grid communities, especially for micro-businesses and schools, however, with a bulk purchase, the PBX price will significantly drop. Payment in instalments options allows the PUC and PIs to payback for the technology using income generated from the PBX. A short payback period meant that PUC and PIs made slimmer margins during payback, some PUCs reported that they used other sources of income to top up payback amounts during payment rounds. Increasing the payback period will help relieve the pressure, making it easier to pay within what is generated from the PBX. An assessment of PUC/PI income and payback information shows that PUCs were able to increase customers and increase income and were able to make some profit during payback periods. In only one case did a PUC report losses. PUCs and PIs would be able to better manage these initial investments through longer repayment periods that allow for lower payback amount.

Figure 7: Payback per category of PUC/PI



“Since the rural people are surplus producers, they can afford to have the PBX if they can get it. In the short run and medium term, the PUC have ample market from rural community and it can guarantee them for its sustainability. Once we consulted the PUC, they deposited the needed money swiftly within a day to own the PBX. This indicates as they have interest and they are convinced with the business and aspire to get the energy and ensure its sustainability. The PUC also covered the remaining payment well. The first down payment the PUC paid was 31,360 ETB.” District agriculture office

The EneRSU project envisioned to engage with financial institutions who would support access to finance of the PBX for rural off-grid communities. This remains a viable option with a few factors for consideration if scaling. The targeted areas were remote, often without access to financial services except from nearest woreda town centres. The micro-finance institution serving the region has morphed into a banking institution, leaving a gap for micro and small businesses. PUC and PIs paybacks were interest free, accessing loans from financial institution may mean interest rates as high as 18%, increasing the final cost the PUCs and PIs repay. There are several renewable energy projects planned to begin that will actively engage with the private sector and financial institutions. These are also discussed in section 2.5.6.

There is low access to financial services at the targeted areas. Linking community members (PUCs) to financial services would greatly enable their opportunity of acquiring the technology in more affordable terms and conditions. Financial service institutions are rarely available in remote areas with an even less probability for micro-finance institutions. The assessment found that communities do not save their money in banking institutions. The more common form of organised savings and lending group was the table banking system, often established with the support of an NGO project. The concept of cooperatives is still nascent, the EneRSU project in most instances, led the organisation of MSMEs to pool together to afford the PBX.

“In our locality there is no trend of getting loan from bank. It is not common in our locality to get loan from financial institutes... There are informal women saving and credit association at the locality level. But there is no formal credit and saving institution that provides credit within our locality” FGD Bidimo women

The lack of forex in Ethiopia makes it difficult to engage the private sector in an open market as the technology is imported. Strict forex control and shortages of foreign currency have contributed to a parallel black market where the local currency exchange rates to the dollar are double the bank rates. These variations imply difficulty for commercial partners to make profits and would also mean pricing of the PBX would be even more expensive for the end user through a commercial private sector supply model. The IMF called for the devaluation of the Ethiopian currency as a condition for the Ethiopian government to access loans- a difficult decision for the government to make as it will affect the current government loans as well as the economy in general. Devaluation is unlikely to happen in the short term.

2.5.2. REMOTENESS OF THE AREA

The PBX technology is suitable for remote off-grid communities which makes the project relevant and timely. The positive outcomes discussed in section 2.2 are also enabled by the context in which the PUC and PIs are operating. Partly, the businesses that are thriving the most are also located in areas with low competition, yet close enough to households to provide ready customers. Businesses/PIs that are far from households/demand, are making less revenue.

“The challenge would be, what would happen if the market for the energy needs saturated. If the BPX expands in a given rural Kebele, would the PUC have enough to stay in the market. But now, the neighbouring within 25 km range which have two or one PBX, which still the demand is high. The community used to travel to Taltale with 200 ETB transportation to charge a phone.” GreenREAP representative

Houses and businesses are far from each other which makes it difficult to connect households/businesses. Good quality electric connection wires are also costly and hard to find. This remoteness and distance from services, may pose a challenge for piloting a central energy-as-a-service model – which may be a more affordable option to reach poorer off-grid rural communities with minimal requirements for energy.

“When there is power interruption from the PBXs, local people become offended and call us a number of times. The high installation cost for households who are far from the PBX is somehow an impeding factor. Individual households are spending from 4000 birr to 4500 birr to get connected to the PBX.

For example, a 100-meter cable is up to 2000 birr which is used to connect 50 meters since it is installed via sides. There are also other accessories like switches, divider and socket. This high cost is the most impeding factor. Our rural people are scattered and far from each other. The farthest the households from the PBX, more energy will be lost to reach such household.” District agriculture office

Community incentives may increase community participation in meeting PBX costs for PI use.

For schools (and health centres) that rely on community contributions, it seemed that community members were more likely to contribute if they experienced firsthand benefits of the PBX. An incentivization scheme may contribute towards deeper commitment from community members, for instance, incentivized mobile charging services for community members, stronger awareness creation on the uses of the PBX and the use of the revenue raised through the PBX by the PI.

2.5.3. SECTORAL TARGETING

EneRSU seemed stronger in MSME and healthcare use cases. Specifically, enabling diversification of revenue sources and creating opportunities for new businesses. The challenges seemed to be responding to agricultural needs for energy which is mainly for irrigation/cold storage – which were not targeted primary use cases for EneRSU. Power-Blox Ag is making nascent progress in using the PBX to meet agricultural sector energy demands which could potentially be piloted in the scale up in partnership with other actors implementing projects on renewable energy use in agriculture.

2.5.4. REGULATORY CONSIDERATIONS

EneRSU project has worked collaboratively with several signatory offices for the success of the pilot. Regulatory considerations will be important when scaling up similar or related projects. The Government of Ethiopia exempted solar products from customs duties in 2010 and in 2022, a guide for the exemptions was developed for harmonised interpretation and application of taxes that apply. Most solar products are exempted from import duty, sur tax and excise tax; 15% VAT and 3% withholding tax still apply. However, spare parts are still subject to tax, as are electrical accessories.

*“...the custom usually only gives privilege for the main product, yet spare parts are always important.”
KII donor/min rep*

“There are no original materials like power extensions cable and the equipment used for working with the PBX” PUC respondent

Beyond the pilot, CACH needs to reconsider energy-as-a-service model for areas where this is a possible option. This model makes sense for poorer households who may not have heavy energy requirements and are willing to pay for service. PUCs and PIs were able to charge for service at the cost of 100 ETB per lamp per household, which demonstrated potential for the model. When scaling, considerations should be placed for how rates are set and services are charged by PUC and PI, especially in areas where the service has no competition. It was possible that the businesses would charge steeper rates to help cover for the initial cost of the PBX, for instance, while some households were charged 100 ETB per lamp per month, there were instances where PUCs charge 200-250 ETB per lamp per household. The Ethiopia Energy Authority (EEA) approved the Mini-Grid Directive No. 268/2020 in 2022 which provides directives for operating privately operated mini-grids in Ethiopia,

including tariff setting based on operational costs and affordability to the end-user, it was unclear at the time of the study how the directives would apply for the small-scale businesses that EneRSU PUCs and PIs were operating in providing light and power to households and micro-businesses. Other projects have experienced this similarly as illustrated in a comment below from a solar mini-grid project using the energy-as-a-service model.

“...it is a community owned mini grid, and we want them to sustainably run the mini grid. So, they need the customers to pay a cost reflective tariff, which is not the experience in Ethiopia. As you know, the tariff on grid customers is very cheap. And even those mini grids under development by the Ethiopian electric utility, the tariff is the same as the on-grid customers, which is difficult even to sustain the market” KII, donor/ministry representative

2.5.5. OTHER ACTORS

The following table highlights past and ongoing projects within the energy sector, and specifically renewable energy for off-grid communities in Ethiopia.

Organization/s	Name of the Project	Brief Details	Location	Opportunities for EneRSU
World Bank	Access to Distributed Electricity and Lighting in Ethiopia (ADELE)	A five-component project targeting both urban and rural communities, schools and health facilities with access to electricity. 2021-2027	Addis Ababa and other state capitals, and rural Ethiopia	The project is implemented by Development Bank of Ethiopia (DBE), Ministry of Water and Energy, Ethiopia Electric Utility. EneRSU is most relevant under the third component, solar home systems for households, and small businesses, and the fourth component - standalone solar systems for health and education facilities.
World Bank	Energizing Ethiopia	This World Bank program is set to strengthen and expand the electricity network, improve sector financial viability, and enable renewable energy generation	Ethiopia	The project seeks to actively engage the private sector

		through private sector participation in Ethiopia. Through this program, the WB will partner with Ethiopia over the next 10 years (beginning March 2024) with a financing envelope of up to \$1.4 billion, to help the government crowd in other development partners and the private sector		in expanding renewable energy sources including solar, potential opportunity to engage with the project as a financing partner
SNV	The Distributed Renewable Energy-Agriculture Modalities (DREAM)	DREAM project will facilitate the implementation and private sector operation of nine renewable energy mini-grids and irrigation systems across Ethiopia. The project was planned to run from November 1, 2021, to October 31, 2023, but has been delayed.	Across Ethiopia.	Engage from a knowledge exchange and lesson sharing perspective
UNDP and China	Trilateral Cooperation on Renewable Energy in Ethiopia	As part of the UNDP-supported project, Ethiopia and China have recently launched a joint research and extension centre, which is expected to serve as a research, training and demonstration platform to enhance the capacity to access renewable energy technologies in Ethiopia and facilitate the realization of the SDGs. The project is expected to benefit up to 50,000 households in Ethiopia	Ethiopia	The project primarily envisaged supporting renewable energy technology dissemination and scale-up for Ethiopia's climate-resilient growth. While focused on renewable energy experiences from China, EneRSU may engage and share current technology
GIZ	Energizing Development (EnDev) Expanding the Green People's Energy	Energizing Development (EnDev) is implemented and coordinated by GIZ and supports sustainable energy access in two main components: Clean Cooking and Rural Electrification. Target groups are lower-income households, social institutions and small to	Ethiopia	GIZ is extending its solar energy projects in Ethiopia and seems to be interested in different types

	<p>initiative in rural regions</p> <p>The Ethiopian-German Energy Cooperation</p>	<p>medium sized enterprises, mostly in rural areas. The project implements five components in support of efforts to expand green energy in rural areas; particular emphasis is placed on the involvement of municipalities, cooperatives and local companies.</p> <p>A small-scale project fund provides financial support for projects by local stakeholders in sub-Saharan Africa.</p> <p>The project pilots the digitalization of hydropower plants with the state-owned power generation company Ethiopian Electric Power. Besides supply of essential spare parts, it sets up digital maintenance systems to enable long-term, cost-effective use.</p>		<p>of solar solutions for rural development. Potentially engage as first-loss partner</p>
USAID	Power Africa	<p>Power Africa has supported the development of electricity generation projects in Ethiopia. In addition, various firms have received U.S. Embassy support to move transactions forward. With support from Power Africa, as a result of assistance provided to host country governments and the private sector, energy customers in Ethiopia, Ghana, Kenya, and Nigeria gained access to new or improved electricity.</p>	Ethiopia, Ghana, Kenya, and Nigeria	Potential first-loss partner
Ministry of Water and Energy	Access To Distributed Electricity And Lighting In Ethiopia (Adele) Project.	<p>The project will increase access to new and improved electricity services for households, smallholder farmers, commercial and industrial users, and social institutions in urban, peri-urban, rural, and deep-rural areas through on-grid, off-grid, and mini-grid solutions by leveraging public and private delivery modalities. Runs Apr 23, 2021 - Jul 30, 2027 with \$500million</p>	Ethiopia	<p>The PBX presents a strong use case in the pilots for some of the energy demands that the project aims to respond to for rural off-grid communities. The PBX could potentially be one of the technologies among those</p>

				the project seeks to deploy
Carbon Initiative for Development (Ci-DeV)	Ethiopia: Off Grid-Renewable energy	<p>Ci-Dev is helping to support a small but growing off-grid lighting market.</p> <p>In coordination with the Development Bank of Ethiopia, a \$60 million World Bank project is working to distribute 2.8 million solar lanterns and more than 200,000 solar home systems to households that are not connected to the electrical grid. These off-grid renewable energy products will replace polluting kerosene lamps and diesel generators.</p>	Ethiopia	Potentially, the PBX may be provided as an alternative solar product to the SHS in future adaptations of this project

3. CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations are organized by the OECD-DAC criteria, highlighting key observations, drawing conclusions from the observations and providing recommendations as relevant.

Relevance: was the PBX technology, the project approach and interventions, relevant and effective in their ability to respond to community, PUC and PI needs and priorities?

Observations:

EneRSU strongly aligns with national priorities for productive use of energy, particularly supporting NEP 2.0. In addition to supporting national strategies for rural electrification through off-grid solutions, signatory office and ministry respondents strongly felt that EneRSU was aligned to their own objectives in the health, education and job creation sectors, including economic empowerment of women and youth. EneRSU's work with PUCs illustrated the potential of the model to create income generating activities and generate employment opportunities for youth and women.

The pilot generated community interest in the PBX. Anecdotal evidence from interviews with participating PUCs and PIs, as well as signatory offices suggests that there is rising demand for the PBX. MSMEs are demanding energy sources with low to no operation and maintenance costs, is durable and can provide power for long hours. They are also demanding for power that can support their income generating activities. Households were interested in accessing affordable light sources that last more than two hours and can provide light for wider areas. These qualities were associated with the PBX in comparison with locally available energy sources that could not adequately meet these demands such as dry cell batteries, solar lanterns, solar home systems, diesel and benzene powered generators. PUCs and signatory offices also mentioned a gap in the availability of suitable power sources for agricultural use such as irrigation, value addition, and cold storage, which were not targeted use cases for EneRSU.

Conclusion: EneRSU's objectives are relevant and support Ethiopia's national and sector specific plans. They are well aligned with the needs of the community, providing an energy source that meets these demands. Focus on specific use cases such as MSMEs and public institutions providing education and health care services present as viable use cases for the pilot.

Recommendation: Scale up of the project should retain current objectives and target group focus. Engagement with relevant government ministries, has ensured buy-in for the objectives of the project, which provides an enabling foundation for a scale up. Agricultural use cases such as irrigation are currently outside the scope of EneRSU.

Observation:

The curriculum enhancement and training component will remain relevant in the expansion of the pilot and if the technology demand and supply increases. EneRSU supported renewable energy curriculum enhancement in collaboration with Borana University and with TVETs. This also encompassed a TOT for signatory office representatives. The TOTs will provide training on the PBX and widely on renewable energy to participating PUCs and PIs. This component of the pilot is still in its early stages, the assessment found that investments made in engaging with local TVET and the university to build local capacity in renewable energy technologies and learning about the PBX will be crucial in the future for scale up and sustainability. Government stakeholders participating in the assessment particularly felt that it was necessary that any new technology should have skills available locally to respond to any repair and maintenance needs. PBX-Ag is working on a smart-phone application that will connect end-users with developers to help troubleshoot technical issues. These components are important in a future scenario that foresees increased distribution of PBX cubes.

Conclusion: It was not clear how the training component would be sustained or scaled, as it was still very new at the timing of the impact assessment. While the content was considered sufficient, there

were recommendations to include practical lessons on how to repair and maintain the PBX and deeper technical know-how to promote local capacity to provide such O&M services in the future.

Recommendation: Continuously engage with relevant stakeholders to strengthen handover of the training component. Relevant government ministry is best placed to drive the agenda, provide financing for ToT movement and mentoring of PUCs and PIs. In scale up of pilot, the curriculum revision should also reflect CACH's intention for local capacity building in the maintenance and repair of the PBX. As the intervention may reach scale in the future, adjust content and make it repetitive to build capacity. There is potential to create jobs for the local community should a market for the PBX expand, in the next eight years when the PBX need to be serviced/replaced/renewed.

Effectiveness: *The level of contribution of project activities towards intended outcomes and the interventions that are most effective at delivering change for PUCs, PIs and local communities.*

Observations:

The pilot achieved its intended outcomes, which were considered highly significant by project participants. Regardless of slight variations in experiences, MSMEs and health centres demonstrated significant change in increased energy consumption and impact on their lives. Schools consumed the least energy, while health centres still used the diesel generators they were using before to supplement energy. PUCs faced barriers to expansion including no access to more PBX cubes, and limited access to electrical appliances such as quality phone chargers and connection wires.

MSMEs varied in their system utilization dependent on the number of PBX cubes they were able to afford and power demands of their businesses. Businesses in locations that seemed to have higher customer traffic reported that they experienced power shortages on busy days such as market days, when the volume of customers increased. Some businesses also reported that they sometimes ran out of power and had to cut short supply to households before the agreed daily cut-off time at midnight.

Integration with EMIT and GreenREAP demonstrated the potential models in which the technology can be extended to reach ultra-poor households and enhance their income generating activities. Project participants from EMIT and GreenREAP, benefited from diversifying income and expanding their businesses. EneRSU's approach to include ultra-poor households through collaboration with the projects, demonstrated the significant change that owning the PBX made in the participant's ability to generate new and increased revenue, and make savings; as well as providing an approach to make the technology accessible to ultra-poor communities.

Conclusions on effectiveness: The pilot achieved its intended outcomes, demonstrating the potential of using the PBX to provide electricity to rural communities for public service improvement, generation of new income and diversification of income sources. Integration with other projects supported potential models²⁸ that could be used for inclusion of ultra-poor households to facilitate access to productive use of energy and economic empowerment. PUCs and PIs required better guidance on gauging their energy needs and better predicting how many PBX cubes they required.

Recommendations: To increase outcomes for participants, it is recommended that more guidance or support is provided to PUC and PIs in determining the amount of power they require, for schools, this may make the PBX more affordable and payments manageable. The PBX made a significant difference for ultra-poor women supported by EMIT and GreenREAP in helping to diversify their income sources, expand their businesses and increase their savings. Integrating with livelihoods projects or projects targeting community members who would otherwise be disadvantaged in accessing similar technologies through the open market contributes towards inclusion.

²⁸ The GreenREAP business group were not required to pay an upfront downpayment, rather they paid back for the PBX in instalments. Although they were provided a further subsidized cost (25%) they were able to payback, expand their business and save.

Impact: *The type of change or outcome that has been observed in the targeted communities that relate to the intended objectives of the EneRSU (positive and negative).*

Observations on impact:

The assessment applied metrics borrowed from 60_Decibels to understand impact of the PBX on project participants as follows:

Impact at PUC/PI Level: Impact was measured by PUC and PI assessment of the impact of the PBX on the quality of their lives. The majority of PUC participants (83%) felt that the PBX had “*very much improved the quality of their life,*” while public institution respondents felt that the PBX had ‘very much improved their lives and the lives of teachers/ health staff’. None of the PUC or PI respondents felt indebted by the PBX payback or negatively affected by the cost of acquiring the technology. In comparison, in a performance assessment report by 60_Decibels on why off-grid energy matters, the benchmark stands at 62% users reporting significant life change for using the solar home systems.

PUC and PIs were satisfied with the quality of power, functionality and ease of using the PBX. The PBX has a Net Promoter Score²⁹ of 86, within this score, 86% of PUCs and PIs rated 9-10 that they would recommend the PBX to a friend and 14% rated 7-8 out of 10 that they would likely recommend the PBX. The global benchmark for NPS is 43, and for solar home systems, in comparison, is 50 in the 60_Decibels³⁰ report. PUC and PI experience of the PBX was mostly positive related to power consistency, capacity and ease of use.

PUCs and PIs faced few technical and external challenges with the PBX. There were five instances reported of PBX technical malfunction, all of which were resolved, and in one case, the PBX replaced. External factors such as cloud cover affected the charging rate of the PBX (two instances reported). PUCs were also concerned over the lack of quality electrical supplies in the local market such as extension cables and connection wires that they required. There were reports of mobile chargers that got over heated or wires that burnt up, difficulties in connecting households that were further away. Participating PUCs and PIs also seemed to have mismatched expectations of the PBX. In three cases, PUCs said that they expected the PBX to support their use of refrigerators.

All 22 PUC and PIs interviewed said that they could not find an alternative source of power that was comparable to the PBX in the local market. Respondent comparisons were based on qualities attributed to the PBX, no maintenance and operational costs, long and consistent uptime, what is available such as solar lantern and battery cells which could not support productive use, diesel and benzene powered generators which had high maintenance and operational costs, and solar home systems which respondents associated with poor quality and high malfunction rates.

Conclusions on impact on PUC and PI: The PBX was rated highly transformative to the general wellbeing of PUC owners and strongly compared over other off-grid energy sources on specific metric. Within the targeted communities, available alternative energy sources fall short of meeting demands for sources that can support multiple productive uses, provide long hours of power supply at no operational and maintenance costs. Recorded issues and downtime related to use of the PBX was very low, making it suitable for off-grid rural communities. PUCs and PIs provided challenges that they faced while using the PBX including external factors and mismatched expectations. EneRSU responded well to emerging needs for electrical wiring and accessories by providing and supporting participating PUCs and PIs.

Recommendation: If the pilot is scaled, PUC and PIs would require more sensitization and training to a) manage mismatched expectations b) to provide an understanding of the external issues and potential

²⁹ The Net Promoter Score is worldwide as a proxy for gauging customer loyalty and satisfaction by assessing the extent to which a customer/end-user would recommend the product/service to a friend on a scale of 0-10. The NPS is calculated by percent of users rating 9-10 out of 10, minus percent of users rating 0-6 out of 10 that they are likely to recommend the product.

³⁰ 60_Decibels, 2024, why off-grid energy matters: an impact performance report.

solutions. It would be beneficial to train users on how to use the PBX efficiently to avoid any risks of wastage/long term damage to the PBX. Future projects should keep consideration in their design for electrical appliances required for connection to the PBX and PUC and PI access to them. This could be through partnership with private sector suppliers who may provide an incentive for participants and offer quality products at discounted prices.

Observations on Impact at community level: The pilot contributed to community access to affordable and clean energy source, particularly for light and mobile phone charging. Households living in close proximity to participating PUCs and PIs were able to access light at ETB 100-250 monthly for powering one lamp between 6pm to mid-night. This was a significant improvement for the household which probably relied on dry cell batteries, kerosene or solar lanterns for their lighting needs. Compared, they felt that the PBX light cost less compared to these other alternatives and gave brighter light, illuminating the entire house for longer hours. Having light for longer hours in the evening meant women could do their evening chores in well-lit areas, students could study longer in the evening. Other households accessed enough power to also conduct new businesses such as tailoring businesses. Households also used the power for TV and to charge their mobile phones, leading to an improved quality of life. Some PUCs also managed to hire new employees because of the PBX. However, there was no standardization of what to charge for light supply, which may expose community members to over-charging, especially in the initial months when the PUC/PI is raising funds to payback for the technology.

Community members accessed services within their villages at reduced cost. Participating PUCs provided mobile charging services at 20-50% less compared to providers using diesel generators because they had no operational costs. Community members also saved between ETB 50 - 400 in transportation costs to access the same services.

Improved education and health service delivery. Some of the benefits to community members was accessing 24-hour health services and laboratory and other diagnostic services because participating health facilities were able to expand operating hours and invest in more equipment. Related to education, students and teachers accessed textbooks in soft copies to aid learning, schools also used more audio-visual material for lessons. Adults interested in literacy classes were also able to access them for free during the evenings from participating schools.

Increase in communication and entertainment. Generally, there was a feeling that the PBX enhanced communication through increased mobile charging services, DSTV and TV.

Conclusion: The pilot demonstrated the significant outcomes that access to renewable productive use energy sources can provide for rural off-grid communities. These significant outcomes and low operational and maintenance costs of the PBX justify investing in the technology.

Recommendations: The impact achieved for participating PUCs and PIs was significant enough to warrant replication of the pilot, or its expansion. Should the pilot be scaled, careful consideration should be taken for guidelines on tariff setting for off-grid energy supply in an energy-as-a-service model currently provided by PUC and PIs. Setting up a cost-benefit approach to gauge the amount of benefit in monetary terms that is generated from the amount invested will be a useful indicator for the pilot.

Sustainability: *The extent to which the program interventions and results are likely to be sustained after the completion of the program; the financial viability of the technology and the operating model in the local context.*

Observations:

PUCs and PIs were able to generate income from the PBX and payback subsidized cost of the PBX³¹. All³² project participants were able to payback (50% of subsidized cost of the PBX at 44,800 per PBX) within 10 months and were reporting gross profits. However, project participants expressed the need to extend the payback period to at least two years to enable easier payback. Although schools struggled to payback monthly, they managed to raise over ETB 80,000 in downpayment representing between 50% - 80% of the required amount. The schools also may have purchased more PBX cubes than they required for their energy needs.

The greatest concern among PUCs, PIs and stakeholders was the lack of spare parts and maintenance services. Participating PUCs and PIs were worried about how easy it would be to access maintenance services and spare parts when it is required in the future given that the technology was imported. The lack of quality electrical accessories in the local market affected mobile charging businesses.

Community members were difficult to convince to purchase the PBX as they are used to associating NGOs with a grant model. Stakeholders agreed that it was more sustainable to apply the current lease-to-own purchase model, even though it has subsidy. The required downpayment in some cases may have been a deterrent in purchasing the PBX. EneRSU was accommodative of participating PUCs and PIs, allowing between 10% to 30% downpayment, and in one case, waived downpayment for ultra-poor women in the GreenREAP project. Suitable mechanisms should be used to make the technology affordable to rural households without distorting the market.

Conclusions on sustainability: The pilot provided sufficient evidence that the technology works and is technically suitable for off-grid communities where access to technical know-how and costs of operation and maintenance significantly impact on the cost of doing business. At the same time, it is impressive that the participating PUC and PIs were able to payback for the technology, with majority providing an upfront downpayment, with no reported feeling of indebtedness. The performance of different PUC and PI cases based on ability to generate income, payback and utilize available power, suggests that MSMEs maybe the obvious anchor load customers for the pilot, closely followed by health facilities. Schools benefit greatly from the technology but should be engaged strategically to ensure power demand matches supply and the school's community is not overly burdened/benefits from the PBX.

Recommendations: Any plans to scale the pilot or replicate should maintain flexibility in downpayment options and a lease-to-own model with extended payback periods. It is essential that participating PUCs and PIs do not get into debts as the businesses/income generating activities are still heavily dependent on prevailing market conditions. The next phase of the pilot should also continue finding ways for stimulating demand for the PBX, whether it is in linking to electric accessory supplies, facilitating expansion of business growth through links to finance.

Scalability: Identifying what types of PUCs/PIs have most successfully adopted the PBX; what project activities have been crucial towards achieving intended change/outcomes. Aim to identify what approaches can be used to efficiently scale future iterations of the project

Observations:

EneRSU subsidies on solar panels and electric appliances and lease-to-own options made the technology accessible for PUCs and PIs in the pilot phase. Without the subsidy, the PBX would be

³¹ EneRSU provided 100% subsidy on solar panels and electrical supplies, and 50% subsidy on the cost of each PBX cube. In addition, EneRSU covered for the cost of importing the PBX, transportation, training and installation.

³² One school paid up to 90% of the cost as a downpayment and did not complete the remaining 10% due to challenges in raising the funds.

considered too expensive for most rural off-grid communities³³, especially for micro-businesses and schools. Further the lack of foreign currency in Ethiopia and substantial differences in parallel forex exchange rates would increase the landing price of the product through purely commercial models. These factors necessitate a blended financing approach with a first-loss partner, to reach rural off-grid communities.

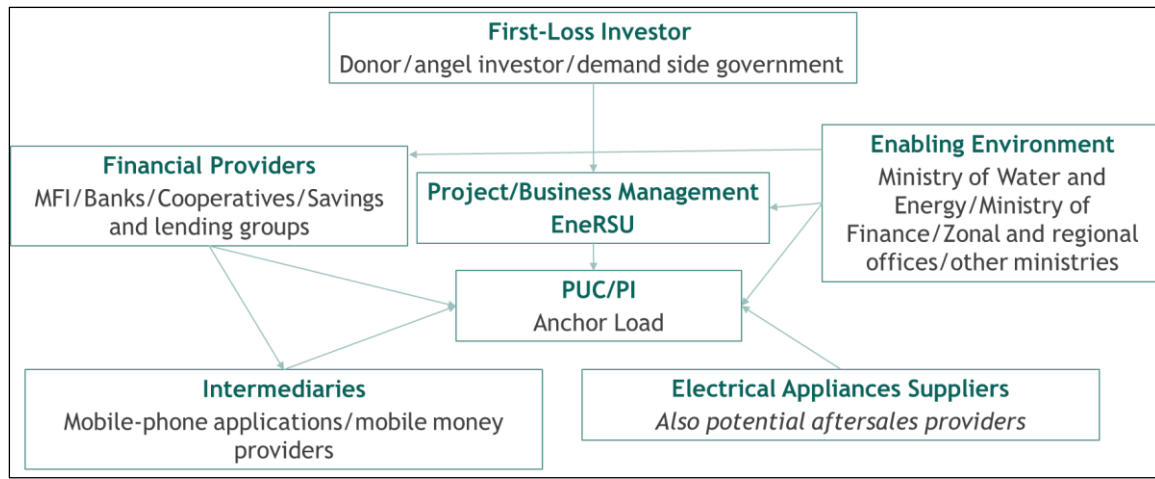
The EnerSU project envisioned engaging with financial institutions who would support access to finance of the PBX for rural off-grid communities. There is low access to financial services at the targeted areas, with nearest access at woreda capital centres. Microfinance institutions in Ethiopia operate by region. The MFI present in the Oromia region since became a bank leaving a gap in access to micro-finance loans. Only two PUCs accessed downpayment finance through a loan, and it was from friends and relatives. Since PUCs and PI's need for financing would be for the downpayment for the technology, it is recommended to test a model where the technology can be installed without the need for a downpayment, and PUCs and PIs would payback in tranches, with a grace period, to allow them to start generating income from the PBX. This can also be guaranteed by the first-loss partner or government partners, depending on the use case.

EneRSU seemed stronger in MSME and healthcare use cases, who are potentially anchor clients for the technology. Both in terms of load demand and ability to generate income using the PBX, MSMEs and health facilities seemed better fit for the PBX. Health facilities compared to schools had more expensive energy sources at baseline- fuel and benzene generators compared to Pico solar systems with batteries that the schools were using. Public health facilities participating in the project also benefitted from partner financing which schools participating in the project did not have. In the case of MSMEs, location of the businesses determined the amount of revenue the business could generate. Businesses that were closer to households had more customers. Schools said that they struggled to generate revenue from the PBX because they were located far from where most houses were. Integrated projects demonstrated the pilot's potential in empowering ultra-poor households and catalyse business growth.

Conclusions on scalability: EnerSU will require 'first loss' investors to scale up. CACH financed administrative and logistical costs of the pilot, its implementation, 100% solar panel and electrical appliances costs and 50% of the cost of the PBX for the pilot phase to prove concept. These costs could not yet be sustainably transferred to rural off-grid communities, who have a right to affordable clean energy. However, applying a grant approach will create community dependency and distort the market. With controlled foreign money exchange rates, lack of forex and a parallel black market dollar rate twice the bank rate, a private sector supplier model is highly unlikely to work in Ethiopia. It will only make the product less affordable for the community and not lucrative for potential suppliers.

Recommendation: The assessment proposes a public-private-partnership.

³³ It is anticipated that prices of the PBX significantly reduce when purchased in large quantities, which was not possible for the pilot proof of concept. The subsidies were applied to correct for the high price caused by the small quantity purchased for the pilot.



PUC/PI: Anchor load clients, potentially MSMEs and health centers (private and publicly owned who have finance partners. Other clients like schools can participate but will not likely be substantial up takers.

Government stakeholders: Play the role of facilitating an enabling environment, including interpretation of relevant policies and guidelines, facilitating negotiations with local finance institutions to enhance access to financing for interested project participants, lead in Outcome 2 component on curriculum enhancement, training and capacity building on renewable energy and related technologies, extend incentives for stimulating demand, including applicable taxes and tariffs on technology spare parts, and electrical appliances. In the case of rural hospitals and schools, contribute towards fund raising and budget lines for acquisition of technology. Connect to other partners, donors working on similar or complementary projects for potential collaborations.

First-loss partner(s): Potentially, donor/angel investor/demand side government. Provides grant funding to facilitate administrative and logistical costs. Help adjust PBX cost/subsidize as relevant. Cover administrative costs, logistics and implementation, as well as set up of post-sales support mechanisms. The First-loss partner may also take on downpayment risks enabling inclusion of ultra-poor households, or start-ups that may not have the finances for a downpayment but demonstrate capability for paying back with their business proposal/business opportunity.

Financiers: Support stimulating demand, offering friendly advance downpayment/advance support at zero to low interest rates. Could include MFI/Banks/Cooperatives/Savings and lending groups willing to advance downpayments for the cost of the PBX technology, solar panels, and whatever capital is required for the businesses. The financier partners would provide suitable financial products targeting PUCs and PIs with the aim of reducing/meeting capex. It is important that interest rates are zero to very low to avoid plunging PUCs into debt. A payback period of two years is advisable in comparison with other projects and recommendation from PUC and PI respondents.

Electrical appliances suppliers/solar panel suppliers: Electrical Appliances Suppliers: will address major external challenges with electrical supplies, providing discounted and quality products to PUC and PIs. As model advances, they could also potentially provide after sales support, if well trained.

Project management/business manager: project management would connect various stakeholders and ensure smooth implementation. Project management would also be responsible for identifying and enrolling anchor load clients. If the next phase of the pilot can generate demand for 2000 plus PBX cubes, then the cost of a cube significantly drops reducing the final price to the end-users.

**ANNEX A: OUTCOME HARVESTING DATABASE –
SEPARATELY PROVIDED**

**ANNEX B: EVALUATION FRAMEWORK – SEPARATELY
PROVIDED**

ANNEX C: KEY INFORMANT INTERVIEW SCHEDULE