EVALUATION OF KTF'S LIGHT FOR LEARNING PROJECT

EQUITY ECONOMICS AND DEVELOPMENT PARTNERS

APRIL 2023

EQUITY ECONOMICS

KTF

Celebrating 20 YEARS of changing lives

About us

ABOUT EQUITY ECONOMICS

Equity Economics is a leading consulting firm, providing analysis, policy development, design and evaluation services to government, private sector and non-government clients.

We specialise in economic and social policy, and international development. We combine technical economic skills with policy and design expertise, helping our clients contribute to a more inclusive, equitable society. Our work addresses the persistent challenge of social and economic disadvantage, through new and practical solutions. We work in collaboration with our clients and are believers in life-long learning. We are committed, and in for the long haul.

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ABOUT KOKODA TRACK FOUNDATION

Kokoda Track Foundation is a non-government organsation that works alongside people and communities in Papua New Guinea to improve lives, livelihoods and futures.

KTF has four focus areas: education, health, equality and leadership.

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KTF WOULD LIKE TO ACKNOWLEDGE THE SUPPORT OF ITS PARTNERS

Australian Government
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SDP

PNGAus Partnership

LITTLE HEARTS Learning

Schneider Electric Foundation

PUMA ENERGY FOUNDATION

ACKNOWLEDGEMENT OF COUNTRY

Equity Economics acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Owners of Country throughout Australia and their continuing connection to both their land and seas. We also pay our respects to Elders – past, present and emerging – and generations of Aboriginal and Torres Strait Islander peoples now and into the future.

CITE THIS REPORT AS

Equity Economics (2023), Evaluation of KTF's Light for Learning Project

Executive Summary

Light for Learning is a project which installs household and community solar systems to villages in Oro and Western Province in remote, off- grid communities linked to KTF's education projects. The solar systems provide power for light and device charging and other low-energy activities. The project seeks to improve access to lighting and power, decreasing reliance on kerosene and other battery devices. Its objective is to improve education, health, safety, and security outcomes for remote communities.

This evaluation reviews the evidence for the Light for Learning project for solar installation in Oro and Western provinces from August 2021 through to mid -2022. This evaluation was based on input data from documents provided by KTF, a large survey conducted by the installation team and qualitative in-person interviews conducted by KTF. The evaluation drew on the Organisation for Economic Development's (OECD) evaluation guidance[1] on using and applying six evaluation criteria plus gender equity disability, and social inclusion (GEDSI). The evaluation considered the project therefore through a lens of seven criteria – relevance, effectiveness, efficiency, impact, coherence, sustainability, and GEDSI.

1. Relevance: The evaluation found the project is highly relevant with a strong need for increased lighting and energy sources across Oro and Western Provinces with Western Province households in particular, with very few alternative light and energy sources prior to installation.
2. Effectiveness: It is highly effective and exceeded its targets for electrification by 30% - having provided an estimated 26,768 people with improved access to working solar units.
3. Efficiency: KTF has used its networks, experience, and expertise to design a project that leverages its other projects for support, logistics and know-how. It is therefore highly efficient, providing value for money on several fronts.
4. Impact: Broader social and economic impacts were significant. The project:
    a. Reduced energy costs and reliance on biomass and polluting fuels for more than 20,000 people across Western and Oro Provinces. The survey found Oro Province households saved 31% of their income as a result of solar installations, the majority of which was spent on school fees.
    b. Increased students' ability to study with significant increases in time spent reading and doing homework.
    c. Improved health outcomes in a variety of ways including through reducing smoke and irritation as well as supporting health posts.
    d. Increased access to knowledge and improved communications. Mobile phone use increased – mostly in Western Province - increased light supported increased socialisation and community connection.
    e. Improved opportunities for small business largely due to increased light after dark though in Western Province possibly increased access to mobile phones also assisted small business whereas in Oro Province, interviewees highlighted use of night hours as important.
    f. Enhanced personal and community sense of safety.

[1] OECD 2021, Applying Evaluation Criteria Thoughtfully, OECD Paris

5. Coherence: The project was found to be coherent across KTF's own projects and national government policies with little duplication or gaps.
6. Sustainability: The project was found to be sustainable, but maintenance concerns have emerged in Western Province. Early indications are that Western province households may have some trouble maintaining their systems over the long term.
7. GEDSI: Women were positively impacted by the project, particularly with regard to safety and security. The solar systems also assisted travel to health posts, communication and the provision of health services.

The most significant impacts of the project were highlighted in Western Province where access to energy and light was minimal prior to installation. As a result, Western Province saw significant increases in opportunities to study, and increased levels of mobile phone use and communication. While this finding suggests that KTF could consider focusing on solar installation to the most remote and high-needs villages, at the same time, there is a concern that these villages may be unable to maintain the equipment over the long term. Western Province showed some evidence of lower rates of functionality at 12 months due to maintenance issues. Lower incomes may also reduce the ability of Western Province households to fund battery purchases in 5 years.

Impacts in Oro Province were very positive but less significant. Possibly impacts were compromised by reductions in tourism activity due to COVID-19. That said, interviews that took place in early 2023 certainly highlighted marked increases in activity at night including the establishment of night markets as well as time spent making items for sale - leading to increased small business opportunities.

Key recommendations for the project from the evaluation are:

1. KTF should continue to monitor and support maintenance of solar equipment, particularly in Western Province to ensure ongoing workability of systems. The development of solar hubs, already well underway, will further support the project objectives and incentives. Further education and training of solar champions and community members will also be necessary to ensure solar systems are utilised and maintained effectively.
2. Close consideration of subsidisation of replacement parts and batteries is needed. Ongoing subsidies while supporting the longevity of the equipment also reduces household independence and diminishes sustainability of the project. Further consideration could be provided to consider other ways to support households to save for replacement parts and batteries. KTF has taken the first step by training solar champions in financial literacy to support households. Consideration could also be given to using FODE centres and FODE students to encourage savings and identify income earning opportunities or other financial schemes to encourage full ownership and responsibility for replacement parts. This would help to build household autonomy and reduce reliance on ongoing KTF support.
3. Further rollout of the project should be guided by where KTF can leverage existing connections and relationships. Supporting Light for Learning in lock-step with the establishment of FODE centres is a critical ingredient of KTF's success.

Key recommendations for the survey and future surveys are:

1. To get a better understanding of the impact on women, people with a disability and other groups it would be useful to specifically target these groups through the survey process. The proportion of women survey respondents in the current survey was low – 24% in Oro and 35% in Western Province. It was also unclear whether womens' answers were based on their households' view or their own personal view. Any future evaluation would be strengthened by the addition of some

women-only surveys oriented specifically to identify impacts on women. Likewise surveys could be tailored to persons with disabilities and the impact of solar on their lives. This would ensure the insights and voices of women and other groups are accurately reflected and not lost in the large survey sample size.

2. The survey would also be strengthened by surveying the same households twice - rather than different villages and households each time (as occurred in Western Province). Ensuring the same question was asked across all households and provinces would also improve the accuracy and reliability of the survey data.

Project Overview

CONTEXT

Energy poverty, or a lack of access to sustainable modern energy services and products, is a key contributor to inequality and poverty world-wide.[2] . The poorest families spend nominally and proportionately more time and money to meet their energy needs, due to less efficient equipment, more expensive energy sources and smaller incomes. A lack of energy contributes to poverty by limiting the productive capacity of individuals by reducing time or resources needed to increase household earnings and improve livelihoods. Energy poverty relates to the United Nations Sustainable Development Goal 7 "Ensure access to affordable, reliable, sustainable and modern energy for all".[3]

In PNG, only 13% of the population has access to a power grid-resulting in a significant proportion of the population relying on kerosene, biomass or batteries for their energy needs.[4] These energy sources are expensive, time consuming to collect and dangerous to users' health.

With the introduction of the National Electrification Rollout Plan in 2017, PNG aims to provide electricity grid access to 70% of the population by 2030.[5] Unfortunately, PNG's rural communities are among the most difficult groups to service due to significant distances between communities and the existing grid, transport and access issues and limited economic activity.[6]

PROJECT DESCRIPTION

Light for Learning is a project which installs household and community solar systems to villages in remote, off- grid communities linked to KTF's education projects, improving access to lighting and power, decreasing reliance on kerosene and expensive battery devices, improving education via KTF's tablet-based learning, and improving health, safety, and security outcomes for remote communities. The solar systems provide power for light and device charging and other low-energy activities. Box 1 outlines the type of solar equipment installed and the maintenance and equipment needed.

The project has 7 desired outcomes:

3. Improve energy access for 20,000+ people across remote and rural Western and Oro Provinces
4. Decrease energy costs and reliance on biomass and polluting fuels for 20,000+ people across remote and rural Western and Oro Provinces

[2] UNDP (2018). Accelerating SGD 7 Achievement Policy Brief 08, p.2
[3] UNDP (2022). "The Sustainable Development Goals Report 2022." United Nations Statistics Division. https://unstats.un.org/sdgs/report/2022/.
[4] World Bank (2021), Papua New Guinea: Improved access to reliable, affordable energy, Press release April 2021, https://www.worldbank.org/en/news/press-release/2021/04/06/papua-new-guinea-improved-access-to-reliable-affordable-energy
[5] World Bank (2023). "Access to electricity (% of population) - Papua New Guinea. https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=PG.
[6] USAID. "When are renewable energy mini-grids more cost-effective than other options?", from https://www.usaid.gov/energy/mini-grids/economics/cost-effectiveness.

5. Improve education outcomes for students studying at the Kokoda and Balimo Colleges; and educational outcomes for school students from beneficiary communities
6. Improve health outcomes via reduced exposure to smoke and fuels, reduced fires, burns and accidents, and improved respiratory health
7. Improve communications and access to information for students and community members
8. Improve opportunities for livelihoods and small businesses due to improved communications, access to information, training and project business related activities
9. Improve personal and community sense of safety and security

The project builds on a pilot, the Village Connect project, which installed over 1,000 household solar systems and 60 larger community systems, providing almost 6,000 people with clean energy along the Kokoda Track area. Student's studying remotely at KTF's Kokoda college were able to charge their tablets due to this project-an essential requirement for their remote education.

Image 1: Sun King System

SOLAR EQUIPMENT INSTALLED BY KTF.

The equipment installed by KTF is the Sun King
System Specifications: SK home 120

Lighting

- –Power LEDs with 600 lumens total flux (200 lumens per lamp)
- Three light modes: Turbo (200 lumens); Normal (100 lumens); Low (40 lumens)

Battery & Power

- – 5 year lifetime, 12000 mAh Lithium Ferro-Phosphate (LFP) battery
- – 12 W detachable, polycrystalline panel with aluminum frame and 5 meter wire
- Up to 24 hours of run time on a day's charge

Device Charging

- 12V power output designed to power 12V DC appliances
- 5.5V USB power output designed to power any standard USB device
- Includes USB cable and common phone adapters

Materials & Durability

- Drop-proof, UV-stable, IP65 rated polycarbonate & ABS casing
- Water and humidity resistant

SOLAR CHAMPIONS AND SOLAR HUBS

Solar Champions are trained by KTF on a range of aspects related to solar installation to provide a support person in each village to whom households can turn for solar support. KTF trains the Solar Champions on technical aspects of installation, maintenance, safety, operation, and repair of solar systems, as well as on financial literacy and COVID-19 awareness. In addition to in-person trainings, modules are provided via USB for Solar Champions to continue training other village members. On average, KTF trains 7 Solar Champions per village (58% men, 42% women and 13% with a disability).

Image 2 and 3: Solar champions being trained by the KTF solar installation team (L) Solar equipment being installed (R)

Development of two solar hubs is well underway. Infrastructure, training, staffing and procurement of supplies is in progress. The solar hubs provide the option to purchase further equipment (replacement parts, batteries) as well as technical advice and support to the solar champions. The solar hubs are based out of KTF's Kokoda College and SDP's Balimo College initiative, facilitated in partnership with KTF. Batteries need to be purchased after approximately 5 years and the solar hubs will be operational to ensure smooth replacement of batteries at that point in time.

PROJECT LOCATION

The project was conducted in the rural areas of Oro and Western provinces (see map below for province locations). In Oro Province, the project supported 21 villages located in Kokoda, Oro Bay and Tufi Rural Local Level Government's (LLGs). In Western Province, the project supported 30 villages in Balimo Urban and Gogodala Rural LLGs.

Light for Learning communities were selected on the basis of a student in the village attending one of KTF's FODE College and requiring energy to charge their tablet, provided by KTF to support their learning. Light for Learning provided solar equipment not only to the student's household but the entire village and nearby villages. This had a number of benefits:

- Helped to eliminate the risk of rivalry or conflict within and between villages and sidestepped potential problems with traditional ownership systems.
- Reduced the risk of theft and tampering.
- Lowered the unit cost of installation since transportation, freight and installation were significant one-off costs.

The project also provided solar equipment to the health post and some other communal facilities such as churches.

Map 1. Project locations

ABOUT THIS EVALUATION

This evaluation reviews the evidence for the Light for Learning project for solar installation in Oro and Western provinces from August 2021 through to mid-2022. The project has proceeded with additional rounds of installations in both provinces.

This evaluation was based on input data from documents provided by KTF, a large survey conducted by the installation team and qualitative in-person interviews conducted by KTF. The survey was conducted at the time of installation - Oro Province in August-September 2021 and Western Province from July 2021 to April 2022. Follow up surveys took place approximately 12 months after installation. The survey was

conducted by the installation team of approximately 10% of all households. Further detail on the survey is provided in Appendix A Methodology.

The evaluation drew on the Organisation for Economic Development's (OECD) evaluation guidance[7] on using and applying six evaluation criteria plus gender equity disability, and social inclusion (GEDSI) such that the evaluation considered the project through a lens of seven criteria – relevance, effectiveness, efficiency, impact, coherence, sustainability, and GEDSI. The evaluation rubric for analysis is provided in Annex 1. Evaluation methodology is discussed further in Annex 2.

[7] OECD 2021, Applying Evaluation Criteria Thoughtfully, OECD Paris

Findings

The evaluation found that the KTF Light for Learning project scored a total of 32/35.

Criteria	Score (out of 5)
Relevance	5
Effectiveness	5
Efficiency	5
Impact	5
Coherence	5
Sustainability	3
GEDSI	4
Total	32/35

Table 1. Evaluation criteria

The project has met its objectives in both provinces. The greatest improvements in outcome were seen in Western Province where many households shifted away from complete darkness and limited alternate forms of lighting and energy to reliable solar lighting. Oro Province also demonstrated significant gains including in incomes and economic activity – the creation of a night market demonstrating the role light plays in income generation.

1. The evaluation found the project is highly relevant with a strong need for increased lighting and energy sources across Oro and Western Provinces with Western Province households with very few alternative light and energy sources prior to installation.
2. It is highly effective and exceeded its targets for electrification by 30% - having provided an estimated 26,768 people with improved access to working solar units.
3. KTF has used its networks, experience, and expertise to design a project that leverages its other projects for support, logistics and know-how. It is therefore highly efficient, providing value for money on several fronts.
4. Broader social and economic impacts were significant:
    a. The project reduced energy costs and reliance on biomass and polluting fuels for more than 20,000 people across Western and Oro Provinces. The survey found Oro Province households saved 31% of their income as a result of solar installation, the majority of which was spent on school fees.
    b. The project increased students' ability to study with significant increases in time spent reading and doing homework.
    c. The project improved health outcomes in a variety of ways including through reducing smoke and irritation as well as supporting health post effectiveness and travel and access.

d. The project increased access to knowledge and improved communications. Mobile phone use increased – mostly in Western Province - and light supported increased socialisation and community connection.
e. The project improved opportunities for small business largely due to increased light after dark.
f. The project improved personal and community sense of safety.

5. The project was found to be coherent across KTF's own projects and national government policies with little duplication or gaps.
6. The project was found to be sustainable, but maintenance support must be an ongoing focus, particularly in Western Province. Early indications are that Western province households may have trouble maintaining their systems over the long term. Expansion of the project is reliant on donor funds and there is limited opportunity for developing the capacity of villages to fund or coordinate their own installation – battery replacement will also continue to be subsidised by KTF.
7. Women were positively impacted by the project, particularly with regard to safety and security.

RELEVANCE

Are the project's aims and objectives still relevant and important, and are the project activities consistent with the aim of the project?

RELEVANCE - SCORE 5/5

The evaluation found the project is highly relevant with a strong need for increased lighting and energy sources across Oro and Western Provinces.

Community consultations prior to the project identified the sources, cost and adequacy of energy and lighting and confirmed the ongoing relevance of the project across the two provinces. Data gathered prior to installation identified that access to electricity was very low. Existing lighting options were both unsatisfactory and costly and insufficient lighting and access to electricity was having wide social impacts. There was thus a clear need for energy support in these communities and the project responds appropriately with an off-grid system to support these objectives.

The project was carried out in provinces where lighting and energy was scarce.

- Oro Province in which the Kokoda Track is located, is closer to Port Moresby and benefits from economic activity generated by Kokoda Track trekkers. That said, social and economic indicators and development are still low compared to the PNG average. Many households in Oro had access to small, low-cost handheld solar systems that could provide light for a short period after dark and could afford to purchase kerosene on a weekly basis. However, Oro Province was particularly affected by COVID-19, and the combination of travel restrictions and the closing of the Kokoda Track had significant economic implications for the province. Of all Oro households surveyed, 75% rated their satisfaction with lighting of their home low (1 or 2 on a scale of 1 to 5).
- Western Province is one of the poorest most isolated provinces in PNG with very low development indicators. Baseline data showed very low weekly incomes, low levels of access to electricity and very low levels of alternative lighting sources such as kerosene. In Western Province 70% of households rated satisfaction with lighting low (1 or 2 on a scale of 1-5).

Electricity use in both provinces is very low. Prior to installation most participants did not use electricity (75% Oro Province, 91% Western Province) – refer Fig 1 below. For those that did, the major source of power was small solar units.

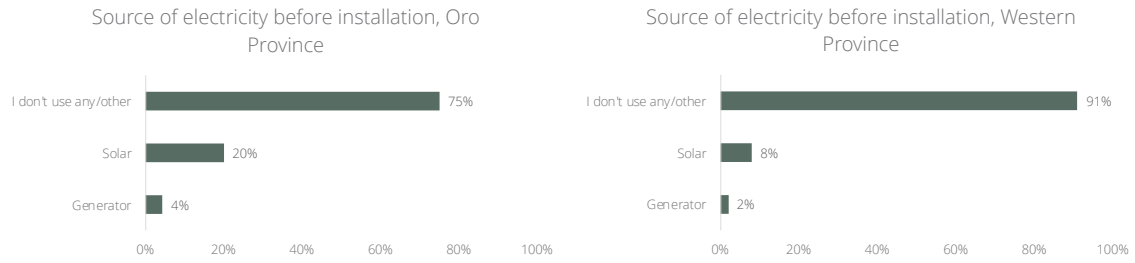


Fig 1: Sources of electricity

Participants in Oro province cited a number of different sources of lighting prior to installation including woodfire (82%), battery torches (77%) and more basic solar systems with lower output and lighting capacity (74%). Kerosene lamp was another source of lighting for households (23%). Western Province households identified the main sources of lighting as battery torches (89%), and woodfire (51%). Less common energy sources were solar (17%) and, kerosene lamps (5%) – refer Fig. 2 below.

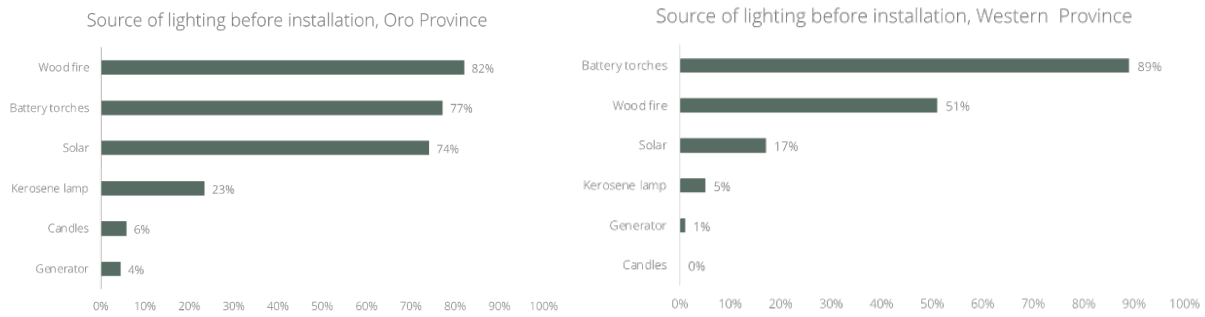


Fig 2 Sources of lighting before installation

EFFECTIVENESS

Is the project achieving its intended objectives? The project has 7 objectives, of which the first is discussed here and the remainder are discussed under "Impact".

EFFECTIVENESS - SCORE 5/5

The evaluation found the project is highly effective and exceeded its targets for electrification by 30%.

The project aimed to improve energy access for 20,000 people across remote PNG. The project exceeded this goal by over 30%, having provided an estimated 26,768 people with improved access to working solar units.

In Oro Province, 2,069 household solar systems and 84 facility solar systems (eg. health posts) were installed across 21 villages. In Western Province, 4,970 household solar systems and 54 facility solar systems were installed across 30 villages.

Type	Oro Province	Western Province	Total
Household solar system (12W)	2,069	4,970	7,039
Facility solar system	84	54	138
			7,177

Table 2. Unit cost

The project has trained 242 solar champions, 134 solar champions were trained in Oro Province and 208 solar champions trained in Western Province. Of the 342 solar champions:

- 144 female solar champions (21 with a disability)
- 152 male solar champions (25 with a disability)

The shift away from previous energy sources highlights the extent to which the project sufficiently met residents' energy needs. This shift can be seen by a change in spending patterns and income – discussed in the following section.

Improved energy access was distributed relatively evenly amongst household members with the survey highlighting that in both provinces' benefits were shared evenly as all households were provided solar equipment.

EFFICIENCY

Are the activities cost-efficient and do they deliver on intended outputs in a timely manner?

EFFICIENCY - SCORE 5/5

The evaluation found the project is highly efficient, providing value for money on several fronts.

The evaluation found the project is highly efficient for three key reasons. Firstly, it draws on the networks and relationships created through KTF's FODE and other projects to help determine which villages should be provided solar equipment. These connections increase efficiency through transportation and logistics with KTF already accustomed to working in these locations.

Second, installation by the one qualified installation team ensures that the team is skilled and experienced in solar installation in remote villages locations. Moreover, the same team provides training to solar champions and also conducts the surveys. This allows important data to be collected in an efficient and streamlined manner and ensures that solar champions can support maintenance of systems.

Thirdly, the cost of the project compares favourably to the published costs of other similar projects. The total cost of the project was AUD 2.55 million with total number of installations of 7,177. This equates to an installed cost per unit of AUD 355 and a cost per village for full electrification of AUD 50,025.

	Budget (AUD)	Unit cost (AUD)
Procurement of 7039 household solar units	$1,313,405	$187
Procurement of 138 facility systems	$117,300	$850
Logistics, installation, management, training 7177 units	$1,212,122	$169
Total	$2,642,827	$355 (household) $1019 (facility)

Table 3. Unit cost

With an installed cost in remote communities of AUD 355 per household unit this project this is less costly than published costs of comparable World Bank projects in Laos and Mongolia. In addition, it also compares favourably in terms of installed power generation - with an estimated cost of about AUD 29/Watt installed solar with the AUD 51/Watt in China.

	Budget (USD, 2012)	Number of households	Cost per household (AUD, 2022)	Est. Solar System size	Project details
China	288,500,000	400,000	$ 1,388	28 Watts	Install 10 MW of installed SHS capacity reaching 350,000 household
Laos	13,800,000	9,200	$ 2,886	N/a	Distribute 9,000 SHS to households in villages in seven southern provinces
Mongolia	23,000,000	50,000	$ 885	N/a	Install 40,000 SHS to nomadic herders and soum centres in rural areas

Table 4: 2012 comparative study of comparable World Bank rural solar electrification projects. Source: Progress in Development Studies 12, 4 (2012) pp. 315–335

IMPACT

What difference does the intervention make?

IMPACT - SCORE 5/5

The project was found to have a significant impact across outcomes 2, 3, 4, 5, 6 and 7.

Outcome 2: Decrease energy costs and reliance on biomass and polluting fuels for 20,000+ people across remote and rural Western and Oro Provinces.

The project reduced energy costs and reliance on biomass and polluting fuels for more than 20,000 people across Western and Oro Provinces. The survey found Oro Province households saved 31% of their income as a result of solar installation, the majority of which was spent on school fees.

In Oro Province, energy costs and reliance of polluting fuels reduced after solar installation. The money saved was spent primarily on school fees and food. Of all Oro households: 93% of households agreed with statement " I spend less money on kerosene" with estimated weekly savings of 17.95 Kina – as shown in Table 5. This represents an estimated 97% reduction in kerosene use based on reported weekly spend[7]. 95% of households agreed with the statement "I spend less money on batteries", with estimated weekly savings of about 12.56 Kina. This represents an estimated 87% reduction in the use of disposable batteries.[8]

Estimated overall weekly savings on batteries and kerosene in Oro Province was 30.51 Kina this represents 31% of estimated weekly income.

	Kina spent before installation batteries per week	Kina spent after installation on batteries per week	Savings	Kina spent before installation on kerosene per week	Kina spent after installation on kerosene per week	Savings	Total savings	Total savings as % of post installation income
Oro Province – average response	14.58	2.02	12.56	18.56	0.61	17.95	30.51	31%

Table 5. Total savings

Savings were most commonly spent on school fees, food, clothing and household items, as shown in Fig. 5. Western Province was not surveyed with respect to the amount of money saved on kerosene and batteries after solar installation although prior to installation, average spending was just 2 Kina on kerosene per week, which is consistent with the very low use of kerosene for lighting (just 5% of households). In terms of savings, Western Province participants planned to spend savings on school fees, soap, goods, salt and food, as shown in Figure 5.

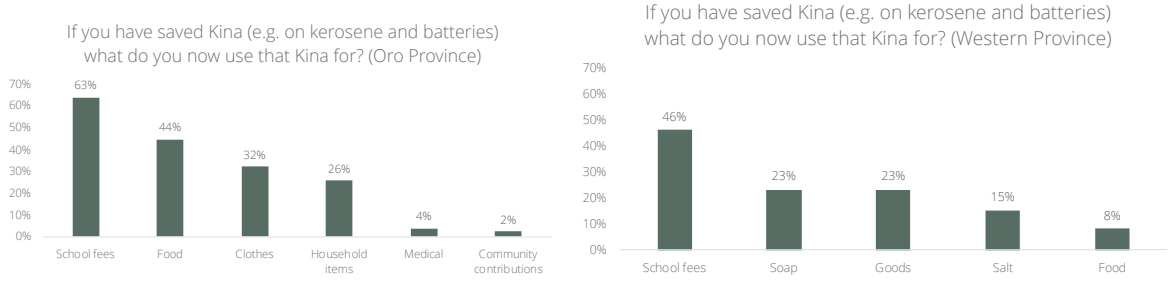


Fig 5. If you have saved Kina, what do you now use that Kina for?

“SINCE I RECEIVED THE SUN KING SOLAR LIGHT SYSTEM IT CHANGE MY LIFE BY STOP BUYING AMOUNT OF KINA ON KEROSENE.”

“IT HAS HELP SAVE ME SPENDING KINAS ON BUYING BATTERY TORCH.”

“I USE THE KINA FOR CHILDREN'S SCHOOL FEES.”

“HELPS ME TO SAVE SOME MONEY TO BUY OTHER THINGS LIKE SALT, SOAP.”

“THE SOLAR LIGHT CHANGE MY LIFE TO SPEND LESS MONEY ON KEROSENE AND BATTERIES AND ALSO CHANGE MY CHILDREN'S STUDY AT NIGHT.”

“I VERY HAPPY, THE SOLAR LIGHT CHANGE MY LIFE BECAUSE IN THE PREVIOUS I SPEND MORE MONEY ON KEROSENE AND BATTERIES.”

“MY LIFE HAS CHANGE AFTER I RECEIVE MY SYSTEM AND IT HELP ME TO SAVE MORE MONEY AND DO WORK AT NIGHT.”

Outcome 3: To what extent did the project improve education outcomes for students and provide increased ability to complete studies?

The project increased students' education outcomes demonstrated through increased time studying and reading at night.

While the project's primary focus was to provide an opportunity for students at KTF FODE colleges to study from home using a tablet, the decision to include the whole community provided education benefits to all children in the community. In both Western Province and Oro Province solar installation saw significant increases in the time children spent on educational activities after dark. Figure 6 shows that of all Oro Province households, 86% agreed their child/ren spent more time doing homework and 84% said their child/ren spent more time reading at night. In Western Province households, 80% agreed that their child/ren spent more time doing homework and 88% said their child spent more time reading at night.

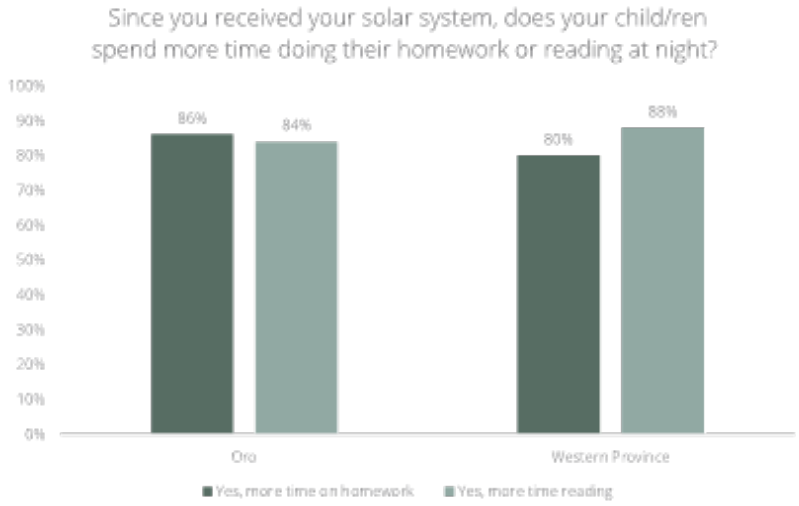


Fig 6. Since you received your solar system, does your child/ren spend more time doing their homework or reading at night? Yes/No

In terms of the time spent reading, both Provinces saw a dramatic increase in time spent reading with Western Province the most significant increase from 6.7 minutes before installation to 82.9 minutes after installation. Similarly with time spent doing homework – Western Province saw the largest increase from 8 minutes before installation to 103.1 minutes after installation - as shown in Fig 7.

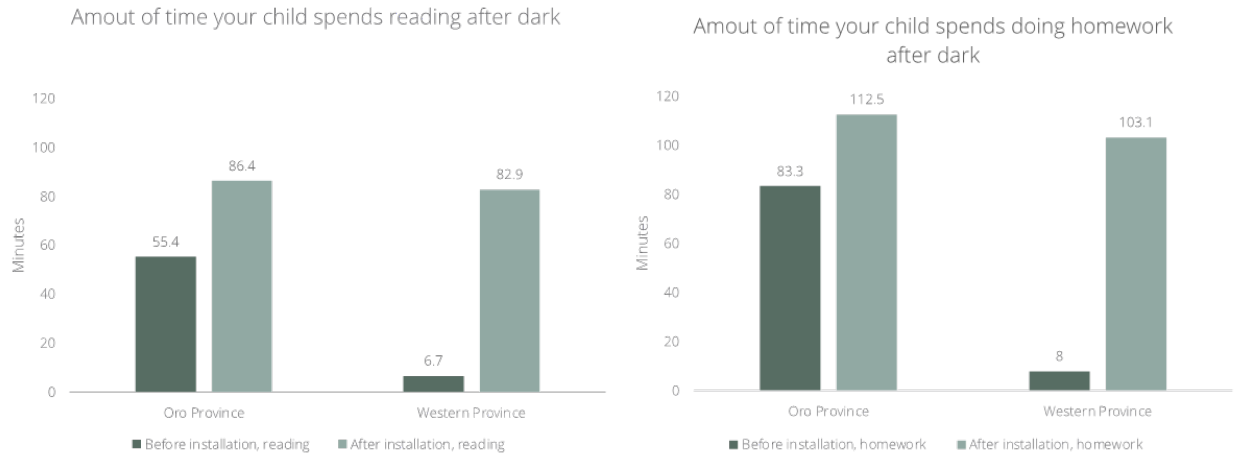


Fig 7. Amount of time your child spends reading and doing their homework at night? (minutes)

Another way in which the progam supports student education is through creating savings (from reduced kerosene/battery purchases) that are often spent on school fees (refer previous section Fig 5.).

"Solar light helps my children do their homework, study and read books at night. "

"My kids are 10 and 7. They use the lights for their homework studies and reading usually from 6-9pm every night. They like the lights and they are very happy. "

"First of its kind, KTF you have changed my life completely. Thank you so much in supporting our children through education lights".

"I am a FODE student. I enrolled in 2019 and this year I am in Grade 12. I did not have the solar units when I was previously studying. We have only had them for one month but so far it is very good and I think I can study better. I only walk up to Kokoda College so have previously gone there to charge my tablet. "

"I feel safe at night and my kids can do studies after dark. I can read and do other things like business after dark. Thank you KTF for changing my life."

Outcome 4: To what extent did the project improve health outcomes? What impacts have the project activities had on the occurrence of respiratory illnesses?

The project improved health outcomes in a variety of ways including through reducing smoke and irritation as well as supporting health post effectiveness and travel and access.

Households from both Oro and Western Provinces reported a reduction in soreness/irritation of eyes as well as improvement in respiratory health. Table 6 shows that in Oro Province, the biggest difference caused by solar installation on health was a reduction in smoke in the house and sore and irritated eyes but the change in family members coughing and sneezing was also significant. In Western Province, health changes were less significant with the main noticeable difference after installation with respect to a reduction in sore and irritated eyes. Only a small difference was noted regarding coughing and sneezing in Western Province. Respondents noted an increase in smoke in the house. This may be explained by the fact that different households were interviewed before installation and after installation. – possibly with different results.

	How much smoke is in your house each day?			How often are you or your family members coughing or sneezing?			How often do your eyes feel sore or irritated?		
	Prior to installation	After installation	Difference	Prior to installation	After installation	Difference	Prior to installation	After installation	Difference
Western Province	2.63	3.11	-0.48	1.93	1.77	0.16	1.86	1.21	0.65
Oro Province	3.44	1.81	1.63	2.77	1.70	1.06	2.95	1.71	1.24

Table 6: Please answer the following questions on a scale of 1 to 5, where 1 = Not at all and 5 = A lot

Lighting of the aid post made the health services provided at night-time more effective. Health workers noted that they were better able to assess, monitor and treat patients with better lighting. It was easier for example to monitor the symptoms of patients presenting with malaria. Wounds were easier to clean and stitches easier to do with improved lighting. It was easier to see any complications with respect to birthing. Interviewees noted that they had more confidence in the ability of the health post worker to support them at night-time and were thus more likely to seek help.

Interviews highlighted that lighting provided by the project encouraged more people to access health services at night. An unanticipated benefit of lighting was that it seemed to deter crocodiles and gave people seeking health assistance more confidence to safely walk to the aid post.

Interviews also highlighted the importance of encouraging night-time access to health services. A health aid worker noted that many patients come to the aid post due to domestic violence and need to seek care at night-time. Lighting thus not only helps these patients have the confidence to walk to the aid post but also get appropriate help and lighting also made their feel safer in doing so.

The project may also have helped support health outcomes by increasing savings for households to spend on medicines or on hygiene items such as soap. Parents also reported being able to provide better care for sick children or family members after dark.

The project has also increased a sense of general wellbeing. In interviews, community members mentioned that the solar had improved the outlook of individuals. One interviewee, a 31-year-old male

from Oro Province commented- "The lights make the community beautiful, when you look around the village. People are very much happier."

"THE LIGHTS HELP WITH MANY THINGS. WE ARE ABLE TO TREAT PEOPLE IN THE NIGHT IF THEY COME TO THE AID POST. THE LIGHTS ALSO HELP KEEP THE CROCODILES AWAY AT NIGHT SO WE ARE ABLE TO MOVE AROUND AT NIGHT AND PEOPLE ARE ABLE TO WALK TO THE AID POST WITHOUT BEING SCARED OF CROCODILES. THE LIGHTS HAVE MADE OUR LIVES SO MUCH BETTER. THE WOMEN THEY ARE SAFER. AND THEN CHILDREN THEY ARE SAFER."
ORO PROVINCE, CHW AID POST WORKER, FEMALE

"AT NIGHT WE GIVE PEOPLE DRUGS OR TREAT WOUNDS LIKE CUTS ON THEIR HANDS OR BROKEN BONES. IT WOULD HAVE BEEN DIFFICULT TO TREAT THESE INJURIES AT NIGHT WITHOUT THE LIGHTS AND THEY ALL NEED TO BE TREATED RIGHT AWAY AS THEY ARE EMERGENCIES".
ORO PROVINCE, 28 YEAR OLD MALE

Outcome 5. To what extent did the project increase access to knowledge and improve communications?

The project increased access to knowledge and improved communications. Mobile phone use increased – mostly in Western Province - and also light supported increased socialisation and community connection.

There was a small increase in mobile phone use to contact friends and family in Oro (23%) and Western Provinces (11%). In Oro Province before installation, 40% reported using their phone a "fair amount" or "a lot" to contact friends and family (25% a "fair amount" and 15% "a lot"). After installation 63% said they used their phone "a fair amount" or "a lot". In Western Province, where mobile phone use is significantly lower, prior to installation only 3% said they used a phone to contact family and friends before installation "a fair amount" or "a lot" and 14% after installation.

"I have noticed people in the community are buying new phones. It has made communication easier. We can now talk to people in other villages or towns. FODE students are able to purchase phones and study on them also." Oro Province, 28 year old male

There was an increase in using mobile phones for work related conversations after installation in Western Province but decrease in Oro. In Oro Province 41% used their mobile before installation for business and 37% used it after installation - which may reflect the economic impact of the track closure due to COVID-19. In Western Province, 15% used a mobile phone for business before installation and 50% used their mobile phone for business after installation.

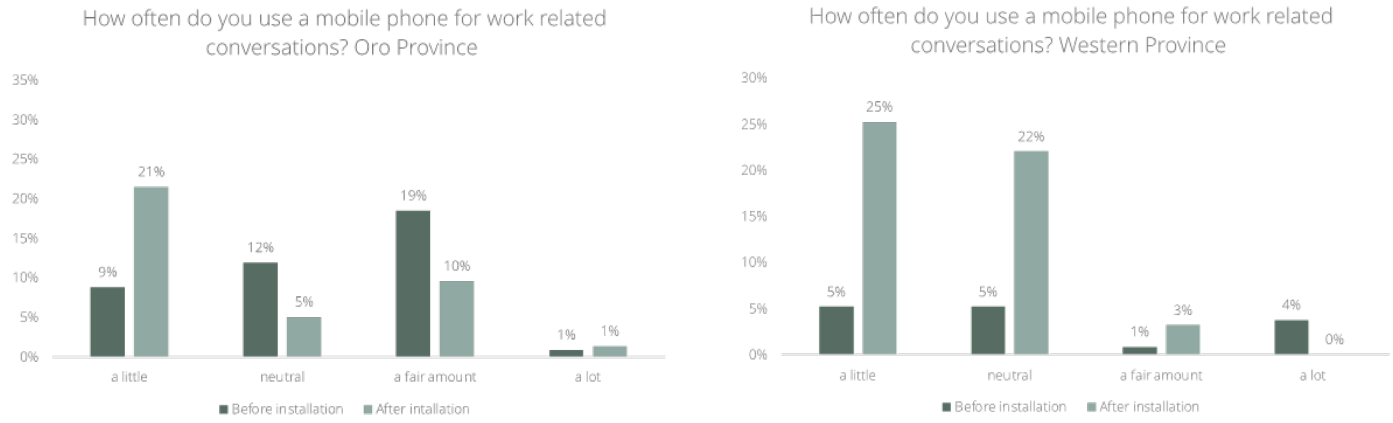


Fig 8. How often do you use a mobile phone for work related conversations?

Mobile phone use for health care increased in both Provinces after installation from a low base. In Oro Province, 38% used a mobile phone for health care before installation but after installation, 41% reported an increase in mobile phone use to access services such as health care. In Western Province, 16% reported using a phone for health care prior to installation and 51% after installation.

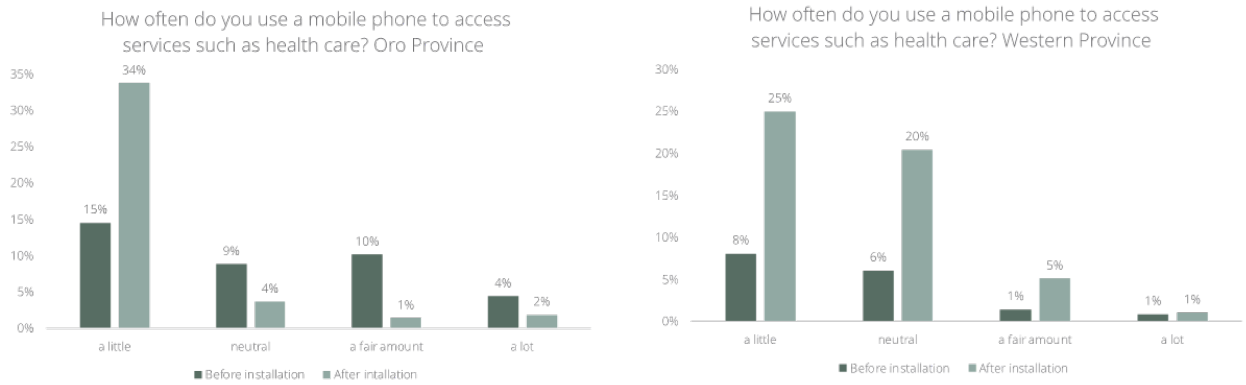


Fig 9. How often do you use a mobile phone to access services such as health care?

Data on households' sense of how informed they feel on services available to them showed that only a small proportion of people feel informed. In Oro Province before installation 37% felt informed to some degree about available services, and after installation only 20% felt informed. In Western Province 16% felt informed about available services before installation whereas after installation, 51% felt informed. Some of these results from Oro Province may represent lower than usual economic activity as a result of COVID-19-driven track closures and not necessarily due to the installation per se. In one-on-one interviews, which took place in March 2023, Oro households were upbeat about community connections driven by the installation. In interviews, respondents noted that lights had made the community more social at night-time. For example, a consequence of providing light to the church was that the community could meet at night time for community meetings, socialisation and prayer.

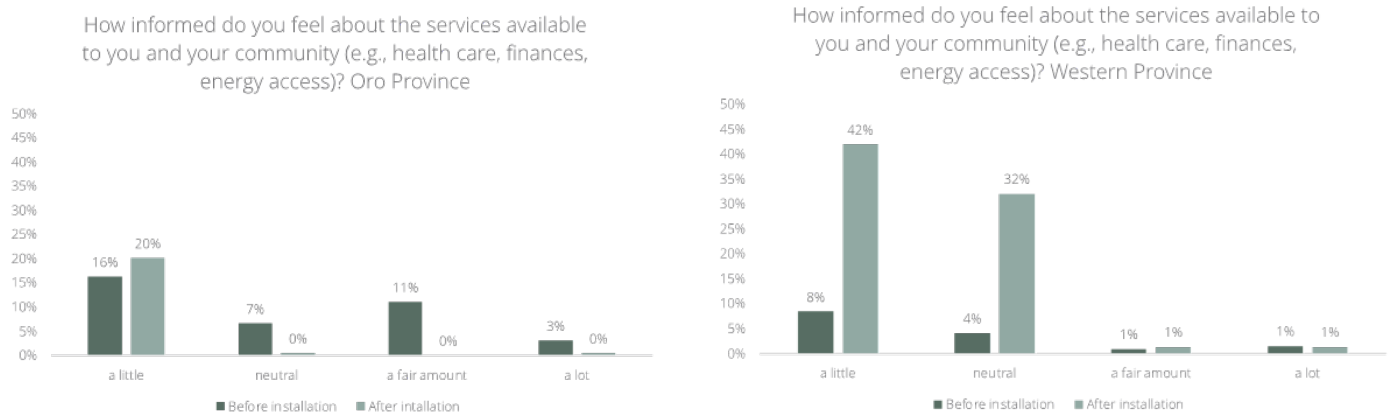


Fig 10. How informed do you feel about the services available to you and your community?

"WE NOW HAVE COMMUNITY MEETINGS AT NIGHT. PEOPLE USED TO ONLY STAY IN THEIR HOMES AFTER DARK. BUT NOW WE ALSO HAVE FELLOWSHIP 2-3 TIMES PER WEEK".
ORO PROVINCE, 30 YEAR OLD MALE

"THE LIGHTS MAKE PEOPLE'S LIVES MUCH EASIER. PEOPLE ARE MORE SOCIAL WITH THE LIGHTS. GOING AROUND TO OTHER PEOPLES' HOMES AND TELLING STORIES INTO THE NIGHT."
ORO PROVINCE, 30 YEAR OLD MALE

"WE HAD LIGHTS INSTALLED IN THE COMMUNITY FACILITIES (SHARED OPEN SPACE). WE NOW HOLD FELLOWSHIP AT NIGHT. WE DO THIS TWICE A WEEK. WE NEVER USED TO HAVE FELLOWSHIP AT NIGHT BEFORE THE LIGHTS BUT NOW WE HAVE MORE TIME TOGETHER IN THE NIGHT TO DO THESE THINGS."
ORO PROVINCE, 31 YEAR OLD MALE.

Outcome 6: How did the project improve opportunities for livelihoods and small businesses due to improved communications, access to information, training, and business related activities?

The project improved opportunities for small business largely due to increased light after dark though in Western Province possibly increased access to mobile phones also assisted small business whereas in Oro Province, interviewees highlighted use of night hours as important.

The project has improved opportunities for livelihoods and small business. In Oro Province, 64% of respondents agreed with the statement that they receive more income from business. They reported that they earned on average an extra 64.50 Kina per week or 65% of their income[9], as a result of the solar installation (increasing the average income from 34.50 Kina per week to 99 Kina per week). Of those surveyed, 63% agreed with the statement "I spend more time on small business" – as shown in Table 7.

In interviews, Oro Province households noted that markets were now held at night-time between 6-8pm which did not happen before the solar installation. They also noted that they were able to make items after dark. One interviewee said they now make string bags and baskets after dark with other women. Others noted that they do baking or sewing for the markets at night.

	Do you receive more income from small business? (Yes/No)	How much income did you receive from small business before installation?	How much income did you receive from small business after installation?	Increase in average income after installation
Oro Province households	Yes = 64%	34.7 Kina	99.2 Kina	64.5 Kina

Table 7. Income changes

	Do you spend more time on small business?	How much time did you spend on small business before installation?	How much time did you spend on small business after installation?	Increase in average time spent on small business after installation
Oro Province households	Yes = 63%	38 minutes	70 minutes	32 minutes

Table 8. Time changes

In Western Province, data on incomes was collected in only two of the 19 villages surveyed. In the two villages (Dogono and Wasaya) 78% agreed they received more income from small business with average weekly incomes increasing by more than 100% (from 23.50 Kina to 56.7 Kina). Data on time spent on small business was collected in just one village (Waseya) where residents reported spending 4 extra hours on small business after dark. Other common pursuits included study and cooking.

"My life changed. I can read at night and do business activities after dark at my village because the lights are so bright. KTF you are real life changers. Thank you so much".

"We make bilum bags and sew clothes. We sell things at table stalls. We make flags. We are able to sell things at night. That never used to happen but now multiple households sell things into the night and people are able to move around the village and buy things."

"I use the lights to wash dishes and prepare for the next day. We used to use torches. Now I also do baking for the markets. I bake bread or trade bettlenut at night for money. I also do other work ([in her capacity as a soccer coach] so I am able to prepare my notes."

"My life has change when I received my solar and it help me to work at night and save money for my family needs."

Outcome 7 To what extent did the project improve personal and community sense of safety and security particularly for women, children and persons living with disabilities?

The project improved personal and community sense of safety. (For discussion of the specific impacts on women and other groups refer forthcoming section on GEDSI.)

Households reported that they felt safter at night because of the project. Residents in Oro and Western Province, both male and female, felt significantly safer at night according to survey results.

In interviews, respondents said that the brightness of the light increased their sense of safety. As a result, there was more socialising and walking around at night-time. It also gave households more confidence in their safety. One respondent for example noted that he felt more confident to leave his family to travel to Kokoda College for his studies as a result of the lighting. Another respondent noted that the light kept crocodiles away.

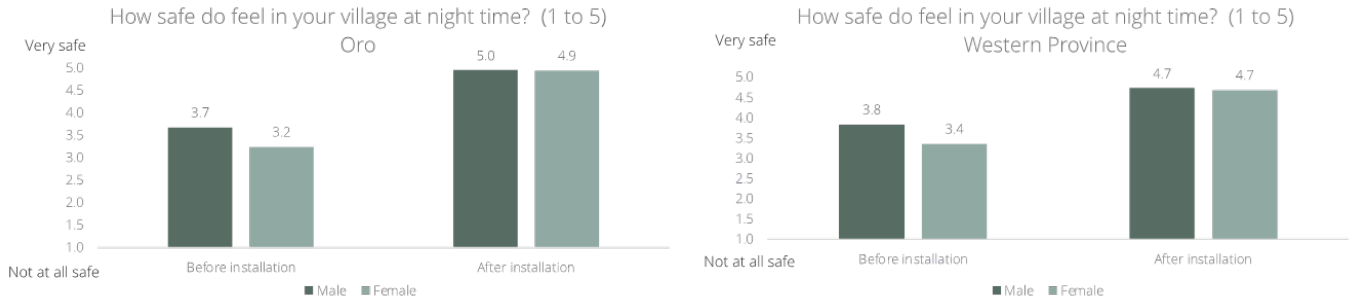
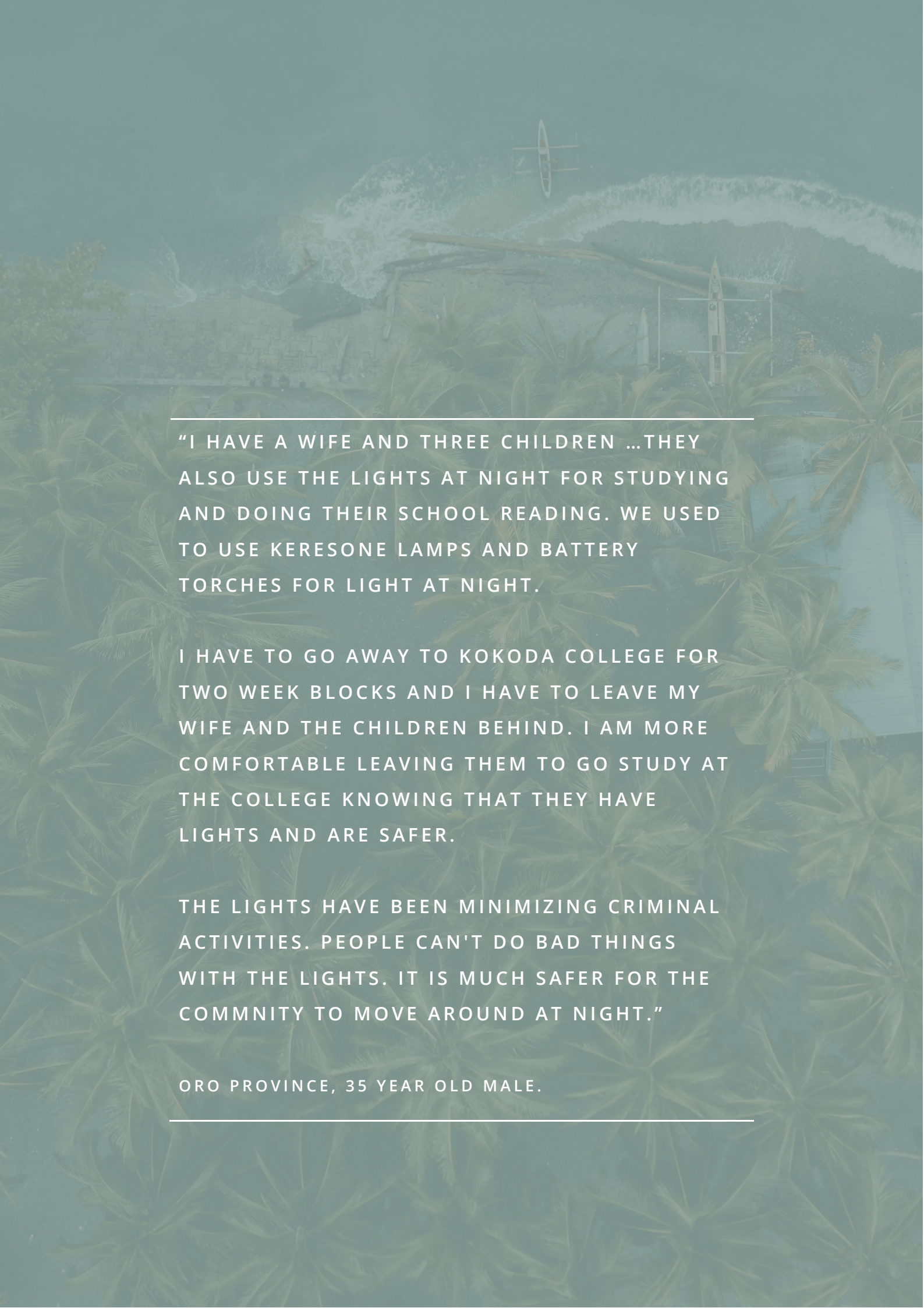


Fig 11. How safe do you feel in your village at night time? 1=Not at all and 5 = A lot.



"I HAVE A WIFE AND THREE CHILDREN …THEY ALSO USE THE LIGHTS AT NIGHT FOR STUDYING AND DOING THEIR SCHOOL READING. WE USED TO USE KERESONE LAMPS AND BATTERY TORCHES FOR LIGHT AT NIGHT.

I HAVE TO GO AWAY TO KOKODA COLLEGE FOR TWO WEEK BLOCKS AND I HAVE TO LEAVE MY WIFE AND THE CHILDREN BEHIND. I AM MORE COMFORTABLE LEAVING THEM TO GO STUDY AT THE COLLEGE KNOWING THAT THEY HAVE LIGHTS AND ARE SAFER.

THE LIGHTS HAVE BEEN MINIMIZING CRIMINAL ACTIVITIES. PEOPLE CAN'T DO BAD THINGS WITH THE LIGHTS. IT IS MUCH SAFER FOR THE COMMNITY TO MOVE AROUND AT NIGHT."

ORO PROVINCE, 35 YEAR OLD MALE.

“The community uses the lights for security. The village feels much safer. People walk around more at night and are able to do things like fetch water at night without fear.”

Oro Province, 25 year old male

“The lights help with many things….The lights also help keep the crocodiles away at night so we are able to move around at night and people are able to walk to the aid post without being scared of crocodiles. The lights have made our lives so much better. The women they are safer. And then children they are safer.”

Oro Province, CHW aid post worker, female age unknown

COHERENCE

How well does the intervention fit?

COHERENCE - SCORE 5/5

The project was found to be coherent across KTF's own projects and national government policies with little duplication or gaps.

KTF's Light for Learning project has leveraged the networks, logistics and experience of operating its FODE and other projects across PNG for many years. This has enabled KTF to secure project efficiencies and build effectiveness across the project. The project also supports its other projects such that they provide mutual benefits for households as well as KTF itself.

- KTF's Flexible Open Distance Education (FODE) colleges, located in Oro Province and Western Province, provide a second chance for adults at a high school education. The colleges focus on students from remote villages aiming to work in healthcare or education in a remote setting. The projects are designed for remote students by using a mix of short intensives at the college, and remote learning tasks done in a student's home village using a tablet provided by KTF. Light for Learning is essential in facilitating this tablet-based distance learning strategy. The networks forged by KTF's FODE Colleges enabled Light for Learning to communicate with villages and arrange solar installation. Many villages were already familiar with KTF and this reduced the need to introduce and orient the villages with KTF's ways of working. The FODE Colleges are also the current site of the solar hub where households can turn if they experience maintenance or repair issues. In this way, the two projects are mutually beneficial to households benefiting from the scheme as well as KTF as a means of increasing project efficiency and effectiveness.

- KTF also runs a project aimed at reducing gender-based violence called Project Zero. The project partners with government and other NGOs to provide a safe house and community education workshops in Oro province. The improved home lighting from Light for Learning contributes to increasing women's safety.

- Rural healthcare in PNG is reliant on community health workers. KTF's Healthy Communities Project supports the training, postings and salaries of these essential workers. By facilitating electrification of the health posts, Light for Learning improves the ability of the health posts to provide emergency services (such as midwife services) after dark contributing to PNG's rural healthcare needs.

The Light for Learning Project is consistent with the national government's priority for increased national electrification. The PNG Government's overarching National Energy Policy aims to achieve 70% electrification by 2030 through national grid extension, mini-grids and household solar, with the most remote parts of PNG to be serviced by mini-grids and household solar. However, without other nearby organisations mini-grids are generally not feasible in rural areas at the moment due to the very minimal load required by rural communities, access and local ability to pay. While the national government has engaged in sector reform, there is limited expectation that electrification would reach rural communities before 2030. The Light for Learning Project hence works to help the PNG national government achieve its aims and does not duplicate or replace national efforts.

While other donor projects have tried to achieve similar success in electrification of rural and remote areas, few have operated in similar areas to KTF thus there has been no duplication of overlap of efforts with other donors.

The World Bank and a collection of donor countries through the PNG Electrification Partnership have engaged in a range of ad hoc projects targeting electrification in rural areas. The most prominent such project was Lighting Global, a consumer awareness roadshow helping rural persons to access solar products including pay as you go finance. While alternative financing methods can assist communities, there is limited uptake of such products in rural areas due to financial limitations. Pawarim Komuniti – was a 2020 Off-Grid Electrification Project funded by the PNG-Australia Partnership to support access to clean energy in rural and remote communities in PNG focused mainly on mini-grid systems. The Electrification Partnership and bilateral agreements have also funded projects through NGOs including Kampim Pawa, a rural household and solar lighting project by Tenkile Conservation Alliance.

"Our government didnt supply service like this but we are thankful to KTF to supply us with light. This will help my children to study at night."

SUSTAINABILITY

To what extent will the benefits of the project continue after the donor funding ceases?

SUSTAINABILITY - SCORE 3/5

The project was found to be sustainable, but maintenance concerns have emerged in Western Province.

Project sustainability is demonstrated through relatively high equipment working status 12 months after installation as well as the existence of effective supports in place to promote maintenance, repair and the purchase of parts. In Oro, 98% of units were still working, however in Western Province just 83% of units were fully working after approximately 1 year.

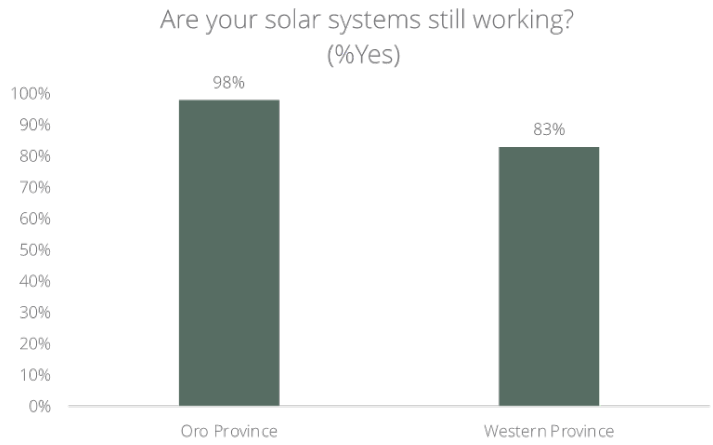


Fig 12. Are your solar systems still working? (%Yes))

The most commonly cited explanations for units not working in Western province were a switch or light bulb issue, as shown in Table 9.

If your system is not working what is wrong with it? (Western Province)	
Switch	5.9%
Light bulb	5.4%
Batteries	3.8%
Light cable	0.5%
USB	0.3%
Sun King inverter	0.3%
System working	83%

Table 9. If your system is not working what is wrong with it?

Of all Western Province households, 83% had functional solar systems approximately 12 months after installation. 9% had purchased new items and solar was now working, 4% had purchased new items and solar was still not working, 11% of households had not purchased new items and solar was not working. KTF has identified that these units aren't working and have notified the Balimo Solar Hub, which will send support staff to make any necessary repairs. It is possible that some of the systems are faulty. It is also possible that some of the units have been tampered with – highlighting the need for further training for communities and solar champions on appropriate use and maintenance of the systems.

Of the households in Western province where solar was not working, 97% indicated saving towards replacement batteries, an indicator of household motivation to repair and maintain their units.

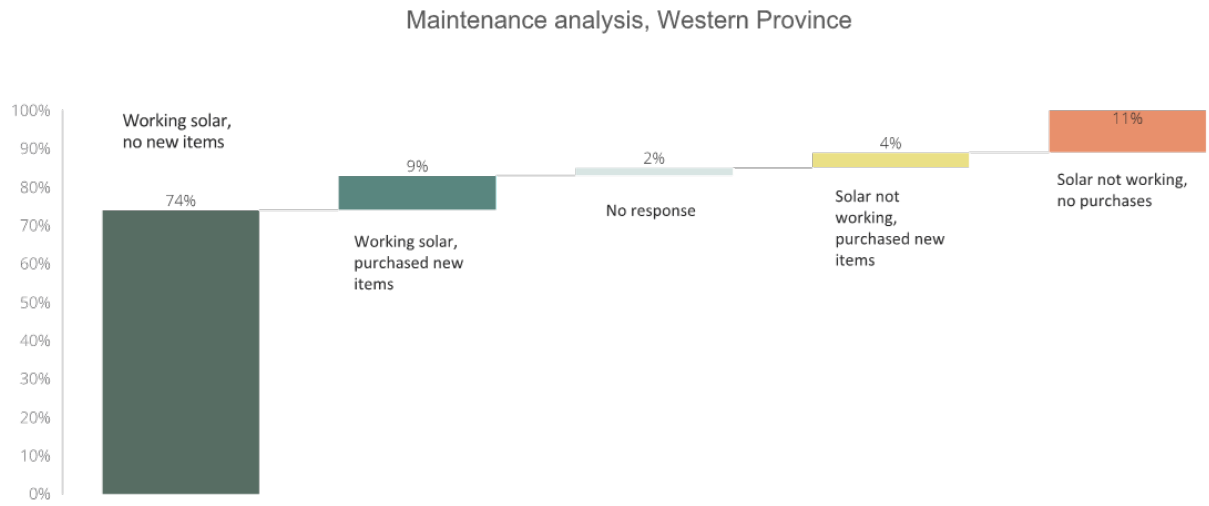


Fig 13. Maintenance analysis

There is a need to better understand the cause of the lower function of the units in Western province compared to Oro Province. It may be due to a combination of a more challenging logistics, installation challenges, lower understanding of how to maintain system and lower incomes and remote location making more difficult for households to save for and purchase basic items such as light bulbs and switches.

A key aspect of sustainability for the systems in both provinces is the ability to replace batteries. Batteries need to be replaced every 5 years. In Oro, 63% of households had saved for a replacement battery with

on average households saving 67 Kina toward the battery. In Western Province, 96% reported saving toward a battery with savings on average 41.78 Kina.

KTF estimates that batteries will be charged at a cost of 50 Kina to households, at a subsidised rate from an overall price currently being negotiated with suppliers. KTF's ongoing subsidisation helps support maintenance of the systems and ensures ongoing benefits to households which is positive. On the flipside, the requirement for ongoing subsidisation support reduces the sustainability of the project. Depending on the total cost of the batteries, KTF could consider different ways to support households fund the entire cost of batteries. One way KTF is already helping support household savings is through training in financial literacy by solar champions.

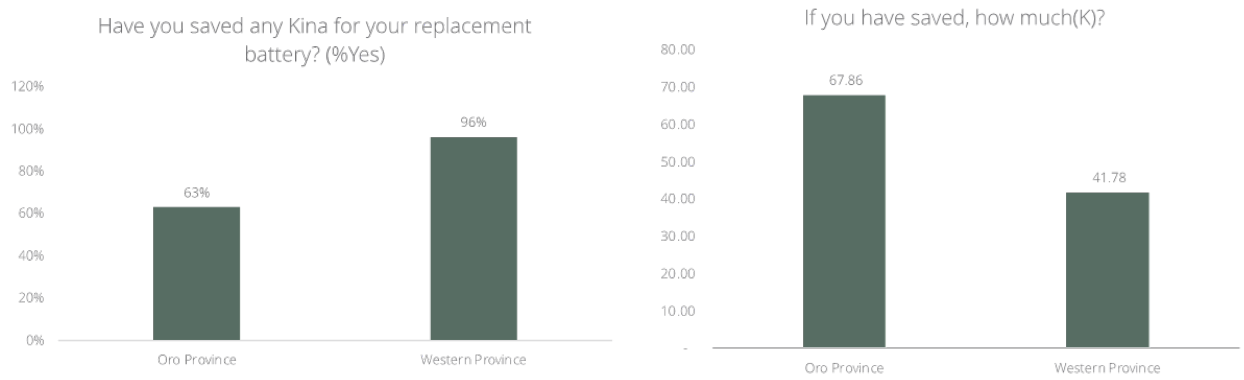


Fig 14. Have you saved any Kina for your replacement battery? If so, how much?

Solar champions have been recruited and trained in both provinces. The ability of the solar champions and solar hubs to help troubleshoot solar difficulties with households is a key aspect of project sustainability. The ongoing provision of light and energy is dependent on households being able to solve any technical issues. KTF is currently developing solar hubs, beginning with FODEs.

Particular regard should be paid to difficulties experienced in Western Province where households appear to be experiencing additional challenges. Drawing on its wide range of programs across the region, and significant ongoing presence in these communities (for example, via its SDP education and other programs) KTF is well placed to actively support solar hubs maintenance including over the long run.

The project is not sustainable from the perspective that the cost of the equipment and installation team costs are solely borne by KTF. Apart from training of solar champions, few other parties are trained in solar installation.

While thought could be given to pivoting the project to a "pay as you go" model. Little success has been achieved through this approach by other projects. Furthermore, in these remote areas, few households have capacity to fund their own system given comparatively low incomes.

GEDSI

Do the project's aims and activities align and promote GEDSI principles?

GEDSI - SCORE 4/5

The evaluation found the project supports GEDSI principles though further analysis of women impacts are required for a better understanding of these changes. .

Women are impacted by the project in a variety of ways that intersect with the outcomes discussed earlier.

- Energy access – increases access to energy and light to improve wellbeing
- Education- increases their ability to study themselves or support children's education
- Health - reduces health issues and that of their family
- Safety – increases feelings of safety and security
- Savings – increases savings due to reduced energy costs
- Livelihoods – provides opportunity to engage in small business activities at night, or communicate or use technology through charging
- Communication – to improve relationships across families, villages and connect to information

Women's responses to the survey were comparatively low with women only comprising 24% of respondents in Oro Province and 35% in Western Province. Furthermore, their responses reflect a mix of households where women are the head of household (e.g. widows or single parents) and households where the woman is not the head, but answered the survey. As a result, it is difficult to get an accurate sense of when a woman's response reflects her own view and situation or that of her households.

In Oro Province, on average women respondents lived in smaller households than men, they spent more time working in small business and reported higher small business incomes. They also spent more on kerosene and reported lower rates of saving potentially indicating different spending patterns or obligations. Women felt less safe at home and in their villages during the day and at night, and a greater improvement in sense of safety following the installation of solar. They were less likely to own or use a mobile phone and less likely to report feeling well informed. Differences were similar in Western Province except that here, women spent less than men on kerosene. The table below highlights differences between men and women at Oro and Western provinces prior to installation.

	Oro Province			Western Province		
	M	F	Difference	M	F	Difference
Household size (people)	6.22	5.33	0.89	7.08	7.23	0.15
Weekly Kina on Kerosene (Kina)	9.34	17.04	7.70	2.42	0.54	-1.88
Weekly small business income (Kina)	142.06	173.74	31.68	22.05	21.64	-0.41
Weekly small business time (minutes)	74.30	101.67	27.36	13.55	7.00	-6.55

Table 10. Women respondents' household size, income spending and time use

In terms of safety, women felt less safe than men at night-time in both provinces prior to installation. After installation, women felt significantly safer overall. While women still felt less safe than men, the marked increase in their sense of safety is significant.

	Oro Province			Western Province		
	M	F	Difference	M	F	Difference
How safe do you feel in your village at night (prior to installation) Scale of 1 to 5, 1 = Not at all and 5 = A lot	3.80	3.26	-0.53	3.83	3.36	-0.47
How safe do you feel in your village at night (after installation) Scale of 1 to 5, 1 = Not at all and 5 = A lot	4.95	4.94	-0.01	4.73	4.68	-0.05
Change Scale of 1 to 5, 1 = Not at all and 5 = A lot	1.28	1.70	0.42	0.90	1.33	0.43

Table 11. Women respondents' perspective on their feeling of safety

In interviews, women noted they had more time to either finish their domestic chores in the evening or alternatively had more time to earn an income through small business activities.

Further analysis of the impact on women would be useful and future surveys should specifically target women to garner their views and clarify the impact on women more specifically.

> **"I USE THE LIGHTS TO WASH DISHES AND PREPARE FOR THE NEXT DAY. WE USED TO USE TORCHES. NOW I ALSO DO BAKING FOR THE MARKETS. I BAKE BREAD OR TRADE BETTLENUT AT NIGHT FOR MONEY.I ALSO DO OTHER WORK [IN HER CAPACITY AS A SOCCER COACH] SO I AM ABLE TO PREPARE MY NOTES."**

Conclusions and recommendations

Overall the Light for Learning project is a highly effective and impactful project. KTF builds on its other projects and experience to roll out a project that is coherent, relevant and sustainable.

The most significant impacts of the project were highlighted in Western Province where access to energy and light was minimal prior to installation. As a result, Western Province saw significant increases in opportunities to study, and increased levels of mobile phone use and communication. While this finding suggests that KTF could consider focusing on solar installation to the most remote and high-needs villages, at the same time, there is a concern that these villages may be unable to maintain the equipment over the long term. Western Province showed some evidence of lower rates of functionality at 12 months due to maintenance issues. Lower incomes may also reduce the ability of Western Province households to fund battery purchases in 5 years.

Impacts in Oro Province were in some ways less pronounced and possibly impacts were compromised by reductions in tourism activity due to COVID-19. That said, interviews that took place in early 2023 certainly highlighted marked increases in activity at night including the establishment of night markets as well as time spent making items for sale - leading to increased small business opportunities.

Key recommendations for the project from the evaluation are:

- KTF should continue to monitor and support maintenance of solar equipment, particularly in Western Province to ensure ongoing workability of systems. The development of solar hubs will be an important next step for the project. Further education and training of solar champions and community members will also be necessary to ensure solar systems are utilised and maintained effectively.
- Close consideration of subsidisation of replacement parts and batteries is needed. Ongoing subsidies while supporting the longevity of the equipment also reduces household independence and diminishes sustainability of the project. Further consideration could be provided to consider other ways to support households to save for replacement parts and batteries. KTF has taken the first step by training solar champions in financial literacy to support households. Consideration could also be given to using FODE centres and FODE students to encourage savings and identify income earning opportunities or other financial schemes to encourage full ownership and responsibility for replacement parts. This would help to build household autonomy and reduce reliance on ongoing KTF support.
- Further rollout of the project should be guided by where KTF can leverage existing connections and relationships. Supporting Light for Learning in lock-step with the establishment of FODE centres is a critical ingredient of KTF's success.

Key recommendations for the survey and future surveys are:

- To get a better understanding of the impact on women, people with a disability and other groups it would be useful to specifically target these groups through the survey process. The proportion of women survey respondents in the current survey was low – 24% in Oro and 35% in Western Province. With respect to those women that answered the survey, it was also unclear whether their answers were based on their households' view of their own personal view. Any future evaluation would be strengthened by a more targeted approach to ensure the insights and voices of women and other groups are accurately reflected.

- The survey would also be strengthened by surveying the same households twice - rather than different villages and households each time. Ensuring the same question was asked across all households and provinces would also improve the accuracy and reliability of the survey data.

ANNEX 1 - EVALUATION RUBRIC

Score out of 5	1	2	3	4	5
Relevance	The project's aims and objectives are not relevant or important and not consistent with the aims of the project.	The project's aims and objectives are only slightly relevant and slightly consistent with the aims of the project.	The project's aims and objectives are relevant and consistent with the aims of the project.	The project's aims and objectives are truly relevant, important, and very consistent with the aims of the project.	The project's aims and objectives are highly relevant and incredibly important and completely consistent with the aims of the project.
Effectiveness	The project has not achieved its intended objectives.	The project has fallen short of achieving its intended objectives.	The project has gone a long way toward achieving its intended objectives.	The project has achieved its intended objectives.	The project has thoroughly achieved its intended objectives.
Efficiency	The activities are not cost-efficient, and they do not deliver on intended outputs in a timely manner	The activities are only slightly cost efficient and only slightly deliver on intended outputs in a timely manner.	The activities are reasonably cost-efficient, and they deliver on intended outputs in a mostly timely manner.	The activities are cost-efficient, and they deliver on intended outputs in a timely manner.	The activities are extremely cost-efficient, and they deliver on intended outputs in a timely manner.
Impact	The intervention generates broader negative impacts.	The intervention generates slightly negative impacts.	The intervention generates moderately positive impacts.	The intervention generates positive impacts.	The intervention generates extremely positive impacts on a broad and transformative scale.
Coherence	The intervention does not fit and is not consistent internally or externally.	The intervention only slightly fits and is only slightly consistent internally or externally.	The intervention mostly fits and is mostly consistent internally and externally.	The intervention fits and is consistent internally and externally.	The intervention fits and is extremely consistent internally and externally.
Sustainability	The project is not sustainable and funding sources are very limited.	The project is not very sustainable, and funding is difficult.	The project is sustainable, and funding is available, but donor funding is still the major source of total funding.	The project is - sustainable but relies on some donor support.	The project is entirely self-sustaining.
GEDSI	The project does not reflect GEDSI principles.	The project is not reflecting GEDSI principles very well though there is some attempt to do so.	The project reflects some GEDSI principles.	The project reflects GEDSI principles effectively.	The project promotes GEDSI through every element of its activities and impact.

Annex Table 1.

ANNEX 2 – METHODOLOGY INCLUDING LIMITATIONS

Survey

Survey data was drawn from a large survey undertaken by the installation team at 2 time-points:

1) Baseline – prior to installation
2) Follow-up - approx. 12 months after installation

In Oro the survey covered the same households (227 at baseline and 219 at follow -up) representing 10% of households and about 1364 household members. Oro surveys encompassed 37% households per village.

- Male 76%
- Female 24%
- Average age: 42.4

Adult male	Adult female	Child Male	Child female	Total children	Total household	Mean Household size
314	300	386	364	750	1364	6.0

Annex Table 2.1 Baseline Households Oro Province

In Western Province the survey covered 346 respondents at baseline, representing 2469 household members and 372 (different households) at follow up representing an estimated 2641 household members about 8% of solar systems installed. Villages were similar but baseline villages surveyed included Kenewa and Pikiwa while follow up included Kewa Village.

- Male: 65%
- Female: 35%
- Average age: 42.6

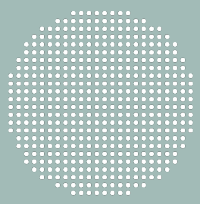
Adult male	Adult female	Child Male	Child female	Total children	Total household	Mean Household size
594	610	675	608	1272	2469	7.1

Annex Table 2.2 Baseline Households Western Province

Limitations:

While the survey size was impressive and mostly robust there were a few concerns noted by the evaluation team. In response, the evaluation team interpreted the missing data and extrapolated where necessary. In some cases, only Oro Province data was included due to challenges with Western Province data. The identified issues include some misinterpreted, missing or mis-matched questions.

Other external factors (social, political, or economic) may have an impact on survey responses. An important external factor to consider is the impact of COVID-19 travel restrictions which resulted in the closure of the Kokoda track to tourism and impact of lockdown restrictions. These would impact Oro residents more than residents in Western province. In particular, in Oro household estimated income *prior* to solar installation*, dropped* between baseline and follow-up. Furthermore, while there was an increase in overall mobile phones use after solar installation, in Oro households reported using their mobile phone *less frequently* for business than they did at baseline and reported that they felt *less well informed* which would be consistent with a community losing tourism income. As a result, this analysis considers only at household income estimates during the post-installation follow up, noting that these are household self-assessments of income.



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