Baseline Report

MCC Indonesia Green Prosperity Project

Grant Facility Community-Based Off-Grid Renewable Energy Grant Portfolio

February 2018

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CONTENTS

TABLES & FIGURES

TABLE OF TABLES

TABLE OF FIGURES

ACRONYMS

ADB	Asian Development Bank
AEI	Akuo Energy Indonesia
ARI	acute respiratory infection
BI	Bahasa Indonesia
BTS	Base Transceiver Station
BUMDes	*Badan Usaha Milik Desa*
CBA	cost-benefit analysis
CBNRM	community-based natural resource management
CBOG	community-based off-grid
CEM	coarsened exact matching
CEO	chief executive officer
CIA	conditional independence assumption
CIFOR	Center for International Forestry Research
CPI	Charta Putra Indonesia
DFS	detailed feasibility study
DiD	difference-in-differences
DRB	Disclosure Review Board
EDR	Evaluation Design Report
EPC	engineering, procurement, and construction
EQ	evaluation question
ERR	economic rate of return
ESMP	Environmental and Social Management Plan
EVI	Electric Vine Industries
FGD	focus group discussion
GEF	Global Environment Facility
GHG	greenhouse gas
GIS	geographic information system

GoI	Government of Indonesia
GP	green prosperity
GSK	Green Sumba Consortium
GW	gigawatt
ha	hectare
IBEKA	*Inisiatif Bisnis dan Ekonomi Kerakyatan*
ICC	intra-cluster correlation
IDR	Indonesian rupiah
IE	impact evaluation
IEA	International Energy Agency
IIEE	Indonesian Institute for Energy Economics
IRB	Institutional Review Board
ISEAS	Yusof Ishak Institute
KEN	*Kebijakan Energi Nasional* (National Energy Policy)
KII	key informant interview
KKI Warsi	*Komunitas Konservasi Indonesia WARSI*
kWp	kilowatt peak value
LED	light-emitting diode
M&E	monitoring and evaluation
MCA-I	Millennium Challenge Account – Indonesia
MDES	minimum detectable effect size
MHP	micro-hydropower
MKS	*Peseroan Terbatas Mikro Kisi Sumba*
MW	megawatt
NRE	new and renewable energy
NRM	natural resource management
O&M	operations and maintenance
OECD	Organization for Economic Cooperation and Development
PCA	principal component analysis

PE	performance evaluation
PKK	*Pembinaan Kesejahteraan Keluarga* (Women's Groups for Empowerment and Family Welfare)
PLN	*Perusahaan Listrik Negara*
PLTMH	micro-hydropower plants
PLTS	*penerangan lampu tenaga surya rumah tangga*
PLUP	Participatory Land Use Planning
PMAP 1	Participatory Mapping and Planning
PNPM	*Program Nasional Pemberdayaan Masyarakat* (National Program for Community Empowerment)
PSGIP	Project Social and Gender Integration Plan
PSM	propensity score matching
PT	Perseroan Terbatas (limited liability company)
PV	photovoltaic
RE	renewable energy
REDD	Reducing Emissions from Deforestation and Forest Degradation
RESCO	Renewable Energy Service Center
RT	sub-village administrative unit, also known as *kampung*
RUPTL	*Rencana Usaha Penyediaan Tenaga Listrik*
RW	community or neighborhood unit within a *desa*
SCADA	Supervisory Control and Data Acquisition
SD	standard deviation
SEHEN	*Super Ekstra Hemat Energi* (Super Extra Energy-Efficient)
SI	Social Impact
SHS	solar home system
SPV	Special Purpose Vehicle
TA	technical assistance
TAPP	Technical Assistance and Preparation Project
TV	television
UN	United Nations

UNEP	United Nations Environment Program
VBS	village boundary setting
WtP	Willingness to Pay
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

Overview of Compact and Interventions Evaluated

To combat environmental degradation and alleviate rural poverty, the Millennium Challenge Corporation (MCC) entered a five-year, $600 million compact with the Government of Indonesia (GoI) in April 2013, establishing the Millennium Challenge Account – Indonesia (MCA-I). The $332 million Green Prosperity (GP) Project, the flagship project of the Compact, is designed to promote environmentally sustainable, low-carbon economic growth. The GP Facility, one of four main activities of the project, finances grants to mobilize greater private-sector investment and community participation in renewable energy (RE) and sustainable land use practices.

The GP Facility funded a total of 26 grants with community-based, off-grid (CBOG) RE components using solar, hydro, or biomass technology together with some model of community ownership and management. Each of these has its own specific logic that serves as a connection between the outcomes of the projects within the CBOG RE grant portfolio and the intended impacts of the GP Project. Subject to technical, administrative, and budgetary constraints and following a process described in our Evaluation Design Report (EDR) and in Annex 9.3, SI selected two of these grants for pre-/post-evaluation.

The first grant is for the Off-Grid Power Plants for Three Villages in Berau Regency – East Kalimantan Project (referred to as W3A Akuo Energy Solar/Micro-Hydro, Berau), which targets three villages in Berau. Most or all households in each village will be connected to a new micro-grid powered by solar photovoltaic (PV) technology, with extra capacity from an upgraded micro-hydro facility in one village. Each of these grids will be owned and operated by village-level, community-managed Special Purpose Vehicles (SPVs) following grantee-led training and capacity-building exercises. The SPVs will set tariffs, collect revenue, conduct operation and maintenance (O&M), and reinvest profits into their respective villages.

The second grant is for the Solar PV Distributed System in East Sumba Project (W3A Anekatek Solar, East Sumba), which targets 909 households in the East Sumba regency for electrification via connection to 11 *kampung*-level solar PV micro-grid systems distributed across five villages. Compared to the grant in Berau, which will set up a decentralized SPV in each village in which it operates, the grant in East Sumba will establish one SPV to cover all 11 treatment areas. Each village will have a local organization feeding into the umbrella SPV. Once the SPV is generating revenue and funds have been set aside for a maintenance reserve, dividends remaining after O&M and contractor costs will be allocated for activities to benefit the local communities.

These new micro-grids combined with the SPV approach are meant to (i) increase awareness among communities of RE resources, (ii) increase access to RE electricity sources, (iii) build capacity to manage an SPV, and (iv) increase local economic opportunities through utilization of the newly available electricity. By substituting RE electricity for electricity previously generated from fuels such as diesel or kerosene, it is posited that households and enterprises in these communities will reduce expenditure on energy as well as greenhouse gas (GHG) emissions and

free up resources for other economically productive tasks, thus helping to achieve the grander GP objectives of reduced poverty and low-carbon economic growth.

Evaluation Type, Questions, Methodology

This portfolio evaluation is a mixed-methods evaluation, with quasi-experimental methods aimed toward rigorously establishing impact estimates on outcomes of interest as well as non-experimental methods more in line with a typical performance evaluation. The evaluation is guided by four primary evaluation questions (EQs):

1.) How have energy consumption patterns changed among beneficiary households and businesses in response to the provision of a renewable source of electricity?
    a. What are the implications of these changes for household expenditures?
2.) Has the electricity provided through the RE infrastructure been used for economic purposes at the community or household level?
    a. Has the productive uses/profit-generating component of the grant been effective, and has it helped the SPV be sustained?
3.) To what extent do any changes in energy consumption patterns favor reduced GHG emissions?
    a. Are there any other ways in which the grants contribute to the objective of reducing or avoiding GHG emissions?
4.) Has the Special Purpose Vehicle been an effective intervention to improve community buy-in and sustainability of the infrastructure?

While a pre/post methodology including quantitative and qualitative elements will be applied to both of the selected grants, only the methodology applied for W3A Anekatek Solar, East Sumba is quasi-experimental. In order to achieve rigorous impact estimates on outcomes of interest for the quantitative questions above (EQs 1–3), we have selected 17 “control” kampungs not targeted by the project to serve as a comparison to how the treatment kampungs may have fared in the absence of the intervention. Because the selection of treatment and control kampungs was non-random by necessity, we find that the groups are different on important baseline characteristics, and statistical matching techniques will be combined with a difference-in-differences (DiD) analysis approach to minimize observable and unobservable differences between the groups.

The same instruments and metrics used in East Sumba will be used in Berau without a control group, since the treatment villages are heterogeneous and there are too few to generate enough statistical power for an experimental approach. Although this will not allow for rigorous impact estimates, it will be useful in qualifying the success of the broader approach to contrast similar programming employed in a different geographic, socioeconomic, and cultural setting.

We propose to return to East Sumba and Berau twice to measure short- and long-term outcomes and sustainability—once 12 months after baseline and again 36 months after baseline. During these follow-ups, other grants and ex-post lines of inquiry may be added to the scope of the portfolio evaluation.

Descriptive Statistics and Assessment of Program Logic

EQ1: Energy Consumption and Expenditures

Typical energy sources utilized vary greatly between East Sumba, where small-scale solar technology appears most prevalent, and Berau, in which households rely more heavily on individual or shared generators (also called *gensets*) for power. Surveyed enterprises mirrored this consumption pattern, with enterprises in East Sumba much more likely to use solar technology for productive purposes. Energy expenditure also varies across the sites, with Berau averaging over twice as much per month as East Sumba, likely reflecting the much larger reliance on gensets rather than solar.

Table 1: Energy sources and consumption, by kabupaten

		Berau		East Sumba	
Variable	**Definition**	**Mean**	**SE**	**Mean**	**SE**
HH uses a solar energy source	% of HH	29.5%	(0.15)	84.0%	(0.04)
HH uses an individual genset	% of HH	34.3%	(0.23)	9.9%	(0.02)
HH uses shared genset	% of HH	61.2%	(0.19)	4.1%	(0.01)
HH has no source of electricity	% of HH	7.8%	(0.02)	7.3%	(0.02)
Diesel consumption	liters/month	14.0	(3.34)	4.8	(1.33)
Gasoline consumption	liters/month	30.1	(10.58)	11.7	(2.75)
Kerosene consumption	liters/month	0.8	(0.19)	2.2	(0.55)
Electricity access	hours/day	5.3	(0.66)	9.2	(0.54)
Expenditure on energy consumption	IDR/month	551,515	(64,553)	251,015	(29,413)
Energy expenditure vs. total expenditure	%	23.6%	(0.007)	14.6%	(0.014)

We ran linear regressions using hours of electricity access per day, lamp-hours of lighting per day from an electric source (the summed combination of the number of bulbs in the house times the number of hours that each bulb is lit), and liters of diesel, gasoline, and kerosene, respectively, as dependent variables to test which variables were associated with these outcomes at baseline. All else equal, household connection to a solar energy source is associated with an increase of between 3.11 and 6.21 hours per day of electricity access and an increase of between 12.40 and 15.08 lamp-hours per day of electric lighting, depending on the kabupaten.

Many metrics of wealth are positively and significantly associated with consumption of diesel, gasoline, and kerosene. A 1,000,000 Indonesian rupiah (IDR) increase in occupational income per month is associated with a two-liter-per-month increase in diesel consumption in Berau and a one-liter-per-month increase in gasoline consumption in East Sumba, all else held constant. Despite the difference in diesel consumption between Berau, where use of non-renewable energy sources is high, and Sumba, where renewable sources are more prevalent, possession of a solar energy source is not significantly associated with reductions in any fossil fuel consumption within either of the kabupatens after other factors have been controlled for.

At least one metric of electricity consumption is significantly associated with increases in energy expenditure in each kabupaten. In Berau, each additional hour of access to electricity per day corresponds to a 3,700 IDR/month increase in expenditure on energy repair, all else equal. Meanwhile, in East Sumba, each additional lamp-hour of electric lighting per day is associated with a 400 IDR/month increase in expenditure on energy source repair and a 2,000 IDR/month increase in the consumption of energy. These coefficients are consistent with findings from our

other regressions, in the sense that expenditure only increases with access in Berau, where non-renewable sources are more prevalent.

These findings lend support to the notion that access to a solar PV micro-grid is likely to increase the consumption of energy. Furthermore, access to energy from micro-grids may also be expected to reduce energy expenditures among most households. Expenditure on energy is lower in East Sumba, where the prevalence of renewable energy sources is higher, than in Berau. Even within kabupatens, households across all kampungs with individual gensets pay significantly more for energy consumption and repair of energy sources than their peers without such a connection. Although regression results do not link use of a solar energy source to reduced fuel consumption at baseline, seemingly at odds with the theory of change and GP objective of reducing fuel consumption; this could be related to the low capacity of solar energy sources currently in use. The capacity of the micro-grid for each household should increase energy available from a solar source by over 400 watts in Sumba and over 900 watts in Berau, which may be sufficient to encourage substitution.

An important caveat to the support that our findings lend to the project logic is that the baseline level of fossil fuel consumption in East Sumba is small due to the prevalence of solar energy sources. Hence, at least in East Sumba, the potential for impacts lies much more in increased consumer surplus through higher capacity and more reliable electricity than it does in expenditure savings by substitution of renewable energy in the place of energy from non-renewable sources.

EQ2: Productive Use

Enterprises in both kabupatens report optimism surrounding the potential for increased economic opportunities with access to electricity from the new micro-grids—around 80% of enterprises surveyed in each location indicate they plan to buy new equipment or machinery when the new electricity is available. Furthermore, 75% of enterprises surveyed indicated that connection to the new micro-grid would improve their productive capabilities.

However, quantitative and qualitative findings corroborate the notion that treatment areas in East Sumba, in particular, have highly localized economies—57% of all enterprises surveyed in East Sumba obtain 60% of their customers or more from either their immediate or neighboring sub-village. Only 38% of enterprises in Berau, on the other hand, source 60% or more of their customers from immediate or neighboring sub-villages.

Although income from transformed agricultural products is statistically equivalent in the two kabupatens, the average household's occupational income in Berau is over three times the amount reported in East Sumba. This is likely related to the diversity of occupations practiced by people in Berau compared to East Sumba, where only 6.9% of heads of household have an income-generating primary occupation that is not farming, fishing, or hunting for sale.

Table 2: Household-level EQ2 outcomes of interest, by kabupaten

Variable	Definition	Berau		East Sumba	
		Mean	SE	Mean	SE
Occupational income of household	Average IDR/month, all members	4,059,016	(1,290,692)	1,506,012	(282,972)

Variable	Definition	Berau		East Sumba	
		Mean	SE	Mean	SE
Income from transformed agricultural goods	Average IDR/month, all members	142,400	(46,961)	102,690	(31,521)
Head of household's primary occupation is non-farming/fishing/hunting	% of households	21.5%	(0.11)	6.90%	(0.02)

Most metrics of energy sources and consumption at baseline are not associated with increased income or productive time. Diesel consumption is actually positively associated with occupational income in Berau, where each additional liter consumed by the household per month is associated with an 18,900 IDR/month increase in occupational income. Again, however, the electrical capacity delivered by the project is far in excess of the capacity currently available to the households, which may make patterns observable at baseline an invalid comparison to what may be expected at endline.

Despite the evidence that enterprises intend to procure new equipment once connections are established, qualitative evidence—the composition of types of enterprises in each location, the customers they serve, and the improvements they seek as a result of electricity—points to principally local economies and in marginal improvements to production or quality of goods sold by each enterprise. Thus, the validity of the program logic is partially reliant on the magnitude of the change that is expected. MCC's economic rate of return (ERR) calculations set a reasonable expectation that these improvements will be marginal in Berau (adding less than 1% to the ERR) and negligible in East Sumba. Improvements of a larger magnitude are unlikely, unless grantee efforts to promote tourism in Berau succeed in tapping into the larger regional economy.

EQ3: Outlook for GHG Emissions

MCA-I contracted ICF International to calculate the reduction of GHG emissions resulting from the introduction of electricity from a solar source, and this evaluation will provide a verification of those calculations from the two grants evaluated. The reduction in GHG emissions attributable to the project would be determined by subtracting emissions following the project from emissions preceding the project.

Using the household averages from Table 1, and sharing ICF International's assumption that diesel, gasoline, and kerosene are the only relevant fuels for substitution by RE sources and hence reductions in emissions, the average baseline GHG emissions for a household in East Sumba is 0.0451 tons of carbon dioxide equivalent (CO_2e) per month. For Berau, the average overall figure is 0.1078 tons of CO_2e per household per month. Figuring in the total number of connected households plus additional diesel known to be contributed in kind by logging and palm oil firms to community generators in two of the villages in Berau, total baseline GHG emissions in East Sumba are 41.00 tons CO_2e/month, compared to 44.08 tons CO_2e/month in Berau.

The soundness of the assumption that utilization of the solar PV micro-grids will lead to decreased GHG emissions is dependent on the baseline level of diesel, gasoline, and kerosene use in treatment areas for purposes that might be replaced by the new micro-grid. Our baseline data suggests that this logic is particularly sound in Berau, where communities rely heavily on diesel

generators or direct combustion for lighting, pumping water, operating mills, and other purposes. In East Sumba, on the other hand, households in treatment areas have a low pre-existing level of GHG emissions. Although kerosene use is higher in East Sumba, only about 37.5% of the kerosene consumed by the average household is used for lighting, suggesting that the potential reduction of kerosene and corresponding GHG emissions is small.

This assumption is also partially reliant on the successful and reliable functioning of the new solar PV micro-grids. In all cases, the micro-grids will maintain backup diesel generators for times when they fail. Additionally, qualitative evidence from at least one KII with a community member in Berau suggests that community members with individual gensets plan to maintain these in the event of outages and to operate outdoor machinery, such as fuel-based mills. Hence, early O&M difficulties with the micro-grids or energy demands in excess of their capacity may reduce the amount that is ultimately foregone in favor of RE.

EQ4: The SPV Approach

Each of the grantees has successfully undergone lengthy administrative and legal preparation to establish local SPVs as legal entities with “business area” and “power generation” permits that are fundamental prerequisites for legitimate construction, power generation, and business operations. Community members in villages visited by the qualitative data collection team demonstrated a general awareness of the respective projects, although there was less certainty surrounding the structure and functioning of the SPVs. Recruitment for SPV members in Berau had just started during data collection, while SPV formation was more advanced in East Sumba due to pre-existing governance structures there. Even without a full awareness of how the SPV will function, community members expressed optimism and support for the project based on the progress achieved to date and the high volume of grantee interactions with villagers and village heads, both significant departures from previous local experience with similar projects.

There is a strong culture and history of collectivism and village governance structures in both East Sumba and Berau. Traditional systems of problem solving, such as *“musyawarah”* consensus-building processes, frequently resolve conflicts before escalation to external government authority is required. While these attributes will be important to the success of future SPVs, technical human capacities will also be critical. To this end, SPV applicants in Berau seemed relatively young and inexperienced to interviewers, although they frequently had completed a specific training or degree in a subject such as accounting. The existing group members in East Sumba appeared older, more educated, and more experienced in working in a committee setting. Nevertheless, local officials and SPV candidates and members in all treatment areas expressed concern that training and activities from the grant may not be enough to transfer the capacity needed to manage the micro-grids.

The success of the SPVs in generating consistent revenue will be partially dependent on willingness and ability to pay in the local communities. Demand for electricity and awareness that an adequate price must be paid for it appears high in both communities, although households in Berau have a much higher ability to pay. Pre-payment systems will be employed in both locations and facilitate the timely collection of revenue and enforcement of tariffs.

Interviewees in treatment areas and in MCA-I expressed concern that grantee engagement may fall off after their contractual obligation of two years, when their direct financial incentive for engagement will be limited. Neither grantee appears poised to generate significant revenue from their portion of SPV ownership. Furthermore, grantees express that their own capacity to respond to problems may be limited following Compact closure unless they can secure additional funding.

The high level of community and grantee engagement at baseline is promising for the SPV approach's capacity to sustain results from the micro-grid. In the short term, the presence of the grantees for at least two years following commissioning is likely to support the achievement of outcomes of interest. However, the sustainability of the grids will depend on the grantees' ability to transfer all the necessary technical capacity to the SPVs over this timeframe or otherwise remain incentivized to stay engaged with the SPVs until this transfer can be achieved. To this end, preliminary indications are that grantees may stay engaged for five years or more. Otherwise, the sustainability of the micro-grids may depend on the potential for these to be integrated into nationwide energy policy designs and the national PLN (local utility) operational framework.

Assessment of the Experimental Design

Compared to secondary data utilized in preliminary power calculations for our study, we find significantly higher means for energy expenditures and electricity access per day in our own data, though we find much lower variation in overall kerosene usage. We also find relatively consistent intra-cluster correlations (ICCs), with clustering at the kampung level. Based on these values, overall power calculations are still in line with estimates from our EDR and as a whole do not represent a significant, new threat to validity.

Table 3: Updated power calculations

Outcome	Mean	Std. Dev.	ICC	MDES (SD)	MDES (Outcome Units)
Monthly electricity expenditure (IDR)	204,007	266,750	0.08	0.39	104,033
Monthly kerosene use (liters)	1.57	3.98	0.04	0.32	1.27
Monthly kerosene use for lighting (liters)	0.75	2.06	0.01	0.26	0.54
Electricity access per day (hours)	8.76	4.35	0.11	0.43	1.87

To assess the similarity of the treatment and comparison group, we test for difference of means in 34 baseline variables. We find that on demographic variables including sex of household head and years of education, the treatment and comparison groups are very similar. However, on variables related to assets and finances, we find significant differences, including in transportation assets, access to financial services, income, and expenditures. In all cases, treatment households are significantly wealthier. We also find significant differences in time use, with comparison adult males and females spending significantly more time on income-generating activities, including farming, and treatment adults spending more time watching TV.

We also find significant differences at the community level. Treatment communities are significantly larger, closer to the main road, more likely to have an elementary and junior high school, have better phone signals, and have more shops and more social infrastructure connected to electricity. However, we find no significant differences among energy access variables tested, including lack of an energy source, use of solar, hours of access per day, and total lighting fixtures.

We do find a nearly significant difference in total kerosene use, though we find no difference in amount of kerosene used for lighting.

Although the relative similarity between the treatment and comparison groups on key outcomes in East Sumba is encouraging, the high number of significant differences between the groups on financial and community characteristics raises questions about the validity of the comparison group. That is, despite similar baseline levels on most key outcome variables, we might expect the treatment and comparison samples to differ in trends in these outcome variables over time, even in the absence of an electrification program, due to the large differences in access to household and community resources observed at baseline.

We use statistical matching techniques, including coarsened exact matching (CEM) and propensity score matching (PSM) in a tentative analysis to demonstrate how these differences may best be accounted for. Since some potential comparison communities may be lost to contamination from PLN electrification efforts, this analysis should be completed again before each future data collection event on the full sample of available comparison communities to maximize the comparison sample (and, thus, statistical power of the study).

Table 4: Matching results: CEM and PSM

Model	Matched Sample	Significant Differences on 34 Variables Tested	Average *p*-Value on 34 Variables Tested
Unmatched	841	23	0.15
CEM			
3 bins	443	16	0.28
4 bins	509	18	0.23
5 bins	391	13	0.33
PSM	660	17	0.24

In Table 4, we show that the preferred PSM model achieves similar balance compared to the preferred CEM model but retains a larger sample, including households from 14 comparison communities, thereby retaining more power. Additionally, retaining a larger sample improves the generalizability of the results to the full treatment sample, also raising external validity. Based on these results, we provisionally recommend the PSM approach.

In summary, although we do find significant differences between the treatment and comparison groups, even after matching, the differences are diminished, and the groups are similar along the key outcome variables. The differences in household and community assets represent a threat to validity, but this threat can be at least partially addressed through analysis, by looking at differences in differences among a matched group, as well as looking at trends across groups with different resource levels.

1. INTRODUCTION AND BACKGROUND

1.1 Country Context

Indonesia, which has the largest economy in Southeast Asia, has experienced steady growth averaging between 5 and 6% since the Asian financial crisis of 1997–1999.[1] Nonetheless, as an archipelago nation stretching over 5,000 kilometers across Oceania, Indonesia is vulnerable to the increased occurrence of extreme weather events, flooding due to sea-level rise, and water-borne illnesses that are likely to accompany the climate change that is already being observed across the country.[2] For this reason, it is a stated objective of the Government of Indonesia (GoI) to achieve a reduction of greenhouse gas (GHG) emissions "in a way that is consistent with pro-growth, pro-poor, and pro-job development objectives."[3] As one way of achieving these parallel objectives, Indonesia's National Energy Policy (Kebijakan Energi Nasional, or KEN) set a target of increasing the country's use of new and renewable energy (NRE) from 4% of all energy use in 2011 to 23% by 2025 and 31% by 2050.[4] Indeed, the Asian Development Bank (ADB) indicates that renewable sources of electricity offer many "positive cobenefits" in addition to reduced GHG emissions, including rural revitalization, jobs and employment, economic development, and avoided environmental costs of fuel extraction and transport.[5]

In 2014, only 3.0% of the population in Indonesia did not have access to electricity according to the World Bank's World Development Indicators.[6] However, the vast majority of the unelectrified population resided in remote islands or rural villages where the feasibility and cost of electrification through traditional means is prohibitive. Indeed, in rural East Nusa Tenggara, for example, electrification rates were only at 54.4% in 2015.[7] As a result, households in these villages traditionally resort to 'costly and polluting' diesel-fired power generation for intermittent electricity throughout the day. For some of these communities, off-grid, renewable resources (such as solar, biomass, or micro-hydro systems) represent a more feasible path to electrification than traditional, fossil fuel–based power grids.

To support these initiatives, the Millennium Challenge Corporation (MCC) funded community-based, off-grid (CBOG) renewable energy (RE) projects under the Grant Facility of the Millennium Challenge Account – Indonesia (MCA-I) Green Prosperity (GP) Project, designed to increase access to electricity in these types of communities through renewable means. MCC has contracted Social Impact (SI) to conduct an evaluation of the portfolio of CBOG RE grants, primarily oriented towards assessing their ability to achieve outcomes of interest and the effectiveness of their approaches to ensuring the sustainability of their interventions.

[1] https://www.adb.org/sites/default/files/publication/178039/ino-paper-09-2015.pdf, p. 6.
[2] https://www.adb.org/sites/default/files/publication/215986/adbi-wp622.pdf, p. 2.
[3] https://www.illegal-logging.info/sites/files/chlogging/uploads/IndonesiasiaranpdfGreenPaperFinal.pdf, p. 20.
[4] http://prokum.esdm.go.id/pp/2014/PPpercent20Nomorpercent2079percent202014.pdf, p. 8.
[5] https://www.adb.org/sites/default/files/publication/217001/ewp-502.pdf, pp. 7-8.
[6] http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators
[7] 2015 Intercensal Population Survey (SUPAS), BPS

1.2 Objectives of This Report

This report will begin by providing an overview of MCC's Compact with Indonesia, the GP Project, and the interventions evaluated. Although this evaluation targets the overall portfolio of CBOG RE grants of the GP Project's Grant Facility, this baseline report will focus on two specific grants selected for pre/post evaluation: The Off-Grid Power Plants for Three Villages in Berau Regency – East Kalimantan Project (W3A Akuo Energy Solar/Micro-Hydro, Berau) and the Solar Photovoltaic (PV) Distributed System in East Sumba Project (W3A Anekatek Solar, East Sumba).[8] After a literature review summarizing existing evidence relevant to the CBOG RE portfolio's overall goals and logic, we review the quantitative and qualitative evaluation design.

With the previous sections as context, the report will proceed with its primary objectives. The first of these is to present quantitative and qualitative findings, separated by our four evaluation questions, that are meant to describe baseline conditions in treatment areas of these grants to which endline conditions will be compared. We will assess any implications that these conditions have for the project logic underlying the grants. The second of the report's primary objectives is to re-assess our experimental design in the context of our baseline findings and describe how our evaluation may proceed with this assessment in mind. The final section of the report will provide an overview of the administrative elements of the evaluation, including an updated schedule and dissemination plan.

[8] Annex 9.3 explains in further detail why these two grants were selected in lieu of others from the portfolio.

2. OVERVIEW OF COMPACT AND INTERVENTIONS EVALUATED

2.1 Program Logic (Input, Output, Short-Term Outcomes, Medium-/ Long-Term Outcomes, Ultimate Impact)

The CBOG RE grant portfolio aims through various strategies to contribute to the GP project's overarching goal of promoting environmentally sustainable, low-carbon economic growth in Indonesia. The following sections provide background on the logic underlying the Compact, the GP project, the portfolio, and the two specific interventions discussed in this Baseline Report.

2.1.1 Compact Level

To combat environmental degradation and alleviate rural poverty, the Millennium Challenge Corporation (MCC) entered a five-year, $600 million compact with the Government of Indonesia (GoI) in April 2013, establishing MCA-I, which aims to reduce poverty through economic growth. The GP project, the flagship project of the Indonesia MCC Compact with a budget of $332 million, is designed to support the GoI's commitment to a more sustainable, less carbon-intensive future by promoting environmentally sustainable, low-carbon economic growth. The main objective of the project is to work with local communities to create economic opportunities that alleviate poverty and improve management of Indonesia's natural capital. The project will provide a combination of technical assistance and grants to help communities improve land management practices and design and implement economic activities that enhance livelihoods and protect critical ecosystem services that people rely on for income and well-being. It is anticipated that activities under the GP project will complement the GoI's efforts to reduce emissions from deforestation and environmental degradation. More broadly, the project is also expected to help foster greater, greener, and smarter outside investment in Indonesia by improving the basis by which land use decisions are made and by creating incentives for increased deployment of cleaner technologies.

The Green Prosperity project as a whole is comprised of four discrete activities, detailed below:

1. The **Participatory Land Use Planning (PLUP)** activity is meant 1) to ensure that projects funded by the GP Finance Facility are designed based on accurate and appropriate spatial and land use data and adhere to and reinforce existing national laws, regulations, and plans; and 2) to strengthen the capacity of local communities and district-level institutions to manage their own land and resources. This is accomplished through participatory village boundary setting (VBS), updating and integrating land and other natural resource use plans, and enhancing district and provincial spatial plans. The first PLUP contract, called Participatory Mapping and Planning 1 (PMAP 1), was awarded to Abt Associates to implement PLUP Tasks 1 through 4 in the four starter districts. Seven additional PMAPs with varying levels of implementation of the four PMAP 1 tasks were also originally planned, although one of these—PMAP 5—has since been canceled. As of August 2017

PMAPs 1–4 are complete and PMAPs 6–8 are under way. Overall, PMAP contracts will include implementation in up to 45 districts throughout Indonesia.

2. The **GP Facility** provides grant financing to mobilize greater private-sector investment and community participation in RE and sustainable land use practices. The GP Facility investments are intended to enhance sustainable economic growth and social conditions while also reducing Indonesia's carbon footprint. The GP Facility targets investments in commercial and community-based renewable energy projects less than 10 megawatts (MW) in size, sustainable natural resource management, and community-based projects to promote improved forest and land use practices. These investments will support a number of objectives that promote productive use of energy and protect renewable resources from which energy can be derived. Grants will be funded through three schemes, or "funding windows": Partnership Grants (Window 1), Community-Based Natural Resource Management Grants (Window 2), and RE Grants (Window 3).
3. The **Technical Assistance and Oversight** activity is designed to provide assistance and oversight for eligible districts, project sponsors, and community groups to identify and develop potential investments in sustainable low-carbon economic growth. This activity will also institute a comprehensive set of procedures to track and evaluate the progress of the projects it funds and the effectiveness of the GP Project activities implemented to facilitate the success of those projects. Technical Assistance will include performing or reviewing detailed feasibility studies (DFSs) and engineering designs, as well as requirements on environmental, social, and economic benefit, and monitoring and evaluation to meet GoI permitting and international performance standards.
4. The **Green Knowledge** activity supports and enhances the results of GP projects by facilitating the collection, application, and dissemination of knowledge relevant to low-carbon development within and beyond GP districts. The activity will provide capacity building for local and provincial stakeholders, develop and improve centers of excellence in science and technology related to low carbon, and create broad networks for information exchange, knowledge generation, and sharing.

The **outputs** of the GP Project could be considered as the financed projects from each of these four discrete **activities**. The combined **outcomes** of the projects financed through each of these activities are meant to lead to the intended downstream **impacts** of the GP project, namely: the creation of economic opportunities that alleviate poverty and improve management of Indonesia's natural capital.

2.1.2 Portfolio Level

The GP Project's CBOG RE Grant Portfolio is funded entirely through the GP Facility. At the outset of the GP Facility, grants were meant to be issued through three separate funding windows, each with different mechanisms for selecting grantees. At the time of this report, MCC prefers to consider aggregations of GP Facility grants by thematic area (e.g., CBOG RE, palm oil, cocoa, etc.) rather than by the funding window through which they were granted. We will introduce the CBOG RE portfolio in the context of how each grant was funded before proceeding to characterize each grant by the method through which it aims to promote the usage of CBOG RE in Indonesia.

Window 1 of the GP Facility aimed to co-fund grants leveraging private resources to accomplish an array of larger GP objectives including "improving land governance, resource management, and renewable development to improve people's access to clean energy."[9] Ultimately, two grants co-financed through this window included renewable energy components, although only one (implemented by a Hivos-led consortium) maintained this component.

Window 2 of the Facility sought to issue grants for small-scale, community-based natural resource management (CBNRM) projects that "promote community-based initiatives in forestry, agriculture, and off-grid renewable energy, enhanced management of watersheds and forests to improve the sustainability of renewable energy and/or agriculture investments, and support rural livelihoods and economic development."[10] Although it is uncommon that these grants focus entirely on CBOG RE components, many (18 of 49) include some kind of CBOG RE component in their programming.

Finally, Window 3 of the GP Facility funded grants focusing almost entirely on the promotion of RE. These grants were divided into two funding schemes: Community-Based RE Grants (Window 3A, or W3A) and Commercial-Scale RE Grants (Window 3B). The former funding scheme provides grants for "project preparation, construction, initial operations and maintenance (O&M), and training for suitable small RE projects that will benefit local communities. These grants will help communities receive reliable and adequate supplies of electricity and benefit from revenue streams derived from energy production."[11] The projects financed by these grants are defined by new or expanded electricity generation from a community-based facility utilizing off-grid micro-hydro, solar, biomass, and/or wind energy systems.

In all, 26 grants were funded through a combination of these three windows that included CBOG RE components using solar, hydro, or biomass technology. Each of these has its own specific logic that serves as a connection between the outcomes of the projects within the CBOG RE grant portfolio and the intended impacts of the GP project. Subject to technical, administrative, and budgetary constraints and following a process described in our Evaluation Design Report (EDR), SI selected two of these grants for pre/post evaluation (see Annex 9.3 for more detail on the selection process). The logic of these specific grants is outlined in greater detail in the section below, since it will be the most relevant for our baseline results.

2.1.3 Project Level

Both of the projects selected for baseline data collection originate from Window 3A of the GP Facility, all the grants of which operate on a nearly identical theory of change: if communities with low access to electrification in remote areas of Indonesia are provided with renewable-energy based micro-grids and capacity building in the proper operation and management of these micro-grids, then (i) the communities will have an increased awareness of RE and sustainable natural resource management, (ii) households in these communities will have reliable and sustainable access to electricity, and (iii) community cooperatives will have the capacity to operate and manage the micro-grids. Supposing these outcomes are realized and the communities derive

[9] http://www.mca-indonesia.go.id/en/project/green-prosperity/grant/green-prosperity-partnership-grant
[10] http://www.mca-indonesia.go.id/en/project/green-prosperity/grant/community-based-nrm-cbnrm-grants
[11] http://www.mca-indonesia.go.id/en/project/green-prosperity/green-prosperity-facility

sustainable benefits as Special Purpose Vehicles (SPVs) continue to provide adequate O&M services, household income will increase and GHG emissions will decrease due to the improved access to and utilization of electricity generated from RE sources. In addition to the three outcomes mentioned above, most of the Window 3A grants additionally posit that increased economic opportunities will result from productive uses of the increased supply of electricity. By way of example, the log frame for W3A Anekatek Solar, East Sumba (Figure 1) depicts the logical progression of this theory of change from the status quo through to final impacts.[12]

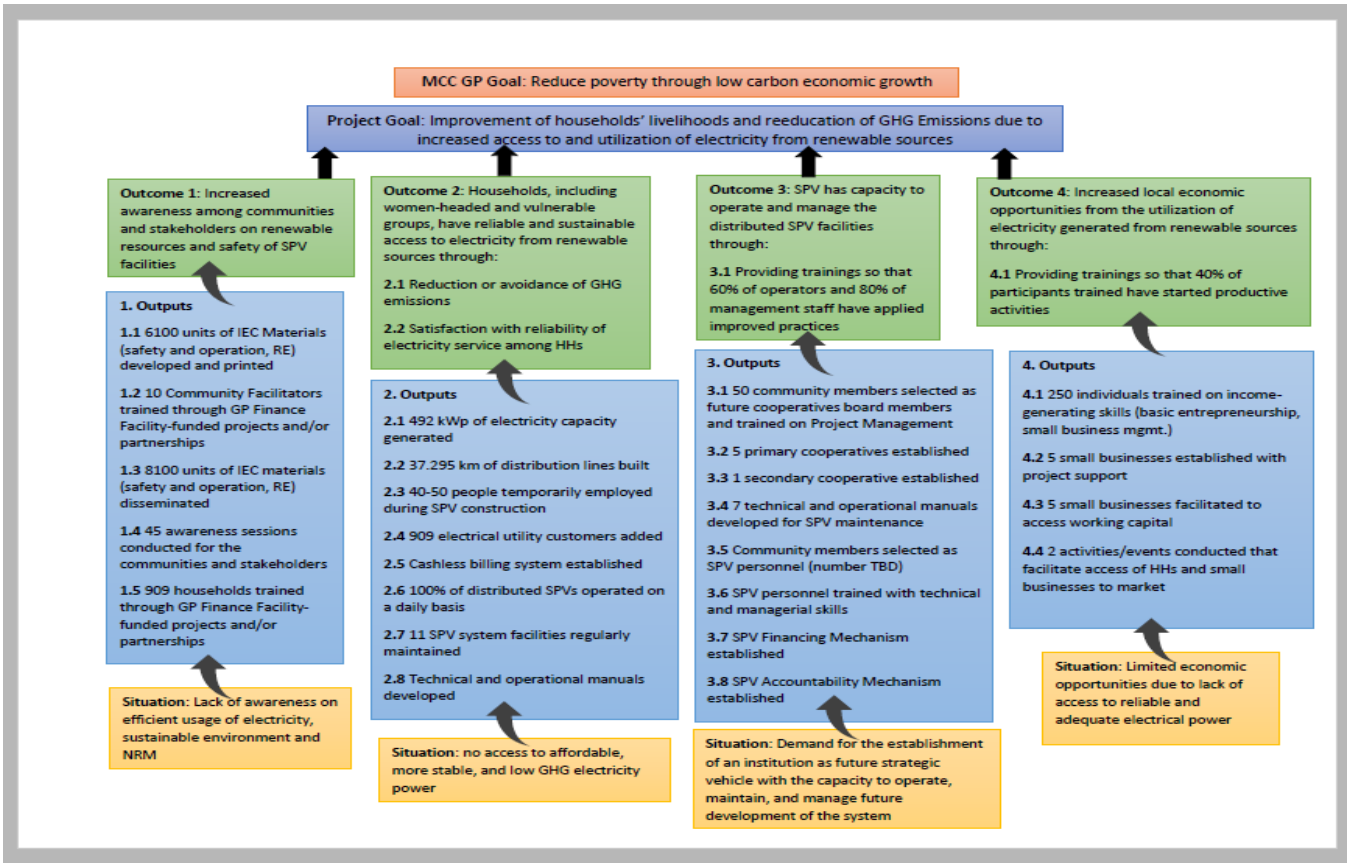


Figure 1: Log frame for W3A Anekatek Solar, East Sumba

Although the DFS or M&E (Monitoring and Evaluation) Plans for the Window 3A grants typically include some characterization of the theory of change above, they rarely include the underlying assumptions or detailed intermediate steps required for the ultimate goals to be realized. We provide a bit more detail from the literature here to highlight key measurement areas for the evaluation.

In theory, electrification is expected to positively affect households and service provision (see Lenz et al., 2017). First, it improves incomes via a decrease in energy expenditures, an extension

[12] Our presentation of program logic in this section is representative of the benefit streams outlined in project M&E plans. There are frequently additional outcomes associated with increased electricity access, including improved gender equality through changes in time use due to time-saving appliances and improved security due to lighting. Our evaluation will aim to capture such outcomes of similar programming, even if they are not included in project M&E documents.

of working hours, the use of productive motive power, and eventually better income opportunities and new and more efficient businesses. Women benefit in particular if electric appliances facilitate female labor-intensive domestic work. Second, electrification yields better education via extended study hours, improved access to knowledge and information, and improved school services. Third, it leads to improved health from a decrease in polluting lighting sources (kerosene) and improved health services by electrified health facilities. Fourth, it yields positive effects on security, community participation, and attitudes via improved connectivity and media access (see Lenz et al., 2017). This in theory affects women via changes in gender roles, family planning, and domestic violence habits.

These theorized impacts are contingent upon a handful of key assumptions:

1. Households are open to using the new technology. While this is generally not a problematic assumption, it could be violated if there is mistrust between the community and the implementer or a lack of optimism in the community that the new technology will be sustainable.
2. Beneficiary communities will have adequate access to regional and national markets to allow village enterprises to count on more than local demand. Without this, there may be little incentive to expand or create new businesses. This assumption is likely to be tested more often in agricultural communities that cannot count on the same export base as enterprises in communities that rely on fishing or ecotourism.
3. For education outcomes to materialize, schools must be up and running and students must have access to study materials in order to allow households to use electricity in a beneficial way with regards to education.
4. Finally, this theory of change assumes that all program components are fit for purpose. The physical infrastructure and training of community members must be suitable for achieving the purposes set out above. If they are not, the construction of solar arrays may not result in a sustainable source of usable electricity that meets the energy demands for uses that contribute to the above stated goals. For example, if energy supply in practice is only sufficient to power small household appliances or lights, then new economic opportunities may not be available. Similarly, without sufficient training and resources, communities might not have the capacity to conduct adequate O&M procedures to ensure the sustainability of physical outputs.

In this report, we will highlight any baseline findings that jeopardize either the veracity of the logic outlined in Figure 1 or of the assumptions underlying that logic that we have enumerated.

2.1.4 Program Participants and Geographic Coverage

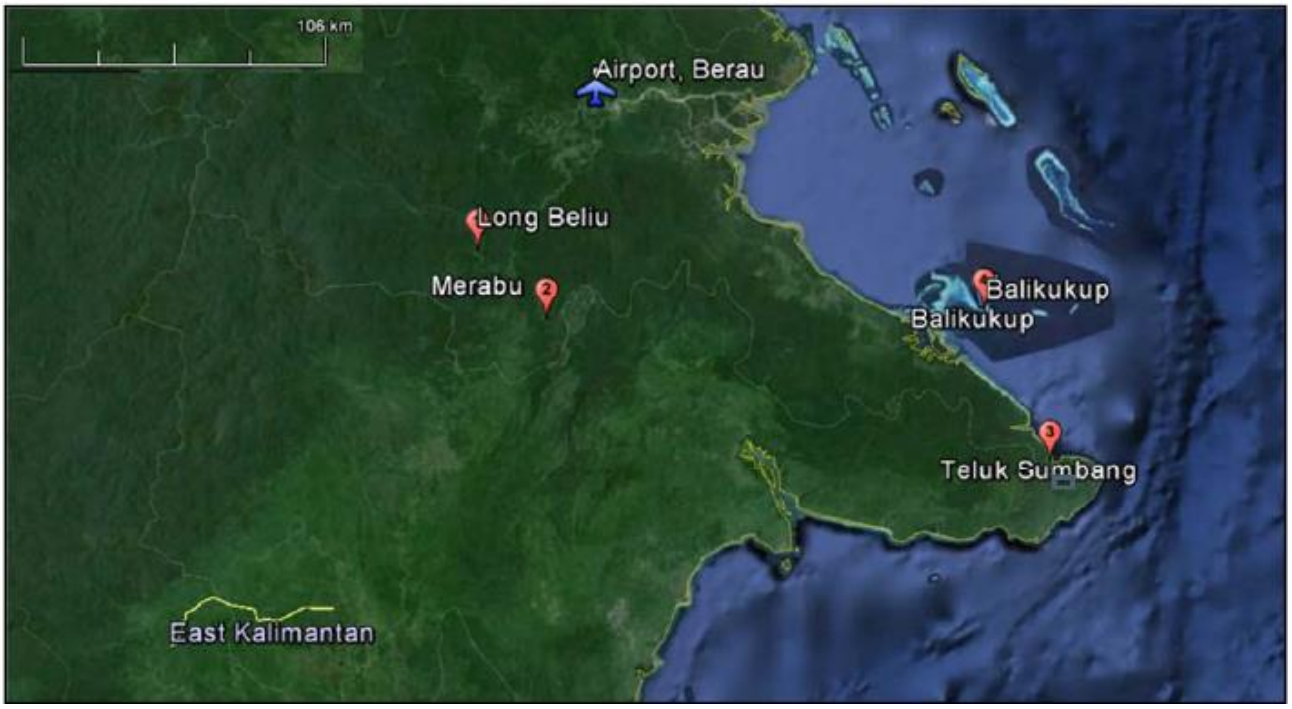
2.1.4.1 *W3A Akuo Energy Solar/Micro-Hydro, Berau*

The Off-Grid Power Plants for Three Villages in Berau Regency – East Kalimantan Project (W3A Akuo Energy Solar/Micro-Hydro, Berau) targets three villages in the Berau regency of the East Kalimantan province: Teluk Sumbang, Long Beliu, and Merabu. All the households in Teluk Sumbang and Merabu (comprising 167 and 73 households, respectively) will be connected to the

new and/or upgraded power systems. In Long Beliu, 223 out of 251 total households will be connected to the new power system. In all cases, the grantee plans to attempt to connect all households where a connection would be practical and feasible based on distance from the grid and socioeconomic conditions. In the case of the non-connected households in Long Beliu, all these pertain to a sub-village administrative unit (or "RT") that is wealthier than other parts of the village, located directly along the main village road. The target households pertain to a different RT seven kilometers away from the road.

At the village level, site selection occurred on the basis of government priority lists of villages with low or no rates of electrification. The Mining and Energy Agency in Berau (Dinas Pertambangan dan Energi, or Distamben) collected applications from villages to receive grant assistance and presented a list of 10 suitable villages to Perseroan Terbatas (PT) Akuo Energy for potential inclusion in the project. PT Akuo Energy initially selected four of these villages in which they would conduct a DFS and ultimately dropped one (Balikukup) when the study found that the most suitable location for a solar PV micro-grid was prone to erosion and potentially unsustainable. Figure 2 displays the final three villages selected for grant assistance, along with the originally considered fourth village.

Figure 2: Map of target villages for W3A Akuo Energy Solar/Micro-Hydro, Berau



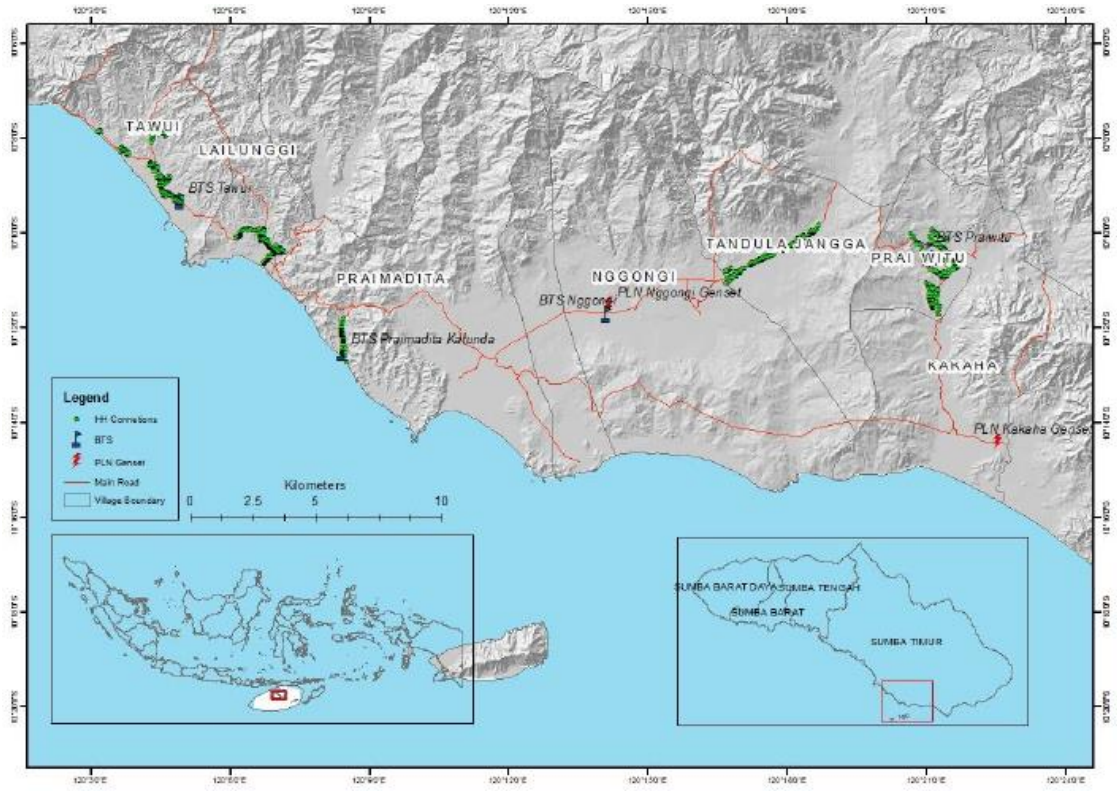
2.1.4.2 *W3A Anekatek Solar, East Sumba*

The Solar PV Distributed System in East Sumba Project (W3A Anekatek Solar, East Sumba) targets 909 households in the East Sumba regency for electrification via connection to 11 sub-village (or *kampung*)–level solar PV micro-grid systems. These 11 systems are distributed across

five villages: Tawui, Lailunggi, Praimadita, Tandula Jangga, and Praiwitu. The 909 households targeted include all the households in the 11 kampungs targeted across the five villages.

The East Sumba regency was targeted by this project based on previous studies executed under an ADB Technical Assistance grant (TA 8287) held by Castlerock Consulting, a service provider on cross-cutting deliverables on the W3A grant.[13] Within this regency, the implementer selected villages (*desa*) based on criteria that included mobile network access and proximity to a Perusahaan Listrik Negara (PLN)[14] station. Finally, targeted kampungs were selected within these villages based largely on population density, as measured by a GPS roof-tagging exercise. Aside from population density, it is the implementer's belief that there are no categorical differences between selected and non-selected kampungs. Figure 3 displays the kampungs targeted by the project in the larger context of East Sumba.

Figure 3: Map of target sub-villages for W3A Anekatek Solar, East Sumba



13 The purpose of this TA was to "support the GoI's Sumba Iconic Island Initiative," which aims to electrify 95% of households on the island of Sumba via 100% renewable means by 2025. The referenced Network Planner exercise was part of a "comprehensive least-cost electrification planning exercise" for Sumba, wherein the most cost-effective and technically appropriate means for achieving a 100% electrification ratio were laid out (ADB 2014).
14 Indonesian state-owned company tasked with supplying the electricity needs of the Indonesian people.

2.1.5 Implementation to Date and Planned Outputs

During qualitative baseline data collection, we gained an updated sense of the progress of implementation of each of the grants as of October 2017. Although neither of the projects had progressed to the point where important outputs could be verified at that time, we will still present progress to date in order to provide an appropriate context for our baseline findings.

2.1.5.1 *W3A Akuo Energy Solar/Micro-Hydro, Berau*

Physical Outputs

W3A Akuo Energy Indonesia (AEI) Solar/Micro-Hydro, Berau, started construction of all facilities and necessary complementary outputs for all three villages in June of 2017. All three facilities were expected to complete construction and installation activities by December of 2018 and be commissioned in February of 2018. A summary of the main physical outputs from this project and their corresponding power capacities can be found in Table 5.

Table 5: W3A Akuo Energy Solar/Micro-Hydro, Berau, summary of physical outputs

Location	Technology	Number of Facilities	Capacity (kWp)	Household Connections
Teluk Sumbang	Solar PV, micro-hydro	2	414 (solar), 30 (hydro)	138
Long Beliu	Solar PV	1	518	165
Merabu	Solar PV	1	311	97
TOTAL		**4**	**1,273 kWp**	**400**

Once connected, households in Berau will receive a capacity of 900 watts (W) per household, with an option to request an increased capacity of 1,300 W, 1,800 W, or 2,200 W. The in-house installations provided by the project will include four bulbs, three sockets, and two switches.

SPV and Training

While the facilities are under construction, AEI will work with the local communities to form SPVs—the so-called Perusahaan Listrik Desa—that will be responsible for the facilities' long-term operation. According to the grant's SPV Business Plan (revised May 8, 2017), these village-level SPVs will be dually owned by the implementer and a village-owned enterprise (Badan Usaha Milik Desa, or BUMDes). During construction, AEI will have a majority share in the SPV, whereas after construction shares will be split 51% to 49% in favor of the BUMDes. Each SPV will be shaped according to the organigram in Figure 4.

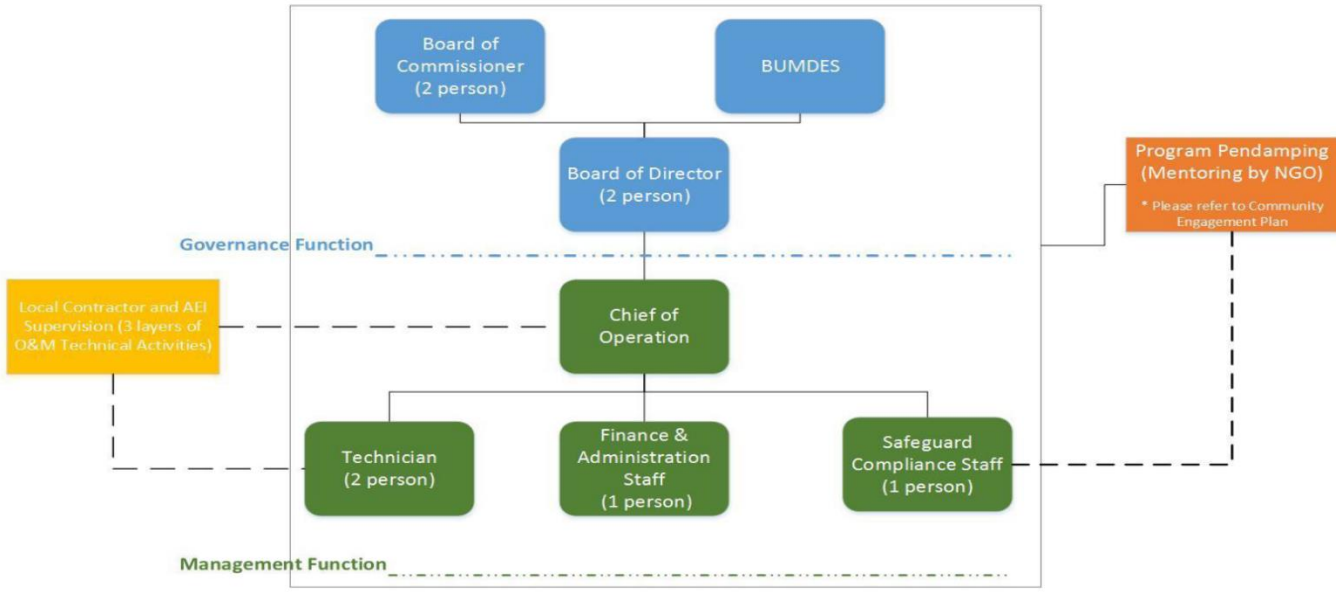


Figure 4: W3A Akuo Energy Solar/Micro-Hydro, Berau, SPV organigram[15]

Operationally, the technician is responsible for day-to-day O&M of the plant. The finance and administration staff is responsible for bookkeeping and documentation as well as managing the SPV's voucher-based sales system and financial reporting. The safeguard compliance staff is responsible for coordinating community development and compliance with environmental and social standards. This includes enforcement of project benefit sharing across communities and genders. Routine preventative maintenance and intermediate troubleshooting will be contracted out to a local O&M company, while system control and advanced and inverter troubleshooting will be handled by AEI. AEI will accompany the village for one year to teach management, administration, control, and maintenance of the Supervisory Control and Data Acquisition (SCADA) system. It will also provide a 25-year warranty on solar modules and spare parts as well as a 15-year warranty on the battery.

As of October 2017, job advertisements for SPV positions had been posted on many house walls in the Berau communities, but candidates had not yet been selected. Overall, 26 men and 13 women applied for the 18 available positions in the SPVs. AEI plans to communicate the results of the application process to candidates well before the micro-grids are commissioned.

Although AEI will have a 49% share in the SPV, all SPV dividends will belong to the BUMDes for use in community development, with a particular focus on women and vulnerable groups. These dividends will be utilized according to the procedure outlined in Figure 5. Specifically, the 10% of gross profits reserved for community benefits each year will target electricity usage effectiveness

[15] This organigram comes from page 7 of the W3A-33 SPV Business Plan dated May 4, 2017. It is the most updated SPV business plan available to SI as of this report. However, we acknowledge based on MCA-I comments that it may be incorrect and that rather than the BUMDes and Board of Commissioners existing separately on an equal plane, the Board of Commissioners is comprised of equal representation from the BUMDes and AEI.

awareness and economic activities by women's groups. It will also be used for general community development interventions, which will be identified by local villagers at a later stage.

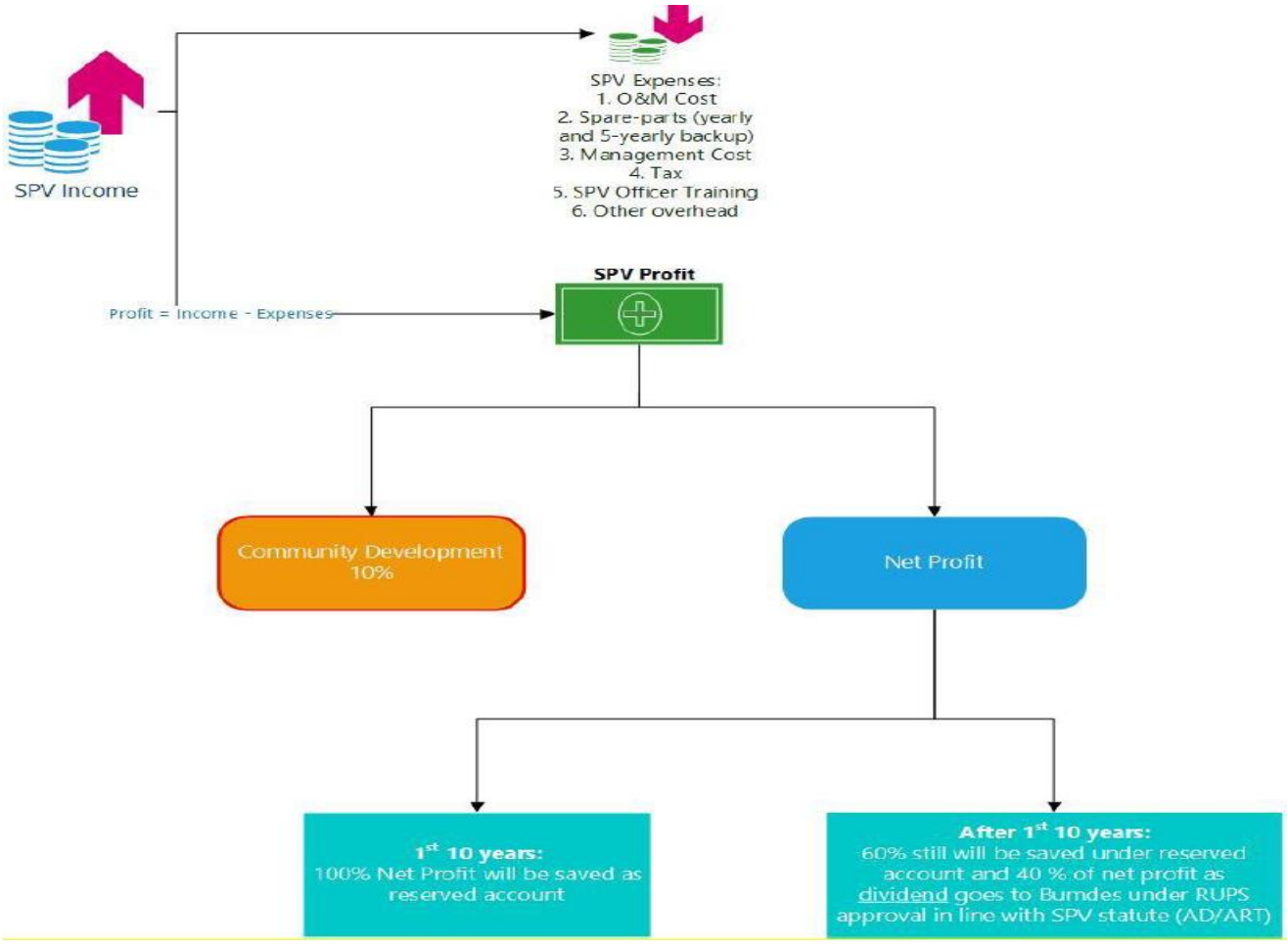


Figure 5: W3A Akuo Energy Solar/Micro-Hydro, Berau, SPV profit utilization

AEI is represented in the field by two employees who are responsible for M&E and community development. They both visit each village for around three days per month and will support M&E during one year from Bali. SPV training in all communities in Berau started in October 2017 and include a one-week training per month of three to five hours, plus separate trainings for the different SPV roles. In addition, by the time of the survey, Akuo Energy had implemented mostly entrepreneurial trainings on ecotourism and conducted village meetings. After commissioning takes place in March 2018, AEI will revisit the communities every two to three months and SPV members will submit monthly reports. At the time of the baseline qualitative data collection effort, AEI had posted high-quality sensitization materials at various locations in treatment villages (see Figure 6 and Annex 9.4).

Figure 6: W3A Akuo Energy Solar/Micro-Hydro, Berau, sensitization materials

2.1.5.2 *W3A Anekatek Solar, East Sumba*

Physical Outputs

Construction of solar PV facilities and complementary structures for W3A Anekatek Solar, East Sumba, commenced in August of 2017. The facilities in Tawui Riyang, Tawui Northeast, Tawui North, and Tawui West were due to be commissioned by November 10, 2017. The remaining facilities were to be commissioned between November 28, 2017 and January 31, 2018, although Castlerock Asia (a member of the Anekatek consortium) advised the SI team that work may last until March of 2018. Table 6 summarizes the capacity and expected household connections of each of these facilities.

Table 6: W3A Anekatek Solar, East Sumba, summary of physical outputs

Location	Technology	Number of Facilities	Capacity (kW)	Household Connections
Tawui Riyang	Solar PV	1	9	18
Tawui West	Solar PV	1	12	28
Tawui Northeast	Solar PV	1	7.5	17
Tawui North	Solar PV	1	12	27
Tawui South	Solar PV	1	99	209
Lailunggi	Solar PV	1	103.5	216
Rehi Jara	Solar PV	1	16.5	32
Tanah Rong	Solar PV	1	24	44
Tandula Jangga	Solar PV	1	75	136

Location	Technology	Number of Facilities	Capacity (kW)	Household Connections
Praiwitu North	Solar PV	1	103.5	136
Praiwitu South	Solar PV	1	30	46

Once connected, households in Sumba will receive a capacity of 450 W. In addition to in-house installations, communities expect street lamps to be installed by the project, including 72 in Lailunggi and 100 in Tawui.

SPV and Training

Compared to the W3A grant in Berau, which will set up a decentralized SPV in each village in which it operates, W3A Anekatek Solar, East Sumba, has established one SPV, "PT BUMDes," to cover all 11 treatment areas spread across five villages.[16] The BUMDes structure employed in Berau establishes a new community organization, whereas in Sumba the BUMDes representing all 11 communities together will take advantage of, extend, and preside over existing BUMDes structures in each village. The implementer's sister company, Electric Vine Industries (EVI), will have 100% ownership of the SPV during the construction phase, after which ownership will be split 51% to 49% in favor of the communities.

Operationally, the SPV will issue a contract to an external firm for O&M of the facilities and management of administration and finance. Where other grants' SPVs typically aim to complete finance and administration in-house, PT Mikro Kisi Sumba (MKS) is paying for these to be completed externally since the contractor has key experience and software to implement a mobile phone-based, pre-paid "smart metering" system that aims to increase project sustainability by matching payment cycles with end users' income cycles. Users of the micro-grids will lose access to power once they have exhausted their pre-paid credit. Custodians employed by the SPV will be responsible solely for O&M tasks related to cleaning arrays and clearing vegetation and debris from the roots and distribution. Besides the custodians, the only other operational SPV staff will be community, social, and environmental officers responsible for overseeing the implementation of ESMP and the Project Social and Gender Integration Plan (PSGIP) along with liaising between cooperative members and technical and managerial SPV staff—including registering customer complaints. Since the Sumba SPV is taking advantage of existing BUMDes structures in the five villages, community members that will form the electricity unit within the overall BUMDes have already been chosen. The Anekatek consortium, like AEI in Berau, will offer a warranty on the physical outputs provided by the project. See Figure 7 for an overview of the SPV's structure following the end of the construction phase.

[16] The information presented in this section is based off the grant's SPV Business Plan, dated July 5, 2017, which is the most updated plan available to SI as of July 2017. SI acknowledges, based on MCA-I comments, that this approach may have been updated since this time and has incorporated as many updates as possible from qualitative data collection.

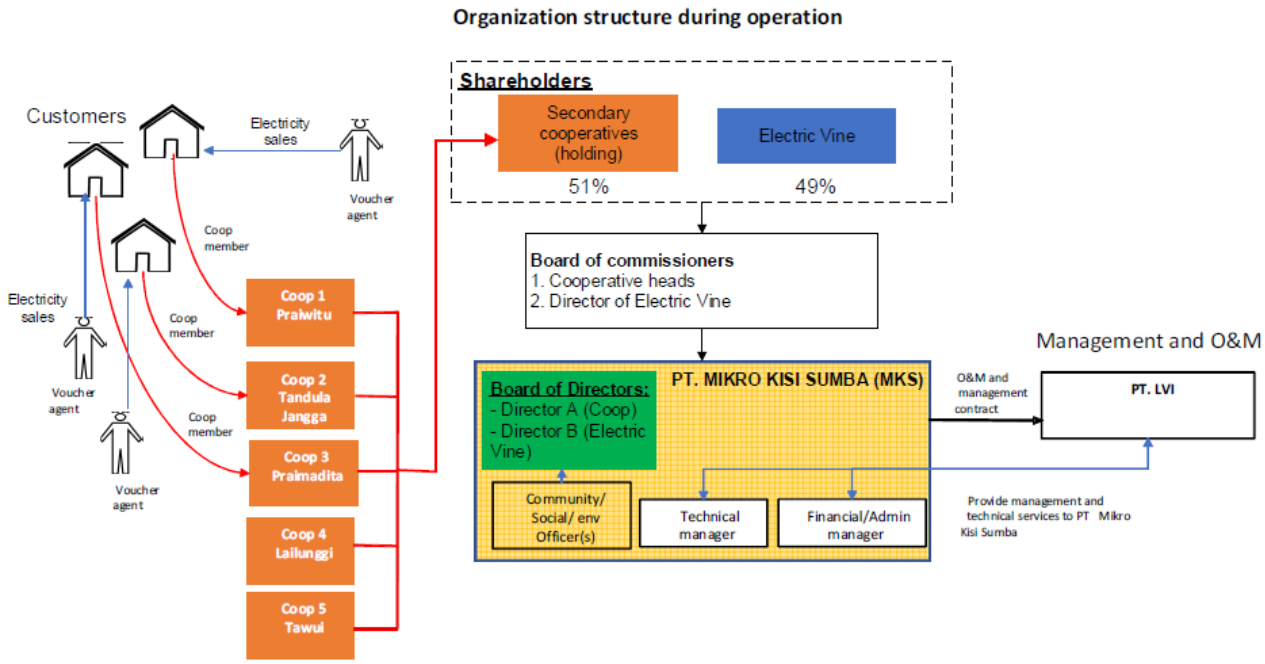


Figure 7: W3A Anekatek Solar, East Sumba, SPV organigram[17]

Anekatek Solar designed the systems for Sumba and subcontracted Castlerock Asia for social and environmental project targets. Castlerock is represented in the field by a co–team leader responsible for fieldwork and three local facilitators trained to work as project representatives with each village. Castlerock also employs a local gender specialist who is part of the field team. Castlerock will support O&M from Jakarta for two years after commissioning. Furthermore, Castlerock hired EVI to conduct capacity building of the BUMDes and economic opportunity trainings.

One of the two EVI employees tasked with capacity building is a specialist in agriculture and fieldwork and lives in the area. His trainings are constant processes instead of one-shot activities and have focused thus far on making biological fertilizer out of pineapples. The trainer until now has reacted to villagers' needs rather than to the grantee's original training framework, which includes post-harvest activities, local handicraft making, and management and marketing sessions. He and his trainings are extremely popular among the villagers and are easy to follow. Furthermore, many interviewees in Sumba have participated in safety and environment trainings, system management, and health and safety on the construction site.

Once the SPV is generating revenue and funds have been set aside for a maintenance reserve, dividends remaining after O&M and contractor costs will be allocated for activities. These may include capital for new businesses in the villages, incentives for members that do not have sufficient income to pay electricity tariffs, or capital for cooperative members.

[17] W3A Anekatek Solar, East Sumba, SPV Business Plan (dated July 5, 2017); Exhibit 2. As of baseline data collection, it was confirmed that the communities will form village-level BUMDeses instead of cooperatives, and that these will establish a unified holding company to represent their collective 51% shares in the SPV.

2.2 Link to ERR and Beneficiary Analysis

The largest and most consistent economic benefit considered by MCC cost-benefit analyses (CBAs) for the Window 3A grants is derived from the increased access to electricity from the newly established power systems. This benefit mirrors Outcome 2 in the grants' logical frameworks. The economic benefit of this outcome is quantified as the increased consumer surplus from the increased access to electricity (as measured through a Willingness-to-Pay (WtP) methodology). Another benefit stream that appears consistently in all the economic rate of return (ERR) calculations is a resource cost savings benefit, measured by the decrease in consumer expenditure on electricity from the new RE sources compared to status quo sources such as kerosene or diesel generators. This substitution is not explicitly linked to any of the four grant outcomes, although it is an implicit mechanism for the increased household income and decreased GHG emissions cited as the overall objective and impact of the grants.

Inconsistently, individual CBAs consider additional benefits to the increased consumer surplus and resource cost savings. In the case of W3A Akuo Energy Solar/Micro-Hydro, Berau, these additional streams include increased income for honey and boat production and additional resource cost savings on ice for the storage of caught fish. These benefits are linked to Outcome 4 of the grant logic, which involves productive uses of the increased electricity supply. Although these benefits are between 10 and 50 times the magnitude of the standard resource cost savings benefit from substitution of the source of electricity, they still pale in comparison to the increased consumer surplus benefit. After adding these to the WtP benefit, the overall 20-year ERR only increases from 24.5% to 25.0%.

Table 7: ERR for each of the Window 3A grants

Grant	20-Year ERR (Standard Benefits)	20-Year ERR (Total)
W3A Akuo Energy Solar, Berau	24.50%	25.03%
W3A Anekatek Solar, East Sumba	19.45%	19.45%

3. LITERATURE REVIEW OF THE EVIDENCE

Micro-grids play a crucial role in efforts to provide universal access to electricity by 2030 around the world, as proclaimed by the United Nations (UN) initiative Sustainable Energy for All (SE4All) and the Sustainable Development Goal 7. The International Energy Agency (IEA) estimates that 42% of the additional electricity generation capacity to reach universal access can most economically be achieved through micro-grids[18].

The academic literature is inconclusive about the impacts of rural electrification on rural development, and there are only few rigorous studies to provide compelling evidence. For example, in India, Bangladesh, and Vietnam, respectively, van de Walle et al.,[19] Khandker, Barnes, and Samad,[20] and Khandker, Barnes, and Samad,[21] find evidence for positive effects on job market indicators, household income, and educational performance as a result of electrification. Parikh et al.[22] find positive effects in particular for women from infrastructure provision, including electricity, in Indian slums on literacy, income, and health. Grimm, Sparrow, and Tasciotti[23] and Peters and Vance[24] show that electrification contributes substantially to the fertility decline in Indonesia and Côte d'Ivoire, respectively. In addition, some positive evidence on firm productivity comes from India, Kenya, Nicaragua, and South Africa.[25,26,27,28]

There is, however, a set of more sobering findings. While research indicates that lighting is a high priority for people and is in fact used also for purposes considered to be beneficial from a development perspective, impacts on productive activities are often much less pronounced than

[18] Birol, F. (2010). "World energy outlook 2010." International Energy Agency, 1(3).
[19] van de Walle, D., Ravallion, M., Mendiratta, V., and Koolwal, G. (2015). "Long-term impacts of household electrification in rural India." *World Bank Economic Review*, forthcoming.
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expected.[29,30,31,32,33,34,35,36,37,38] A recent large-scale evaluation of a rural electrification program in Tanzania,[39] for example, finds reductions in some traditional energy source uses and positive effects on land prices and lighting usage as proxies for well-being. However, there are no impacts on non-agricultural employment or firm creation. The reason is often that in most rural areas electricity is not the only bottleneck that impedes business development. In the absence of roads and market access, electricity can only be used for productive purposes that serve the local demand, which is often small. Moreover, households and enterprises in rural areas typically have a very low ability to pay. As a result, typical household electricity demand is very low.[40,41,42] Electricity in rural areas is often only used for lighting, charging mobile phones, and operating radios and sometimes TV sets.[43,44]

The impacts of electrification on GHG emissions and the environment depend on the source of electricity that is supplied and the initial energy sources that are being replaced. Currently, RE sources make up between 15 and 20% of the world's total energy demand. In the case of solar PV and micro-hydro plant installation, the energy provided is from non-depletable fuels solely and consumption does not emit GHG.[45] The more these new systems replace initial reliance on oil, coal, and natural gas, the better the environmental impacts of the intervention. One example is dry-cell batteries and light-emitting diode (LED) lamps, which have replaced kerosene in many parts of the developing world.[46] Furthermore, high emission reductions can in particular be expected when rural households replace diesel-driven machinery use or biomass-based cooking and heating with electric appliances. Biomass use for cooking and heating

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is a major cause of climate-relevant emissions.[47,48,49] While electricity is rarely used for cooking in developing countries, the use of electric rice cookers is very common in Asia.

There are very few rigorous studies on the sustainability of micro-grid programs, partly because only a few examples of sustainably working micro-grid programs exist that have matured beyond the installation of just a model micro-grid. There are a few potential reasons for low sustainability. First, institutional and political challenges often impede cost-covering electricity consumption tariffs that would make investments into micro-grids attractive. In most countries, rural electricity tariffs—even for the national grid—are not cost-recovering[50] but highly subsidized by governments or, in the best case, cross-subsidized by urban consumers. Accordingly, regulatory bodies or the incumbent utility typically will not readily approve higher tariffs that are needed to make micro-grids cost-covering.[51] In addition, payment enforcement may be hampered by low ability to pay[52] and irregular, seasonal income flows that are typical among agriculture-reliant populations. Furthermore, there may be a low willingness to pay, as the costs of renewable energies (solar, hydro, wind) are not directly visible for the population given its local generation (as compared to, for example, the case of generators).

Mini-grids can be operated by public-private partnerships or by communities. For micro-grids operated by the community, the two key challenges are tariff setting and payment enforcement.[53] Incentives and obstacles to enforce payment rigorously are different for a community member than for outsiders working for a commercial operator. Most importantly, social entanglements may complicate rigorous enforcement. In theory, the same mechanism can also work the other way around, where social cohesion might lead people to feel more obliged to pay their contributions. Last, payment for operational staff may seem dispensable in rural subsistence communities where paid labor is an exception rather than the rule. This, again, may lead to too-low tariffs and bad payment discipline.

3.1 Evidence Gaps That the Current Evaluation Fills

This evaluation can provide evidence on three gaps in the literature. In particular, two design features of the Window 3A projects are highly interesting from a global learning point of view.

First, as outlined above, despite high costs attached to electrification, there is generally no consensus on the impacts of electrification on rural development and less so for the case of micro-grids. Given that micro-grids play an important role in the SE4ALL goal of universal electricity access, evidence is highly required. Second, a comparison of different micro-grid management or financing systems does not exist in the literature. The only examination has been done in Indonesia for non-private micro-grids run by the

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community and fully subsidized by the government.[54] Evidence on the impacts of the management system on the sustainability of micro-hydro plants is not available and, more concretely, there is no understanding of the dynamics that may hamper or foster payment enforcement among local customers and O&M practices among the local community operators.

Third, there is no study that assesses the impact of providing electricity access paired with productive use promotion. The exception is one study on microfinance and electricity.[55] Given high impact expectations from electrification and productive use aspirations but often limited income effects in practice, learning on combined interventions is highly relevant. The trainings on productive use, as provided by the Window 3A projects, in conjunction with electricity provision therefore serve as a unique opportunity to fill this gap.

[54] Peters, J., and Sievert, M. (2015). "The provision of electricity to rural communities through Micro-Hydro Power in rural Indonesia: Micro Hydro Power pilot programme within the national programme for community development (PNPM) supported by the Netherlands through energising development," (No. 88). RWI Materialien.
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4. EVALUATION DESIGN

4.1 Evaluation Type

This portfolio evaluation will be a mixed-methods evaluation, with quasi-experimental methods aimed toward rigorously establishing impact estimates on outcomes of interest as well as non-experimental methods more in line with a typical performance evaluation. Taken as a whole, this evaluation aims, to the extent possible, to validate the program logic underlying the portfolio of CBOG RE grants in the GP Grant Facility, doing so through a focused investigation of two specific grants: 1) W3A Akuo Energy Solar/Micro-Hydro, Berau and 2) W3A Anekatek Solar, East Sumba. It will simultaneously aim to measure impacts and compare and contrast how the grants operate, both in terms of how similar programs operate in different contexts within Indonesia and in terms of how programs with different approaches to electrification and community engagement operate. Although data collection and analysis for each of these grants will have quantitative and qualitative pre/post elements, only the analysis for W3A Anekatek Solar, East Sumba, uses a comparison group and can be considered an impact evaluation.

4.2 Evaluation Questions

At baseline, the evaluation sought to characterize baseline conditions of outcomes of interest and important contextual factors for program success through quantitative and qualitative means that will ultimately allow for a rigorous validation of program logic and comparative study of approaches. Our baseline will contribute to this effort by validating the logic underlying two typical Window 3A grant approaches to increasing household income and reducing GHG emissions via the increased utilization of electricity generated from renewable sources. The evaluation is guided by four primary questions:

1) How have energy consumption patterns changed among beneficiary households and businesses in response to the provision of a renewable source of electricity?
    a. What are the implications of these changes for household expenditures?
2) Has the electricity provided through the RE infrastructure been used for economic purposes at the community or household level?
    a. Has the productive uses/profit-generating component of the grant been effective and has it helped the SPV be sustained?
3) To what extent do any changes in energy consumption patterns favor reduced GHG emissions?
    a. Are there any other ways in which the grants contribute to the objective of reducing or avoiding GHG emissions?
4) Has the Special Purpose Vehicle been an effective intervention to improve community buy-in and sustainability of the infrastructure?

It is possible that additional lines of inquiry to these evaluation questions may be pursued in future data collection periods using *ex post* evaluation approaches of additional CBOG RE grants in the GP Facility.

4.2.1 Country-Specific and International Policy Relevance of Evaluation

The electrification rate in Indonesia has been increasing at a steady pace, expanding from approximately 43% in 1995 to 97.0% by 2014.[56] There are, however, great disparities in electricity access across regions, ranging between 36.4% in Papua to 100% in Jakarta. Generally, electrification is disproportionately provided in the centers of Java and Bali, while the eastern provinces are characterized by the lowest electrification rates. In 2012, the provinces East Kalimantan (W3A Akuo Energy Solar/Micro-Hydro, Berau) and East Nusa Tenggara (W3A Anekatek Solar, East Sumba) had electrification rates of 64% and 44%, respectively, lagging behind the average electrification rate of 75% of that year. These percentages mask a large disparity between rural and urban electrification according to the 2015 intercensal population survey, only 54.4% of households in rural East Nusa Tenggara were electrified compared to 98.9% of households in urban East Nusa Tenggara.[57]

The country has an installed electricity-generating capacity of 51.92 GW (gigawatts), of which the vast majority is generated from fossil fuels (83.2%), with coal being the predominant type of fossil fuel. Eleven percent of the capacity is generated by hydroelectric plants, and the remaining 5.8% comes from other renewable sources.[58] The country produces high levels of GHG emissions. The use of fossil fuels, in particular in the power sector and transportation, is expected to more than double the country's energy-related CO_2 emissions in the coming 25 years, rising to more than 800 million tons by 2035.[59]

The GoI political agenda pursues as major objectives the increase in electricity access, an expansion of RE use, and green growth. The country was one of the first to ratify the United Nations Framework Convention on Climate Change and to adopt the Kyoto Protocol.[60] The country's national energy policy (KEN) aims at increasing the country's use of new and RE from 4% of all energy use in 2011 to 23% by 2025 and 31% by 2050.[61] Simultaneously, the 2015–2019 National Medium Development Plan sets the goal of reaching an electrification rate of 96.6% by the end of 2019, with a particular focus on disadvantaged communities and remote, undeveloped regions.[62] In an attempt to bring together these multiple goals, the GoI and Perusahaan Listrik Negara (PLN), the state electricity company, have launched several rural electrification plans. Among them stands out the longer-term solar development plan Thousand Islands Program, which aims at expanding the country's solar installed capacity to 620 MW (megawatts) by 2020.[63]

However, the government faces several challenges in reaching the remaining 16% of its population that lacks electricity access. This population group is the most costly and timely and technically more difficult to serve, given the lower population density and ability to pay. Moreover, the mountainous topography of the archipelagic nation represents a challenge for the expansion of electricity access. Electricity supply

[56] http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators
[57] 2015 Intercensal Population Survey (SUPAS), BPS
[58] https://www.adb.org/sites/default/files/publication/178039/ino-paper-09-2015.pdf, p. 8
[59] https://www.adb.org/sites/default/files/publication/178039/ino-paper-09-2015.pdf, p. 9
[60] http://prokum.esdm.go.id/pp/2014/PP%20Nomor%2079%202014.pdf, p. 8
[61] https://www.adb.org/sites/default/files/publication/178039/ino-paper-09-2015.pdf, p. 31
[62] Current policies in the RE sector include the Ministerial Decree No. 38/2016, which aims at expediting electricity access in remote Indonesia. However, the Ministerial Decree No. 12/2017 by the Ministry of Energy and Mineral Resources regulates tariffs of electricity generated from RE, and Decree No. 4 and 5/2017 by the Ministry of Industry set quality requirements for the content of solar PV modules. Both may hamper investments into RE (see https://d2oc0ihd6a5bt.cloudfront.net/wp-content/uploads/sites/837/2017/06/ACEF-2017-Session-18-Info-sheet-02-06-2017.pdf)
[63] https://www.adb.org/sites/default/files/publication/182314/achieving-electricity-access-ino.pdf, p. 35

in the provinces East Kalimantan (W3A Akuo Energy Solar/Micro-Hydro, Berau) and East Nusa Tenggara (W3A Anekatek Solar, East Sumba) is particularly costly.[64]

Concerning off-grid electrification programs, the ADB[65] summarizes the experience made by PLN and several governmental agencies to be "mixed at best." Private-sector efforts are small in number and are described as *ad hoc*. In addition, they seem to be hindered by project-specific regulatory requirements. Off-grid efforts by line ministries and regional governments (Pemerintah Daerah) often only fund initial installation of plants but do not ensure financial and technical sustainability, resulting in high failure rates. PLN would be better placed to assure sustainability but has little experience with renewable technologies, is in a bad financial situation, and has a high workload in conventional grid extension.

As a result, many initial attempts of the Thousand Islands Program have been delayed due to financing or technical difficulties. The following problems have been encountered in the implementation of off-grid electrification projects:

- Failure to assess full present and future electricity needs of the target population
- Poor design, materials, and workmanship, which compromise technical performance and sustainability
- Lack of financing mechanisms to trigger payment discipline among customers to finance O&M
- Lack of human resources to operate and maintain the plants
- Pricing that is inconsistent with the target population's ability to pay
- Limited scale-up opportunities due to a centralized focus on PLN and too little mobilization of local governments, NGOs, the private sector, and community

The window 3A project approaches coincide largely with current and future (governmental) efforts of providing electricity to the remaining unconnected 16% of the Indonesian population, which are characterized by residence remoteness, low ability to pay, and limited productive activities. The projects and the evidence that the Window 3A grants create are sustainable and worthwhile, as well as relevant and timely. In addition, the project design incorporates several features to tackle past challenges in sustainable off-grid electricity provision outlined above. First, the community-based operation approaches (EQ4: Special Purpose Vehicles and the primary-secondary cooperative scheme) may serve as examples of how to trigger payment discipline, thereby financing O&M and assuring sustainability of the plants. Second, the implementation of income-generating trainings (EQ2) might represent a positive example of complementary activities to unlock the growth potential of electrification interventions. Based on these experiences, learnings from this evaluation may inform the design of a (still lacking) coordinated, sound policy instrument to foster sustainable, off-grid provision in rural areas. Third, this evaluation will provide evidence on electricity consumption patterns in the typical unconnected areas (EQ1), which will improve assessment of present and future electricity needs of the unconnected 16% of the population. Lastly, an assessment of off-grid electrification impacts on households, GHG emissions (EQ3), and the

[64] https://www.adb.org/sites/default/files/publication/182314/achieving-electricity-access-ino.pdf, p. 46
[65] https://www.adb.org/sites/default/files/publication/182314/achieving-electricity-access-ino.pdf, p. 46

local economy can confirm or adjust theoretical impact expectations and provide evidence on potential bottlenecks to unlock them in practice.

4.2.2 Define Key Outcomes Linked to Program Logic

Table 8 broadly defines the key outcomes that will be used to respond to each evaluation question, along with which instrument will be used to obtain them and which outcome in the log frame pertains to them. These outcomes will be even more meticulously defined in Section 5.

Table 8: Evaluation design overview

EQ	Key Outcomes	Data Source (Type)	Log Frame
1	Household and enterprise energy consumption (by source), energy expenditures	Household Survey (quant.) Community KII/FGD (qual.) Enterprise Survey (quant.) Enterprise KII (qual.)	Outcome 2
2	Productive uses of electricity, occupational and transformed agricultural income, employment	Household Survey (quant.) SPV KII protocols (qual.) Community KII/FGD (qual.) Enterprise Survey (quant.) Enterprise KII (qual.)	Outcome 4
3	Greenhouse gas emissions	Household Survey (quant.) Gov. official KII (qual.) Grantee KII (qual.)	Outcome 2
4	Capabilities of SPV members, sustainable operation of facilities	All qualitative instruments	Outcome 3

4.3 Methodology

4.3.1 Identification Strategy

To answer Evaluation Questions 1–3, which seek to identify the impact of the RE installations, we compare the outcomes of individuals who have received increased access to electricity through RE sources against the counterfactual: the outcomes for these same individuals *if they had not received increased access to RE sources*. Since it is not possible to directly observe the counterfactual, we need a mechanism to estimate it with as little bias as possible. The ideal method is to randomly assign participation among a sample of potential participants, creating a treatment and control group. Through random assignment, the treatment and control groups, on average, are expected to be similar along the characteristics affecting the outcome of interest. Hence, in the absence of the project, both groups would have the same expected outcome and any differences between the two groups after project implementation can be attributed to the project.[66]

For the grants we are evaluating, including Grant W3A Anekatek Solar, East Sumba, participation is *not* randomly assigned. Rather, sites were purposefully selected for installation of RE, as described above. One means of randomization would have been to randomly assign connections (or randomly offer

[66] Assuming a well-run experiment without spillovers, differential attrition, Hawthorne effects, etc.

discounted connection fees to generate random variation in connection status) to the micro-grids within selected villages. However, for political, logistical, and ethical reasons, nearly all households in selected communities will receive free connections to the micro-grid, with only very remote households not being offered a connection. Thus, SI will utilize a quasi-experimental approach that incorporates elements of statistical matching techniques and difference in differences (DiD) to estimate counterfactual outcomes and program impact for the W3A Anekatek Solar, East Sumba grant.

We propose to collect panel data from a sample of treatment and comparison households, with the evaluation sample identified using the following approach:

1) **Identification of comparison kampungs:** Given that nearly all households in the 11 treatment kampungs will be electrified and the few that will not be are systematically different, we must identify comparison households from other kampungs in the same desa or in nearby desas. To do this, we developed a sample frame of nearby kampungs that 1) had, like the treatment kampungs, been classified as suitable for a micro-grid according to a recent network planning activity conducted by the ADB (described below) and 2) were not, based on discussions with key stakeholders, slated to receive electrification in the following year through other planned initiatives, including through Window 2 grants. From this sample frame, we used data on population size and geographic distance to identify a sample of 17 comparison kampungs. Comparison kampungs (relative to treatment kampungs) were oversampled in order to increase power (given the fixed and limited number of treatment kampungs) to generate a buffer in case a small number of comparison kampungs are electrified during the evaluation period and to provide a larger pool of potential comparison units from which to draw matches.
2) **Baseline data collection:** Within each treatment and comparison kampung, we sampled an average of 30 households, as described below in Section 4.3.3.
3) **Match similar treatment and comparison households:** To generate the final sample of households for the evaluation, the evaluation design recommends using statistical matching techniques to identify similar treatment and comparison groups. In this baseline report, we present results from two types of matching at the household level, coarsened exact matching (CEM) and propensity score matching (PSM). Given the potential for electrification in comparison areas, which would exclude the electrified community from the evaluation comparison sample frame, we recommend that final matching is conducted again to identify the final evaluation sample prior to follow-up data collection. More detail is provided below in Section 6.2.

Follow-up data collection with the final matched sample will be conducted 12 months after baseline data collection and then again 36 months after baseline. As described below, we will then analyze the results using a DiD regression approach.

The initial selection of similar kampungs and matching of treatment and comparison households helps to reduce selection bias by minimizing differences along observed household and community characteristics measured at baseline. However, all matching methods rest on the conditional independence assumption (CIA). That is, we assume that, conditional on the vector of baseline characteristics used in matching, the expected outcomes of the treatment and comparison groups are independent of the assignment and selection bias is removed. However, the potential exists that unobserved variables will differ across the treatment and comparison group, thus violating the CIA. The

DiD approach to analysis will serve to reduce the threats posed by unobservable differences between the households that do not vary over time.

Also, there is a tradeoff in CEM between the level of coarsening and power that is similar to the common support condition or assumption of other matching approaches. With very fine coarsening of variables (separating them into higher numbers of strata), we increase the number of strata and reduce the likelihood of matches. This leads to pruning higher numbers of observations, which reduces sample size and power and limits our ability to generalize to the full evaluation sample (or to those pruned observations). However, if we use only very loose coarsening of variables (separating them into fewer strata), we increase the likelihood of matches, preserving a larger proportion of the evaluation sample, but we risk retaining a greater degree of imbalance between treatment and comparison units. We propose a systematic approach to variable selection and degree of coarsening, as described below in the baseline analysis section, which optimizes the tradeoff between imbalance and power.

4.3.2 Power Calculations, Sample Size Requirements

4.3.2.1 *Quantitative Sample Unit*

The quantitative portion of the evaluation took a clustered approach, where individual sample units include households that are clustered into either “settlement aggregations” in East Sumba or villages/desas in Berau. For the most part, the settlement aggregations in East Sumba are sub-village units, sometimes referred to as kampungs. Occasionally, a settlement aggregation encompasses a whole village.

4.3.2.2 *Power Calculations and Assumptions*[67]

Given the clustered nature of the intervention and sample, we collected data from all 11 treatment settlement aggregations and 17 comparison settlement aggregations in East Sumba. To determine the number of households to sample in each settlement aggregation prior to data collection, we needed to estimate the intra-cluster correlation (ICC) for key outcomes and then look at the relationship between minimum detectable effect size (MDES) and cluster size at the estimated values of ICC. To estimate ICC, we used data from Castlerock’s baseline survey in the W3A Anekatek Solar, East Sumba target villages

[67] These power calculations were done before we had our own baseline data. Updated power calculations and implications for our evaluation design are presented in Section 6.2.

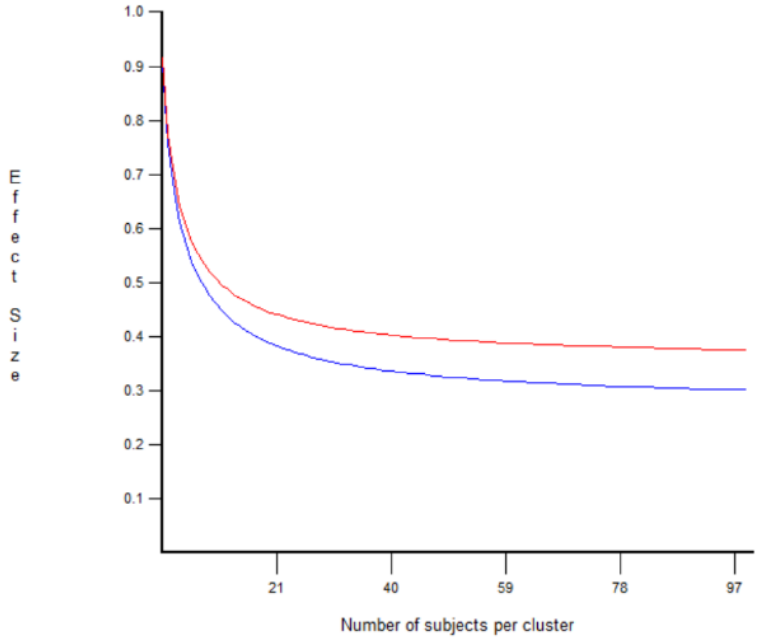

Figure 8: Relationship between cluster size and MDES

and calculated values ranging from 0.00 to 0.10 (see Table 9). The graph in Figure 8 displays the relationship between cluster size and MDES using the highest estimated ICC values (0.06 and 0.10) as well as assuming 22 total clusters, power of 80%, alpha (α) = 0.05, and *R*-squared = 0.2. Unsurprisingly, we found an inflection point around approximately 15 households with diminishing returns to power for additional households per cluster beyond that. Given this relationship and the fact that five of the 11 treatment kampungs have between 27 and 41 households, we recommended a sample size of approximately 25 households per cluster,[68] which corresponds to an MDES of 0.37 and 0.43 for ICC values of 0.06 and 0.10, respectively. Based on Hivos's baseline data, this corresponds to an ability to confidently measure a change in monthly electricity expenditure of at least approximately 60,000 to 70,000 IDR or a change in electricity access of 1.52 to 1.77 hours per day.[69]

Table 9: Power calculation summary statistics

Outcome	Mean	Std. Dev.	ICC	MDES = 0.35 (ICC = 0.06)	MDES = 0.41 (ICC = 0.10)
Monthly electricity expenditure (IDR)	82,660.93	161,915.2	0.06	59,909	69.623
Monthly kerosene use (liters)	1.73	32.93	0.00	12.18	14.16
Monthly kerosene use for lighting only (liters)	0.43	2.06	0.02	0.76	0.88
Electricity access per day (hours)	3.23	4.12	0.10	1.52	1.77

To account for attrition and pruning during the matching process, we proposed to inflate this sample by 20% at baseline, yielding a total baseline sample size of approximately 840 households in Sumba.

Since our evaluation design in Berau does not include a counterfactual approach (e.g., we will not be making comparisons between a treatment and control group), there was no need to do a power calculation. The sample size of 150 households was selected because this number would be adequate to pull representative samples from each village.

[68] Only 2 treatment kampungs have fewer than 25 households.
[69] The grant's CBA indicates that expected benefits include a 19,583 IDR per month reduction in energy expenditures and an increase in energy consumption of 39.19 kWh/month. We would be adequately powered to detect such a change in consumption, although we may not be adequately powered to detect changes in expenditure unless they exceed those predicted in the CBA.

4.3.3 Study Sample

4.3.3.1 *Quantitative Sample Frame*

Since treatment units have already been selected by the grantee in East Sumba, the sample frame for W3A Anekatek Solar, East Sumba, includes all 909 total households among the 11 treatment kampungs. To construct this sample frame, we requested and received a list of these households from the implementer.

For the comparison group, the sample frame included all settlement aggregations in East Sumba that satisfied the following conditions:

1) The Network Planner Activity of ADB TA 8287 indicated that the settlement aggregation was best suited for electrification via micro-grid or off-grid technology;
2) The settlement aggregation did not include households that are currently connected to the PLN grid; and
3) The settlement aggregation was not targeted by PLN for electrification until after September 2018.

After selecting settlement aggregations from this sample frame, the household sample frame was constructed by requesting a list of all the households in each settlement aggregation.

The sample frame for household data collection in Berau includes all households that will be connected to the solar or micro-hydro micro-grid. This includes 463 households among three villages. We requested and obtained a list of these households from the grantee.

In both kabupatens, the sample frame for enterprises was constructed by asking local officials upon arrival about the location of enterprises in each kampung.

4.3.3.2 *Quantitative Sampling Strategy and Sample Size*

For the evaluation of W3A Anekatek Solar, East Sumba, we used a **random sampling** strategy from the sample frame in treatment areas where settlement aggregations include over 25 households. Where settlement aggregations include fewer than 25 households, replacement households were selected randomly from other treatment settlement aggregations.

Since the objective of selecting comparison settlement aggregations was to match the treatment aggregations as closely as possible (and not to represent the entire sample frame of potential comparisons), settlement aggregations were selected using a **non-random method**. Specifically, we calculated the distance between each of the settlement aggregations that met the conditions from the list in the previous section and each of our 11 treatment settlement aggregations and selected the 17 that were closest to a treatment settlement aggregation, under the assumption that these would be the most similar on important characteristics in the absence of any other data.[70] For the selection of comparison households within comparison aggregations, we used the same **random sampling** technique as was

[70] The only data in our possession on these settlement aggregations prior to the baseline survey were GIS coordinates and population figures, so we did verify that the distribution of aggregations on each of these characteristics was similar to the treatment kampungs prior to sampling.

used for treatment households from lists of households obtained by local officials in selected settlement aggregations. The final sample obtained for East Sumba is presented in Table 10.

Table 10: Sampled settlement aggregations and households, baseline

No.	Kampung, Kecamatan (Treatment)	Sampled Households	Kampung, Kecamatan (Control)	Sampled Households
1	Tawui Northeast, Pinu Pahar	15	Kalimbu Maramba, Mahu	14
2	Tawui Riyang, Pinu Pahar	17	Tara Amah, Mahu	15
3	Tawui West, Pinu Pahar	25	Mauhani, Paberiwai	21
4	Tawui North, Pinu Pahar	26	Pahulu Bandil, Matawai La Pawu	22
5	Rehi Jara, Karera	28	Lumbuwudi, Pinu Pahar	25
6	Praiwitu North, Ngadu Ngala	31	Pingi Ailun, Matawai La Pawu	28
7	Tanah Rong, Karera	33	Linggi Tana, Paberiwai	29
8	Praiwitu South, Ngadu Ngala	34	Prai Kalu, Paberiwai	30
9	Tandula Jangga, Karera	35	Laipabundu, Pinu Pahar	31
10	Lailunggi, Pinu Pahar	40	Undut Maringging, Pinu Pahar	31
11	Tawui South, Pinu Pahar	46	Rakamau, Pinu Pahar	32
12			Winumuru, Paberiwai	33
13			Matawailuri, Pinu Pahar	34
14			Pada Djara, Ngadu Ngala	34
15			Prai Maninggat, Paberiwai	37
16			Laironja, Matawai La Pawu	38
17			Dusun 2, Matawai La Pawu	57
	Total	**330**	**Total**	**511**

For W3A Akuo Energy Solar/Micro-Hydro, Berau, households were sampled using a simple stratified random sampling technique. The strata included the three treatment villages, from each of which 50 households were randomly selected.

In both kabupatens, up to eight enterprises were sampled for the enterprise survey per kampung. If fewer than eight enterprises existed, all of them were surveyed. If more than eight existed, enterprises were purposively selected for the survey to cover a broad cross-section of industries.

4.3.3.3 *Qualitative Sample Frame*

In the case of W3A Akuo Energy Solar/Micro-Hydro, Berau, the three villages selected for qualitative study include all three treatment units involved in the grant. In the case of W3A Anekatek Solar, East Sumba, time and feasibility constraints precluded the qualitative team from visiting any more than three villages. The sample frame for these villages included all five of the treatment villages targeted by the grant.

The sample frame of stakeholders to serve as key informants in each village was constructed by soliciting contact lists from each of the grantees. The sample frame of beneficiaries to serve as focus group participants was constructed from beneficiary lists from each grantee. The sample frame of enterprises in each village was constructed by communicating with village officials in advance about how many and which types of enterprises were present in the village.

4.3.3.4 *Qualitative Sampling Strategy and Sample Size*

At the village level, the three villages selected for additional qualitative study in East Sumba were selected **purposively** to draw the most interesting comparisons possible both within East Sumba and between East Sumba and Berau. These also contained as many treatment kampungs as possible.

Most key informants were selected using a **purposive** sampling technique. In many cases, there was only one person or a few specific people who were performing the role whose perspective we required as a key informant. We reviewed program documents and worked with the grantee before data collection to identify which role this was in village and regency government offices and in each contractor's office. In the event that the identified informant indicated a colleague who could provide additionally illuminating information, we attempted to contact this colleague to serve as an additional informant (**snowball** sampling).

Community beneficiary FGD participants were selected using a **convenience** method on the basis of which community members were available to participate in an FGD when the evaluation team passed through each village. Since qualitative field work occurred before quantitative field work, it was not necessary to avoid community members who may have been fatigued from participating in the quantitative survey. Given that there were reportedly few enterprises in each village, especially those that were not basic kiosks or shops, we used a **purposive sampling** technique to ensure that the firms selected represent as diverse a cross-section as possible of enterprises in each treatment unit. Table 11 includes a summary of the respondents ultimately sampled, separated by location and respondent category.

Table 11: Summary of respondents by qualitative protocol, baseline data collection

Interviewee	# Interviews	# Interviewees	Percentage of Interviewees Female	Location
Officials				
Kepala Desa	6	6	0	*All*
Head of sub-district	1	1	0	Long Beliu
Bappeda head of economics division	1	1	100	Sumba
Bappeda head of GIS unit	1	1	0	Sumba
Bappeda secretary	1	1	0	Sumba
Project Grantees/Managers and Contractors				
Anekatek Solar	2	3	0	Berau
MCA-I	2	2	0	Jakarta
Akuo Energy	1	1	0	Berau
Castlerock	2	2	50	Sumba
Construction manager	3	3	0	Sumba and Berau
SEI	1	1	0	Sumba
SPV Leadership				
SPV candidates	6	9	56	Berau
Members of BUMDes electricity unit	3	7	29	Sumba
Household members (FGD)				
Men	6	46	0	*All*
Women	6	53	*100*	*All*
Indigenous Community of Dayak Basap	1	14	0	Teluk Sumbang
Enterprises				
Large shop owner	1	1	100	Long Beliu

Miller	2	2	0	Long Beliu, Praiwitu
Small shop owner (and other)	3	3	100	Merabu, Teluk Sumbang, Tawui
Carpenter (and other)	4	4	0	Merabu, Teluk Sumbang, Lailunggi, Praiwitu
Water refill enterprise	1	1	0	Teluk Sumbang
Mechanic (and other)	2	2	0	Lailunggi, Tawui
Total	**56**	**164**	**40**	

4.3.4 Exposure Period: Includes Exposure Quantity and Duration

We propose to conduct two follow-up data collection periods to measure short-term and long-term impacts and sustainability of the grants. The first of these would occur 12 months after the commissioning of the grids, in November 2018. By that time, we expect replacements in present levels of energy consumption from old sources to the new micro-grids to be observable. Although changes requiring longer exposure periods may not have had the chance to occur over this timeframe, such as capital investments and productive uses of the new energy source and potential breakdowns in O&M causing stresses in the SPV approach, it will be important to return before control settlement aggregations are potentially contaminated by the rapidly expanding PLN electrification effort in East Sumba in order to preserve the validity of our quasi-experimental design.

We propose to conduct a second follow-up 36 months after the commissioning of the grids, after which changes requiring a longer exposure period will have had the chance to manifest. Although the risk for contamination of our control group during this period will be greater, we will at least be able to detect these longer-term outcomes of interest and document the perceived effect of the SPV approach on long-term sustainability of the infrastructure after the SPVs have had some time to operate autonomously.

5. DATA SOURCES AND OUTCOME DEFINITIONS

This baseline report relies on both existing secondary data on treatment and control areas as well as new, primary qualitative and quantitative data, as described in the following sections.

5.1 Quantitative

5.1.1 Existing

Although existing secondary data is not important to the analysis of outcomes presented in this report, it was essential in developing a sample frame from which treatment and control areas were selected. A list of secondary quantitative and GIS data sources and description of how each was used in the sampling approach can be found in Section 4.3.3.1.

5.1.2 New

Section 4.2.2 links general outcome themes from each evaluation question to new data sources from this evaluation. Annex 9.1 includes the final text of each of the instruments used to generate quantitative data for the evaluation, including the Household Survey, Enterprise Survey, and Village Official Survey. From these instruments, we will use the variables in Table 12 as our primary indicators for outcomes of interest for each evaluation question. Where relevant, we will present other variables that elaborate upon the findings from our key outcome variables. Not all of these variables will be evaluated using an IE methodology, but all will be presented as pre- and post-measurements at minimum and qualified accordingly.

Table 12: Outcome variables, by evaluation question and data source

EQ	Variable	Calculation	Data Source	Question(s)
EQ1	Liters/month household diesel consumption	Respondent recall	Household Survey	75b_1
EQ1	Liters/month household gasoline consumption	Respondent recall	Household Survey	75b_2
EQ1	Liters/month household kerosene consumption	Respondent recall	Household Survey	75b_3
EQ1	Lamp-hours per day from electric sources	Summed number of bulbs/lamps in household requiring electricity times hours per day each is illuminated	Household Survey	68, 69
EQ1	Hours per day of access to electricity	Respondent recall	Household Survey	51
EQ1a	IDR per month expended on consumption of energy	Units per month consumed of various energy sources times price per unit	Household Survey	48_1, 47_3, 49_4, 62,

EQ	Variable	Calculation	Data Source	Question(s)
				76_1-76_7, 76_8
EQ1a	IDR per month expended on repair of energy sources	Respondent recall per energy source, normalized to the month	Household Survey	50_2, 50_4
EQ1	Type of energy source that powers enterprise appliances	Respondent recall	Enterprise Survey	10
EQ1	Type of energy source used for productive processes among enterprises	Respondent recall	Enterprise Survey	12
EQ1	Operating hours of enterprise on a regular business day	Respondent recall	Enterprise Survey	14
EQ1	Number of lighting devices used by enterprises	Respondent recall	Enterprise Survey	15
EQ1	Number of hours lighting is used per day by enterprises	Coded by enumerator after respondent is prompted to describe typical business day	Enterprise Survey	16
EQ2	Hours per day spent on income generating activity, including farming	Coded by enumerator after respondent is prompted to describe typical day; calculated only for adult male and adult female in house	Household Survey	113_2, 114_2
EQ2	Occupational income	Respondent recall; sum of income per month from primary occupation and secondary occupation	Household Survey	24
EQ2	Income from transformed agricultural products	Units of transformed product sold times price per unit, summed across all transformed products	Household Survey	98, 99
EQ2	Number of enterprises that will purchase machinery/appliances in the case of electrification	Respondent projection	Enterprise Survey	20
EQ2	Number of cases in which micro-grid connectivity will improve enterprise production and prices	Respondent projection	Enterprise Survey	21
EQ3	Tons CO_2e emitted/month from combustion of diesel, gasoline, and kerosene	ICF International Equation 9, using diesel, gasoline, and kerosene consumed per month as an input	Household Survey	75b_1, 75b_2, 75b_3
EQ4	Qualitative, N/A		N/A	N/A

5.2 Qualitative

All qualitative data used in support of this evaluation is new; the primary data collected using the qualitative protocols is located in Annex 9.7 of this report. The qualitative analysis of the combined information from all of these KIIs and FGDs is not oriented towards developing established metrics for each of the evaluation questions. Instead, the analysis is meant to bring out common themes expressed by many respondents, certain types of respondents, or uniquely informed or knowledgeable respondents that either provide important context for quantitative findings or establish a qualitative baseline to which a future state of affairs can be compared. For EQ1 through EQ3, the former purpose of qualitative findings is more relevant. For EQ4 in particular—and EQ2 to a lesser extent—the latter purpose of qualitative findings is pursued.

6. FINDINGS

In this section we present the baseline conditions for each grant for each of the four evaluation questions based on primary quantitative and qualitative data collected between September and November of 2017. We also reassess our experimental methodology on the basis of our baseline data and present the implications of this for endline data collection.

6.1 Descriptive Statistics, Regression Results, and Qualitative Findings for Key Variables

After describing demographic characteristics of treatment areas in East Sumba and in Berau, we proceed to present descriptive statistics, regression results, and qualitative findings for outcomes of interest that are relevant to each of the four evaluation questions. We conclude the discussion of findings for each evaluation question with an assessment of what these findings imply for the project logic underlying each of these grants.

6.1.1 Demographics Information on Treatment Areas

Table 13 displays key household- and *dusun*-level[71] demographic characteristics of treatment households in Berau and East Sumba, weighted to better reflect the actual treatment population.

Table 13: Household demographic characteristics, by kabupaten

	Berau		East Sumba	
	Mean	**SE**	**Mean**	**SE**
Mean years of education, adults in household	6.66	(0.85)	6.26	(0.31)
Total household income, tens of thousands IDR	477.10	(111.69)	219.98	(37.09)
Total household members	4.07	(0.37)	4.66	(0.09)
Rooms in main building of household	4.55	(0.54)	3.56	(0.14)
Years living on current plot of land	9.35	(1.64)	15.87	(0.98)
Years of access to at least one energy source	4.60	(1.09)	3.06	(0.15)
Non-energy expenditure, tens of thousands IDR	219.47	(44.76)	155.04	(10.82)
Walls made of wood, brick, or stone	96%	(0.02)	40%	(0.11)
Floor made of earth	0%	(0.00)	37%	(0.06)
Male head of household[72]	91%	(0.03)	91%	(0.01)
Household does not own means of transport	15%	(0.09)	43%	(0.05)

[71] Several different terms are used in this report to describe sub–village-level geographic units. In Indonesia, villages are referred to as *desas*, and sub-village administrative units are sometimes referred to as *kampungs* or *dusuns*, depending on the location. At a more granular level, community or neighborhood units within a desa are referred to as *rukun warga* (RW) or *rukun tetangga* (RT). This is complicated by the fact that the treatment clusters in the grant in East Sumba do not always reflect a consistent administrative geographic cluster—the micro-grids in Tawui each span multiple dusuns but are individually referred to by the implementer as kampung-level grids. In other places, such as in Lailunggi, a micro-grid spans a whole village. In this report, we borrow the implementer's terminology and will refer to treatment clusters as kampungs. When we speak about conditions in the administrative geographic cluster in which a household resides, we will refer to their dusun. By way of example, of the 46 households sampled that will be connected to the Tawui South kampung's micro-grid, 28 live in the Oriangu administrative dusun, 17 live in the Janggamangu dusun, and one lives in the Rinhomu Pahamu dusun. The 28 households in the Oriangu dusun are themselves split among 11 different RTs.

[72] Per established sampling protocols, interviewed respondents were not always heads of household but were instead household members most informed about electricity use; 133 of 150 (88.7%) of respondents in Berau were men, compared to 302 of 330 respondents (91.5%) in East Sumba.

	Berau		East Sumba	
Households per dusun where household resides	154.34	(22.81)	163.97	(49.24)
Km from dusun road to main road	15.33	(10.62)	2.05	(1.22)
HH in dusun that has an elementary school	98%	(0.03)	72%	(0.19)
HH in dusun that has a BUMDes or cooperative	0%	(0.00)	59%	(0.20)
HH in dusun that has a farmers'/fishermen's group	37%	(0.36)	72%	(0.19)

The data present clear disparities between the two treatment areas in terms of wealth. The average treatment household in Berau earns about 4.8 million IDR per month, equivalent to a little under 360 USD. The average treatment household in East Sumba, in turn, earns less than half that amount. East Sumba seems also to be more agrarian in nature—18% of average household income comes from the sale of agricultural goods, compared to just 6% in Berau. Indeed, nearly three quarters of households in east Sumba live in a dusun with a farmer's or fishermen's group, compared to barely over a third in Berau.

The aforementioned pattern holds for non-monetary metrics of wealth as well. Almost all households in Berau have walls constructed from a sturdy material such as wood, brick, or stone; none have floors made of bare earth. Nearly 40% of households in East Sumba have walls made from a flimsier material, such as bamboo, and floors made of earth. Most households in Berau own at least one means of transportation, while 43% of households in East Sumba have access to no transportation at all.

There is a significant disparity between kabupatens with respect to experience with community organization—local officials where treatment households resided reported that 59% of households in East Sumba lived in dusuns with an existing BUMDes or cooperative. No such dusuns were reported in Berau.

6.1.2 Previous Access to Government and Aid Programs (Qualitative)

All treatment villages have participated in a range of governmental and aid programs, covering educational and health assistance, the nationwide health insurance program, latrines, and roof and well installation programs. Treatment villages have received funds through Indonesia's *Dana Desa* ("village fund") program since 2011, which tripled the direct financial transfers from the central to the local village government. Teluk Sumbang (Berau), for example, receives approximately 146,000 USD annually. Community members, village heads, enterprises, and SPV applicants/BUMDes members unanimously state that the village fund infrastructure investments improved well-being tremendously in their respective villages and empowered communities to plan and foster village development autonomously according to their needs. The village fund in certain treatment areas has been used to finance electrification projects. For example, the three Sumbanese communities financed solar home systems (SHSs) for poor community members. In Praiwitu, 60 small SHSs were purchased. The initiative was not further extended because of the initiation of the CBOG RE project.

Treatment communities also have a long history of requesting—and receiving—electricity from various sources. In Berau, the PLN grid currently reaches villages that are approximately 30 kilometers away. Though none of the treatment communities currently have access to PLN power, the two sub-district capitals of the district of Long Beliu are scheduled for PLN connection in 2018. One sub-village of Long Beliu, which is outside the project's reach, will be connected as well. PLN does not currently plan to reach the other two Berau communities (Merabu and Teluk Sumbang). According to the grantee, PLN has agreed not to enter the treatment communities in the 10 years following solar PV micro-grid construction.

In all Berau communities, micro-hydro generators were installed in recent years by different projects. In Long Beliu, for example, a project was financed by the National Program for Community Empowerment (*Program Nasional Pemberdayaan Masyarakat*, or PNPM). These generators are not currently working.

In East Sumba, the PLN network reaches 16 of 22 districts but none of the treatment communities. Grid-connected villages are approximately 30 kilometers away. All three treatment communities have contacted PLN about a connection to the grid. In the past, villages requested PLN electricity through lengthy processes. For example, the community of Praiwitu regularly requested PLN electricity from 2009 to 2015 but received no response. Surprisingly, PLN visited Praiwitu this year, in spite of the ongoing project process, and delivered poles for grid connection. No construction work had been completed at baseline, however. Villagers in the two other communities reported similar events: PLN offered electricity—via letters, visits, or even construction material—and some neighboring villages are currently being connected to a PLN grid. The grantee in East Sumba is still waiting for PLN to issue the electricity access area license, which assures that no other parties can cover the areas.

Furthermore, the governmental SHS dissemination project PLN SEHEN (*Super Ekstra Hemat Energi*, i.e., Super Extra Energy-Efficient) was implemented in all three Sumbanese communities. According to FGD respondents, PLN shipped the SHSs to the villages and charged a deposit of around 3.40 USD. After a year, PLN took back the SHSs without paying back the deposit. According to FGD respondents in all three communities, PLN activities were discontinued due to payment defaults and poor communication between the project and the communities.

Last, in two of the Sumbanese villages, individual female community members reported that they had been offered a biogas digester three to four years ago by "*Indonesians from the research and development scene.*" The interviewees made preparations for the digesters to be installed, but the individuals did not return. In Lailunggi, a communal diesel generator financed by the government broke in 2015 after one year of operation due to a lack of resources for maintenance and management because of households' payment defaults. At baseline, cables of the system had been stolen and poles demolished.

6.1.3 EQ1: Energy Consumption Among Households and Businesses and Implications for Household Expenditures

6.1.3.1 *Energy Consumption at the Household Level*

For households in treatment areas, typical energy sources utilized vary greatly between East Sumba, where small-scale solar technology appears most prevalent, and Berau, in which households rely more heavily on individual or shared generators (often referred to as gensets) for power. Table 14 displays energy source and consumption disaggregated by kabupaten.

Table 14: Energy source and consumption, by kabupaten

		Berau		East Sumba	
Variable	**Definition**	**Mean**	**SE**	**Mean**	**SE**
HH uses a solar energy source	% of HH	29.5%	(0.15)	84.0%	(0.04)
HH uses an individual genset	% of HH	34.3%	(0.23)	9.9%	(0.02)
HH uses shared genset	% of HH	61.2%	(0.19)	4.1%	(0.01)
HH has no source of electricity	% of HH	7.8%	(0.02)	7.3%	(0.02)
Diesel consumption	liters/month	14.0	(3.34)	4.8	(1.33)

Gasoline consumption	liters/month	30.1	(10.58)	11.7	(2.75)
Kerosene consumption	liters/month	0.8	(0.19)	2.2	(0.55)
Electricity access	hours/day	5.3	(0.66)	9.2	(0.54)
Lighting from an electric source	lamp-hours/day	26.8	(0.85)	27.7	(2.08)

Very few households surveyed lacked access to any source of electricity whatsoever. Only 33.3% of households sampled in Berau and 41.9% in East Sumba that did not presently have access to electricity have ever had access to electricity, with most having lost it due to malfunctioning equipment. No sampled household in either of the kabupatens has access to PLN electricity. Many respondents did not know the wattage of solar panels when they possessed them, but those who did know indicated that panels in East Sumba were generally in the 3.5- to 20-watt range. In Berau, they ranged from 50 to 60 watts.

Households in Berau average only a little over five hours of access to electricity per day—qualitative evidence indicates that this corresponds to a typical timeframe of 6 pm to 10 or 11 pm during which village generators are turned on to illuminate houses and shops. Meanwhile, electricity is available to households in Sumba for an average of around nine hours per day, although this electricity may be used to illuminate fewer lamps or bulbs than in Berau. Indeed, households in Sumba have on average only three bulbs requiring electricity, compared to five in Berau.

Besides the listed non-renewable energy sources, households in each site also consume a significant amount of firewood—mostly for cooking. Households in East Sumba consume an average of 120.5 kilograms (kg) of firewood per month, compared to 45.0 kg per month in Berau.

Energy expenditure also varies across the sites, averaging over twice as much per month in East Sumba as in Berau, likely reflecting the much larger reliance on gensets rather than solar.

Table 15: Energy expenditure, by kabupaten

		Berau		East Sumba	
Variable	**Definition**	**Mean**	**SE**	**Mean**	**SE**
Expenditure on energy consumption	IDR/month	559,430	(109,70)	217,081	(36,085)
Expenditure on repair of energy sources	IDR/month	20,148	(13,635)	12,096	(3,859)
Energy expenditure vs. total expenditure	%	21.6%	(0.010)	11.8%	(0.014)

A key outcome in the grants' logic model is that the increased access to electricity resulting from connection to the micro-grid will increase satisfaction among households with the reliability of electricity service. At baseline, 73.0% of sampled households in East Sumba and 69.2% in Berau that possessed energy-saver bulbs, the most commonly owned electric bulb, reported being "satisfied" or "very satisfied" with the lighting quality of their bulb. The two most frequently cited complaints in each community about the power supply was that it is not on all day—reported by 8.2% of households in East Sumba and 23.3% in Berau—and that it is too noisy—according to 3.9% of households in East Sumba and 14.0% of households in Berau.

6.1.3.2 *Energy Consumption at the Enterprise Level*

Current use of equipment requiring electricity at the enterprise level is high in both data collection sites; only 7% of enterprises in Sumba and 16% in Berau report using no equipment or machinery. Among the respective 93% and 82% of enterprises that use equipment, each business owns and uses, on average 1.4 pieces of equipment (1.8 units in Berau and 1.2 units in Sumba). Type and distribution of equipment

varies by kabupaten; while appliances used for lighting are the most commonly owned equipment type in both data collection sites, 89% of enterprises in the treatment group use lighting equipment in East Sumba, compared to 58% in Berau. However, only about half of enterprises in both locations use electricity for equipment other than lighting.

Figure 9 illustrates the type of energy that powers at least one appliance (hence the total does not necessarily sum to 100) in our sampled enterprises, disaggregated by kabupaten. The vast majority of enterprises in East Sumba rely on appliances powered by either connection to electricity (e.g., a generator or solar panel) or by direct combustion of fuel, compared to enterprises in Berau, energy sources for which were spread more evenly between electric, direct combustion, and mechanical power.

Figure 9: Energy source that powers enterprise appliances, by kabupaten

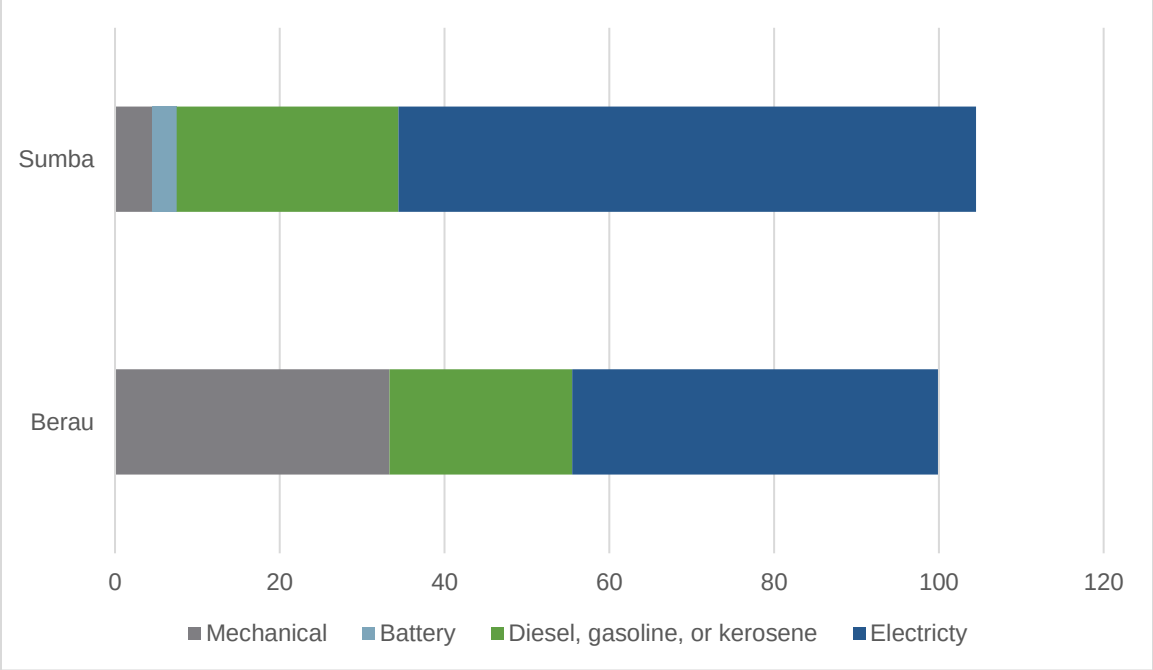

Table 16 presents the energy sources that enterprises in each kabupaten tend to use for lighting and operating equipment. Following previously established patterns of dependency on non-renewable energy among households in each kabupaten, 54.1% of enterprises surveyed from Berau report using non-renewable energy sources such as kerosene for lighting. Meanwhile, 76.1% of enterprises in East Sumba use renewable energy sources for lighting. Firewood proves to be an important source of power for operating equipment in East Sumba enterprises. Despite the reliance on renewable sources for lighting in East Sumba, enterprises in both kabupaten use non-renewable fuel sources most frequently for operating equipment, suggesting that the renewable sources are currently not suitable, either due to hours of operation or wattage, for operating equipment needs.

Table 16: Sources of energy used by enterprises for lighting and operating equipment, by kabupaten

Energy Source	Lighting				Operating Equipment			
	Berau		East Sumba		Berau		East Sumba	
	n	%	*n*	%	*n*	%	*n*	%

Renewable (solar panel, micro-hydro, etc.)	4	16.7	51	76.1	0	0	2	3.0
Fuel, gas, charcoal, kerosene	13	54.1	21	31.3	7	29.2	16	23.9
Firewood	n/a	n/a	n/a	n/a	1	4.2	14	20.9
Other energy source	3	12.5	0	0	5	20.8	1	1.5

Operational hours are relatively constant across districts, with Sumba enterprises remaining open for, on average, 12.7 hours per day, compared to Berau enterprises that remain open for a mean of 11.4 hours daily. Survey findings reveal that lighting usage is not proportional to operational hours, and that enterprises in Sumba use lighting for nearly twice as many hours as their counterparts in Berau; businesses in Berau report a mean of 3.5 hours of lighting use compared to Sumba businesses, which report 6.4 hours of daily lighting use. This finding is directly linked to the potential for productive use (discussed in detail in Evaluation Question 2 findings), as businesses that can remain lit for a greater number of hours have increased capacity to complete productive processes and sell goods.

Overall, the data also show that lighting is a key energy application for enterprises in both data collection sites: 58% of businesses in Berau and 90% in East Sumba report using lighting in some capacity. This differential is likely correlated with the fact that East Sumba enterprises have higher rates of access to renewable energy sources and thus can use power to generate light, potentially at a lower cost. Most enterprises in each kabupaten use energy-saver bulbs for lighting.

6.1.3.3 *Regression Results*

In Table 17 and Table 18 we present the results of linear regression models[73] using the key outcome variables presented above as dependent variables in order to explore the relationship between these variables and demographic characteristics of each of the treatment areas. This exercise is also useful as a baseline test of some of the posited relationships between these variables in the project logic (see Figure 1). In this section we present regression models for Berau and East Sumba separately, since the significance and direction of some coefficients differs between the two kabupatens.

Table 17: EQ1 outcomes of interest regression, Berau

Legend	*p*<0.01, positive	*p*<0.05, positive	*p*<0.10, positive	*p*<0.01, negative	*p*<0.05, negative	*p*<0.10, negative

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Electr. access	Lamp hrs/day, el.	Diesel l/mo.	Gas l/mo.	Kero l/mo.
Livestock wealth index	0.38	-1.02	-0.12	6.44	0.71
	(0.3820)	(0.6820)	(0.9840)	(0.2180)	(0.3770)
Durable goods index	-0.01	1.61	2.23	2.29	0.07
	(0.9130)	(0.0034)	(0.0803)	(0.0450)	(0.6950)
Occ. income, 10K IDR/mo.	0.00	0.00	0.02	0.01	0.00
	(0.3980)	(0.6680)	(0.0211)	(0.1240)	(0.7790)
Tranf. ag. income, 10K IDR/mo.	0.00	0.02	0.03	-0.06	0.00
	(0.8630)	(0.3570)	(0.5120)	(0.1530)	(0.8550)

[73] All regressions presented in this report are simple multivariate linear regressions using weighted data from treatment households with clustered standard errors. *p*-values are shaded according to the significance of the coefficient (darker is more significant) and the direction of the effect (green is positive, red is negative).

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Electr. access	Lamp hrs/day, el.	Diesel l/mo.	Gas l/mo.	Kero l/mo.
Non-tranf. ag. income, 10K IDR/mo.	-0.01	-0.02	-0.13	0.17	-0.01
	(0.3810)	(0.5350)	(0.1360)	(0.0322)	(0.2850)
Male head of household	-1.22	-8.01	5.55	4.89	0.51
	(0.0898)	(0.0526)	(0.5640)	(0.5700)	(0.6990)
Mean years educ. among HH members	0.11	1.32	-0.17	-0.99	0.11
	(0.0973)	(0.0004)	(0.8380)	(0.1920)	(0.3260)
Non-energy exp., 10K IDR/mo.	0.00	0.01	0.02	0.05	0.00
	(0.1050)	(0.3450)	(0.4310)	(0.0170)	(0.7920)
No. of HH members	0.00	-1.03	-4.13	-1.73	0.11
	(0.9770)	(0.2080)	(0.0328)	(0.3130)	(0.6860)
Rooms in HH	-0.24	1.89	-0.37	-0.72	-0.40
	(0.1700)	(0.0579)	(0.8750)	(0.7280)	(0.2050)
Farmer or fisher, for sale in HH	-0.13	5.18	5.94	-7.29	0.64
	(0.7730)	(0.0482)	(0.3320)	(0.1830)	(0.4450)
HH does not own transport	0.27	1.79	-8.65	-18.13	-0.14
	(0.6630)	(0.6140)	(0.2990)	(0.0158)	(0.9000)
HH uses ind. genset	1.41	1.04	0.88	-2.75	1.25
	(0.0434)	(0.7940)	(0.9250)	(0.7410)	(0.3270)
HH uses shared genset	1.33	2.91	-1.02	-18.87	1.19
	(0.0239)	(0.3860)	(0.8970)	(0.0080)	(0.2690)
HH uses solar panels or SHS	3.11	12.40	-0.71	-2.53	0.09
	(0.0000)	(0.0000)	(0.9180)	(0.6780)	(0.9220)
Dusun infrastructure index	0.30	2.80	10.23	-1.25	0.65
	(0.3070)	(0.0943)	(0.0098)	(0.7210)	(0.2270)
Constant	4.58	2.70	3.18	35.55	-0.70
	(0.0001)	(0.6740)	(0.8330)	(0.0092)	(0.5580)
Observations	150	150	150	150	150
R-squared	0.382	0.492	0.328	0.482	0.056

Table 18: EQ1 outcomes of interest linear regression, Sumba

Legend	*p*<0.01, positive	*p*<0.05, positive	*p*<0.10, positive	*p*<0.01, negative	*p*<0.05, negative	*p*<0.10, negative

	(1)	(2)	(4)	(5)	(6)
VARIABLES	Electr. access	Lamp hrs/day, el.	Diesel l/mo.	Gas l/mo.	Kero l/mo.
Livestock wealth index	0.21	2.77	3.73	-1.36	-0.10
	(0.3450)	(0.0032)	(0.0000)	(0.1070)	(0.7230)
Durable goods index	0.00	2.98	4.47	6.78	2.41
	(0.9960)	(0.0333)	(0.0003)	(0.0000)	(0.0000)
Occ. income, 10K IDR/mo.	0.00	0.00	0.01	0.01	0.00
	(0.5910)	(0.4540)	(0.1210)	(0.0634)	(0.0993)

	(1)	(2)	(4)	(5)	(6)
VARIABLES	Electr. access	Lamp hrs/day, el.	Diesel l/mo.	Gas l/mo.	Kero l/mo.
Transf. ag income, 10K IDR/mo.	0.00	0.01	0.00	0.00	0.00
	(0.6910)	(0.4400)	(0.9070)	(0.9930)	(0.7570)
Non-Tr. ag. income, 10K IDR/mo.	0.00	-0.01	0.13	0.01	0.00
	(0.4980)	(0.7190)	0.0000	(0.3760)	(0.5760)
Male head of HH	1.25	-0.28	-0.93	3.36	-1.11
	(0.1010)	(0.9290)	(0.7370)	(0.2440)	(0.2310)
Mean years educ. among HH adults	0.08	0.06	-0.60	-0.01	0.18
	(0.2960)	(0.8460)	(0.0357)	(0.9660)	(0.0539)
Non-energy exp., 10K IDR/mo.	0.00	0.03	0.00	0.03	0.00
	(0.2210)	(0.0001)	(0.8590)	(0.0010)	(0.3280)
No. HH members	0.03	-0.19	0.70	-0.85	0.06
	(0.7940)	(0.6850)	(0.0898)	(0.0463)	(0.6690)
Rooms in HH	0.40	2.59	-0.66	-1.45	-0.43
	(0.0373)	(0.0013)	(0.3420)	(0.0455)	(0.0654)
Farmer or fisher, for sale in HH	0.18	-3.82	-2.07	1.86	-0.36
	(0.6730)	(0.0343)	(0.1890)	(0.2530)	(0.4920)
HH does not own transport	-0.06	1.83	4.48	-8.26	1.67
	(0.9070)	(0.3620)	(0.0112)	(0.0000)	(0.0048)
HH uses indiv. genset	-0.35	3.78	-2.00	8.26	-0.70
	(0.6890)	(0.2990)	(0.5310)	(0.0128)	(0.5120)
HH uses shared genset	-0.66	-2.45	2.18	2.33	1.37
	(0.5320)	(0.5770)	(0.5700)	(0.5590)	(0.2890)
HH uses solar panels or SHS	6.21	15.08	-0.94	-0.88	-0.69
	0.0000	(0.0000)	(0.6510)	(0.6830)	(0.3230)
Dusun infrastructure index	0.34	2.62	-0.71	4.18	-0.34
	(0.3400)	(0.0814)	(0.5870)	(0.0023)	(0.4350)
Constant	0.69	6.28	5.19	24.61	3.71
	(0.6110)	(0.2690)	(0.2960)	(0.0000)	(0.0262)
Observations	330	330	330	330	330
R-squared	0.37	0.424	0.406	0.443	0.225

The covariates selected explain between 6 and 49% of the variation in our outcome variables of interest. We include two measures of electricity consumption as dependent variables in our regressions—hours of access to electricity per day and lamp-hours per day of lighting from an electric source consumed by a household (the summed combination of the number of bulbs in the house times the number of hours each bulb is lit). All else equal, household connection to a solar energy source is associated with an increase of between 3.11 and 6.21 hours per day of electricity access and an increase of between 12.40

and 15.08 lamp-hours per day of electric lighting, depending on the kabupaten.[74] These increases are significant at over a 99% degree of confidence.

Significant increases in lamp-hours per day of electric lighting are also correlated in both kabupatens with increases in the durable goods wealth index and the number of rooms in a household. The effect of the gender of the head of household on electricity access is negative in Berau and insignificant in East Sumba, and the effect of at least one household member farming or fishing partially for sale on lamp-hours per day of electric lighting switches signs between the kabupatens. Livestock ownership, a source of wealth that is of particular economic importance in Sumba, is highly significantly associated with an increase in lamp-hours per day of electric lighting in that kabupaten.

Many metrics of wealth are positively and significantly associated with liters per month of diesel, gasoline, and kerosene consumption in both kabupatens. In Berau, the durable goods wealth index, occupational income, and non-transformed agricultural income are all associated with increased consumption of either gasoline or diesel at a minimum 92% confidence level. Likewise, the livestock wealth index is positively associated with diesel consumption and the durable goods wealth index is positively associated with the consumption of all three fuels at a minimum 99.8% degree of confidence in East Sumba.[75] A 1,000,000 IDR increase in occupational income per month is associated with a two-liter-per-month increase in diesel consumption in Berau and a one-liter-per-month increase in gasoline consumption in East Sumba, all else held constant. Surprisingly, despite the difference in diesel consumption between Berau, where use of non-renewable energy sources is high, and Sumba, where renewable sources are more prevalent, possession of a solar energy source is not significantly associated with reductions in any fossil fuel consumption within either of the kabupatens after other factors have been controlled for.

Unsurprisingly, households that do not possess any means of transportation consume between 8.26 and 18.87 liters of gasoline fewer per month than households who do, all else equal. Households with access to a shared genset in Berau consume 18.87 fewer liters of gasoline per month than those without access, all else equal. An index constructed from the village official dataset as a proxy for the remoteness of the dusun where a household resides is significantly and positively associated with diesel consumption in Berau as well as with gasoline consumption in East Sumba.

Table 19 presents regression results using monthly household expenditure on energy consumption and repair of energy sources as dependent variables, with indicators of electricity consumption included among the other covariates. Monthly consumption of diesel, gasoline, and kerosene were not included because these are used as part of the calculation of monthly energy expenditures.

[74] Connection to a shared or individual genset is also associated with increased electricity access in Berau, although at a lesser magnitude and significance.
[75] See Annex 9.5 for a discussion of how these indices were constructed and which variables are included.

Table 19: EQ1a outcomes of interest linear regression

Legend	*p*<0.01, positive	*p*<0.05, positive	*p*<0.10, positive	*p*<0.01, negative	*p*<0.05, negative	*p*<0.10, negative

	(1) Berau	(2) Berau	(1) East Sumba	(2) East Sumba
VARIABLES	HH energy cons. exp., 10K IDR/mo.	HH energy repair exp., 10K IDR/mo.	HH energy cons. exp., 10K IDR/mo.	HH energy repair exp., 10K IDR/mo.
Livestock wealth index	7.22	-0.46	1.06	-0.12
	(0.3330)	(0.5160)	(0.4030)	(0.6030)
Durable goods index	6.50	-0.03	14.77	0.28
	(0.0001)	(0.8480)	(0.0000)	(0.4170)
Occ. income, 10K IDR/mo.	0.05	0.01	0.01	0.00
	(0.0000)	0.0000	(0.2110)	(0.0969)
Transf. ag. inc., 10K IDR/mo.	-0.04	0.00	0.00	0.00
	(0.4660)	(0.8990)	(0.7250)	(0.9120)
Non-transf. ag. inc. 10K IDR/mo.	0.06	0.01	0.10	0.00
	(0.6250)	(0.5450)	(0.0000)	(0.3000)
Male head of household	16.65	0.01	2.48	0.90
	(0.1890)	(0.9920)	(0.5640)	(0.2420)
Mean years educ. among HH adults	-1.38	-0.16	-0.13	0.04
	(0.2260)	(0.1480)	(0.7750)	(0.5720)
Total no. HH members	-4.63	-0.21	0.10	-0.16
	(0.0716)	(0.3800)	(0.8750)	(0.1540)
Total no. rooms in HH	0.82	0.04	-1.86	-0.11
	(0.7880)	(0.8890)	(0.0902)	(0.5610)
Farmer or fisher, for sale in HH	-3.95	1.20	0.98	-0.03
	(0.6160)	(0.1080)	(0.6920)	(0.9480)
HH does not use transport	-30.19	-1.11	-4.50	-0.06
	(0.0052)	(0.2690)	(0.0982)	(0.8970)
HH uses indiv. genset	-12.89	1.68	5.11	7.31
	(0.2940)	(0.1480)	(0.2950)	(0.0000)
HH uses shared genset	-20.02	-1.35	6.54	0.96
	(0.0543)	(0.1690)	(0.2720)	(0.3660)
HH uses solar panels or SHS	-9.43	-0.92	-2.73	0.30
	(0.3490)	(0.3320)	(0.4790)	(0.6590)
Dusun infrastructure index	11.57	-0.22	5.60	0.73
	(0.0242)	(0.6510)	(0.0062)	(0.0441)
HH electricity access per day (hrs)	2.25	0.37	-0.19	-0.03
	(0.1710)	(0.0175)	(0.6000)	(0.6660)
Lamp-hours per day for lighting fixtures requiring electricity	-0.08	0.00	0.20	0.04
	(0.7750)	(0.9020)	(0.0182)	(0.0099)

	(1) Berau	(2) Berau	(1) East Sumba	(2) East Sumba
VARIABLES	HH energy cons. exp., 10K IDR/mo.	HH energy repair exp., 10K IDR/mo.	HH energy cons. exp., 10K IDR/mo.	HH energy repair exp., 10K IDR/mo.
Lamp hours per day for lighting fixtures not requiring electricity	-1.17	0.07	-0.01	0.05
	(0.2690)	(0.5000)	(0.9770)	(0.2710)
Constant	34.22	-1.47	37.77	0.84
	(0.1010)	(0.4550)	(0.0000)	(0.5420)
Observations	150	150	330	330
R-squared	0.556	0.573	0.503	0.307

Possession of durable assets predicts significant and sizable increases in spending on energy consumption in both sites, as does the index constructed as a proxy for remoteness of the dusun where a household is located (in this case, households in more remote dusuns spend more on energy, all else equal). An increase of 100,000 IDR/month in occupational income in Berau is associated with a 5,000 IDR increase in monthly expenditure on the consumption of energy as well as a 1,000 IDR increase in monthly expenditure on the repair of energy sources, each significant at over a 99% degree of confidence. Although this relationship is barely significant and of a lesser magnitude in East Sumba, an equally significant impact of larger magnitude exists for non-transformed agricultural income, where a 100,000 IDR/month increase predicts a 10,000 IDR increase in expenditure on the consumption of energy.

In both East Sumba and Berau, the absence of a means of transportation in a household is associated with a decrease of between 45,000 and 301,900 IDR per month in expenditure on energy consumption (although this coefficient is only significant at a 90% confidence level in East Sumba, where the magnitude of the change is smaller). As established in the previous section, households without a means of transportation tend to consume significantly less gasoline, thus reducing energy expenditure. In East Sumba, consumption of energy from an individual genset is associated with a 73,100 IDR/month increase in expenditure on the repair of energy sources.

Finally, one metric of electricity consumption is significantly associated with increases in expenditure in both Berau and Sumba. In Berau, each additional hour of access to electricity per day corresponds to a 3,700 IDR/month increase in expenditure on energy repair, all else equal. Meanwhile, in East Sumba, each additional lamp-hour of electric lighting per day is associated with a 400 IDR/month increase in expenditure on energy source repair and a 2,000 IDR/month increase in the consumption of energy. These coefficients are consistent with findings from our other regressions, in the sense that expenditure only increases with access in Berau, where non-renewable sources are more prevalent.

6.1.3.4 *Assessment of EQ1 Project Logic*

Baseline quantitative findings support the notion that access to a solar PV micro-grid is likely to increase the consumption of energy for beneficiary households—our regression results indicate that households currently with access to solar energy sources have several hours per day more of access to electricity than those who do not. Additionally, connection to the micro-grid promises to increase the capacity of households with existing solar electricity sources by over 400 watts in East Sumba and by 900 watts or

more in Berau.[76] As most enterprises in each location rely heavily on equipment for lighting, and enterprises in East Sumba in particular utilize equipment requiring electricity, there is a strong potential for changes in consumption at the enterprise level as well.

Although regression results do not link use of a solar energy source to reduced fuel consumption at baseline, seemingly at odds with the theory of change and GP objective of reducing fuel consumption, this could be related to the low capacity of solar energy sources currently in use. The increased capacity of the micro-grid compared to current solar sources for each household may be sufficient to encourage substitution.

Qualitative evidence suggests that there is a high likelihood of strong uptake of the micro-grid connection in both kabupatens. In Berau, interviewed community members expressed displeasure with the cost and noise associated with individual and community generators. In East Sumba, community members expressed that the solar energy sources currently in use are under-capacitated for anything more than television and lighting, and that they are not easy to use. All communities are therefore eager to obtain access to 24-hour service and higher capacities, which is expected to allow them to "use more than just TV and lighting."

Furthermore, access to energy from micro-grids at the household level may also be expected to reduce energy expenditures among most beneficiary households. Expenditure on energy is lower in East Sumba, where the prevalence of renewable energy sources is higher than in Berau, where non-renewable sources are more prevalent. Even within kabupatens, households across all kampungs with individual gensets pay a statistically significant higher amount for energy consumption and repair of energy sources than their peers without such a connection. This relationship also holds for households with access to a shared genset, except for in Long Beliu and Merabu, where community leaders explained in key informant interviews that village gensets and the diesel used to power them are provided to the community for free as part of a corporate social responsibility initiative from palm oil and logging enterprises operating in the area.[77] Indeed, in these communities energy expenditure may actually increase relative to the baseline scenario if they elect to pay a tariff for more constant and less noisy electricity instead of continuing to rely on free power from community generators.

Without considering the consumption of diesel, gasoline, and kerosene as factors, our regression results indicate that wealth and electricity consumption are also linked to increased expenditure on the consumption of energy. Hence, some of the reduction in household expenditures likely to be brought on by household substitution of electricity from the micro-grid for electricity from generators will be negated by a net increase in energy consumption, and the net decrease in expenditures will be dependent on the price differential between current fuel sources and the tariff for the micro-grids.

[76] For context, a 900-watt capacity connection with constant lighting throughout a household could still adequately power a standard refrigerator or freezer plus a television. Most solar panels currently in use by the households in East Sumba have a capacity below 20 watts. A 20-watt capacity connection would be enough to power a few light bulbs and a small television with the potential to recharge a radio, flashlight, and phone throughout the day.

[77] It should be noted that these gensets only cover one sub-village in Long Beliu and exclude Mapulu in Merabu. Although they provide a consistent supply, it is only available at night and community members reportedly demand energy in excess of what the generators are able to provide, frequently supplementing their use with other energy private energy sources.

An important caveat to the support that our findings lend to the project logic is that the baseline level of fossil fuel consumption in East Sumba is small due to the prevalence of solar energy sources. Hence, at least in East Sumba, the potential for impacts lies much more in increased consumer surplus through higher capacity and more reliable electricity than it does in expenditure savings by substitution of renewable energy in the place of energy from non-renewable sources. On the other hand, households in Berau stand to gain much more in the form of expenditure savings by connecting to a new micro-grid, given the existing level of expenditure on diesel and gasoline.

6.1.4 EQ2: Productive Use at the Household and Community Levels

A key outcome identified by the Green Prosperity logical framework is the generation of increased local economic opportunities from the utilization of renewable energy. Given this, the evaluation was structured to capture potential for increased productive use of renewable energy following connection to the micro-grid, operating under the assumption that beneficiaries would achieve increased productive use through either engaging in new entrepreneurial activity or adding value to existing enterprises. The following section will present findings relevant to this outcome from sampled households and enterprises within the treatment area and identify potential for increased productive use following implementation of the Green Prosperity grant portfolio.

6.1.4.1 *Household Survey Findings*

Table 20 presents descriptive statistics for outcome indicators that could potentially be affected by economically productive uses of electricity from the new solar PV micro-grids. Although the level of income from transformed agricultural products is statistically equivalent in the two kabupatens at baseline, the average household's occupational income in Berau is over three times the average household's occupational income in East Sumba. This is likely related to the diversity of income-generating occupations practiced by people in Berau compared to East Sumba, where only 6.9% of heads of household have an income-generating primary occupation that is not farming, fishing, or hunting for sale.

Table 20: Household-level EQ2 outcomes of interest, by kabupaten

Variable	Definition	Berau		East Sumba	
		Mean	SE	Mean	SE
Occupational income of household	Average IDR/month, all members	4,059,016	(1,290,692)	1,506,012	(282,972)
Income from transformed agricultural goods	Average IDR/month, all members	142,400	(46,961)	102,690	(31,521)
Time spent on income-generating activity, adult men	Hours per day	8.22	(0.17)	6.12	(0.12)
Time spent on income-generating activity, adult women	Hours per day	3.65	(0.17)	4.11	(0.12)
Head of household's primary occupation is a farmer, partly for sale	% of households	25.4%	(0.10)	46.1%	(0.05)
Head of household's primary occupation is a farmer for own consumption	% of households	19.9%	(0.08)	37.0%	(0.06)

Variable	Definition	Berau		East Sumba	
		Mean	SE	Mean	SE
Head of household's primary occupation is non-farming/fishing/hunting	% of households	21.5%	(0.11)	6.90%	(0.02)

Quantitative and qualitative data support the notion that the economies in each of these locations is primarily local and run by micro-enterprises, with only some export of goods to the regional economy reported in East Sumba and Teluk Sumbang. The Household Survey indicates that the most frequent durable assets used for productive uses are refrigerators (used by 7.3% of households in Berau, 0.1% in East Sumba), phones (used by 17.1% of households in Berau, 10.0% in East Sumba, presumably to sell credit to use local telecom networks), and stoves (used by 4.5% of households in Berau, 4.2% in East Sumba). Computers, printers, mills, and sewing machines are all used by an occasional household at negligible rates. Households sometimes reported that they had recently purchased durable goods in anticipation of connection to the micro-grid, most of which were geared toward information access. The most frequently reported goods were smartphones, non-smartphones, televisions, and satellite receivers.

6.1.4.2 *Enterprise Survey Findings*

Out of 142 surveyed enterprises, 91 are identified as within the treatment area (67 in East Sumba, 24 in Berau). The majority of businesses identify themselves as trading enterprises, with 78 commercial kiosks, or *warungs*,[78] comprising 86% of the sample. Eleven household industry enterprises comprise 12% of the sample, while restaurants and large industry businesses are sparingly represented. This distribution is, for the most part, mirrored in both data collection sites, with 14 trading enterprises, one restaurant, and no large industry businesses surveyed in Berau,[79] and 64 trading enterprises, zero restaurants, and one large industry business surveyed in East Sumba. It is worth noting that while household industry enterprises comprised a mere 3% of businesses in East Sumba, they made up 38% of the sample in Berau. The average enterprise age across sub-villages is 4.6 years.

In addition to enterprise type, survey findings shed light on services offered by businesses across data collection sites. While the majority of Berau businesses are categorized as part of the food and beverage industry, enterprises in East Sumba are heavily involved in the sale of small products such as cigarettes, batteries, and gasoline. Of the 56 small product enterprises in East Sumba, 17 are concentrated in Lailunggi, while Long Beliu leads Berau in food and beverage institutions, with six distributed throughout the kampung. Table 21 displays the type of services offered by enterprises, disaggregated by kabupaten.

Table 21: Services offered by enterprises in East Sumba and Berau, by kabupaten

Type of service offered by enterprise	Berau		East Sumba	
	n	%	*n*	%
Weaving	5	14.3	0	0.0
Furniture/carpentry	6	17.1	5	4.5

[78] Small family-owned business
[79] Although no large industries were surveyed in Berau, there are large extractive industries operating in the area: 1.6% of the population in our three treatment villages are employed by logging, palm oil, or rubber enterprises.

Type of service offered by enterprise	Berau		East Sumba	
Sale of small products	7	20.0	56	50.0
Rice milling	1	2.9	6	5.4
Other goods and services	8	22.9	10	9.0
Food and beverages	8	22.9	34	30.0
Clothes	0	0.0	1	0.9
Total	35	100.0	112	100.0

Enterprises in Sumba serve a mean of 11.1 customers per day and are more highly frequented than those in Berau, which serve, on average, 8.3 customers per day. Furthermore, qualitative findings that describe sub-villages in East Sumba as highly localized economies are corroborated by customer composition of enterprises across data collection sites—57% of all enterprises surveyed in East Sumba obtain 60% of their customers or more from either their immediate sub-village or a neighboring (walkable) locality. This indicates that, while businesses in Sumba may be empowered to store refrigerated goods or light their storefronts for more hours per day following electrification, the majority of enterprises will still be serving the same population and thus may have limited potential for business growth. Only 38% of enterprises in Berau, on the other hand, source 60% or more of their customers from immediate or neighboring sub-villages, implying that there may be a greater potential for growth throughout this kabupaten.

While the majority of employees in both data collection sites work less than seven hours per day, 29% of enterprises in Berau and 34% of enterprises in Sumba report employing one individual who works for more than seven hours per day. Interestingly, 58% of Sumba enterprises and 77% of Berau enterprises have zero paid employees, which is likely linked to the fact that 33% of Berau employees and 49% of Sumba employees are family members of the enterprise owner.

Enterprise survey responses demonstrate potential for improved production, with 75% of respondents indicating that connection to the micro-grid network will increase their business's production. Table 22 sheds light on the coded responses that enterprise representatives shared when prompted to identify the reason that micro-grid connection could improve their productive capabilities. In East Sumba, a plurality (31%) of respondents indicated that a micro-grid connection would enable them to produce or sell refrigerated goods, implying that a key constraint to entrepreneurial growth in that kabupaten is lack of refrigerators and other preservation-enabling machinery. In Berau, on the other hand, 32% of enterprises cite being able to diversify goods produced or sold as the primary reason that a micro-grid connection could improve productive use.

Table 22: Potential productive uses of connection to micro-grid

Productive Use	Berau		East Sumba		Total	
	n	%	*n*	%	*n*	%
Could sell goods for a higher price	2	10.5	5	10.2	7	10.3

Productive Use	Berau		East Sumba		Total	
	n	%	*n*	%	*n*	%
Could increase production of goods	4	21.1	13	26.5	17	25.0
Would have more time to sell goods	1	5.3	7	14.3	8	11.8
Could produce or sell refrigerated goods	4	21.1	15	30.6	19	27.9
Could diversify goods produced/sold	6	31.6	8	16.3	14	20.6
Could purchase (non-refrigeration) machinery	1	5.3	1	2.0	2	2.9
Other	1	5.3	0	0.0	1	1.5
Total	19	100.0	49	100.0	68	100.0

In addition, 79% of respondents in Berau and 82% of respondents in East Sumba indicated they would buy machinery or equipment for their enterprise if electricity were available in their respective areas, implying that an overwhelming majority of enterprises have the potential to add productive value as a result of connection to the micro-grid. With that being said, the reasons that most enterprises cite that connection to the grid would be helpful imply marginal changes to their business, such as increasing production, increasing operating hours, or increasing the price of goods (supposedly due to some new value-add, such as refrigeration) rather than significant changes in type of enterprise or service. It remains to be seen if investments in machinery and increased connectivity will lead to fundamental shifts in the local economy. One grantee employee indicated that management of expectations would be important in this regard, since it may take ten years or more for "large productive uses to develop" as a result of the intervention.

In order to qualitatively gauge the entrepreneurship of local communities, the qualitative field team prompted interviewed entrepreneurs in six villages to describe how they might generate new or different business as a result of the new source of electricity. Table 23 summarizes business ideas articulated by interviewees, ordered by the number of villages in which at least one interviewee mentioned them; the electricity service that is required for the respective business according to the interviewees is given in parentheses. Most of these ideas target local demand, reinforcing the idea that productive use of the new electricity may be limited to the local economy. Grantee activities in Berau seemingly are working to oppose this trend, as they are training community members to provide ecotourism services that may tap into the regional market. In Sumba, however, grantee trainings are mostly focused on agriculture.

Table 23: Enterprise ideas, by village

Enterprise ideas	Lailunggi, Sumba	Praiwitu, Sumba	Tawui, Sumba	Merabu, Berau	Long Beliu, Berau	Teluk Sumbang, Berau
Handicrafts in evening hours	Yes *(lighting)*	Yes, establish weaver and tailor group *(lighting)*	Yes *(lighting)*	Rattan products *(electric machines and lighting)*	Sewing and rattan products *(lighting)*	Weaving *(lighting)*
Iced products		Sell cool drinks *(refrigerator)*	Sell cool drinks *(refrigerator)*		Ice blocks for cooling of fish and cold drinks for sale *(freezer)*	Ice for fish export and storage; ice pops for school students *(refrigerator and freezer)*

Enterprise ideas	Lailunggi, Sumba	Praiwitu, Sumba	Tawui, Sumba	Merabu, Berau	Long Beliu, Berau	Teluk Sumbang, Berau
Tourism			Located close to surfer spot *(none)*	Hiking and waterfall visits; homestay *(none)*	Trips to waterfalls and gold mining; homestay *(none)*	Coral reef snorkeling and Bidadari waterfall visits *(yes)* Homestay *(none)*
Agricultural storing and processing	Bio fertilizer *(blender)*	Organic fertilizer, cashew roasting by BUMDes *(blender)*	Organic fertilizer *(blender)*			Coconut oil; shred coconuts for pig feed; sort chilies at night; store vegetables; cool fish *(lighting, refrigerator, freezer)*
Cake and cookie production		By individual women, for sale *(blender)*	By individual women, for sale *(blender)*			Coconut cakes by women for ceremonies *(blender)*
Meat or fish production		Chicken sale *(chicken boilers)*	A meatball shop *(refrigerator)*			Fish nuggets; fish more and preserve or export fish *(refrigerator)*
Carpentry shop		Train young people in woodcraft *(none)*				70% of villagers have carpentry skills *(electric appliances)*
Vegetable chips production				By women's group together with TNC *(electric cutter and sealer)*		Banana chips *(yes)*
Drinking water production				Plans and preparations for small industry *(production site will not be reached by CBOG)*		A small water purification shop *(yes)*
Hair salon					Currently an outsider comes to the village *(none)*	
Sell bigger electric appliances					Sell fans and rice cookers and offer credits to clients	

Enterprise ideas	Lailunggi, Sumba	Praiwitu, Sumba	Tawui, Sumba	Merabu, Berau	Long Beliu, Berau	Teluk Sumbang, Berau
					(none)	
Sell electricity vouchers				By small shop owners *(yes)*		
Honey production				Electric emulator is available, but currently no production *(yes)*		

*Note: The table displays mentioning of potential future activities by **at least** one interviewee from the village. Empty cells imply lack of mentioning, not negation. Information in parentheses reproduces the role of electricity for each activity as perceived by interviewees, i.e., "none" implies that no clear use of electricity is stated by interviewees, "yes" implies that it is required but no further details are given.*

6.1.4.3 *Regression Results*

Table 24 displays regression results for household-level outcomes of interest and various covariates, separated by kabupaten. These outcomes are ones which may be expected to change if the program logic underlying Outcome 4 of the grants' log frame proves to be accurate.

Table 24: EQ2 outcomes of interest linear regression, combined

Legend	*p*<0.01, positive	*p*<0.05, positive	*p*<0.10, positive	*p*<0.01, negative	*p*<0.05, negative	*p*<0.10, negative

	Berau				East Sumba			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
VARIABLES	Prim. and sec. occ. inc., 10K IDR	Inc. from transf. Ag. products, 10K IDR	Time spent on inc.-gen. act, hrs/day (females)	Time spent on inc.-gen. act, hrs/day (males)	Prim. and sec. occ. inc., 10K IDR	Inc. from transf. Ag. products, 10K IDR	Time spent on inc.-gen. act, hrs/day (females)	Time spent on inc.-gen. act, hrs/day (males)
Livestock wealth index	15.06	22.45	-0.02	1.63	-9.54	-1.18	-0.02	0.17
	(0.7510)	(0.0575)	(0.9640)	(0.0109)	(0.5210)	(0.8470)	(0.9100)	(0.2860)
Durable goods index	11.19	-3.36	-0.04	-0.25	16.08	-3.13	-0.21	0.11
	(0.3090)	(0.2170)	(0.7500)	(0.0887)	(0.4890)	(0.7440)	(0.3930)	(0.6610)
HH head gender	-87.44	5.73	0.61	-0.82	16.68	9.55	0.44	-0.08
	(0.2830)	(0.7760)	(0.5820)	(0.4610)	(0.7310)	(0.6350)	(0.5220)	(0.8840)
Mean years of educ., HH adults	4.34	-1.48	-0.09	-0.01	13.92	0.06	-0.08	-0.06
	(0.5520)	(0.4130)	(0.2360)	(0.9150)	(0.0051)	(0.9780)	(0.1490)	(0.2820)
Non-energy exp., 10K IDR	1.64	0.01	0.00	-0.01	0.30	-0.03	0.00	0.00
	(0.0000)	(0.7620)	(0.5830)	(0.0153)	(0.0228)	(0.5880)	(0.1370)	(0.4360)
Total no. HH members	22.69	9.99	0.35	0.57	-1.69	-1.51	0.07	-0.02
	(0.1590)	(0.0130)	(0.0436)	(0.0178)	(0.8140)	(0.6110)	(0.3850)	(0.8160)
Total no. rooms in HH	-19.68	4.41	-0.26	0.87	11.18	11.06	0.10	0.01
	(0.3170)	(0.3640)	(0.2090)	(0.0014)	(0.3680)	(0.0317)	(0.4590)	(0.9180)

	Berau				East Sumba			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
VARIABLES	Prim. and sec. occ. inc., 10K IDR	Inc. from transf. Ag. products, 10K IDR	Time spent on inc.-gen. act, hrs/day (females)	Time spent on inc.-gen. act, hrs/day (males)	Prim. and sec. occ. inc., 10K IDR	Inc. from transf. Ag. products, 10K IDR	Time spent on inc.-gen. act, hrs/day (females)	Time spent on inc.-gen. act, hrs/day (males)
Farmer or fisher for sale in HH	81.30	-3.13	-0.53	0.23	50.43	-0.81	-0.51	0.03
	(0.1050)	(0.8000)	(0.3040)	(0.7360)	(0.0655)	(0.9430)	(0.0787)	(0.9120)
HH does not own transport	108.20	14.22	0.00	2.58	-16.89	-4.06	0.10	0.24
	(0.1180)	(0.4050)	(0.9970)	(0.0098)	(0.6010)	(0.7610)	(0.7760)	(0.4930)
HH uses indiv. genset	-62.11	17.28	-0.36	0.00	-33.48	-5.94	0.30	-0.15
	(0.4300)	(0.3750)	(0.6800)	(0.9990)	(0.5520)	(0.7980)	(0.6150)	(0.8070)
HH uses shared genset	-71.33	-4.41	-1.31	1.16	-62.04	-7.73	-0.02	0.21
	(0.3030)	(0.7960)	(0.0962)	(0.2380)	(0.3560)	(0.7810)	(0.9750)	(0.7700)
HH uses solar panels or SHS	-16.68	-14.49	-0.21	1.02	47.85	6.21	-0.27	-0.16
	(0.7960)	(0.3650)	(0.7520)	(0.2540)	(0.2700)	(0.7290)	(0.5680)	(0.7400)
Dusun infrastructure annex	-32.26	10.43	0.27	-0.19	22.53	-3.79	-0.12	-0.02
	(0.2920)	(0.1690)	(0.4240)	(0.6550)	(0.3260)	(0.6890)	(0.6130)	(0.9430)
Daily electricity access (hrs)	-11.06	-0.68	0.00	-0.29	-3.88	0.21	0.02	0.03
	(0.2990)	(0.7970)	(0.9730)	(0.0508)	(0.3440)	(0.9000)	(0.5850)	(0.5750)
Lamp-hours per day of lighting fixtures requiring electricity	-0.03	0.43	0.02	0.00	0.85	0.26	0.00	-0.01
	(0.9890)	(0.3420)	(0.4910)	(0.9730)	(0.3870)	(0.5300)	(0.8910)	(0.3960)
Lamp-hours per day of lighting fixtures not requiring electricity	-6.21	-1.56	-0.10	-0.20	-0.48	0.47	0.00	0.01
	(0.3590)	(0.3520)	(0.1460)	(0.0303)	(0.8660)	(0.6870)	(0.9920)	(0.6870)
Monthly diesel consumption (liters)	1.89	0.05	0.01	0.02	0.97	-0.06	0.01	0.02
	(0.0077)	(0.7940)	(0.4050)	(0.1260)	(0.2600)	(0.8670)	(0.4040)	(0.0708)
Monthly gas consumption (liters)	1.37	-0.25	-0.01	0.02	1.64	-0.06	0.00	0.02
	(0.0945)	(0.2240)	(0.3650)	(0.1190)	(0.0928)	(0.8870)	(0.7620)	(0.1470)
Monthly kerosene consumption (liters)	-0.79	-0.59	-0.06	0.03	3.22	0.13	0.04	0.04
	(0.8810)	(0.6520)	(0.2360)	(0.7180)	(0.3020)	(0.9180)	(0.2140)	(0.2270)
Constant	66.03	-15.80	9.12	0.84	-68.34	-38.75	4.96	4.24

	Berau				East Sumba			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
VARIABLES	Prim. and sec. occ. inc., 10K IDR	Inc. from transf. Ag. products, 10K IDR	Time spent on inc.-gen. act, hrs/day (females)	Time spent on inc.-gen. act, hrs/day (males)	Prim. and sec. occ. inc., 10K IDR	Inc. from transf. Ag. products, 10K IDR	Time spent on inc.-gen. act, hrs/day (females)	Time spent on inc.-gen. act, hrs/day (males)
	(0.6260)	(0.6380)	(0.0000)	(0.6610)	(0.4490)	(0.2990)	(0.0000)	(0.0000)
Observations	150	150	142	138	330	330	315	320
R-squared	0.757	0.152	0.126	0.297	0.215	0.028	0.05	0.069

In Berau, after controlling for non-energy expenditure, which appears to explain most of household occupational income out of the covariates, diesel consumption is the only other variable significantly associated at greater than a 95% degree of confidence. Each additional liter of diesel consumed per month is associated with an increased household income of 18,900 IDR per month. Non-energy expenditure is also a predictor of occupational income in East Sumba, although there are other significant predictors such as mean years of education among adults in the household—each additional year is highly significantly associated with 139,200 IDR/month of income—and whether or not a household includes a farmer or fisherman who sells at least part of his harvest. The latter variable is only weakly significant and likely explained by the fact that most community members either sell part of their harvest or use it all for their own consumption.

Household size and wealth in terms of livestock are associated with increases in household income from transformed agricultural products in Berau, potentially indicating that livestock or manpower is useful as a means for transformation there. Each additional household member is associated with 99,900 IDR/month increase in this type of income, significant at nearly a 99% degree of confidence. In Sumba, the only significant predictor of transformed agricultural income is the number of rooms in the main building of the household, with each additional room associated with a 110,600 IDR/month increase.

There are few significant predictors of the number of hours an average adult male in a household spends on income-generating activities. In East Sumba, the only significant predictor of this variable was whether or not the household included at least one member who was a farmer or fisherman who sold part of their harvest. This had a negative, barely significant effect of only a half hour on time spent on income-generating activity. In Berau, household size had a positive effect, with each additional household member increasing the time spent on income-generating activity by 0.35 hours. Meanwhile, adult males in households with access to a shared genset were associated with a 1.31 hour decrease in time spent on income-generating activity, significant at a 94% confidence level.

Our model is the most predictive for hours spent on income-generating activity by female adults in Berau, where household size, the possession of transportation, non-electric lamp-hours of lighting, and various metrics of wealth all had a statistically significant effect. Women in Berau without a means of transportation in the household are likely to spend 2.58 more hours than their peers, all else being equal, on income-generating activity—an intuitive result. In terms of energy resources, each additional lamp-hour of lighting from a non-electric source is associated with a 0.20 hour decrease per day in income-generating activity. This is a non-intuitive result, as the project posits that additional electricity might extend the working day. Meanwhile, in East Sumba, the only covariate significant at even a 90%

confidence level in predicting time spent on income-generating activity for adult women in the household is diesel consumption, with each additional liter per month weakly associated with a 0.02 hour per day increase in time spent on income-generating activity.

6.1.4.4 *Assessment of Project Logic*

Although enterprises in both Berau and East Sumba seem to be optimistic about the potential for using the increased electricity available from the new micro-grids for productive purposes, the likelihood of this outcome manifesting in a significant way is partially dependent on the magnitude of improvement expected. Our regression results show that, according to our baseline data, important metrics for improved economic opportunity and productive use are relatively unaffected by changes in energy source or energy consumption.

The composition of types of enterprises in each location, the customers they serve, and the improvements they seek as a result of electricity all point to principally local economies in both locations where the potential for improvement of enterprises in the near- and intermediate-term mostly lies in marginal improvements to production or quality of goods sold by each enterprise. This could change to the extent that villages in Berau are able to attract tourists from the regional economy or that agricultural producers in Sumba can export improved goods to a regional market, but qualitative evidence suggests that these changes may be at least decade away.

With this being stated, the ERR calculations made by MCC as part of the CBAs for these projects did not include a productive use component for the Anekatek Solar grant, and the inclusion of benefits from productive uses in the ERR for the AEI grant in Berau increases the ERR by less than 1%. Hence, as long as the expectation is that changes in productive use will be marginal and potentially important to individual households, it could be that the logic of Outcome 4 of the logframe is sound.

6.1.5 EQ3: Outlook for Greenhouse Gas Emissions

According to an MCC-funded exercise implemented by ICF International, the reduction in greenhouse gas emissions resulting from solar PV projects in the GP Grant Facility is a direct function of the displacement of diesel, gasoline, or kerosene consumed by households or communities for either direct combustion (e.g., kerosene used to light a hurricane lamp) or to power generators in favor of electricity consumed using the solar PV micro-grid. The reduction in emissions is calculated by a simple subtraction of emissions after each project compared to those before each project, according to the formula in Figure 10:

Figure 10: ICF Equation 9—baseline emissions for solar PV projects[80]

[80] The net calorific value of diesel, gasoline, and kerosene is assumed to be 0.0359, 0.0326, and 0.0359 GJ/liter, respectively. The fuel emission factor of each of these fuels is assumed to be 74.3538, 69.5538, and 72.1538 kg CO_2e/GJ, respectively. Our study finds no reason to doubt these assumed figures.

$$\text{Baseline Emissions (tonnes } CO_2e) = \text{Amount of Fuel Displaced (unit)} \times \text{Net Calorific Value } \left(\frac{GJ}{unit}\right) \times \text{Fuel Specific Emission Factor } \left(\frac{\text{tonnes } CO_2e}{GJ}\right)$$

Because the equation for calculating GHG emissions is the same regardless of whether or not the displacement of fuels is coming from combustion or substitution of solar PV electricity for generator electricity, we do not differentiate how diesel and gasoline are used by households in our household survey instrument. However, we have captured kerosene consumption according to different uses, since kerosene used for lighting is likely to be substituted for electricity from the micro-grid, whereas kerosene used for cooking or other uses is likely to persist. Indeed, FGDs from baseline data collection suggest that community members in treatment kampungs do not use and often are not even familiar with electric cooking appliances, with the exception of "Magic Jars" or rice cookers.

As displayed above, households in East Sumba consume 4.8 liters/month of diesel, 11.7 liters/month of gasoline, and 2.2 liters/month of kerosene on average. Households in Berau average 14.0 liters/month of diesel, 30.1 liters/month of gasoline, and 0.8 liters/month of kerosene. Using these estimates, the average baseline GHG emissions per month from these three fuels for a household in East Sumba is 0.0451 tons CO_2e. For Berau, the average overall figure is 0.1078 tons CO_2e per household. With 909 households targeted for connection in East Sumba and 400 targeted household connections in Berau, this would make the total baseline emissions 41.00 tons CO_2e/month in East Sumba and 43.12 tons CO_2e/month in Berau.

During qualitative data collection we learned that, besides household use of diesel for generators, the villages of Long Beliu and Merabu are provided 200 and 160 liters per month of diesel for free to use in village generators provided by corporate social responsibility initiatives from large mining and palm oil companies operating locally. To the extent that these new micro-grids supplant the donated generators and corresponding diesel from these companies, this is an additional 0.96 tons CO_2e/month that may be displaced by the project in Berau.

6.1.5.1 *Assessment of Project Logic*

The soundness of the assumption that utilization of the solar PV micro-grids will lead to decreased GHG emissions is dependent on the baseline level of diesel, gasoline, and kerosene use in treatment areas for purposes that might be replaced by the new micro-grid. Our baseline data suggests that this logic is particularly sound in Berau, where communities rely heavily on diesel generators for lighting, pumping water, operating mills, and other purposes. In East Sumba, on the other hand, households in treatment areas have a low pre-existing level of GHG emissions. Although kerosene use is higher in East Sumba, only about 37.5% of the kerosene consumed by the average household is used for lighting, suggesting that the potential reduction of kerosene and corresponding GHG emissions is small. Benefits of the project in East Sumba are much more likely to be realized in the form of increased and more reliable consumption of energy from higher-capacity sources than those that are currently available than in the form of reduced GHG emissions.

The soundness of this assumption is also partially reliant on the successful and reliable functioning of the new solar PV micro-grids. In all cases, the micro-grids will maintain backup diesel generators for times

when they fail. Additionally, qualitative evidence from at least one key informant interview (KII) with a community member in Long Beliu suggests that community members with individual gensets plan to maintain these in the event of outages and to operate outdoor machinery, such as fuel-based mills.

The linear regressions in Section 6.1.3 that use monthly consumption of these three fuels as dependent variables do not yield particularly significant insights as to whether or not their consumption may decrease following connection to the micro-grid.

Aside from the displacement of fuels indicated by ICF as a potential vehicle for reduced GHG emissions from the project, there are a few other avenues that could theoretically lead to reduced emissions, mostly related to firewood consumption and deforestation. Firewood consumption emits black carbon and contributes to forest degradation. Firewood is abundant in the Berau areas, whereas communities in Sumba receive trainings by the forest department and face governmental regulations that prohibit the use of firewood for commercial activities. Last, heavy reliance on the agricultural sector leads to land clearing and hence deforestation. In all communities of Berau, land clearing is a serious issue.

With that being said, qualitative evidence suggests that the intended use of the increased electric capacity is not in line with actions that would significantly reduce firewood consumption or draw people away from agriculture as an occupation in such a significant way that deforestation or degradation would be reduced. Namely, respondents indicated in focus group discussions (FGDs) that they were most likely to use the increased availability and capacity of electricity for entertainment devices, access to information, and kitchen appliances such as rice cookers, mixers, and refrigeration. A limited amount of firewood may be displaced in favor of rice cookers, but likely not enough to make a large-scale difference in GHG emissions.

6.1.6 EQ4: The Special Purpose Vehicle (SPV) Approach

Considering Evaluation Question 4 assumes completion of the project. The baseline data to address this question includes description of baseline conditions, i.e., village preparedness, governance, and capacity.[81] As described below, the project began implementation in villages at the time of baseline data collection and therefore the SPV cannot be discussed in terms of its effectiveness; this will be discussed at endline. This section includes findings related to project progress, village governance and existing capacity, ability and willingness to pay, and village acceptance of the SPV model, followed by an assessment of the project logic based on these findings.

6.1.6.1 *Project Progress and Village Preparedness for the SPV*

While implementation plans are described in Section 2.1.5, additional details here include respondent confirmation of program progress to date and description of village perception of initial progress to help understand village willingness and acceptance of the project model.

[81] Specifically, qualitative instruments were designed to investigate four impact categories: program progress, social cohesion and human capacity resources, ability to pay, and business model.

Both grantees have successfully undergone lengthy administrative and legal preparation steps at the provincial, kabupaten, and village levels required to establish an SPV enterprise as a private power entity for electricity generation/sale and for required construction and installation.

First and foremost, grantees have applied for and acquired legal permits to 1) establish the SPV as a legal business entity requiring the submission of a business plan that details O&M procedures and corporate social responsibility policies; 2) gain a business area permit (*Wilayah Usaha Kerja*) by the Ministry of Energy and Mineral Resources to legally conduct business in the designated location and specifically designate a private power provider the rights, responsibilities, and collaboration requirements for that zone over PLN; and 3) seek an electricity/power generation permit (*Izin Usaha Penyediaan Tenaga Listrik*) awarded by the provincial governor along with an agreed tariff range geared to the national target rate range of IDR 1,800–2,200/kWh. The procurement of these permits by the time of baseline data collection is a fundamental prerequisite for legitimate construction, power generation/sale and the SPV establishment as a business entity (i.e., legitimate within the Indonesian national legislative framework, specifically the National Energy Policy (2014) contributing to Indonesia's full electrification by 2020, comprising 23% renewable energy by 2025).

Villagers generally have a strong awareness of the project—Household Survey results indicate that about 88% of households in Berau and 79% of households in East Sumba are aware of the plans to construct a micro-grid, even though only between 42% and 45% of respondents recognized the grantees' names. Respondents in Berau were more confident that they knew how the electricity pricing would work, with 19% responding to that question affirmatively compared to only 7.7% in East Sumba. Meanwhile, 71.5% of respondents in East Sumba were aware that a BUMDes was being created in their community to manage the micro-grid, compared to only 43.7% in Berau who were familiar with the SPV concept.

At the village level, grantees have negotiated with communities the formal designation of land for construction of the power plant and legitimately sought access to conduct feasibility studies. The communities in both locations reported that they provided the land for free, prepared the land, and constructed roads. The designation of village land for construction and access was collaboratively agreed through a village-level *musyawarah*, a traditional process of open exchange of views to seek eventual agreement by consensus. See photos in Annex 9.3 of progress made on construction sites in both locations at baseline.

Specifically regarding the SPV, the general model at baseline is understood by villagers. For example, tariff structures have been discussed and communicated by grantees with villagers in both sites. In Berau, the tariffs were agreed upon with community input and correspond to different capacity connections. The tariff rates are posted in high-quality, laminated materials on households throughout treatment areas (see Annex 9.4). Berau villagers interviewed were highly aware of the link between connection capacity, electricity consumption, and what this would cost them. The villagers in Berau confirmed that new limited liability companies are being formed, such as the PT Teluk Sumbang Energi, to represent the community in the SPV as a shareholder as the BUMDes (solar) electricity "unit." In East Sumba, respondents confirmed that a (solar) electricity unit will be created within the village-level BUMDes to manage the system and be represented at the PT BUMDes. The members that will form the electricity unit within the BUMDes are already chosen in all Sumba communities.

At the time of the baseline, however, specific preparatory work for the SPV had not advanced in either location but was scheduled to begin over the weeks following data collection. For this reason, respondents voiced confusion and incorrect information about specific SPV details (regarding how it will be organized and how it will operate). For example, the village heads are all aware of the limited liability companies being founded in Berau but did not mention the 51-to-49% ownership split in the proposed shareholder partnership in interviews. One village head in East Sumba expects the village to fully own the CBOG RE solar system.

Moreover, the recruitment processes and training for the SPV staff within the villages in Berau had only just started at the time of data collection. At the time of the baseline, interested villagers had submitted their applications to Berau project grantees, but no selection of SPV staff had taken place. For example, the qualitative data collection team observed job advertisements for SPV positions posted on many house walls in the Berau communities (see Annex 9.3 for a photograph of a job advertisement posting). The grantees plan to discuss and communicate the details of the SPV in the weeks following qualitative data collection (in November and December 2017), before the CBOG RE system is commissioned.

While several villagers reported skepticism regarding the project and the grantees' ability to complete planned tasks in their village, a majority of respondents reported optimism and were in support of the project. A male from a FGD in Merabu (Berau) said, *"Some people and village outsiders were skeptical in the beginning, but now they see progress and are optimistic, and people are supportive of this project as it is a joint village project."* Villagers' willingness to contribute/participate is high in all communities at baseline; and villagers highlighted as key the following factors to previous electrification (RE and PLN) project experiences at the village level: 1) the visibility of construction and home installation, demonstrating action; 2) many grantee activities were already underway or completed (as noted above); and, in particular, 3) up-front training and the high levels of community engagement and consultation in advance of construction. Heads of villages (in interviews) and community members (in FGDs) state that they are satisfied with the project and feel involved and consulted in the process thus far. This is likely driven by the visible presence of grantees in both construction and capacity-building endeavors in the communities as well as by the high number of village meetings and interactions with the village heads. One male community member in Merabu (Berau) noted that involvement of the village by the grantee is much better than during a previous project in the area.

An interviewee from AEI, however, is concerned that villagers will lose interest after a month or so, and expects villagers to only stay engaged if *"they benefit."* The interviewee expects support from the village government to the SPV to be crucial for maintaining village buy-in and ultimate sustainability of the project.

6.1.6.2 *Village Governance and Capacity*

Generally, the villages in both sites have well-established formal administrative and governance structures rooted both in mandated local government administration at the village level, including the relatively new BUMDes mechanism and the now well-established Women's Groups for Empowerment and Family Welfare (*Pembinaan Kesejahteraan Keluarga*, or PKK). The communities have regular village meetings and most decisions are taken by popular vote following a *musyawarah* consultation process. In addition, informal structures exist; in Berau (Long Beliu and Merabu) indigenous customary governance systems rooted in Dayak tradition remain central, especially to land and natural resource governance

and conflict resolution; at baseline, there appeared to be high collectivism, and the standard is collaborative decision-making by consensus (*musyarawarah*), "*serving*" the community, and treating everyone equally, even across ethnicities. In all communities, there are initiatives to support the poorest members. Some interviewees explained that their village was cohesive. In Long Beliu (Berau), for example, a male government employee said, *"We have a strong culture of working together; we borrow money from each other and have housing construction projects together."*

Reports of village cohesion, however, do not mean that these communities are free of conflict. Both female and male community members and heads of villages mentioned conflicts, most relating to individual/personal conflicts between community members. A head of village in Berau said, *"There is a lot of cooperation, but when money is involved, tensions arise sometimes."* Villagers reported that arguments occur over livestock that pollutes water sources or over taking wood fuel from someone else's property, but there seems to be an entrenched culture of collective problem-solving. Villagers noted that they first rely on their *"traditional systems"* for conflict resolution, i.e., they meet with elders and traditional healers, who discuss the conflict and mediate. It is very rare—in cases involving serious crimes—that external governmental authorities have to be included, respondents noted.

There are sub-groups (or minority groups) in both kabupatens. First, communities are divided into neighborhood sub-village units (RTs), with which they clearly identify. Second, two communities, both in Berau, are ethnically or religiously divided. First, Teluk Sumbang is inhabited by the indigenous Berau tribe, the Dayak, and the Bugis. The Bugis emigrated from Sulawesi over the last 20 to 30 years and appeared to our qualitative evaluation team to be better off, both economically and socially. There were not enough Bugis households sampled to corroborate this finding with quantitative income figures. In Merabu, the majority of the village is Christian, while the neighboring village (Mapulu), which will be connected by the project additionally, is mostly Muslim.[82] Some Dayak Basap villagers in Teluk Sumbang felt that Bugis villagers were disproportionally represented in project work simply because they were more able to meet qualifications set out by the grantee. Although the implementer shared information regarding the SPV vacancies equally to all groups in the community, Dayak Basap villagers expressed that they did not apply for the vacant SPV positions despite being interested *"due to the lack of education."* Specifically, an SMA (senior high school) degree was required at minimum to be qualified for the SPV positions. Although the grantee invited all community members to apply, including indigenous Dayak Basap community members, none of them had this degree.

For a sustainable SPV and facility operational and financial management, not only is the presence of existing formal and informal governance structures and social cohesion critical, but also technical human capacities, particularly in the SPV committees. Considering that SPV members have not been selected in Berau, assessing specific individuals' technical capacities was not possible at baseline. Interviews with SPV applicants in Berau, however, revealed a wide range of experience and education. In most cases, relatively young community members have applied thus far. In a majority of cases, especially notable in Long Beliu (Berau) the applicants have completed a specific training or degree, for example in accounting. Yet, in other cases, applicants show very limited levels of understanding and, for example, do not clearly know—or at least cannot communicate—why they applied for the positions. As might be

[82] Mapulu will be connected to the CBOG RE solar grid without being a direct project partner.

expected, the Berau applicants do not have prior experience as members or staff of a village grid management team or group.

In East Sumba, the BUMDes will be used to manage the facility. Though most of the BUMDes and their corresponding electricity units have only recently been formed for the purpose of the SPV, organization structures and members did exist at baseline. The BUMDes members interviewed by the qualitative data collection team were seemingly more experienced in working within an organization/committee and had higher levels of education in comparison to the Berau SPV applicants.

Heads of villages, SPV candidates, and BUMDes members in all villages, however, commented that financial management/oversight and technical capacities will be the main challenge for the SPV and for facility sustainability, and village members repeatedly wondered aloud whether planned training and activities would be enough in the long term.

These concerns also stem from previous negative experiences with government-initiated communal RE grids. In Berau, for example, micro-hydro plants were installed in the past and failed. Sumbanese female village respondents reported that they had purchased home solar systems made available through a dedicated credit scheme, but the system failed and panels were removed following a problem with the payment system, not due to lack of payment. In one Sumbanese village a communal generator is out of order and several have broken. Villagers explained that the reasons for the failures are socio-technical (flooded turbines, low management capacities, low capacity of the systems, low payment rates, and inadequate consultation). Additionally, Berau villagers perceive the micro-hydro projects as failures resulting from poor communication between the project management staff and the community.

6.1.6.3 *Ability and Willingness to Pay*

Detailed feasibility studies conducted prior to project implementation in each site used baseline socioeconomic surveys to quantify the willingness to pay for potential SPV tariffs in each community. In Berau, the survey concluded that households were willing to pay at least the 130,000 IDR/month that would be required to set a sustainable tariff for the project.[83] Likewise, a similar survey conducted in East Sumba determined that the average household would be willing to pay about 29,240 IDR per kilowatt-hour for 15–20 kilowatt-hours per month of electricity. This is in excess of the minimum tariff necessary to recover applicable costs for the micro-grids.[84]

Our primary qualitative data support this notion. A MCA-I project management interviewee states that communities have to belong to the poorer income strata in the country to be eligible for the CBOG RE solar project but still wealthy enough to finance electricity, as the project's sustainability hinges not only on the items described above but also on the willingness and ability of community members to pay. Furthermore, communities have to be willing and able to invest, i.e., by making available land and in-kind contributions for road construction and other works.

The billing system in each location will be prepaid. In East Sumba, a voucher system will be used. The BUMDes will sell the vouchers and PT MKS will transfer the credit to the households' account via the mobile phone network. In Berau a prepaid voucher system will be applied, and, at baseline, small shops

[83] See page 261 of W3A-33 Detailed Feasibility Study dated January 7, 2016.
[84] See Section 8.3.2 of W3A-59 Detailed Feasibility Study dated January 7, 2016.

are preparing for selling them. However, details are not yet known to the interviewees about how exactly this system will work—for example, the denomination of vouchers for sale (Berau) and whether the mobile phone voucher system will be for set values or if the amount purchased can be determined by the customer (East Sumba).

The economic situation in Berau seems stable. The community has access to multiple external income sources and to forest land allocated by timber and mining concessions intended as farmland for each household. Ability to pay for electricity seems to be high (see Table 20 for household incomes in both kabupatens). In Long Beliu (Berau), one male SPV candidate stated, *"Income here is very stable: nobody pays for motorbikes in installments, but at once."* Furthermore, heavy diesel reliance suggests high replaceable energy expenditures at baseline (see Table 10 for energy sources and consumption in each kabupaten). Men in an FGD stated, *"Even the highest electricity consumption scenario printed on Akuo materials is still cheaper than our current diesel expenditures."* In Teluk Sumbang (Berau), the Dayak community is an exception and much poorer. In interviews, they expressed concerns about whether they could afford the CBOG RE solar electricity.

In East Sumba, community members are considerably poorer than those in Berau. The Sumbanese villagers interviewed have access to fewer external sources of income, inhabit and farm a drier landscape, and remain traditionally reliant on a non-monetary economy oriented to weddings and funeral ceremonies for which local production (of textiles, livestock, etc.) is primarily geared. Housing conditions are worse and individuals own fewer electric appliances, motorbikes, and other assets. Interviewees are also less aspirational with regards to potential electricity uses (in FGDs, community members mentioned fewer items for which they could use additional electricity than Berau community members). Furthermore, replaceable baseline energy expenditures are lower because most households use SHSs with no operation costs. Yet, electricity is clearly a high priority for the villagers in both regencies.

Interviewees explained that there is a high seasonality to village income. For example, in Long Beliu (Berau), the highest cash inflow is from July to September from gold mining and rubber harvesting. In Praiwitu (East Sumba), income is estimated to triple from the lowest- to the highest-income season primarily due to cashew harvests. In communities where savings are rare, the seasonality of income is important to consider when introducing services for a fee.

Payment morale (or willingness to pay) is key as well. A grantee interviewee in Berau is worried that people misperceive the project as an aid project instead of an investment. Community members in FGDs, however, all appeared to be aware of the fact that they have to pay an adequate price for the CBOG RE solar service. Nonetheless, different perceptions about what is an appropriate fee may arise as the project progresses, in particular in the case of controversial service quality (outages or capacity limitations). Generally, though, villagers are aware of the necessity to pay maintenance and management costs for this new energy.

6.1.6.4 *Other Findings*

The grantees play a critical role not only in planning/coordinating construction and roll-out of the project activities, but also in providing support in the first years of facility operation. The assumption of the SPV model that includes both community and private stakeholders (as compared to classical community management models) is that it increases long-term sustainability of the energy initiative. This is based on the assumption that the private-public enterprise SPV model should be run as a business, earning

revenues in return for an efficient and effective service to community customers, generating returns for both owners (BUMDes and grantee). At baseline, however, respondents noted that both grantees may lack financial incentives to stay invested in the medium term, let alone in the long term. Community members in one village voiced concern that their grantee will not assume co-ownership for the management and the sustainability of the facility. It is also noteworthy that the grantees' "investment" is not a financial contribution but rather an in-kind one. Grantees' main interest in the project is the installation and implementation of planned activities until the facility is commissioned to the SPV/BUMDes. Grantees do not seem to count on making substantial profits by operating the facility. MCA-I staff in Jakarta agreed that the SPV model may only extend the period during which the grantees actively engage with the SPV. The grantees' agreements allow them to exit the SPV after a minimum period of two years. Although some stakeholders expressed fear that the grantees will take the first opportunity to exit the SPV, MCA-I has suggested that the grantees have indicated a preference to stay for up to five years or longer.

Furthermore, the grantees' presence in the field is obviously limited by the project duration, implying that contracts of the parties responsible for direct community interaction, M&E, O&M, and training activities, i.e., Castlerock, EVI, and the specific Akuo employees, will end in the coming one to two years.[85] This will imply a loss of established networks and social expertise. The time available for O&M, M&E, and trainings is further reduced in East Sumba due to delays in legal processes and contracting of the construction company. A Castlerock interviewee is convinced that villagers can increase their capacity and learn but should do so in stages (and not through one or two trainings). Given grant closure, some Castlerock employees expect problems, as the firm will lack financial resources to finish the project and support communities after contract expiry. In Berau, the communities expressed concern at baseline that one year of support after commissioning from AEI for training and maintenance of the system will not suffice.

6.1.6.5 *Assessment of the Project Logic*

The success and sustainability of project outputs depends in part on the degree to which the community is prepared to make the required contributions (both financially and organizationally) and on the involvement of the private-sector partner. The SPV model is designed to integrate the advantages of a purely community-based and purely privately organized management approach for micro-grids. This potential can only be exploited if both the community and the private-sector representatives are involved in the implementation and the management of the energy facility. At the time of the baseline, both community members/villages and grantees are highly engaged and involved in implementation of the project.

There are concerns, however, about the long-term engagement of the private-sector parties. The theoretical idea of the SPV to have the private parties invested in the project and thereby create a business interest does not seem to be necessarily fulfilled in the visited communities. Both grantees have

[85] As noted in Section 2.1.5, AEI will accompany the villages in Berau for one year to teach management, administration, control, and maintenance of the SCADA system. AEI will also provide a 25-year warranty on solar modules and spare parts as well as a 15-year warranty on the battery. In East Sumba, Castlerock will support O&M for two years after commissioning from Jakarta.

only made in-kind investments, and MCA-I respondents expressed doubts as to whether the grantees will remain involved in the project beyond facility commissioning. Furthermore, the grantees / private-sector representatives are contractually obligated to provide training and other support for two years only, although grantees have reportedly expressed interest in extending their engagement. Respondents noted that even if the communities are well organized, have high capacity, and are ready and willing to pay, technical assistance in the medium and long term will be needed to ensure success. Communities and MCA-I respondents are concerned that ongoing technical assistance and support from grantees and other stakeholders is not guaranteed.

Additional indicators that may contribute to the success of the SPV were present at baseline, namely community cohesion, governance structures, and ability and willingness to pay. At baseline, there was evidence of social cohesion and cooperation within the villages, and there is a culture of communal decision-making, fairness, and support of the poor and disabled in each location. Formal and informal governance structures exist. Though average incomes vary between the two regencies, community members in both areas reported at baseline that they will dedicate a part of their budget they currently spend on energy sources to the CBOG RE source. Human capacity was noted as a key challenge to the model, however, and especially the transfer of technical skills and financial management capacity required within the two years' obligatory grantee commitment. Capacities of community members varied between regencies, with seemingly more experienced community members involved in the SPV in East Sumba.

Overall, baseline conditions support the notion that the SPV approach will build community buy-in and increase the likelihood of infrastructure maintenance and sustainability of the solar PV micro-grid. Previous projects in these areas have failed, in part due to a lack of involvement by stakeholders outside the immediate community (i.e., private-sector representatives) and lack of consultation with communities in the engagement and training phases. They have also failed due to low community involvement and commitment. Given this background, each grantee has begun to implement their approach/model in the kabupatens, focusing on increasing human capacity and engaging with community members frequently to ensure that the system is understood and meeting community needs. While grantees have also committed to additional years of support after facility commissioning, at baseline respondents were concerned that this duration is too short to ensure long-term sustainability.

Respondents noted that integrating the solar PV micro-grid into the PLN grid may increase likelihood of sustainability. Grantees and subcontractors both mentioned this as a potential way to address concerns they had at baseline. This is not currently an option, however, as *"the CBOG RE is an off-grid project"* (grantee in East Sumba). An important challenge for the business model of all SPVs would be such an integration into the grid and the specification of its details, especially with regard to the eventual requirement of tariff alignment to the national tariff band. MCA-I is highly interested in providing the GoI with transferable learning, such as a concept or business model from the CBOG RE project setup. According to the MCA-I interviewees, the GoI is highly interested in lessons learned for establishing sustainable off-grid systems. The CBOG RE project therefore might, if necessary resources are dedicated to it, inform nationwide energy policy design. For the longer term, concepts on how to integrate such systems into the national grid might furthermore be highly relevant for Indonesia's electrification intentions and the sustainability thereof.

6.2 Assessment of the Experimental Design

In this section, we assess the validity of our impact evaluation design in Sumba through three tasks. First, we review our assumptions and results of power calculations based on data from the baseline. Second, we assess the comparability of the treatment and comparison samples. Finally, we review results from various matching approaches to improving similarity of the treatment and comparison groups.

6.2.1 Power Calculations to Confirm Statistical Power of Sample

To reanalyze the study power for the impact evaluation in Sumba, we estimate mean, standard deviations, and ICC (with clustering at the kampung level) for the same four outcome variables using weighted baseline data from treatment and control households in Sumba. We find significantly higher means for energy expenditures and electricity access per day, though we find much lower variation in overall kerosene use. We also find relatively consistent ICCs. Based on these calculated values, and assuming that follow-up data would be collected from 30 households in each of 11 treatment and 11 control communities, allowing for attrition from electrification or matching, we then calculated the MDES for each of these variables, both in standard deviation (SD) and the outcome units. Our updated MDESs are very similar in SD to the original estimates, ranging from 0.26 to 0.43 SD, though there are some differences in MDES in the outcome units due to differences in calculated SD. We calculated a significantly higher MDES in IDR for electricity consumption and a much lower MDES in liters of overall kerosene use. Overall, these calculations are in line with the estimates from the design report and as a whole do not represent a significant new threat to validity.

Table 25: Updated power calculations

Outcome	Mean	Std. Dev.	ICC	MDES (SD)	MDES (Outcome Units)
Monthly electricity expenditure (IDR)	204,006.70	266,750.10	0.08	0.39	104,032.54
Monthly kerosene use (liters)	1.57	3.98	0.04	0.32	1.27
Monthly kerosene use for lighting only (liters)	0.75	2.06	0.01	0.26	0.54
Electricity access per day (hours)	8.76	4.35	0.11	0.43	1.87

6.2.2 Balance in Means Tests and Validation of Internal Validity of Evaluation Design

To investigate the similarity of our treatment and comparison groups in Sumba, we test for differences in means along a number of variables related to socio-demographics, assets and finances, energy access and use, and community characteristics.

As shown in Table 26, we find that on demographic variables including sex of household head and years of education, the treatment and comparison groups are very similar. However, on variables related to assets and finances, we find significant differences, including those in transportation assets, access to financial services, income, and expenditures. In all cases, treatment households are significantly wealthier. We also find significant differences on time use, with comparison adult males and females spending significantly more time on income-generating activities, including farming, and treatment adults spending more time watching TV. Comparison households are also significantly more likely to report that their household conditions have not improved (they either stayed the same or got worse) over the last year.

Table 26: Demographic variables (treatment vs. control)

	Control	Treatment	*p*-Value
Household Demographics			
Head of household is male	0.906	0.912	0.758
Years of education of the head of household	5.804	5.976	0.646
Total members of household	4.221	4.521	0.105
HH Assets and Finance			
Housing walls made of bamboo or coconut	0.297	0.248	0.457
Main flooring material is earth	0.198	0.385	0.021
Household does not own any means of transportation	0.618	0.433	0.006
Household has a bank or savings account	0.098	0.155	0.088
Household took a loan in the last two years	0.055	0.212	0.000
Average monthly income from all sources	1,098,468.12	1,953,079.25	0.008
Total household monthly expenditure	1,188,810.25	1,608,477.00	0.017
Total household monthly energy expenditure	148,435.54	228,235.09	0.013
To cover family needs, household income is insufficient	0.438	0.318	0.005
Wealth index based on livestock ownership only	0.208	-0.069	0.089
Wealth index based on durable goods and household qualities only	-0.809	-0.660	0.057
Other HH Variables			
Hours per day spent on income-generating activities, father/man	6.389	6.027	0.057
Hours per day spent watching television, father/man	0.123	0.419	0.002
Hours per day spent on income-generating activities, mother/woman	4.871	4.183	0.010
Hours per day spent watching television, mother/woman	0.089	0.217	0.022
Family conditions have not improved over the last year	0.789	0.548	0.000

As shown in

Table 27, we also find significant differences at the community level between treatment and comparison groups. Treatment communities are significantly larger, closer to the main road, more likely to have an elementary and junior high school, have better phone signals, and have both more shops and more social infrastructure connected to electricity. We calculate an index representing remoteness and find that comparison communities are significantly more remote than treatment communities.

Table 27: Community characteristics (treatment vs. control)

	Control	Treatment	*p*-Value
Community Characteristics			
Community conditions have not improved over the last year	0.327	0.273	0.369
Total community population	310.861	702.033	0.004

Distance from the village road to the main road (km)	11.361	1.481	0.000
Community has poor or no phone reception	0.706	0.121	0.002
Community has an elementary school (SD)	0.376	0.733	0.061
Community has a junior high school (SMP)	0.029	0.370	0.033
Number of social infrastructure in community connected to an energy source	1.174	3.833	0.000
Total shops, including kiosks, stores, auto shops, and welding shops	4.585	10.294	0.000
Principal component analysis (PCA) for "remoteness"	0.663	-1.537	0.000

However, despite differences in household financial and community characteristics, energy access is relatively similar between the treatment and comparison groups. Indeed, we find no significant differences among the relevant variables tested, including lack of access, use of solar, hours of access per day, total lighting fixtures, and kerosene usage. We do find a nearly significant difference in total kerosene usage, though this is likely related to uses other than lighting, as we find no difference in amount of kerosene used for lighting.

Table 28: Energy use and access (treatment vs. control)

	Control	**Treatment**	***p*-Value**
Energy Access and Use			
Household does not have access to an energy source	0.129	0.094	0.370
Household uses some kind of solar technology as an energy source	0.777	0.830	0.410
Electricity access per day (hours)	8.018	8.842	0.242
Total number of lighting fixtures requiring electricity	2.511	2.797	0.235
Total liters of kerosene consumed per month for any purpose	1.250	2.027	0.108
Total liters of kerosene consumed per month for lighting	0.784	0.750	0.810

6.2.3 Assessment of Internal Validity, External Validity, and Risks to the Evaluation

Although the relative similarity between the treatment and comparison groups on key outcomes in Sumba is encouraging, the high number of significant differences between the groups on financial and community characteristics raises questions about the validity of the comparison group. That is, despite similar baseline levels on most key outcome variables, we might expect the treatment and comparison samples to differ in trends in these outcome variables over time, even in the absence of an electrification program, due to the large differences in access to household and community resources observed at baseline. To account for this, we present below two approaches for matching to reduce initial differences, CEM and PSM. It is important to emphasize that these approaches and their results should be considered tentative, due to the possibility that whole comparison communities may need to be excluded from follow-up due to electrification through government programs between now and when follow-up data collection occurs. Accordingly, we recommend that the evaluation team repeat the matching exercise immediately prior to both follow-up data collection events based on the available comparison communities.

To conduct CEM, we first identify the variables to be included in the model by looking at those variables correlated with key outcomes of interest (as presented above) as well as those variables associated with treatment. For the latter, we estimate various logit regression models, starting with a more comprehensive model including most all of the variables that are significantly different between treatment and comparison

households or are significant predictors of key outcomes. We then conduct a stepwise reduction of the model, removing insignificant predictors (starting with the highest *p*-value) and re-estimating. Following this process, we conducted CEM using the resultant variables, with various bin size specifications. Some variables have a default of two bins (for example, whether the household has any means of transportation), but for all other variables, we test a default of three, four, and five bins.

Accordingly, we use the following variables (and number of bins for each variable in parentheses): years of education of the household head (3, 4, 5); whether the household has a farmer or fisherman that sells part of his harvest (2); whether the household has any means of transportation (2); whether the household has taken a loan in the last two years (2); household total expenditures (3, 4, 5); whether household income is insufficient for needs (2); whether the floor of the dwelling is made of dirt (2); hours of electricity access per day (3, 4, 5); total number of non-electric lighting fixtures (3, 4, 5); total kerosene usage (3, 4, 5); and index for village remoteness (3, 4, 5). Using these variables and a default of three bins, we find matches for 443 households (316 treatment and 127 comparison). If the default number of bins is set to four, the matched sample actually increases to 509 households and then down again to 391 for five bins.

Table 29: Matching results: CEM and PSM

Model	Matched Sample	Significant Differences on 34 Variables Tested	Average *p*-Value on 34 Variables Tested
Unmatched	841	23	0.15
CEM			
3 bins	443	16	0.28
4 bins	509	18	0.23
5 bins	391	13	0.33
PSM	660	17	0.24

As shown in Table 29, we find that, as expected, increasing the number of bins improves balance, and using a default of five bins performs best in terms of reducing imbalance. However, it retains significantly fewer matched households, including households from only four comparison kampungs, which represents a reduction in power to less than 50% for an MDES of 0.3 SD. Accordingly, although it maintains a higher level of imbalance, CEM using four bins is preferred as it retains a much larger, including households from seven comparison communities. Nevertheless, we find that there are still significant differences between the treatment and comparison samples around household assets, finances, and village characteristics (though a few of these are no longer significant). More details on these results are included in Annex 9.5.2.

Because of the remaining differences, we also test matching using PSM. We test a variety of models, including using the same variables as used in the CEM model and then look at differences between the treatment and comparison group among the sample under common support. In Table 29, we show that the preferred PSM model achieves similar balance compared to the preferred CEM model but retains a larger sample, including households from 14 comparison communities, thereby retaining more power. Additionally, retaining a larger sample improves the generalizability of the results to the full treatment sample, also raising external validity. Based on these results, we provisionally recommend the PSM approach.

However, we again note that these matching results are only meant to be indicative, as we expect that some of the comparison communities may be electrified prior to follow-up and therefore need to be excluded from the sample. For the baseline, communities were selected based on lower probability of being electrified, but this must be confirmed in practice. Prior to conducting follow-up data collection, the evaluation team must identify if any of the comparison communities have been electrified. If resources are available, we recommend maintaining the full sample at follow-up (excluding any electrified comparison communities) to allow for maximum power at endline. However, if resources are more limited, we recommend repeating this matching exercise with the communities available at endline to identify the final follow-up sample, considering the tradeoffs of reduced sample size and improved matches.

In summary, although we do find significant differences between the treatment and comparison groups, even after matching, the differences are diminished, and the groups are similar along the key outcome variables. The differences in household and community assets represents a threat to validity, but this threat can be at least partially addressed through analysis, by looking at differences in differences among a matched group, as well as by looking at trends across groups with different resource levels.

Due to the remoteness of the areas covered in our evaluation and the granular level at which our data is meant to be representative, there are no external data sources to our knowledge to which our dataset could be compared as a verification of the external validity of our study. Our dataset is representative at the village level for treatment areas in Berau and sub-village level in treatment and control areas of East Sumba but is otherwise not representative at the kecamatan or kabupaten level that is generally used for other data collected in Indonesia.

7. ADMINISTRATIVE

7.1 Summary of Institutional Review Board Requirements and Clearances (In-Country, International)

In conjunction with MCC's commitment to respect and follow the Common Federal Policy for the Protection of Human Subjects where feasible, SI requested approval for the final evaluation design from its in-house Institutional Review Board (IRB) on October 19, 2017. SI's internal IRB has established protocols for gathering informed consent, protecting anonymity and identifying information, and ensuring ethical data collection—including from children and other vulnerable populations. It is registered with the U.S. Department of Health and Human Services' Office for Human Research Protections.

In addition, SI closely monitors and adheres to human subject research regulations in its countries of operation to ensure all evaluations are registered and fully compliant with local law. In this case, SI's local partner, JRI Research, assured the evaluation team that all local permits and approvals for data collection were acquired in accordance with Government Decree No. 41/2006.[86]

7.2 Data Access, Privacy, and Documentation Plan

SI's process for respecting privacy of respondents during data collection, transfer, storage, analysis, disposal, and dissemination is governed by SI's data security guidelines, which are aligned with MCC's microdata guidelines.

SI will adhere to MCC's open data policy with regard to preparing data for publication. All primary quantitative data collected by the evaluation will be prepared and submitted to MCC according to the most updated version of the Disclosure Review Board (DRB) guidelines available at the time of data collection. On an instrument-by-instrument basis, SI and MCC will weigh the utility of publishing primary qualitative data (even in a restricted-access database) against (i) the risks of respondent re-identification and (ii) the risks of adverse effects on data quality from disclosure. In the event that the utility of this data outweighs the risk of re-identification, and that respondents can be adequately informed via a consent script as to the data's intended use without jeopardizing their willingness to be forthcoming with interviewers, SI will submit this primary qualitative data to MCC as part of the DRB process.

7.3 Dissemination Plan (Description of Products and Online, Presentation Dissemination Efforts)

Since reporting and dissemination must be completed prior to Compact closeout, SI will present the baseline evaluation findings in draft form after receiving feedback from MCC and local stakeholders on the baseline draft evaluation report. The presentation will be given to MCC, MCA-I, and other stakeholders in Jakarta on February 6, 2017. We recommend a similar presentation in both Jakarta and Washington for follow-up reports given the importance of this sector to the GoI and other stakeholders.

[86] The text of which can be found as Annex 1 to this document:
http://www.international.itb.ac.id/web/wp-content/uploads/2010/05/Foreign_Research_Permit_Procedure_2015.pdf

7.4 Evaluation Team Roles and Responsibilities

The evaluation team comprised a field evaluation team and support staff at SI headquarters. In some cases, evaluation team members played a role both as field evaluators and management support staff. The evaluation team includes all personnel described in Table 30.

Table 30: Evaluation team

Personnel	Role	Tech./Support	Responsibility
Mike Duthie	Program Manager	Both	Principal investigator responsible for technical oversight and senior-level evaluation expertise. Led evaluation design, data collection, reporting, and dissemination. Also responsible for oversight of overall contract performance for SI-HQ.
Jörg Peters	Sr. Analyst, Renewable Energy	Technical	Expert in the evaluation of RE programming, responsible for advising evaluation team on sector-appropriate evaluation design and instruments. Led one of two sub-teams for qualitative data collection and oversaw the analysis and reporting of qualitative data.
Krystyna Krassowska	Sr. Analyst, Renewable Energy	Technical	Expert in qualitative evaluation and in the Indonesian policy context. Led the second sub-team for qualitative data collection and contributed to the analysis of qualitative data, as instructed by Dr. Peters.
Hussain Samad	Sr. Analyst, Renewable Energy (advisory)	Technical	Expert in solar PV programming. Served in an advisory role to the team and reviewed evaluation methodology and instruments prior to finalization.
Luciane Lenz	Jr. Analyst	Technical	Subject-matter expert in solar PV technology and programming, advised on quantitative and qualitative instruments and literature review. Participated in qualitative data collection and contributed to the analysis and reporting of qualitative data under the oversight of Dr. Peters.
Amanda Stek	Jr. Analyst	Both	Mid-level evaluator responsible for liaising with local stakeholders and supporting reporting and dissemination, as requested by the principal investigator.
Upik Sabainingrum	Quantitative Research Assistant (local)	Technical	Local research assistant responsible for assisting in the arrangement and oversight of quantitative data collection. Attended enumerator training and accompanied field teams in East Sumba and reported regularly to SI-HQ.
Hamidah Busyrah	Qualitative Research Assistant (local)	Technical	Local research assistant responsible for assisting in the arrangement and oversight of qualitative data collection. Conducted and helped make arrangements for qualitative data collection on one of the two sub-teams.
Miguel Albornoz	Research Assistant (HQ)	Both	Served as the evaluation manager for SI-HQ support staff, and thus managed finances, personnel, scheduling, and contractual compliance for the evaluation. Also served as a research assistant and contributed to evaluation design, data collection, analysis, and reporting under the supervision of the principal investigator. Primarily responsible for managing the data collection subcontractor and overseeing data quality assurance, including attending enumerator training in both field locations and accompanying field team in Berau.

Personnel	Role	Tech./Support	Responsibility
Julia Higgins	Administrative Assistant	Support	Project assistant responsible for administration and project backstopping. Contributed to data quality assurance and reporting under the supervision of the principal investigator.
Putu Adi Sayoga	Administrative Assistant (Local)	Support	Made logistical arrangements and liaised with local stakeholders while traveling with a sub-team for the qualitative data collection effort.
Made Adhi Pratama	Administrative Assistant (Local)	Support	Made logistical arrangements and liaised with local stakeholders while traveling with a sub-team for the qualitative data collection effort. Assisted in cleaning and translating qualitative notes.

7.5 Budget

Per MCC's instructions regarding sensitivities around future procurements, the evaluation budget corresponding to this Baseline Evaluation Report has been provided to MCC separately.

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9. ANNEXES

9.1 SI Response to MCC and MCA-I Comments

This final evaluation report includes responses to comments received on an initial draft by MCC and MCA-I. A record of these comments and SI's Responses can be found below.

Table 31: MCC comments and SI responses

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
MCC M&E Director	v	The first sentence under EQ3 has a couple of errors. MCA-I (not MCC) contracted ICF to estimate the potential GHG emissions reductions resulting from the introduction of electricity from a solar source (not GHG emissions from solar).	Corrected
	v	Spelling error in two places: Figuring in the total number of connected households plus additional diesel known to be contributed in-kind by logging and palm oil firms to community generators in two of the villages in Breau, total baseline GHG emissions in East Sumba are 41.00 tons CO_2e/month, compared to 44.40 tons CO_2e/month in Berau. Additionally, qualitative evidence from at least one KII with a community member in Breau suggests that community members with individual gensets plan to maintain these in the event of outages and to operate outdoor machinery, such as fuel-based mills.	Corrected
	40, Section 6.1.3.3.+	I think it would be beneficial to briefly summarize the regression results (without tables) for EQs 1&2 in the executive summary. I expect stakeholders who may only read the summary to find it useful. The finding on page 43 about access to renewable sources not being associated with reductions in fossil fuel consumption is particularly interesting, given GP's objective.	Discussion of regression results for EQ1 and 2 added. We have added a discussion of RE sources not being associated with reductions in fuel consumption to the executive summary and the report, since we agree it is highly relevant
	46	Was "genset" defined earlier in the doc? If not, please define.	This is synonymous with generator. We added a clarifying paranthetical to the first occurrence in the text and ES, since we use the terms interchangeably

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
	54	ICF's work was funded by the compact through MCA-I, not MCC. The idea was to get an independent estimate of GHG impacts that adhered to international best practice.	Noted and corrected.
MCC GSI lead	General	didn't see any disaggregated (by sex) total on survey respondents, so don't know how many women were actually interviewed	Both quantitative and qualitative data collection included male and female respondents. Table 11 now includes a breakdown of qualitative respondents by sex. We have added a footnote to Table 13 to indicate how many respondents were women, since the respondent was not always the head of household. Additionally, we note that couples and families frequently responded to the survey as a group, conversing with the enumerator who interpreted responses. This ensured the accuracy of time use questions directed at someone other than the interview respondent, for example.
	General	Unfortunately the attention to gender relations and gender gaps is minimal in the report. Some gender-related information about activities and preferences or use priorities were.	We have included sex-disaggregated information where relevant to the EQs - for example, we differentiate between time spent on income generating activities by sex in the discussion of EQ2. The gender equality information in the annex is not strictly related to the evaluation questions, which mostly focus on household-level (not individual-level) outcomes. Because this programming can have important gender dimensions we wanted to include information on these in the annex, despite the fact that they were not directly relevant to the evaluation questions.
	General	the sample does not include both men and women respondeds. Fatal flaw.	Our sample does include both men and women respondents, both for quantitative and qualitative respondents. Although the surveyed respondent and head of household were both most frequently male, female household members often participated in surveys and discussed responses with respondents and enumerators. We have added information in the report to clarify the number of female respondents.

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
	p7 para 1	The report states "Lastly, it yields positive effects via electrification on security, community participation and (gender) attitudes via improved connectivity and media access (see Lenz et al., 2017)". It is unclear what attitudinal changes are discussed here. Needs explanation. Should have mentioned potential benefits from women, in terms of reduced workloads from electricity and labor-saving appliances/devices.	We added two notes on theoretical affects of electrification on women.
	p11 1st para	Not clear what is meant by "gender safeguards". Explain.	An explanation was added to that phrase.
	p15, 1st para	Castlerock hired a gender specialist (local) who is part of the team.	Added to the text.
	p30, table 11	The respondednts are disaggregated by sex, so an opportunity is missed to see gender based differences in responses. We donot have a total of the numbers of male and female respondents.	This has been added to Table 11. 40% of all qualitative respondents were female.
	p40-44, table 17, 18, 19	male HH heads were included, what about Female head of HHs? Why women head of HH not included?	As indicated in Table 13, male and female heads of household are represented in the sample. The regression coefficients in the tables are meaningful for both - the effect of a female head of household is simply the opposite sign of the effect of a male head of household.
	p77 (annex)	It is unfortunate that some of this information on gender equality is hidden in the Annex and not integrated into the text. What is the meaning of this write up in the annex?	We have included sex-disaggregated information where relevant to the EQs - for example, we differentiate between time spent on income generating activities by sex in the discussion of EQ2. The gender equality information in the annex is not strictly related to the evaluation questions, which mostly focus on household-level (not individual-level) outcomes. Because this programming can have important gender dimensions we wanted to include information on these in the annex, despite the fact that they were not directly relevant to the evaluation questions.
MCC Energy	ii	Propose to return 12 months after baseline and 36 months after baseline. Page 25 says 12 & 36 months after SPV energy is commissioned. As commissioning is planned in	Corrected on page 25. We prefer to return during the same season as baseline data collection in order to avoid seasonal affects.

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
		March 2018 for these projects these two timelines could differ by up to 6mos.	
	iii	What does SE column mean? I assume standard error. So in the context of those shown as percentages, SE should be in % too? Not decimals	SE refers to the Standard Error. In all cases, the SE is in the same units as stated in the definition. When written as decimals, the SE of proportions can be interpreted as percentage points by multiplying by 100. We have left them as decimals for two reasons: first, to avoid potential confusion around interpreting them as percentages or percentage points and second, to maintain consistency in presentation.
	v	What timeframe of GHG reductions per household - per annum? Table 1 shows most units per month. Would it be possible to compare these to the GHG assumptions/calcluations from ICF?	The calculated emissions are per month. SI does not have access to ICF's final calculations--only their calculation template.
	vi	Berau SPV is taking in many applicants and training them, then will select and hire later. Hence perhaps the youth. Sumba SPV going straight to hiring.	We go into further detail in the body, but our understanding from interviews is that this is mostly related to pre-existing governance structures in East Sumba that do not exist in Berau.
	vi	Sustainability of SPVs is expcected since grantees maintain 49% share interest. Though text later has Akuo at only 25% - worth rechecking that. There is also further refernce to Akuo providing 25yr system warranty. This definitely needs to be confirmed as if true it will have a big impact on tariff requirement for replacement of key components, and would address many of the technical challenges associated with O&M/sustainability.	We have corrected based on MCA-I feedback. On the warranty, this is based off of information given by only one informant. So, it could be inaccurate if this informant is misinformed.
	vi	Intra cluster correlations ICC ? define cluster - seems to be houses in same neighborhood	The cluster is the kampung. This has been clarified in the text.
	vii	Table 3 - surprising that SD (presumably std deviation) is higher than mean in case of energy use (elect, kerosene). Table 9 page 27 offers no further clue, as in fact it has a very much higher SD for kerosene than the execsum table. In another place (table 27 page 64) SD = elementary school	We have clarified SD=standard deviation in the table. This pattern of standard deviations higher than the mean was also found from the castlerock survey data. There is a signfiicant right hand tail, with a handful of very high values for a few of these variables that contribute to the larger SD. We have verfiied that these are not erroneous responses. We considered doing log transformations (and woudl recommend including this in follow-up analysis), but

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
			decided to retain the orginal variables for consistency and ease of interpretation.
	vii	Treatment and comparison groups - presumably treatment are those to be served by the SPV?	Yes, the comparison group is comprised of nearby communities who also do not have access to the PLN grid, but will not be receiving a micro-grid from the Anekatek consortium
	vii	Treatment groups are signiifcantly wealthier in all cases - so should we question validity of experimental design?	This is a concern, though as shown in the report, the treatment and control samples are very similar on the outcome variables and the majority of other baseline characteristics after matching. Moreover, the proposed Difference in Differences helps to account for initial differences between the groups.
	vii	Introduction of PEM and CSM techniques doesn't seem to make the case any stronger.	While the techniques do not fully remove differences between the two groups, they do significantly reduce differences, reducing the number of significant differences between the two groups by approximately 1/3.
	vii	PLN coming on line is esxpected to contaminate the comparison group. We know PLN is growing.	We have oversampled comparison kampungs in case some are contaminated by PLN before future data collection. Also, we selected comparison kampungs that PLN did not plan to connect until after November of 2018, so these are the least likely comparable kampungs in East Sumba to be contaminated. So, while it is possible contamination will occur, hopefully these measures are enough to preserve a sizable comparison group.

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
	viii	Exec sum closes by questioning validity of comparison technique. But doesn't go so far as to jettison it. What would it take to do so?	The differences in financial status and access to resources is a concern, but we believe that the comparison group and IE design still provides the potential for rigorous, useful, reliable information on program effectiveness, particularly through the matching and analytical techniques discussed in this report and the design report. We would feel more concerned if there were also significant differences on the outcome variables after matching or if matching did not reduce differences between the two groups (or did so only at large costs to sample size).
	p. 46	Reference to certain communities in Berau that receive gensets and diesel for free as part of CSR - please clarify sufficiency and consistency of supply, size of gensets relative to community, etc and the age of this CSR program. Interested to see if this is reliable, meets demand, available to all, and what arrangements have been made for repair/replacement when its usable life is complete. these factors may have an influence on the baseline especially given the possibility that HH expenses might go up if the new project displaces existing, free electricity.	Four gensets were provided to Long Beliu in revent memory, but only one is still working. It powers one sub-village. In Merabu, the whole village is connected to the CSR-financed village genset. The neighboring village Mapulu has a villlage genset, but it is not financed by CSR. The two CSR financed generators in Long Beliu and Merabu are only turned on in the evening hours, and community members own individual gensets as supply is not sufficient to meet their demand. No interviewee mentioned problems with consistency of supply. Both in Merabu and Long Beliu, the companies provide diesel for free to the villages on a monthly basis (in Merabu 160 and in Long Beliu 200 litre per month according to our qualitative interview partners). We do not know the age of the program, the size of the generators, or the repair arrangements, although the situation in Long Beliu suggests repair is delayed or not guaranteed.
	p. 55	reference to GHG reduction expectations: could there be a reference to other counterfactuals such as PLN expansion to the area vs our provision of CBOG RE facilities? I am thinking specifically of the fuel mix of PLN in these areas, and what GHG emissions and costs would be borne in order to provide a similar level of electricity to these communities	We don't have data on this counterfactual in baseline, but it would be interesting and we could collect data on it for a future data collection event. Our understanding is that PLN at first will only extend the grid to the kepala desa's office before evaluating the market to extend reticulation, so the

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
		from the grid. Evaluation seems to focus on changes between baseline and 'with project' alternative, but it doesnt seem to cover the project as an alternative to the default in indonesia where grid is extended to these communities.	change in the fuel mix might be minimal at the outset

Table 32: MCA-I comments and SI responses

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
Rini Widiastuti	Evidence for Q2 - what factors contribute to increase productive use	The baseline and endline report will try to answer - among others- whether access to RE will contribute to GP outcome, i.e. increase income through savings from energy expenditure and productive use of RE access. What we also need to clearly capture is the ***key factors that makes it happen***. Outcome 4 of RE logframe allocate resources to specifically address local economic opportunities. The baseline report should be able to elaborate in more detail, exactly what type of training/activities contributing to oucome 4. Page 15 briefly mentioned about activities done by capacity building specialist, but the more important information is whether the training materials are developed based on the type of enterprise and service offered (as presented in table 21); or potential productive use in table 22. Eventually, if the endline report capture increase income/expenditure/productive use of RE - we need to be able to say ***which particular activities*** under outcome 4 that contribute to such increase both for Sumba and Berau context that has different type of economy.	This will be a goal of the qualitative exercise at future data collection periods, which we propose to conduct after the quantitative exercise has verified the presence of impacts. Without knowing if impacts will in fact occur, we cannot determine at baseline what has caused them. We also note that this analysis will be mostly qualitative and will not be able to rely on an experimental design due to the way different activities in this outcome area are rolled out.

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
Rini Widiastuti	Q4 on sustainability	similar with the point above, the evidence gaps that we need to provide on sustainability. The report briefly mention about SPV structure, village preparedness and governance, willingness and ability to pay. There are ***other critical issues*** that relates to this such as (1) tariff calculation method;(2) SPV capacity in managing customer, perfoming operation and maintenance, and run the business; (3) legal status and structure of SPV that may affect the ability of SPV to tap into other resources to support their operation; (4) what is the consideration used in determining the kWh per HH, wheter they also consider selling the RE to small enterprise with different tarif, etc; (5) whether the business plan of SPV really contribute to sustainability issue. In addition, the selection process of these grantees also need to be synthesized to provide context in presenting the information, because key factors in ensuring sustainabilty will be different if the site location (ability to pay) is different.	We agree that there is scope for many more issues to be explored in terms of sustainability and the SPV model. Yet, please note that the focus of the evaluation was on potential for impacts and what is going on in the villages at baseline stage (including the SPV processes). Some of those very valid questions you are raising either cannot yet be answered (because the SPV was about to be established at the time of our visit) or could not be answered by the respondents we interviewed in the field. More specifically: (1) tariffs calculations can only prove to be adequate or not once they are applied and electricity is consumed (2) The SPV had not yet start working and the staff had not been recruited, (3) we have added as much discussion of the legal permits obtained by the SPV as possible to the EQ4 discussion, (4) we have added discussion of tariffs in the DFS and noted the agreement to set a tariff range within the national target range of 1800-2200 IDR/KwH. The key question is rather whether there will be an increase in demand above what is currently used consumed in the villages by some sort of “economic growth”. This point is extensively addressed in the report. (5) this will be determined at future data collection periods. As for your last point (ability to pay) we believe this is also addressed in the report, including a brief discussion about heterogeneity between sites. We agree however, that many of your points mentioned are very relevant for sustainability, and recommend focusing on them in qualitative assessments at follow up.

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
Arief Sugito	Acronym	BI = Bahasa Indonesia	Corrected
Arief Sugito	22	Paragraph 1, for electrification rates, the data presented used very old data in 2012. can Independent evaluator use the newer data if any as it is quite long time ago (5 years ago).	Updated to reflect mid-2017 figure.
Arief Sugito		From the draft document, the overview of Indonesian context, not so much explaining the success and failure of RE development in Indonesia. In my views, there will be a lot of reference on this as the community based RE projects are not quite new. Indonesian Government has the program of village electrification through ministry of Energy ans Mineral Resource and other government programs such as National Program for Community Empowerment (PNPM) also implemented community-based RE. Many NGOs also developed rural electricity power plant such IBEKA, Warsi, and WWF. I think this needs to be assessed in this draft final report to understand the relevant of this community based RE considering the impediment taken place in Indonesia context.	Unfortunately, except for the Green PNPM facility we are not familiar with those programs by name. However, we do include a discussion of the effect of failures of past RE projects in the treatment areas to community members' perceptions of this type of programming in the discussion of EQ4. See, for example, section 6.1.6.1.
Arief Sugito		Other things that need to be considered is the analysis of Institutional and regulations. This is quite minor in the report. This analysis is critical to understand whether the government regulations is supportive to the achievement of sustainable RE projects as in the report, it is explained that most successful RE project has close engagement with government as government needs to provide subsidy due to the low income of community in the remote village areas to be able to pay the operation and maintenance cost. The institutional analysis is needed to map out the institutional structure in Indonesian whether it is supportive to the development of community based RE or not. This institutional analysis also needed to answer questions No 4 on SPV whether the SPV has strong position in the context of institutional structure of Indonesian Government. This conclusion will lead to sustainability of the project as well as to provide basis for	Since evaluating the affect of GoI instutions and regulations was not part of the SPV 4 question, it was not included in baseline qualitative lines of inquiry. We have added some discussion of the role of Indonesian regulations in the SPV preparation process in the discussion of EQ4 with the information we have available. We suggest adding this line of inquiry explicitly into future data collection periods, when the SPVs will have had more of an opportunity to interact with the GoI institutional framework.

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
		risk mitigation if the fee from community could not cover the operation and maintenance.	
M&E Specialist/Akuo Energy	12	Please check again the date of training you mentioned. Implementer has started the training in May, but for SPV candidates the training started in Oct. Perhaps could you specify what kind of training you referred to?	Corrected
M&E Specialist/Akuo Energy	36	Please attach the sources of data when you stated the statement. I.e " Though none of the treatment communities currently have access to PLN power, the two sub-district capitals of the district of Long Beliu are scheduled for PLN connection in 2018". Who was saying it? Is head of village or head of sub district or staff on district level or from PLN?	We cannot disclose names of interview partners. Before every interview respondents were assured that their statements will be anonymized. No interviews were conducted with PLN.
M&E Specialist/Akuo Energy	59	Please re-phrase the word "precluded". Since the project started, Implementer has very fair open recruitment recruitment process for all and shared the information equally. The word "precluded" is not appropriate to presenting on their feeling. In contrary, Implementer has focused to empower indigenous people (IP) as stated on ESMP indicators such as special training or session to the IP. Moroever, IP (Basap) has involved a lot on the construction activities.	Rephrased to state the following: "Although the implementer shared information regarding the SPV vacancies equally to all groups in the community, Dayak Basap villagers expressed that they did not apply for the vacant SPV positions despite being interested “due to the lack of education.” Specifically, an SMA (senior high school) degree was required at minimum to be qualified for the SPV positions. Although the grantee invited all community members to apply, including indigenous Dayak Basap community members, none of them possessed this degree."

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
Aretha Aprilia/PMC	i, 2	It is advised to add on justifications for the selection of projects that were selected for the evaluation (W3A-33 and 59), instead of the other projects such as W3A-80 that was more progressive in terms of completing the constrution of power plant.	As outlined in Annex 9.2, the selected grants were more appropriate from a technical evaluation perspective. W3A-80 was limited to single island with no nearby islands similar enough to merit comparison. Added references to the annex in both locations for convenience.
Aretha Aprilia/PMC	v	'Breau' should be written as 'Berau'.	Corrected
Syarifah Marlina/PMC	10	The report stated that after construction shares between AEI and BUMDES will be 75 ; 25. Please note that AEI has recently changed the composition and considered to increase their share upto the maximum range allowed in the Grant Agreement i.e. 51% for BUMDes and 49% for AEI. Please reconfirm.	Corrected
Syarifah Marlina/PMC	10	The report stated that "… AEI's interests in the SPV will be represented by Perusahaan Listrik Desa, an electricity company." This statement is confusing i.e. which Perusahaan Listrik Desa this statement refers to? We believe that SPV is the Perusahaan Listrik Desa.	Corrected
Syarifah Marlina/PMC	11	In the SPV organigram, it shows that BUMDES is positioned equal to Board of Commissioner. Both BUMDES and AEI should be represented in the BoC.	We note that this organigram reflects the most recent documentation available to SI. We have included in a footnote that the structure may have changed.
Syarifah Marlina/PMC	11	The report stated that although AEI will have a 25% share in the SPV, all SPV dividends will belong to the BUMDes. Is there any particular reason mentioned by AEI why all dividends will be given to BUMDes?	Pg. 30 of the SPV Business Plan states that the BUMDes will take all dividends so that they can be allocated to help community development with women and vulnerable groups as main beneficiaries. This has been added to the text.
Ahmad Arfiza/PMC	11	The sentence stated "AEI will accompany the village for one year to teach management of the system…..". However, in many discussions AEI expressed their commitment to stay for more than one year (i.e. 2 years). Please reconfirm.	This information was received from a sub-contractor. In line with your statement, one Akuo interviewee expects two years of engagement (but is not yet aware of exact activities during the second year). Hence, either the sub-contractor interviewed is misinformed, or year 2 activities will simply differ from year 1 activities and not

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
			necessarily include system management training.
Ahmad Arfiza/PMC	11	The usage of 10% reserve of the SPV gross profit is not only to target awareness raising on effective use of electricity and economic activities by women's groups but also for general community development interventions, which will be identified by local villagers at a later stage.	Corrected
Ahmad Arfiza/PMC	12	After commissioning in March 2018, are there any justifications as to why AEI will only revisit the communities every two to three months? They have the obligation to stay full time for whatever period they have committed.	According to our understanding they won't stay "physically" in the villages, but only monitor technical issues from Jakarta and participate in shareholder meetings.
Syarifah Marlina/PMC	15	The structure presented in Figure 7 needs to be slightly modified as the project will not establish cooperative but opted for BUMDes and then facilitated these BUMDeses to establish a Holding Company (PT) to represent their collective 51% shares in the SPV.	This is the most updated figure from the business plan we received in July, but we edited the footnote to reflect this situation
Aretha Aprilia/PMC	46	Regarding EQ 2: Ex-ante evaluation of whether 'electricity provided been used for economic purposes' might not be appropriate as the plant has just been constructed and limited impact can be measured at this point in time. Evaluation of impact should instead be carried out months after Compact period ends, as evaluation from current situation is based on assumptions. Also careful attention should be given to the fact that most of the beneficiaries are households, thus there are high degree of likeliness that the energy will be used for consumptive purposes, rather than productive purposes.	We acknowledge that impacts are not expected at baseline. Instead, the report focuses on potential or likelihood for impact based on responses from enterprises and households at baseline. We confirm that we will evaluate impact at follow-up data collection periods.
Aretha Aprilia/PMC	46	Although the issue of tariff was touched upon in the report, however they did not clarify about the status of	We have not spoken to PLN or other regulatory bodies. We only refer to statements by grantees and local authorities.

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
		tariff approval by PLN; i.e. whether or not the tariff has been approved along with the justifications.	
Aretha Aprilia/PMC	55 and v	In terms of GHG emissions estimation, although it was done by another institution (ICF International); careful selection of system boundary and disclosure of information on such boundary should take place. Did the estimation take into account the emission from air transportation to bring the equipments and parts from other city or even other countries to the village?	Response from ICF International: The estimated GHG emissions focus on the annual long term GHG emission reductions within the project boundary rather than a life-cycle assessment of GHGs. Consequently, these secondary effects (i.e., one-time effects or changes in GHG emissions associated with the construction, installation, and establishment or the decommissioning and termination of the project activity) are not accounted for in the GHG estimation. This approach is consistent with the protocol as outlined in The GHG Protocol for Project Accounting (WRI and WBCSD).
Aretha Aprilia/PMC	55 and v	Regarding the changes of livelihood of the community members who sells kerosene that might be impacted by the project due to the existence of RE power plant, were there any observation of how to minimize the risks of lost in livelihoods, e.g. by involving them to be part of the SPV operations, or other measures?	SI did not encounter any such plans during data collection, although that does not mean they do not exist. We could inquire as to this at future data collection periods. Presumably, they would still be able to sell kerosene for non-lighting purposes, however, which accounts for 62.5% of kerosene consumed by households in East Sumba according to our data.
Syarifah Marlina/PMC	57	The report highlighted that "...The villagers in Berau confirmed that new limited liability companies are being formed, such as the PT Teluk Sumbang Energi, to represent the community in the SPV as a shareholder. AEI, on the other hand, is represented by Perusahaan Listrik Desa, an electricity company. This description is confusing. PT Teluk Sumbang Energy is the SPV or called as Perusahaan Listrik Desa. The Community share in SPV will be represented by BUMDes; meanwhile Implementer (AEI) will maintain their own share at 49%.	Corrected

Reviewer Name/ Institution	Page Number	Comment	Evaluator Responses
Aretha Aprilia/PMC	70	Please consider to add a chapter on 'Conclusions', by incorporating succinct answers to the 4 evaluation questions. In addition, a more high-level brief in the Executive Summary could also be considered.	SI feels that such a section would be redundant given what is found in the current executive summary.
Ichsan	59	There is miss interpretation, since most of the SPV members of Akuo is coming from Dayak villages for Merabu & Mapulu and Long Beliu (data can be provided later on by PMC, I checked already with Akuo). This needs to be mentioned here to counter the statement for Teluk Sumbang to avoid wrong impression that we exclude the Dayak community in our SPV organization (see line 4).	Corrected to note that although Dayak Basap were welcome to apply, none of them had the SMA degree required for consideration.
Ichsan	59	There was a household survey that was conducted earlier before project implementation. This study needs to be elaborated more in this section (see section 6.1.6.3).	The results of these surveys are now incorporated into this section.
Ichsan	61	There is misunderstanding that regarding SPV duration. SPV is not only for 2 years (see line 2), but the implementer is allowed to exit after two years of operation (as in the contract). However, the SPV will remain up to 20 years. There is also no evidence that Castlerock and Akuo will terminate after 2 years (see line 5). Based on the latest discussion with the implementer, at least that both will stay up to 5 years. But, it may be longer.	This context, which is new to the evaluation team, has been incorporated into section 6.1.6.4 and the executive summary.

9.2 Outcomes of Interest Unrelated to Evaluation Questions

Based on our literature review and qualitative data collection conducted by SI's renewable energy experts, there are outcomes outside the scope of our four evaluation questions that might be expected to occur as a result of the CBOG RE interventions in East Sumba and Berau. Some of these are logical extensions of increased access to electricity, such as access to new sources of information, while others correspond to portions of the grants' logframe that are not explored in the evaluation questions, such as increased awareness and practice of themes related to renewable energy and environmental conservation.

In this annex, we highlight major categories of "impact potentials," present descriptive statistics from baseline data collection in each category, and explain through which means or on what basis we expect that these outcomes might occur. All of these categories are most relevant to EQ1, in the sense that they are expected to result from changes in energy consumption patterns. These categories include theorized improvements in:

1. **Access to information**
2. **Gender equality**
3. **Health outcomes**
4. **Security**
5. **Non-GHG environmental outcomes**

9.2.1 Access to Information

Although improved access to information is not among the projected impacts of either grant, the potential exists in both kabupatens for increased access to electricity to lead to increased use of mobile phones, television, and the Internet. In FGDs, male and female community members across all communities indicated that one of the benefits they most anticipated from the constant supply of higher-capacity electricity was the enabling of evening activities and increased consumption of entertainment. As cited in Section 6.1.4.1, the most frequent durable goods already purchased in anticipation of the micro-grid were mobile phones (purchased by nine households in Berau and 46 in East Sumba), televisions (nine households in Berau and five in East Sumba), and satellite receivers (nine households in Berau and five in East Sumba).

Table 33 presents baseline figures for various metrics of information access in our household dataset. Households in Berau appear to spend more time watching TV and rely more on TV and the Internet for information, although households in both locations both rely primarily on neighbors or friends as sources of information.

Table 33: Baseline information sources, by kabupaten

	Berau		East Sumba	
Variable	**Mean**	**SE**	**Mean**	**SE**
Neighbor is a main source of information	76.6%	(0.030)	75.9%	(0.047)
Internet is a main source of information	9.5%	(0.041)	3.3%	(0.008)
TV is a main source of information	33.4%	(0.019)	22.2%	(0.041)
Hours per day watching TV, adult male	1.77	(0.075)	0.50	(0.065)
Hours per day watching TV, adult female	1.44	(0.179)	0.26	(0.035)

	Berau		East Sumba	
Variable	**Mean**	**SE**	**Mean**	**SE**
Hours per day watching TV, boy 12–17	2.57	(0.791)	0.63	(0.146)
Hours per day watching TV, girl 12–17	1.08	(0.348)	0.34	(0.108)

Despite community member enthusiasm for increased access to information and entertainment as a result of the increased electricity capacity, the presence and quality of the signal required for each device is an important antecedent to take advantage of this benefit. Village officials report that the mobile phone network signal is fair or better for 61.33% of surveyed households in Berau and for 87.88% of surveyed households in East Sumba, although the mobile data network (to access the Internet) is only fair or better for 28.0% of households in Berau and 26.06% of households in East Sumba.

Out of all the kampungs, quality Wi-Fi is only really available in Merabu while the community generator is running during the evening. Some villagers from Lailunggi make the 15-minute walk to Tawui to access the Internet there. In Praiwitu (Sumba), mobile Internet is available when the diesel-powered Base Transceiver Station (BTS) is working, typically from 7 pm until 10 pm every day. Where Internet is available, women in FGDs state that villagers use it to listen to the news, watch YouTube videos, or comment on Facebook posts. One woman in Lailunggi explains she "does not waste the Internet signal on news." The women are indecisive whether the Internet is good or bad for children, as it may make them lazy, and for young villagers, "as they do not look for jobs anymore" (female FGD, Merabu). The FGDs and interviews revealed substantial differences in use of media for information across generations.

FGD evidence suggests that people often watch TV at their neighbors' homes. They serve as an important source of information, whereas in former times *"people had to walk three days to Waingapu"* (male FGD, Lailunggi) to obtain news. TVs are switched on only during evening hours when the communal generators are running or when resources are available to buy the fuel for individual generators. Women say they watch news, soap operas, comedy shows, the Dangdut Singing contest, and Indian movies. Children watch Japanese and Malaysian cartoons (e.g., *Upin-Ipin*), and wildlife movies. In Merabu, Christian prayers are popular. One woman explains that the TV lets them *"see Jakarta and Bali"* while another mentions *"haze in Berau"* (both female FGD, Long Beliu). In Long Beliu, a female community member explains that TV *"changes the lifestyle and [has] brought new styles and motorbikes."* On a similar note, women in Teluk Sumbang strongly emphasize *"while watching TV, we will get inspiration"* (female FGD, Teluk Sumbang). Another woman explains that she is happy to use the TV *"to switch off her worries in the evening"* (female FGD, Merabu). In most villages, women mention that children may *"get too attached to the TV"* (female FGD, Merabu), as they often start watching right after school. In Teluk Sumbang (Berau), female community members expect the CBOG to increase TV use and state that parents have to limit TV consumption for children to *"two hours per day."* Women in Merabu (Berau) believe that they themselves should watch TV only a limited time as *"they are farmers, and farmers have to work."*

Lighting for studying in evening hours is in most cases sufficient. Some interviewees in FGDs and enterprises in KIIs, however, also mention improved lighting for studying as an expected benefit of the CBOG. When it comes to studying at home after school, boys average 0.91 hours per day in Berau and 0.80 hours per day in East Sumba. Girls average a bit more, studying at home for 1.24 hours per day after school in Berau and 0.90 hours per day in East Sumba.

9.2.2 Gender Equality

There are various ways that increased electricity can lead to improved gender equality. Besides the potential for increased access to information described in the previous section, access to electricity can allow for using household appliances often associated with typically female household gender roles, which frees up time for women to pursue other activities or allow them to cease activities that can be harmful. Women across all of the treatment communities named rice cookers, or "Magic Jars," as a primary desired appliance following connection to the micro-grid. One woman in Praiwitu mentioned that with a rice cooker she would not need to "*be tied to the fire anymore,*" and that she could do other activities while cooking rice.

Washing machines are another highly desired appliance by women in treatment areas, but it is unclear that the capacity of the new connections will be sufficient to power a washing machine or that households will be able to afford them. In principle, switching to electric stoves from firewood could also save women a considerable amount of time and exposure to fire but, as with washing machines, it may not be practical to expect households to make such a large investment and change behavior as a result of connection to the micro-grid.[87] Grantee employees as well as female and male community members across all villages believe that women will benefit from electricity access disproportionately, as they will do handicrafts in the evening hours and use household appliances such as rice cookers and blenders.

Overall, the community members describe men and women as equal. In most villages, both male and female interviewees make statements like *"women participate in village meetings and are entitled to vote"* (male community member, Sumba) or *"during village meetings, women do not only participate by preparing food, but also give their opinions"* (male community member, Berau). Long Beliu stands out: interviewees describe women as the *"dominating gender,"* who make all household decisions, whereas men are often outside the home for more than a week hunting and gold mining. In 86.0% of surveyed households in Berau and 88.2% of households in East Sumba, women manage the household budget.

A woman is head of one BUMDes, simply because, as male FGD participants say, *"people voted for her."* In Teluk Sumbang, a male FGD participant notes that *"there is no problem if a women operates the micro-grid; there is a female tugboat captain in Balikpapan, who has an identical job. If she can do the job on the ocean, women can also do the job in the village."* Even in mixed-gender discussions, both men and women participated equally, and the general idea of unequal sexes did not appear to be a plausible concept to the interviewees.

However, there are clear traditional gender roles in all communities: Over 86.5% of respondents in both communities indicated that women are responsible for household chores, and most qualitative respondents agree they are responsible for raising children. Women in Praiwitu explain that they are solely responsible for cooking, but do not *"have to serve their husbands the plate anymore"* (female FGD, Praiwitu). It is common for women to work outside the home to generate additional household income via the management of small shops, farming, weaving, handcrafting, gardening, husbandry, or teaching. In Praiwitu, men in one FGD all agree that they *"support women who work as long as children are taken care of"* (male FGD, Praiwitu). Women also participate in the village management, or get together in women's groups, dedicated to improving community life or generating income. Men, by contrast, have the primary responsibility for the household income. Around 30% of household survey respondents in each location believe women do not have the same capacity to make money as men, while 82% of

[87] In any case, firewood collection is not generally seen as a burden in Berau, where wood is plentiful. It is only sometimes seen as a burden in Sumba where it is more scarce and cutting down trees is illegal.

respondents in Berau and 71.6% of respondents in East Sumba believe that women should do what their husbands tell them to do.

The communities in Sumba have strong traditions that affect gender roles. First, the ancestral religion of Sumba Marapu allows polygamy. Due to changes brought along by Christian priests, only some elderly men still have more than one wife. Second, in the Sumbanese tradition, marriage is sometimes understood as *"buying and selling"* (male village head, Sumba), i.e., uncles of the bride request dowry, such as livestock, woven fabrics, and jewelry. Women usually do not return to their parents' homes even if desired, as the families are not able to repay the dowry.

The villagers have observed changes in gender roles over time. Women in a FGD in Praiwitu explain, for example, that their husbands are willing to engage in the household in ways that their fathers-in-law would not. For example, husbands may cook when wives are sick. One of the oldest women in Praiwitu explains in the Sumbanese language that women 80 years ago did not work in the fields and were not allowed to leave the house, whereas today young girls go to school and participate in village management.

According to most women in one FGD, women's main problems are associated with raising children, who, for example, do not want to go to school. Domestic violence was only discussed in a FGD in Lailunggi, where it is not perceived as a major problem by the female participants. However, when men are "*blind drunk,"* there *"may be some"* (female FGD, Lailunggi). One woman explains that she does not provide her husband with money for alcohol and closes the door in front of him when he comes home drunk. It appears that domestic violence may be more of a risk in East Sumba—depending on the situation (examples included burning food, leaving the house without informing the husband, neglecting children, arguing with the husband, and wanting to earn money independently). Between 12.8% and 22.4% of respondents in East Sumba indicated violence against women may be justified, compared to between 3.7% and 13.5% of respondents in Berau.

9.2.3 Health

At baseline, our Household Survey found a high prevalence of headaches and respiratory disease over the last six months across sexes and kabupatens, although these were particularly prevalent among adult men. Generally speaking, headaches were more prevalent in East Sumba than in Berau. Respondents during qualitative data collection frequently lamented the noise made by generators, which can be heard across the community and, as mentioned in the previous section, female FGD participants desired electric appliances that would allow them to spend less time by the cooking fire. Hence, it is possible that the prevalence of each of these illnesses could decrease following transition to a noiseless, renewable source of electricity like the solar PV mini-grids.

Table 34: Headaches and respiratory disease over last six months, by kabupaten

		Berau		East Sumba	
Symptom	**Age, Sex**	**Percentage**	**SE**	**Percentage**	**SE**
Headache	Adult, female	12.3%	(0.004)	31.3%	(0.059)
	Adult, male	58.0%	(0.025)	71.7%	(0.031)
	Child, female	14.5%	(0.029)	32.0%	(0.019)
	Child, male	55.3%	(0.028)	74.3%	(0.017)
Respiratory Disease	Adult, female	16.4%	(0.022)	15.1%	(0.019)
	Adult, male	27.0%	(0.028)	33.5%	(0.019)
	Child, female	21.9%	(0.074)	16.7%	(0.018)
	Child, male	25.8%	(0.015)	32.9%	(0.035)

The health facilities in the villages mostly use electricity from a diesel-driven generator or an SHS. Some facilities, though, reported insufficient capacity, either because they only use an SHS or because of high diesel prices. The use of electric devices is thus limited. In Lailunggi, the health center is equipped with a laptop, a fridge, an oxygen machine, and lighting. It also possesses an incubator but does not use it due to high fuel prices. The maternal and child health center in Long Beliu does not have a sterilizer or incubators and thus transfers pregnant women to a nearby health center for delivery. In all facilities, lighting is often not available at night.

Nonetheless, women are satisfied with the health services in their communities. In three villages, namely Long Beliu (Berau), Praiwitu, and Lailunggi (East Sumba) the highest perceived risk is to have a motorcycle accident on the way to a health center. In Lailunggi, FGD participants report that women in recent years started giving birth at the health center, because they are fined approximately 40 USD for giving birth at home. In all villages, there are also traditional healers and medication.

9.2.4 Security

It stands to reason that increased access to electricity may improve at least perceived security, since street lighting can allow for safe passage outdoors with a reduced potential for theft or harm. During qualitative data collection, respondents in the villages communicated that serious security problems do not exist. Between the six villages visited, they had each experienced at most one theft or a bigger robbery (*Teluk Sumbang*) in recent years. One village head of a Sumba treatment community states that *"whole Eastern Sumba is safe."* Generally, the community members do not go out after nightfall, as they are not used to it and there are no activities to pursue. Women in Long Beliu explain that they support the micro-grid, as *"it is scary in the dark."* They are uncomfortable outside because of spirits and snakes.

Our quantitative survey corroborates the notion that women and girls especially refrain from going out at night, with respondents in Berau averaging around 1.0 (for girls) and 1.3 (for women) trips after nightfall per week. Women and girls in East Sumba go out even less. In turn, men go out 2.5 days per week in East Sumba and 3.5 days per week in Berau, with boys going out a little less. Most respondents report that they are afraid for their family members going out at night—97.2% of respondents in Berau and 84.9% in East Sumba would be afraid if their daughter went out at night, compared to 89.0% in Berau and 77.4% in East Sumba who would be afraid if their son went out. Nearly three quarters of Berau respondents feared for their own safety going out at night compared to less than half in East Sumba.

9.2.5 Non-GHG Environmental Outcomes

Besides a reduction in GHG emissions, there are other environmental risks and benefits that follow naturally from the substitution of energy from a solar PV micro-grid for previously used fossil fuels. First, the increased use of batteries in solar PV systems and electrical assets that can be charged from the micro-grid (such as sound systems) can lead to contaminated soil and groundwater, depending on how the batteries are disposed of. The degree to which this is harmful depends on the heavy metals that the batteries contain. Increased electrical lighting consumption may also lead to litter in the form of discarded bulbs. Our quantitative survey indicates that households in each location frequently dispose of batteries and light bulbs in nature—21.3% of households in Berau and 14,8% of households in East Sumba throw broken energy-saver bulbs outdoors (either the river or somewhere else outdoors). The prevalence of batteries being thrown away outdoors is even higher—reported by 30.9% of households in Berau and 16.8% in East Sumba.

Another consequence of the transfer to a renewable energy resource is an increased awareness of renewable energy and its potential benefits. Indeed, this increased awareness is an actual objective of these grants, listed as Outcome 1 in the logframe. For understandable reasons, the interviewed villagers

have little understanding and awareness of global climate change. When asked for environmental problems, community members and head of villages name local environmental problems, which are typically not related to electricity. For example, FGD participants perceive a lack of waste management and haze in Berau, and frequent droughts, landslides, and heavy rainfalls in Sumba. In addition, several FGD participants name the smell and noise emitted by generators as environmental problems. In Berau communities, some governmental programs and Akuo Energy trained the population for the necessity to handle waste management responsibly, i.e., by cleaning the beach. Some households know the term "renewable energy" or "solar energy," most of them because they were informed by the grantees. Many interviewees, including heads of villages, community members, and entrepreneurs, understand that the micro-grid's electricity will come from the sun and that it is renewable but are not aware of its environmental advantages.

9.3 Selection of Grants for Pre-/Post-Evaluation

Based on the documents made available to SI at the EDR stage, only five of the 26 CBOG RE grants were able to be considered for pre/post evaluation. These included all Window 3A grants that had fully executed grant agreements at that time. Of those, it was not clear whether or not one (W3A Charta Putra Biomass, Siberut Island) would move forward in time for the evaluation. The other two (W3A Puriver Solar, Tomia Island, and W3A Sky Energy Solar, Karampuang Island), although suitable for a similar style of evaluation as the one that was pursued in Berau, were not selected because of their implementation in relatively unique geographic contexts, the lessons from which would not be as generalizable as those learned from other programming.

The following annex is an excerpt from our approved EDR, regarding selection of the grants in East Sumba and Berau for pre/post evaluation:

In choosing which grants to include at minimum using a pre/post methodology in this portfolio evaluation, we placed the highest emphasis on which grant would lend itself the most to an impact evaluation design, since such a design is essential to providing valid quantitative responses to Evaluation Questions 1–3. On this question, W3A Anekatek Solar, East Sumba, was the only suitable candidate. All of the Window 3A grants, as described in the previous section, targeted whole villages in a way that made a household-level experiment impractical. As such, any grant that could be evaluated quantitatively needed to provide adequate treatment clusters with similar control clusters nearby. Since W3A Anekatek Solar, East Sumba, is operating in 11 sub-village units with comparable analogs in geographic proximity, we selected it as the subject of our impact evaluation. The other Window 3A grants were either providing treatment to all villages on an island, for fewer communities, and/or for relatively unique communities with few options for similar comparisons nearby.

The utilization of an SPV approach for community engagement and sustainability of program outputs is a fundamental aspect of the design of the Window 3A grants. Any evaluation of the GP Facility's approach to community-scale RE programming must evaluate the extent to which the SPV approach contributes to the achievement (or lack thereof) of program outcomes. This approach differs in specific details and contextual factors from grant to grant, so we selected the remaining grant with the most compelling potential narratives in terms of community engagement for a performance evaluation to combine with the impact evaluation of W3A Anekatek Solar, East Sumba.

On this count, all of the other grants have merits. However, W3A Akuo Energy Solar/Micro-Hydro, Berau, has a variety of factors that will make for interesting qualitative comparison. First, it has a diverse set of villages for implementation that have varying degrees of history with community cooperatives and distinct socioeconomic backgrounds. Second, the grant includes a micro-hydro component—albeit quite small in

the context of the capacity provided by the solar PV facilities—that may provide for interesting comparisons with community management of solar PV components alone. Finally, it is in a different geographic area from W3A Anekatek Solar, East Sumba, allowing for a comparative study of how similar program logic applies in different geographic contexts. By investigating process, outcomes, and sustainability across these two grants, we can qualitatively explore a variety of factors that mediate results and sustainability.

As stated above, W1 Hivos Solar/Biogas, Sumba/Sulawesi, was selected as an ex-post add-on to the evaluation to broaden the types of CBOG RE programming informing the evaluation's answers to its core questions. Specifically, it will allow for the inclusion of off-grid RE technology and a RESCO business plan in a comparison of program outcomes and sustainability in common geographic settings.

9.4 Selected Photographs from Baseline Data Collection

Construction Site, Merabu, Berau

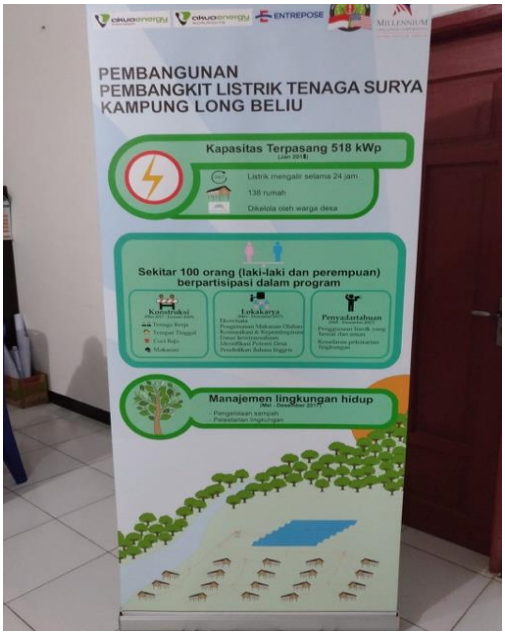
Construction Site, Merabu, Berau

Construction Site, Long Beliu, Berau

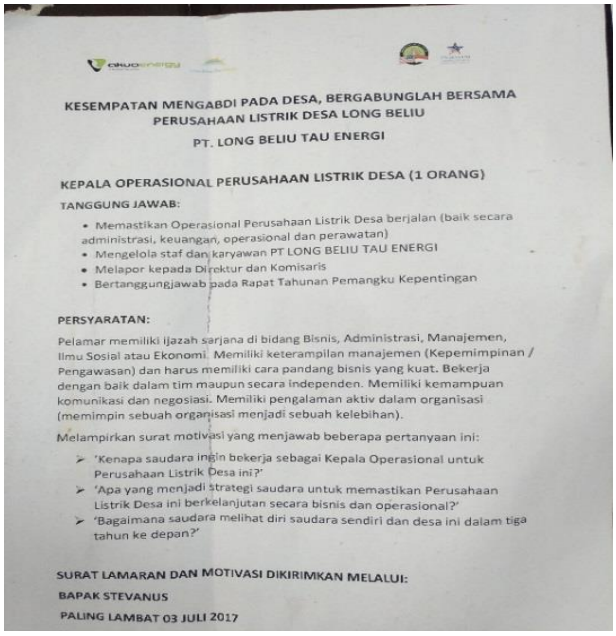
In-house installation old (top) and new (bottom), Long Beliu, Berau

Communal diesel generator in Merabu, Berau

Material by Castlerock in Lailunggi, Sumba



Material by Akuo Energy in Long Beliu, Berau



KESEMPATAN MENGABDI PADA DESA, BERGABUNGLAH BERSAMA PERUSAHAAN LISTRIK DESA LONG BELIU

PT. LONG BELIU TAU ENERGI

KEPALA OPERASIONAL PERUSAHAAN LISTRIK DESA (1 ORANG)

TANGGUNG JAWAB:

- Memastikan Operasional Perusahaan Listrik Desa berjalan (baik secara administrasi, keuangan, operasional dan perawatan)
- Mengelola staf dan karyawan PT LONG BELIU TAU ENERGI
- Melapor kepada Direktur dan Komisaris
- Bertanggungjawab pada Rapat Tahunan Pemangku Kepentingan

PERSYARATAN:

Pelamar memiliki ijazah sarjana di bidang Bisnis, Administrasi, Manajemen, Ilmu Sosial atau Ekonomi. Memiliki keterampilan manajemen (Kepemimpinan / Pengawasan) dan harus memiliki cara pandang bisnis yang kuat. Bekerja dengan baik dalam tim maupun secara independen. Memiliki kemampuan komunikasi dan negosiasi. Memiliki pengalaman aktiv dalam organisasi (memimpin sebuah organisasi menjadi sebuah kelebihan).

Melampirkan surat motivasi yang menjawab beberapa pertanyaan ini:

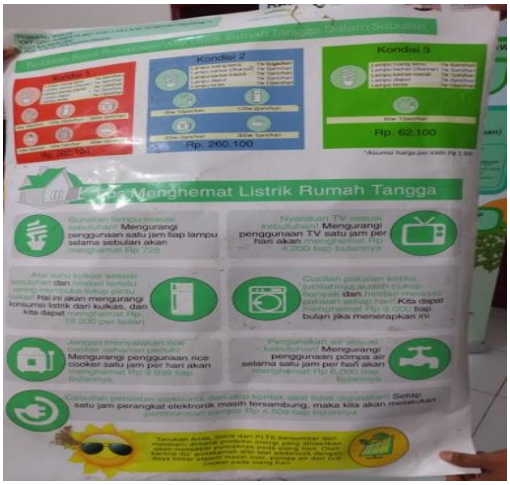
- 'Kenapa saudara ingin bekerja sebagai Kepala Operasional untuk Perusahaan Listrik Desa ini?'
- 'Apa yang menjadi strategi saudara untuk memastikan Perusahaan Listrik Desa ini berkelanjutan secara bisnis dan operasional?'
- 'Bagaimana saudara melihat diri saudara sendiri dan desa ini dalam tiga tahun ke depan?'

SURAT LAMARAN DAN MOTIVASI DIKIRIMKAN MELALUI:

BAPAK STEVANUS

PALING LAMBAT 03 JULI 2017

Tender by Akuo Energy, Long Beliu, Berau



Tariff explanation by Akuo Energy, Long Beliu

Dayak longhouse, from solar panel site, Long Beliu

Household in Pambotanjara, East Sumba

Community in Lailunggi, East Sumba

9.5 Construction of Indices

We use various indices in this report, mainly as covariates for outcomes of interest. All of these indices are principal component analysis (PCA) scores. According to *A User's Guide to Principal Components*,[88] *"PCA is a multivariate technique in which a number of related variables are transformed to a smaller set of uncorrelated variables."* As a result of this process, many colinear variables that measure different but important aspects of a larger concept (in our case, such as wealth of a household or remoteness of a dusun) whose relative weight in the determination of this concept may be unclear to the researcher can be condensed to a single index variable. Although unit changes in the resulting variable do not have an intuitive interpretation, the variable is still useful as a covariate in regressions, for example, because it incorporates the most critical information from all of its component variables without risk of collinearity and allows them to be associated with a dependent variable of interest.

For the purposes of transparency, the tables below display the component variables and definitions included in each of the three indices used in this report. Both of the wealth indices were generated from variables in the Household Survey, while the dusun infrastructure index was constructed from variables in the Village Official Survey. The final set of variables included in each index was selected after verifying that they move intuitively along with the index. For example, at each progressing quintile of the durable goods index, households possess more motorcycles, on average, while simultaneously being less likely to live in a dwelling with floors made of earth. Similarly, at each progressing quintile of the dusun infrastructure index, dusuns tend to be further from the nearest main road and report a worse phone signal.

Table 35: Livestock wealth index

Variable	Definition	Question
Pigs owned	Number	102_1
Sheep owned	Number	102_2
Goats owned	Number	102_3
Rabbits owned	Number	102_4
Buffalo owned	Number	102_5

[88] Jackson, J. Edward. *A User's Guide to Principal Components.* John Wiley & Sons, Inc., 1991.

Variable	Definition	Question
Horses owned	Number	102_6
Cows owned	Number	102_7
Poultry owned	Number	102_8

Table 36: Durable goods wealth index

Variable	Definition	Question
Electric refrigerators owned	Number, all household members	52_1
Ventilators owned	Number, all household members	52_7
Smartphones owned	Number, all household members	52_9a
Non-smartphones owned	Number, all household members	52_9b
CD players owned	Number, all household members	52_11
Color TVs owned	Number, all household members	52_12b
Computers owned	Number, all household members	52_14
Electric water pumps owned	Number, all household members	52_19a
Fuel water pumps owned	Number, all household members	52_19b
Kerosene stoves owned	Number, all household members	52_20a
LPG stoves owned	Number, all household members	52_20b
Firewood stoves owned	Number, all household members	52_20c
Washing machines owned	Number, all household members	52_21
Bicycles owned	Number, all household members	35_1
Motorcycles owned	Number, all household members	35_2
Cars owned	Number, all household members	35_3
Boats owned	Number, all household members	35_4
Tractors owned	Number, all household members	35_5
HH has bamboo or coconut stem walls	0 = Walls are made of wood, brick, or stone 1 = Walls are made of bamboo or coconut stem	11
HH has an iron roof	0 = Roof is made of another material 1 = Roof is made of iron	12
HH has earth floors	0 = Floors of dwelling are made of other material 1 = Floors of dwelling are made of earth	13
Buildings in house	Number	31
Rooms in main building of house	Number	32

Table 37: Dusun infrastructure index

Variable	Definition	Question
Distance between dusun and the nearest main road	Measured in km	2a1
Quality of phone signal in the dusun	1 = Good, 2 = Fair, 3 = Bad, 4 = No Signal	2a2b
PAM (water utility) provides service to some households in dusun	0 = PAM not available as water source in dusun 1 =PAM available as water source in dusun	4a
Schools located in dusun	0 = None, 1 = Elementary school only, 2 = Jr. high school only, 3 = Both elementary and jr. High	3a
Dusun has a Puskesmas Pembantu facility	0 = No 1 = Yes	3a_7
Dusun has a village official's office	0 = No 1 = Yes	3a_24

9.6 CEM and PSM Results

9.6.1 CEM Results

	Unmatched			Default 3 bins			Default 4 bins		
	Control	Treatment	*p*-Value	Control	Treatment	*p*-Value	Control	Treatment	*p*-Value
Sex of the head of household	0.906	0.912	0.76	0.929	0.907	0.362	0.947	0.928	0.477
Years of education of the head of household	5.804	5.976	0.65	5.764	5.833	0.885	5.408	5.227	0.729
TOTAL MEMBERS OF HH	4.221	4.521	0.11	4.465	4.465	0.999	4.175	4.558	0.091
Walls of the main building of household are made of bamboo or coconut stem	0.826	0.53	0.01	0.953	0.535	0	0.947	0.552	0.001
Main flooring material is earth	0.198	0.385	0.02	0.126	0.388	0.006	0.117	0.398	0.003
Household does not own any means of transportation	0.618	0.433	0.01	0.614	0.442	0.198	0.65	0.448	0.066
Household has an account at a bank or savings association	0.098	0.155	0.09	0.126	0.138	0.793	0.087	0.133	0.282
Did the household take up a loan during the last two years?	0.055	0.212	0.00	0.055	0.202	0.001	0.034	0.166	0.001
Average monthly income from all sources	1098468	1953079	0.01	819668.8	1828554	0.002	754525.6	1539878	0.019
Total household monthly expenditure	1188810	1608477	0.02	1044650	1486343	0.012	977650.1	1455508	0.007
Monthly household energy expenditure	148435.5	228235.1	0.01	135053.4	212414.6	0.049	123562	202072.5	0.044
To cover family needs, household income is insufficient	0.438	0.318	0.01	0.449	0.321	0.034	0.476	0.331	0.01
Wealth index based on livestock ownership only	0.208	-0.069	0.09	0.602	-0.101	0.009	0.423	-0.157	0.025
Wealth index based on durable goods and household qualities only	-0.809	-0.66	0.06	-0.798	-0.694	0.215	-0.837	-0.765	0.17
Household does not have access to an energy source	0.129	0.094	0.37	0.15	0.099	0.408	0.15	0.105	0.314
Household uses some kind of solar technology as an energy source	0.777	0.83	0.41	0.748	0.827	0.539	0.743	0.807	0.462
Overall, how many hours in a normal day do you have electricity?	8.018	8.842	0.24	7.315	8.599	0.305	7.354	8.077	0.442
Total number of lighting fixtures requiring electricity	2.511	2.797	0.24	2.543	2.753	0.683	2.398	2.652	0.439
Total liters of kerosene consumed per month for any purpose	1.25	2.027	0.11	0.689	1.968	0.015	0.828	1.343	0.19
How many liters of kerosene do you consume per month for lighting?	0.784	0.75	0.81	0.638	0.777	0.635	0.65	0.566	0.669
Average hours per day spent on income- generating activities including farming, female	6.064	5.753	0.10	5.878	5.68	0.59	6.051	5.736	0.289
Average hours per day spent watching television, father/man	0.116	0.4	0.00	0	0.385	0	0.01	0.406	0
Average hours per day spent on income-generating activities including farming, male	4.575	4.056	0.04	4.312	3.891	0.295	4.436	4.025	0.339

	Unmatched			Default 3 bins			Default 4 bins		
Average hours per day spent watching television, mother/woman	0.083	0.211	0.02	0.028	0.197	0.001	0.01	0.193	0
Family conditions have not improved over the last year	0.789	0.548	0.00	0.772	0.548	0.037	0.801	0.591	0.002
Village conditions have not improved over the last year	0.327	0.273	0.37	0.252	0.272	0.773	0.282	0.32	0.599
Total of Population	310.861	702.033	0.00	359.457	696.702	0.038	317.481	771.519	0.012
Distance from the village road to the main road (km)	11.361	1.481	0.00	9.449	1.424	0.023	10.65	1.856	0.002
Dusun has a weak or no cellular phone reception	0.706	0.121	0.00	0.378	0.112	0.367	0.301	0.188	0.649
Dusun has an elementary school (SD)	0.376	0.733	0.06	0.551	0.734	0.587	0.587	0.779	0.457
Dusun has a junior high school (SMP)	0.029	0.37	0.03	0.118	0.372	0.216	0.049	0.331	0.094
Number of social infrastructure in dusun connected to an energy source	1.174	3.833	0.00	0.992	3.766	0.007	1.286	4.254	0.005
Total shops, including kiosks, stores, auto shops, and welding shops, in dusun	4.585	10.294	0.00	3.039	10.221	0	2.675	10.674	0
Scores for Component 1	0.663	-1.537	0.00	-0.684	-1.552	0.005	-0.245	-1.403	0.005

9.6.2 PSM Results

	Unmatched			**Model 1**			Model 2			
	Control	Treatment	(1) vs. (2), *p*-Value	Control	Treatment	(1) vs. (2), *p*-Value	Control	Treatment	(1) vs. (2), *p*-Value	
Sex of the head of household	0.906	0.912	0.758	0.909	0.912	0.898	0.909	0.912	0.897	
Years of education of the head of household	5.804	5.976	0.646	5.924	5.976	0.901	5.561	5.976	0.286	
TOTAL MEMBERS OF HH	4.221	4.521	0.105	4.267	4.521	0.155	4.282	4.521	0.169	
Walls of the main building of household are made of bamboo or coconut stem	0.826	0.53	0.009	0.827	0.53	0.014	0.782	0.53	0.053	
Main flooring material is earth	0.198	0.385	0.021	0.191	0.385	0.02	0.206	0.385	0.044	
Household does not own any means of transportation	0.618	0.433	0.006	0.552	0.433	0.146	0.579	0.433	0.062	
Household has an account at a bank or savings association	0.098	0.155	0.088	0.109	0.155	0.207	0.091	0.155	0.068	
Did the household take up a loan during the last two years?	0.055	0.212	0	0.079	0.212	0.002	0.079	0.212	0.001	
Average monthly income from all sources	1098468	1953079	0.008	1202290	1953079	0.041	1070343	1953079	0.009	
Total household monthly expenditure	1188810	1608477	0.017	1332740	1608477	0.184	1315334	1608477	0.143	

	Unmatched			**Model 1**			Model 2			
Monthly household energy expenditure	148435.5	228235.1	0.013	166025.4	228235.1	0.091	160878.1	228235.1	0.059	
To cover family needs, household income is insufficient	0.438	0.318	0.005	0.406	0.318	0.054	0.418	0.318	0.029	
Wealth index based on livestock ownership only	0.208	-0.069	0.089	0.408	-0.069	0.021	0.347	-0.069	0.046	
Wealth index based on durable goods and household qualities only	-0.809	-0.66	0.057	-0.747	-0.66	0.296	-0.769	-0.66	0.172	
Household does not have access to an energy source	0.129	0.094	0.37	0.088	0.094	0.885	0.106	0.094	0.764	
Household uses some kind of solar technology as an energy source	0.777	0.83	0.41	0.821	0.83	0.902	0.815	0.83	0.839	
Overall, how many hours in a normal day do you have electricity?	8.018	8.842	0.242	8.245	8.842	0.458	8.191	8.842	0.418	
Total number of lighting fixtures requiring electricity	2.511	2.797	0.235	2.673	2.797	0.656	2.6	2.797	0.471	
Total liters of kerosene consumed per month for any purpose	1.25	2.027	0.108	1.214	2.027	0.113	1.25	2.027	0.127	
How many liters of kerosene do you consume per month for lighting?	0.784	0.75	0.81	0.6	0.75	0.383	0.636	0.75	0.483	
Average hours per day spent on	6.064	5.753	0.096	5.888	5.753	0.525	5.865	5.753	0.604	

	Unmatched			Model 1			Model 2			
income-generating activities including farming, female										
Average hours per day spent watching television, father/man	0.116	0.4	0.003	0.117	0.4	0.004	0.114	0.4	0.004	
Average hours per day spent on income-generating activities including farming, male	4.575	4.056	0.044	4.305	4.056	0.405	4.328	4.056	0.393	
Average hours per day spent watching television, mother/woman	0.083	0.211	0.019	0.095	0.211	0.061	0.083	0.211	0.029	
Family conditions have not improved over the last year	0.789	0.548	0	0.773	0.548	0.001	0.764	0.548	0.001	
Village conditions have not improved over the last year	0.327	0.273	0.369	0.303	0.273	0.611	0.303	0.273	0.627	
Total of Population	310.861	702.033	0.004	316.852	702.033	0.006	327.342	702.033	0.007	
Distance from the village road to the main road (km)	11.361	1.481	0	9.323	1.481	0	9.203	1.481	0	
Dusun has a weak or no cellular phone reception	0.706	0.121	0.002	0.558	0.121	0.037	0.552	0.121	0.039	
Dusun has an elementary school (SD)	0.376	0.733	0.061	0.43	0.733	0.151	0.409	0.733	0.124	
Dusun has a junior high school (SMP)	0.029	0.37	0.033	0.045	0.37	0.048	0.045	0.37	0.048	
Number of social infrastructure in dusun connected to an energy source	1.174	3.833	0	1.345	3.833	0.002	1.294	3.833	0.001	

	Unmatched			**Model 1**			Model 2			
Total shops, including kiosks, stores, auto shops, and welding shops, in dusun	4.585	10.294	0	3.639	10.294	0	3.83	10.294	0	
Scores for Component 1	0.663	-1.537	0	0.174	-1.537	0	0.18	-1.537	0	

9.7 Data Collection Instruments

9.7.1 Household Questionnaire

*Used in East Sumba treatment and comparison sites, and in Berau treatment sites.

HOUSEHOLD QUESTIONNAIRE

Impact Evaluation Baseline Study 2017 Green Prosperity Renewable Energy Grant

1. Questionnaire N° _____

2. Site code _____

3. Geo coordinate _____

4. Date _____

5. Village _____
6. RT _____
7. Religion _____
8. Tribe _____

9. Interviewer's name _____

10. Starting Time of Interview _____ : _____ h

11. The walls of the main building consist of…

1 ☐ Bamboo
2 ☐ Wood
3 ☐ Coconut stem
4 ☐ Unburnt bricks
5 ☐ Burnt bricks
☐ Other_____

12. The main roofing material is …

1 ☐ Ijuk
2 ☐ Palm leaves
3 ☐ Wood
4 ☐ Iron sheets
5 ☐ Concrete
6 ☐ Tiles
☐ Other_____

13. The main flooring material is…

1 ☐ Earth
2 ☐ Bamboo
3 ☐ Wood
4 ☐ Concrete
5 ☐ Bricks
6 ☐ Stones
7 ☐ Ceramics
☐ Other____ _

14. Are the windows fitted with glass?

1 ☐ Yes

15. Is building painted in color outside?

1 ☐ Yes

16. Is the building painted in color inside?

1 ☐ Yes

0 ☐ No	0 ☐ No	0 ☐ No

[COMMENTS]

Basic Information

17. Who are the permanent residents of this household? What relationship does each member have to the head of household? **[Only include household members who are at least 11 years of age]**	**18.** Sex *m / f*	**19.** Age *years*	**20.** Education **1.** Level of education *code*	**2.** Number of years *Years* **[WITHOUT RE-PETITIONS**	**21.** First Occupa-tion *code*	**22.** Second Occupa-tion *code*	**IF CODE 2. or 3.** **23.** Where does he/ she exercise this occupation? *code*	**24.** How much does he/ she earn per month? *IDR*
a. ☐ _____							1.	1.
							2.	2.
b. ☐ _____							1.	1.
							2.	2.
c. ☐ _____								
d. ☐ _____								
e. ☐ _____								
f. ☐ _____								
g. ☐ _____								
h. ☐ _____								
i. ☐ _____								
j. ☐ _____								
k. ☐ _____								
l. ☐ _____								
m. ☐ _____								
n. ☐ _____								

25.

CODE of Q.17 **CODE of Q.21 and 22**

Who is the head of household? _____ LETTER OF Q.17

26. Who is the interviewee? _____ LETTER OF Q.17

27. Is any female household member pregnant? _____ LETTER OF Q.17

28. How many children between 6 and 11 years live in the household? _____

29. How many children younger than 6 years live in the household? _____

30. **[TOTAL NUMBER OF PERSONS IN HOUSEHOLD.]** _____

1. Head of household
2.Spouse
3. Father/ mother
4. Brother/ sister
5. Son/ daughter
6. Grandchild
7. Niece/ nephew
8 Other relative
9. Servant
10. Other non-relative

CODE of Q.20.1

0. None
1. Primary school
2. Junior high school
3. Senior high school.
4. Vocational training
5. University
6. Pesantren

1. Farmer, partly for sale
2. Farmer, own consumption
3. Fisherman, partly for sale
4. Fisherman, own consumption
5. Gold "hunter"
6. Logging enterprise employee
7. Palm oil enterprise employee
8. Rubber enterprise employee
9. Mining enterprise employee
10. Hunter, partly for sale
11. Hunter, for own consumption
12. Civil servant **[SPECIFY]**
13. Other **dependent** occupation **[SPECIFY]**
14. Other **independent** occupation **[Specify]**
15. Studies
16. Domestic work, child rearing
17. Without occupation/work
18. Retired

CODE of Q.23

1. Same village
2.Village in same Kecamatan
3. Village in same Kabupaten

[COMMENTS]

31. How many buildings does your house have? _____

32. How many rooms are there in your main house [excl. bathroom]? _____

33. How long have you been living on this plot of land? _____

34. What year did you arrive to this village?

_____

35. Do you own the following means of transportation? **[IF SEVERAL, GIVE NUMBER]**

0	☐	No	4	☐	Boat____
1	☐	Bicycle ____	5	☐	Cart ____
2	☐	Motorcycle ____	6	☐	Tractor ____
3	☐	Car ____	7	☐	Other: _____

2. Persons migrated

36. Have any former household members migrated? 1 ☐ Yes; 0 ☐ No →**q.42**

	37. What relationship does he/ she have to the head of household?	**38.** What is his/ her age?	**39.** What is his/ her education level?	**40.** Where did he/ she migrate to?	**41.** For what reason does he/ she live somewhere else?
	0. He/ she is the head of household 1. Father 2. Mother 3. Son 4. Daughter 5. Spouse 6. Other	*age*	0. None 1. Primary school 2. Junior high school 3. Senior high school 4. Vocational training 5. University	1. Jakarta 2. Village in same Kecamatan 3. Village in same Kabupaten 4. TanjungRedeb 5. Balikpapan 5. Waingapu 6. Other, – specify	1. Seasonal work 2. Daily wage 3. Regular work 4. Scarcity of land 5. Lack of work 6. Studies 7. Marriage 8. Other, specify?
1.					
2.					
3.					
4.					

[COMMENTS]

3. Electric energy

42. Do you have the following electricity sources in your household? For how long have you been using each source? [**SEVERAL ANSWERS POSSIBLE, duration expressed in years and months]**

0	☐	None	→**q.43**
1	☐	Car battery (without solar panel) __years __months	→**q.46.1**
2	☐	Individual genset __years __months	→**q.46.2**
3	☐	Connection to micro-hydro __years __months	→**q.46.4**
4	☐	Individual traditional waterwheel __years __months	→**q.46.4**
5	☐	Traditional waterwheel in the village __years __months	→**q.46.4**
6	☐	Genset in the village __years __months	→**q.46.3**
7	☐	Genset shared with neighbour __years __months	→**q.46.3**
8	☐	Solar panel (installed on roof) __years __months	
9		_____kW of solar panel	→**q.46.4**
10	☐	Solar panel (not installed on roof) __years __months	
11		_____kW of solar panel	→**q.46.4**
12	☐	Solar PV Kit __years __months	→**q.46.4**

13	☐ PLN __years __months	→q.46.4

		a	b	c	d	e	f	g	h
		Micro-hydro	Car battery	Individual Genset	Village Genset	Traditional water wheel	Solar panel	PLN	No
43.	Have you ever used an electricity source in this household? If so, which type?	1	2	3	4	5	6	7	0
44.	How many years has it been since your household was disconnected from the electricity source or since the source become non-functional?	_____ years	_____ years	_____ years	_____ years	_____ years	_____ years	_____ years	-3
45.	Why are you no longer connected to the electricity source? 1. No longer interested 2. Not able to pay the bill 3. Source no longer functional 4. Other: ____								-3

→q.52

	1.	2.	3.	4.
46.	When did you receive the battery?	When did you receive the genset?	When did you connect to the village genset?	When did you receive this electricity source?
	_____ YEAR	_____ YEAR	_____ MONTH-YEAR	_____ MONTH -YEAR
47.	How many times per year do you charge the battery?	Which fuel do you use for the genset?	How much do you pay per month for connection to the village genset? And electricity use?	How much did you pay for the connection and the electric installation in your house?
		1 ☐ petrol 2 ☐ diesel	_____ IDR	_____ IDR

	TIMES			
48.	How much do you pay for charging the car battery?	How many litres of this fuel do you consume per month?	How did you pay for it?	How did you pay for it?
			1 ☐ Cash	1 ☐ Cash
			2 ☐ Credit	2 ☐ Credit
			3 ☐ It was donated to me	3 ☐ Donation
	IDR	LITRES	4 ☐ Other _____	4 ☐ Other _____
49.	How long does it take you to reach the place where you charge the battery?	How much do you pay per litre for the corresponding fuel?		How much did you pay for the current line last month?
	Minutes	IDR		IDR
50.		How much did you pay for the reparation of this electricity source last year?		How much did you pay for the reparation of this electricity source last year?
		IDR		IDR
	☐q.46.2, 46.3, or 46.4 if other electricity source in household	**☐q.46.3 or q.46.4, if other electricity source in household**	**☐q.46.4, if other electricity source in household**	
51.	Overall, how many hours in a normal day do you have electricity?			
	___hours			

4. Energy for appliances and lighting

52.	**53.**	**54.**

	Do you use any of these appliances or machines in your home? **[READ ALL]** If yes, how many?		Do you use the appliance(s)/ machine(s) to produce goods to sell at home? If yes, for how much time?	Did you buy this appliance in anticipation of being connected to the new micro-grid?
1.	Iron (Electric)	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
2.	Refrigerator			
	a. Fuel-run	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
	b. Electric	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
3.	Electric stove	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
4.	Electric kettle	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
5.	Rice cooker	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
6.	Magic Jar	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
7.	Ventilator	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
8.	Landline telephone	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
9.	Mobile phone			
	a. Smartphone (internet-compatible)	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
	b. Non-Smartphone (not internet-compatible)	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
10.	Radio		----------	
	a. Battery only	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
	b. Bivalent	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
	c. Line power only	_____	☐No ☐ Yes YEARS:	☐No☐ Yes
11.	CD / VCD	_____	☐No ☐ Yes YEARS:	☐No☐ Yes

12.	TV			
	a. Black and white	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
	b. Color	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
13.	Satellite receiver	____	☐No ☐ Yes YEARS:	☐No☐ Yes
14.	Computer	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
15.	Printer	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
16.	Mill			
	a. Fuel-run	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
	b. Electric	____	☐No☐ Yes YEARS: ____	☐No☐ Yes
17.	Sewing machine			
	a. Mechanical	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
	b. Electric	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
18.	Electric Water Purifier	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
19.	Water Pump			
	a. Electric	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
	b. Fuel-run	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
20.	Stove			
	a. Kerosene	____	☐No ☐ Yes YEARS:	☐No☐ Yes
	b. LPG	____	☐No ☐ Yes YEARS:	☐No☐ Yes
	c. Woodfuel	____	☐No ☐ Yes YEARS:	☐No☐ Yes
21.	Washing Machine	____	☐No ☐ Yes YEARS: ____	☐No☐ Yes
22.	Other :_____ _	____	☐No☐ Yes YEARS: ____	☐No☐ Yes

	57. Do household members use electric appliance(s)/ machine(s) to produce goods/ offer service **outside home**?	**58.** Who is the household member **[use code Q.17]**?	**59.** Which are the three most important electric appliance(s)/ machine(s) the household member uses?**[use codes from Q. 52]**
1	1 ☐ Yes 0 ☐ No →**q.60**	_____	A _____ B _____ C _____
		_____	A _____ B _____ C _____
		_____	A _____ B _____ C _____
		_____	A _____ B _____ C _____
		_____	A _____ B _____ C _____

60. Do you charge your mobile phone(s) at home?	**61.** What is the distance to the place where you charge the battery?	**62.** How much do you pay per charge?	**63.** How often did you charge your mobile phone last week?	**64.** How many times did you personally use your mobile phone in the last week?
1 ☐ yes → **q.63** 0 ☐ No -3 ☐No mobile phone in the household → **q.65**	_____ 1 ☐ Metres 2 ☐ Min. by foot ☐ _____	_____ IDR	_____ TIMES	_____ TIMES -3 ☐You do not have a mobile phone

65.	66.
How many flash lights **[PORTABLE]** are there in the household?	How many sockets are there in the household?
_____	_____

		1.	3.	4.	5.
67.	Which lighting sources do you use in your household **[INCLUDING EXTERIOR LIGHTING]**?	Normal electric bulb ☐	Neon/ fluorescent tube ☐	Energy saver ☐	1. Hurricane lamp☐ 2. Tin lamp☐ 3. Gas lamp ☐ 4. Battery-driven LED ☐ 5. Rechargeable bulb ☐
68.	How many of these lamps do you use?	Outside _____	Outside _____	Outside _____	
		Inside _____	Inside _____	Inside _____	_____
69.	How many hours per day do you use the lamp(s)?	Outside ____ HOURS	Outside ____ HOURS	Outside ____ HOURS	
		Inside ____ HOURS	Inside ____ HOURS	Inside ____ HOURS	_____
70.	How satisfied are you with the lighting quality of the lamp? 1. Very satisfied 2. Satisfied 3. Not satisfied 4. Very not satisfied	_____	_____	_____	_____

71.	How many rooms do you illuminate with these lamps?	_____			_____
72.	What is this room used for? 1. Living room 2. Head of HH's room 3. room of other HH members 4. Kitchen 5. Toilet 6. Other [SPECIFY]				
73.	Within the last year, how many of these bulbs/lighting sources you had to replace because they were broken?				
74.	What do you do with the neon lights / energy savers when they are broken?				1. Throw away with garbage 2. Throw away in the toilet 3. Throw away outside (river/ocean) 4. Throw away outside (not river/ocean) 5. Return it to the place where I bought it 6. Other (SPECIFY)

5. Energy sources

		1. Diesel *Kg*	2. Petrol *Kg*	3. Kerosene *litres*	4. Charcoal *kg*	5. Fire wood *bundles*	6. Palm oil *litres*	7. Coconut oil *litres*	8. Batteries *number*
75.	How many units of ____ do you consume per month?	_____ KG	_____ KG	_____ for lighting	_____ for cooking	_____ collected	_____ for cooking	_____ for cooking	_____ for lighting
				_____ for cooking	_____ for ironing	_____ bought			_____ for radio
				_____ for other purposes	_____ other purposes				_____ other purposes
76.									

How much do you pay	IDR per kg MIN	IDR per kg MIN	IDR per litre MIN	IDR per kg MIN	IDR per bundle MIN			IDR per battery MIN

77. **[If HH uses batteries]**
What do you do with the batteries when they are empty?

1 ☐ Throw away →**Where ?** _____
2 ☐ other : _____

Throw away-where:
1. Into garbage
2. Into toilet
3. Into nature
4. Other, please specify: _____

78. Do you see negative impacts induced by electricity?

1 ☐ Yes
0 ☐ No →**q.80**

79. Which negative impacts have you observed?

_____
_____

80. **[** ☐ HOUSEHOLD **HAS A MODERN ELECTRICITY SOURCE (e.g. battery, genset, or grid connection)** →**Q.81**
☐ HOUSEHOLD **DOES NOT HAVE AMODERN ELECTRICITY SOURCE**→**Q.85]**

81. Have any of this household's appliances been damaged due to voltage fluctuation? If yes, which appliance(s)?

1 ☐ No →**q.85**
0 ☐ Yes

82. Which appliance has been damaged?

_____

1 Light bulb/energy saver/neon
2 TV
2 Rice cooker
3 Water cooker
4 Radio
5 Other, SPECIFY

83. Do you wish to see any improvement in the electricity supply?

1 ☐ Yes
0 ☐ No →**q.85**

84. Please specify.
1.Higher power supply
2. Less outages
3. Constant/ all-day supply
4. Lower electricity costs
5. Less noisy
6. Other, specify.

6. Agriculture

85. Do you manage farm land? Whether cultivating by yourself (or with assistance) or cultivating by others

1 ☐ Yes, cultivating by myself (or with assistance)
2 ☐ Yes, but cultivating by other
0 ☐ No →**q.92**

86. What is the property status of your farm land?

1 ☐ Owned (with title)
2 ☐ Rented
3 ☐ BagiHasil
4 ☐ Owned (without title)
5 ☐ Somewone else's land (Can be used for free)

[EXPLAIN THE DIFFERENCE BETWEEN NON-TRANSFORMED AND TRANSFORMED PRODUCTS]

	87. Please indicate your **five most** important agricultural products:	**88.** Which products did you sell in a non-transformed way last year?	**89.** How much did you sell within the last 12 months in a non-transformed way?	**90.** For how many IDR do you sell each unit? **[UNIT OF Q.89]**
1	Apple ☐	☐No☐ Yes	_____ kg	
2	Shallot ☐	☐No☐ Yes	_____ kg	
3	Hot Pepper ☐	☐No☐ Yes	_____ kg	

4	Cocoa ☐	☐No☐ Yes	_____ kg	
5	Maize ☐	☐No☐ Yes	_____ kg	
6	Orange ☐	☐No☐ Yes	_____ kg	
7	Soy Bean ☐	☐No☐ Yes	_____ kg	
8	Beans ☐	☐No☐ Yes	_____ kg	
9	Peanut ☐	☐No☐ Yes	_____ kg	
10	Kangkung ☐	☐No☐ Yes	_____ kg	
11	Rubber ☐	☐No☐ Yes	_____ kg	
12	Potato ☐	☐No☐ Yes	_____ kg	
13	Cucumber ☐	☐No☐ Yes	_____ kg	
14	Coffee ☐	☐No☐ Yes	_____ kg	
15	Cabbage ☐	☐No☐ Yes	_____ kg	
16	Pumpkin ☐	☐No☐ Yes	_____ kg	
17	Mango ☐	☐No☐ Yes	_____ kg	
18	Mangosteen ☐	☐No☐ Yes	_____ kg	
19	Pineapple ☐	☐No☐ Yes	_____ kg	
20	Rice ☐	☐No☐ Yes	_____ kg	
21	Papaya ☐	☐No☐ Yes	_____ kg	
22	Banana ☐	☐No☐ Yes	_____ bunches	
23	Watermelon ☐	☐No☐ Yes	_____ kg	
24	Cassava ☐	☐No☐ Yes	_____ kg	
25	Sugar ☐	☐No☐ Yes	_____ kg	
26	Tea ☐	☐No☐ Yes	_____ kg	
27	Tobacco ☐	☐No☐ Yes	_____ kg	
28	Eggplant ☐	☐No☐ Yes	_____ kg	
29	Sweet Potato ☐	☐No☐ Yes	_____ kg	
30	Fish ☐	☐No☐ Yes	_____ kg	
31	Water spinach ☐	☐No☐ Yes	_____ kg	
32	_____		_____	_____
33	_____		_____	_____
34	_____		_____	_____

91. How much do you earn per year selling non-transformed agricultural products?

_____
IDR

[COMMENTS]

92. Do you transform agricultural products?

1 ☐ Yes
0 ☐ No →**q.100**

	93. What is the basic product? **[USE THE CODE OF Q.105]**	**94.** Who trans-forms the product? **[SEVERAL ANSWERS POSSIBLE]** 1. Family Member (male) 2. Family Member (female) 3.Employee 4.Other, specify	**95.** By which means does s/he transform the product? 1.Motorized appliance 2.Electric appliance 3. Tools 4. By hand 5. Other, specify	**96.** Into what? 1. De-shelled rice 2. Hulled coffee 3. Flour 4. Beverage 5. Oil 6. Grilled product 7. Other- what?	**97.** What is the unit? [Indicate all, if there are multiple kinds of unit] Sack of *x* kg, Bottle of *x* ml, ...	**98.** What are the approximate quantities that you sell per year? **[IN UNITS OF Q.97]**	**99.** For how much do you sell each unit? **[UNIT OF Q.97]** *IDR*
1.							
2.							
3.							
4.							

7. Livestock

100. Do you own domestic animals?

1 ☐ Yes
0 ☐ No →**q.103**

	101. Which animals do you currently own?		102. How many of these animals do you own?
1.	☐	Pig	
2.	☐	Sheep	
3.	☐	Goat	
4.	☐	Rabbit	
5.	☐	Buffalo	
6.	☐	Horse	
7.	☐	Cow	
8.	☐	Poultry	
9.	☐	Dog	
10.	☐	Other,specify _____	

8. Financial Situation

103. Do you have an account at a bank or savings association?

1 ☐ Yes, at a bank
2 ☐ Yes, at a savings association
3 ☐ Yes, other : _____
0 ☐ No

104. Do you save money at home?

1 ☐ Yes
2 ☐ No

105. Did the household take up a loan during the last two years?

1 ☐ Yes
0 ☐ No →q.107

106. Where? **[SEVERAL ANSWERS POSSIBLE]**

1. Kepada keluarga atau orang lain
2. Di toko
3. Di lembaga keuangan
4. Bank
5. Rentenir
6. Lainnya – sebutkan

_____

107. How many, if any, remittances does the householdreceive per month?

108. How many, if any, direct cash transfers does the household receive per month?

109. To cover family needs, your household income is…

1☐Sufficient

_____ IDR	_____ IDR	2☐Tight 3☐Not Sufficient

9. Expenditures

	110.		a.	b.	c.
	Do you spend money on the following expenditures? If Yes, how much do you roughly spend? **[TRY TOGET THE INFORMATION ON MONTHLY LEVEL]** -9. Paid in kind		per week *IDR*	per month *IDR*	per year *IDR*
1.	1 ☐ Yes 0 ☐ No	Rent (house and fields) (in money)			
2.	1 ☐ yes 0 ☐ no	Food (for the whole family)			
3.	1 ☐ yes 0 ☐ no	Crop transformation			
4.	1 ☐ yes 0 ☐ no	Transport (public and private)			
5.	1 ☐ yes 0 ☐ no	Telecommunication			
6.	1 ☐ yes 0 ☐ no	Water			
7.	1 ☐ yes 0 ☐ no	Schooling expenses for children (material, school fees, transport, etc.)			
8.	1 ☐ yes 0 ☐ no	Agricultural expenses (seeds, fertilizer, dung, pesticides, and worker)			
9.	1 ☐ yes 0 ☐ no	Livestock breeding			
10	1 ☐ yes 0 ☐ no	Family and religious ceremonies			
11.	1 ☐ yes 0 ☐ no	Remittances **to** family members who do not live at home			
12	1 ☐ yes 0 ☐ no	Medical expenses [excl. health			
13	1 ☐ yes 0 ☐ no	Cigarettes			
14	1 ☐ yes 0 ☐ no	Clothes (for the whole family)			
15	1 ☐ yes 0 ☐ no	Ice (for cooling)			
16	1 ☐ yes 0 ☐ no	Taxes (PBB)			

	111.
	What other large investment **[>230.000 IDR]** did you make during the last 12 months?
1.	
2.	
3.	

		112.
	[SEVERAL ANSWERS POSSIBLE]	Who manages the household budget?
1.	Male	☐
2.	Female	☐

	113.	114.
On working days, when does the ... in the household usually...	Father/ man	Mother/ woman
0.	☐No father/ man in household → **q.112**	☐No mother/ woman in household → **q.113**

1.	wake up?	_ _: _ _ h	_ _: _ _ h
2.	perform income generating activities **[INCLUDING FARMING]**?	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h
3.	perform household duties?	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h
4.	watch television?	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h
5.	perform other leisure activities?	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h
6.	go to bed?	_ _: _ _ h	_ _: _ _ h

On working days, when do the ... in the household usually...		**115.** children of age 6-11	**116.** **male** children of age 12-17	**117.** **female** children of age 12-17
0.		☐No children of age 6-11 in household → **q.114**	☐ No male children in household of age 12-17 → **q.115**	☐No female children in the household of age 12-17 → **q.116**
1.	wake up?	_ _: _ _ h	_ _: _ _ h	_ _: _ _ h
2.	study at home after school?	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h
3.	perform household duties	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h
4.	study outside the house after school?	From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h
5.	watch TV?	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h
6.	surf the internet?	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h	From _ _: _ _ h till _ _: _ _ h From _ _: _ _ h till _ _: _ _ h
7.	go to bed?	_ _: _ _ h	_ _: _ _ h	_ _: _ _ h

[COMMENTS]

Q.118 & 119 only ask to the household who has TV

118. Who decides what kind of program you watch on TV?

1 ☐ Adult male
2 ☐ Adult female
3 ☐ Child < 18

		119. Which TV programs do the household members watch?	**120.** Which other activities **[THAN Q.111 – 115]** do the household members carry out after nightfall?
		[DO NOT READ] 1. Cartoons 2. Movies 3. News 4. Soap operas 5. Sports 6. Other, specify	1. Radio 2. Reading 3. Praying 4. Playing 5. Going out 6. Household duties 7. Internet surfing 8.Other, specify
a.	Father/ man	1. _____ 2. _____	
b.	Mother/ woman	1. _____ 2. _____	

121. Does any member of the household collect firewood?

1 ☐ Yes
0 ☐ No →**q.124**

		1.	**2.**	**3.**	**4.**
122.	Who normally collects wood?	Code Q. 17	Code Q. 17	Code Q. 17	Code Q. 17
123.	How much time does he/ she need to collect wood per week?	_____ HOURS	_____ HOURS	_____ HOURS	_____ HOURS

11. Health

124. Did any members of your household in the last six months suffer from …?		1. Adults >=18 years		2. Children <18 years	
		m. Male	f. Female	m. Male	f. Female
a.	Headaches	☐	☐	☐	☐
b.	Respiratory disease	☐	☐	☐	☐
c.	Eye disease	☐	☐	☐	☐

125. Do you have a health insurance?

1 ☐ Yes
0 ☐ No ➔ Q.127

126. How much do you pay per _____?

IDR. _____
Year / Month /

12. Security

127. How many days per week do the members of your household go out after nightfall?

1. Man _____
2. Woman _____
3. Boys 12-17 _____
4. Girls 12-17 _____
5. Children <12 _____

128. Are you concerned for their safety when they go out?

1. Yes 0. No
-3. Not applicable

1. Are you outside after nightfall? ___
2. Are your female children outside after nightfall? ___
3. Are your male children outside after nightfall? ___

129. Do you think that darkness is dangerous?

1 ☐ Yes
0 ☐ No

13. Environmental awareness

Do you agree or not if it is said that….

130.	Good air quality is a depletable good	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
131.	Solar power or power derived from the sun, is a depletable good.	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
132.	Wood from trees is something that can run out	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
133.	I consciously try to conserve energy.	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
134.	I am interested to know about environmental problems	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
135.	I dispose of garbage in dustbins	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
136.	Trash should not be burned	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
137.	Our forest ought to be protected	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
138.	Dynamite fishing is bad for the environment	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
139.	Deforestation or cutting trees can be harmful to the environment	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know
140.	Everyone has the responsibility to preserve the environment.	1 ☐	Yes	0 ☐	No	-1 ☐	Don't know

		A	B	Please explain. [Write down keywords]
141.	Do you know what "Renewable Energy " is?	1 ☐ Yes 0 ☐ No →Q.145		
142.	Do you think your community should use Renewable Energy?	1 ☐ Yes 0 ☐ No -1 ☐ Don't know		
143.	Do you think Renewable Energy is better for the environment than alternative electricity sources?	1 ☐ Yes 0 ☐ No -1 ☐ Don't know		
144.	Do you know how to support longevity of a community mini-grid as community member?	1 ☐ Yes 0 ☐ No -1 ☐ Don't know		

14. Gender Equality Awareness

	Do you think that…		
145.	Women should take care of housework	0 ☐ No 2 ☐ No opinion	1 ☐ Yes
146.	Women are good in making business	0 ☐ No 2 ☐ No opinion	1 ☐ Yes
147.	Women have the same capacities to gain money as men	0 ☐ No 2 ☐ No opinion	1 ☐ Yes
148.	Women should do what their husbands tell them to do	0 ☐ No 2 ☐ No opinion	1 ☐ Yes
149.	Men are better political leaders than women	0 ☐ No 2 ☐ No opinion	1 ☐ Yes

	Do you think it is justified that men use **physical violence** against women in the following situations		
150.	She burns food	0 ☐ No 2 ☐ No opinion	1 ☐ Yes
151.	She leaves the house without informing him	0 ☐ No 2 ☐ No opinion	1 ☐ Yes
152.	She neglects her children	0 ☐ No 2 ☐ No opinion	1 ☐ Yes
153.	She argues with him	0 ☐ No 2 ☐ No opinion	1 ☐ Yes
154.	She wants to earn money independently	0 ☐ No 2 ☐ No opinion	1 ☐ Yes

[COMMENTS]

155. **[** ☐ VILLAGE **IS A TREATMENT VILLAGE→Q.156**
☐ VILLAGE **IS NOT A TREATMENT VILLAGE →Q.161]**

15. SPV (Treatment Villages only)

		A	B Who informed you? 1. Unofficially from family and friends 2. Unofficially from village official or SPV member 3. From an official meeting in village 4. Other, specify
156.	Have you heard of [implementer]?	1 ☐ Yes 0 ☐ No	
157.	Have you heard about plans to construct a micro-grid in your community to supply electricity?	1 ☐ Yes 0 ☐ No **→Q.161**	
158.	Do you know how the electricity pricing will work?	1 ☐ Yes 0 ☐ No	
159.			

	Have you heard about the creation of an SPV, BUMDES, or community cooperative in your community?	1 ☐ Yes 0 ☐ No →Q.161	
160.	Are you part of the SPV, BUMDES, or community cooperative?	1 ☐ Yes 0 ☐ No	

16. Conclusion

				became much better	became better	stayed the same	became slightly worse	became much worse
161.	In comparison with the situation 1 year ago, the living conditions…	1.	In your family…	①	②	③	④	⑤
		2.	In your village…	①	②	③	④	⑤

162. How?

1. _____
2. _____

163. Which is your main source of information?

1 ☐	Radio	3 ☐	Neighbour/ friends
2 ☐	TV	4 ☐	Internet
3 ☐	Newspaper	5 ☐	Other

164. Household has mobile phone 1☐Yes 0☐No

[COMMENTS]

165.

166.

Please, could you give us your first and your family name?	Could you give us your telephone number?
_____	_____
_____	

[FINAL COMMENTS / QUESTIONS BY INTERVIEWEE]

[FINAL COMMENTS BY ENUMERATOR]

167.	Finishing time of interview	: h

THANK YOU VERY MUCH FOR YOUR PARTICIPATION!

9.7.2 SPV Leadership KII Protocol

This KII should be issued *at minimum* with the following roles (or equivalents) of SPV leadership:

1. SPV Head
2. Secretary
3. Treasurer
4. Other division heads (e.g. O&M, sales and collection, finance and administration, environment/community officers)

Questions	EQ	KII	Theme
What do you understand the SPV's responsibilities to be as a whole with respect to [grant] and the Solar PV facility in your area? What are the specific responsibilities of your role on the SPV?	4	All	Preparedness

Have you had a leadership role in your community before? If so, explain what your role was.	4	All	Preparedness, existing organization
What is your role in your community? Do you expect conflicts with community members due to your role in the SPV?	4	ALL	Preparedness
Do you expect the SPV to be prepared better to provide sustainable energy systems in the longer term than a private enterprise? Why (not)?	4	ALL	Sustainability
Do you expect high or low payment moral among electrified households? What factors will be decisive for payment moral?	4	ALL	Sustainability, Optimism
How would you describe your existing relationship with [grantee] to this point?	4	All	Relationship with grantee/contractors
How would you describe your existing relationship with [O&M contractor] to this point?	4	O&M	Relationship with grantee/contractors
What challenges do you anticipate will occur in your role with the SPV given your knowledge of your community? [If SPV will include cooperation among treatment units] How do you think [treatment units] will cooperate with one another?	4	All	Preparedness, optimism, cooperation with other villages
How would you describe your existing relationship with the other members of SPV leadership? Have you collaborated with them before on community initiatives? If so, what was your relationship with them then?	4	All	Existing organization
What sorts of enterprises do you anticipate will take advantage of the new renewable energy resource? Do you anticipate that community members will start new business once the micro-grid is commissioned? If so, what kinds of businesses?	2	Head	Productive uses
Why did you decide to pursue participating in the management of the micro-grid?	4	All	Optimism
How would you generally describe members of your community with respect to: • Motivation and work ethic • Environmental consciousness • Community engagement • Gender equality	2, 3, 4	Head, Community Officer	Existing organization, optimism, gender
How does your community generally address community-level problems or goals?	4	Head	Existing organization
What is your assessment of micro-grids as a resource for providing electricity to communities? Have you heard of them being used in other communities? If so, what have other communities experienced with this technology?	4	All	Optimism
[If SPV is set up already] How are responsibilities within the SPV distributed between females and males?	4	ALL	Preparedness
[IF SPV is set up already] How will responsibilities in day-to-day operation and maintenance be handed over to you? Does this process seem reasonable to you?	4	O&M	Preparedness

[If vocational training has already commenced] How confident are you that your training will prepare you for your role in the SPV? What part or parts of your training have seemed the most useful?	4	All	Preparedness, relationship with grantee/contractors
What might affect people in your community's willingness to pay for electricity?	2, 4	All	Optimism
Who stands to benefit the most in your community from increased access to electricity?	2, 4	All	Optimism, productive uses
Will women be affected proportionally by access to RE?	4	All	Optimism, Gender
How might your SPV choose to use surplus electricity or revenue, if a surplus exists?	2	Head, Treasurer	Productive uses
Do you expect any challenges in payments or sustainability of the system?	2,4	All	Sustainability
How does your SPV plan to ensure transparent and participatory monitoring of the community?	4	Head, Community Officer	Sustainability
How will your SPV ensure gender equality and social inclusion in benefits from the new RE systems?	4	Head, Community Officer	Gender
How confident are you that the SPV will be prepared, in terms of capacity, equipment, and legal status, to operate the infrastructure after construction has ended?	4	Head	Optimism

9.7.3 Village Official KII Protocol

*This protocol will be used with Village Heads (Kepala Desa) in treatment and comparison areas in East Sumba, and in treatment areas in Berau. This protocol, in comparison to others for the qualitative component of data collection, includes mostly closed questions with several open-ended questions.

Date: ☐☐ ☐☐ ☐☐

I. Basic Sub-village Data

Name of Data collector: _____

Name of sub-village: _____

Site code : _____

Name of interviewee : _____

Role of interviewee : _____

Phone number of interviewee: _____

→ *All questions shall refer to the sub-village listed above*

1. Demographic Data ***Sub-village***

1.1. Population, male	
1.2. Population, female	
1.3. Population, total	
1.4. Number of households, total	

II. Infrastructure and Services in the sub-village

2. Availability and conditions of basic infrastructure

a. Roads: *(road condition, construction work,* ***access during rainy season)***

a.1 Distance from main road	**a.2 To which city does the main road connect? (the nearest town or rural center)**	**a.3 Access to main road (circled the appropriate one)**	**a.4 Can the road be travelled year-round by four-wheeled vehicles?**
.....		1. Asphalt pavement 2. Stone pavement 3. Earth pavement	1. Yes 0. No

b. Transportation:

b.1 Transport possibilities in the village (circle the appropriate)	**b.2 Price to reach the next urban center (for each option circled in b.1)**	**b.3 If public transport is available, how frequently does it arrive per week?**
1. Bus/ public transport 2. Mototaxi 3. Taxi 4. Donkey cart	1. _____ 2. _____ 3. _____ 4. _____	

5. Other, define: _____	5. _____	

c. TV, radio and mobile phone network reception:

Type of network	Receivable?			If YES : quality of reception?			
	Yes	No	Don't know	Good	Medium	Bad	Don't know
1. Radio	1	0	- 1	1	2	3	-1
2. Mobile Phone Network	1	0	- 1	1	2	3	-1
3. TV	1	0	- 1	1	2	3	-1
4. Internet mobile phone	1	0	- 1	1	2	3	-1
5. Internet landline	1	0	-1	1	2	3	-1

[COMMENTS]

3. Availability and conditions of social infrastructure (SI)

Type of SI	Public or Private	Uses electricity source (M)?	
code	1. Public 2. Private	1. PLTMH 3. Solar panel 5. PLN	2. Battery 4. Genset 6. Kincir

1. Primary school (SD)
2. Junior high school (SMP)
3. Senior high school (SMA)
4. Islamic boarding school (*Pesantren*)
5. Other school – specify
6. Community health center (*Puskesmas*)
7. Community health subcentre (Pustu)
8. Health service post (Posyandu)
9. Midwife house *(house of bidan)*
10. Traditional Healers
11. Other health structure, specify
12. Church
13. Mosque
14. Other religious building
15. Administrative office, specify

[COMMENT]

Question	EQ	Theme
3.1. What are the challenges health facilities frequented by this community face?	1, 2	Community details
3.2. Do you expect health service quality to be affected by access to RE? Why?	1, 2	Community details
3.3. How would you describe maternal health services in your community (consider public and private facilities, Midwifes and traditional healers)?	1, 2	Community details
3.4. How many cases of maternal deaths have you had in your community in the last 12 months?	1, 2	Community details
3.5. Do you think access to RE can improve health and wellbeing of pregnant women? How?	2	Productive Uses, Gender, Community details
3.6 What are the challenges schools frequented by this village face?	1, 2	Community details
3.7 Do you expect school service quality to be affected by access to RE? Why?	2	Productive Uses, Community details

4. Availability and conditions of social infrastructure

a **Main access to water (circle the appropriate response)**	
1. River or lake	3. Fountain (unprotected)
2. Fountain (protected)	4. Private connection
	5. Other, specify _____

III. Energy

Question	EQ	Theme
1. How do you dispose of used/empty batteries and broken energy savers? (If thrown away, where?)	1	Energy Consumption
2. Do you know what "Renewable Energy" is? Pease explain.	1, 4	Sustainability, Preparedness
a. Do you think your community should rely on RE? Explain	1, 4	Sustainability, Preparedness
b. Do you think Renewable Energy is better for the environment than alternative electricity sources? Explain.	1, 3	Environment
c. Do you know how to support longevity of a community mini-grid as community member?	1, 4	Sustainability, Preparedness

IV. Income generation

3. **Enterprises:**

Type of business unit	**Number**	**Electricity Sources of each** 0. None 1. PLTMH 2. Kincir 3. Battery, 4. Genset 5. Solar panel 6. Other, specify	**Gender of Owner of each** 0. Male, 1. Female
Kiosk /warung			
Store			
Carpenter			
Wall-maker/ builder			
Tailor			
Beauty salon			

Flour miller			
Rice huller			
Sawmill			
Auto workshop			
Welding workshop			

4. *Economic opportunities*

Question	EQ	Theme
a. Are there economic activities in this community, which may grow in case of electricity access?	2	Productive Uses
b. What are these activities (for example boat production, honey making, or fishing)?	2	Productive Uses
c. Why or why not may they grow?	2	Productive Uses
d. What are other factors hindering their growth of economic activities in your community? What type of training or support may help reduce them?	2	Productive Uses
e. Do you expect any new or existing businesses would use the RE resource? In what ways? Do you anticipate that community members will start new business once the micro-grid is commissioned? If so, what kinds of businesses?	2	Productive Uses
f. What are typical productive activities pursued by women? How could economic activities of females be encouraged?	2	Productive Uses, Gender

5. *Quality of land in sub-village* *(fertility, acidity, erosion)*

Fertility – majority of land	1. Very fertile	2. Fertile	3. Less fertile	4. Not fertile
Erosion	1. Often eroded	2. Seldom eroded	3. Never eroded	

6. *Sub-village market (held at least once per week)*

Is there a market in the sub-village?

1. Yes, there is ☐

0. No, there is not ☐ Where is the nearest market (distance)? _____km

V. Socio-economic issues

7. *Involvement in sub-village activities:*

**Include definition of organization. Should include SPV if already formed at time of interview (in treatment sites).*

Organization	Type of organization: 1. Religious 2. Non- religious	Main activity	Activity Frequency per month	How many participants 1).0-10 2).10-

8. How would you generally describe members of your community with respect to:

a. Motivation and work ethic

b. Environmental consciousness

c. Community engagement

d. Gender Equality

Question	EQ	Theme
9. How does your community generally address community-level problems or goals?	4	Community details, Preparedness
10. Are there development projects in the sub-village? What do they do?	4	Community details, Optimism
11. Have the general living conditions (particularly poverty level) in the sub-village changed within the last 2 years? *(Explain)* 1. Improved significantly ☐ 2. Improved slightly ☐ 3. Stayed constant ☐ 4. Deteriorated slightly ☐ 5. Deteriorated significantly ☐	4	Sustainability
12. Why	4	Sustainability
13. What factors are hindering an improvement in living conditions in this sub-village? *(Explain)*	4	Sustainability
14. Security		
a. Do people in this community feel safe?	4	Community details
b. Have there been crimes of any sort in your community in the last year? Please explain.	4	Community details

VI. SPV (for treatment site Kepala Desa only)

Question	EQ	Theme
a. What do you understand the SPV's responsibilities to be as a whole with respect to [grant] and the Solar PV facility in your area?	4	Preparedness
b. If you are involved in the SPV, what are the specific responsibilities of your role? If you are not involved in the SPV, how would you describe your existing relationship with the members of SPV leadership?	4	
c. What challenges do you anticipate will occur with the SPV given your knowledge of your community?	4	Preparedness, Sustainability
d. How would you describe your village's relationship with [grantee] to this point?	4	Project details, grantee relationship
e. How would you describe your village's relationship with [O&M contractor] to this point?	4	Project details, grantee relationship
f. What is your assessment of micro-grids as a resource for providing electricity to communities? Have you heard of them being used in other communities? If so, what have other communities experienced with this technology?	4	Preparedness, Sustainability
Conclusion		
g. Final comments/ questions by the interviewee h. Final comments by enumerator	NA	NA

9.7.4 Regency (Sub-District) Official Quantitative Instrument

SURVEY QUESTIONNAIRES – VILLAGE HEAD

Evaluation Study on Renewable Energy Impact-2017
Green Prosperity Renewable Energy Grant

Date: ☐☐ ☐☐ ☐☐

I. Basic Data of Village

Name of enumerator : _____

Name of village : _____

Location Code : _____

Name of Respondent : _____

Role of Respondent : _____
(in village government)

Contact Number of Respondent : _____

→ *All data should refer to the village mentioned above.*

1. Demographic Data of Village

4.1. Population - Male	
4.2. Population – Female	
4.3. Total Population	
4.4. Total Household	

II. Infrastructure and Services in the village

5. Availability and Condition of basic Infrastructure

a. roads :*(road condition, road construction, access during the rainy season)*

a.1 Distance from the village road to the main road	**a.2 Which city is the main road connected to?** *(the nearest city or rural centre)*	**a.3 Type of road heading to the main road** *(circled the appropriated one)*	**a.4 Is the village road passable throughout the year by four-wheel vehicles?** *(it is accessible during the rainy season?)*
.....	.....	4. Asphalted 5. Stone road 6. Dirt road	(1) Yes (0) No

b. Transportation:

b.1 Transportation available in this village *(circled the appropriated one)*	**b.2 Cost spent to reach the next city** *(for every answer circled in b.1)*	**b.3 If public transportation is available, how frequent it arrives per week?**
6. Bus/Public transport 7. Ojek (taxi bike) 8. Taxi 9. Horse-drawn carriage (Andong) 10. Other, please specify: _____	6. _____ 7. _____ 8. _____ 9. _____ 10. _____	

c. Signal receiver network for TV, radio and hand phone:

Type of network	**Receivable?**			If receivable: What is the quality of the signal**?**			
	Yes	No	DK	Good	Fair	Bad	DK
6. Radio	1	0	- 1	1	2	3	-1
7. Signal - handphone TeleponGengam	1	0	- 1	1	2	3	-1

8. TV	1	0	- 1	1	2	3	-1
9. Internet Signal- handphone	1	0	- 1	1	2	3	-1
10. Cable Internet Signal (home/office/internet kiosk)	1	0	-1	1	2	3	-1

[COMMENT]

6. Availability and Condition of Social Infrastructure

Type of SocialInfrastructure	**Government or Private**	**Source of Electricity used (M)?**
Code	1. Government 2. Private	1. PLTMH (PembangkitListrik Tenaga Air/Microhydro) 2. Batteries 3. Solar Panel 4. Genset 5. PLN 6. Waterwheel

16. Elementary school (SD)
17. Junior High school(SMP)
18. Senior High school(SMA)
19. Boarding Islamic School (Pesantren)
20. Other school – please specify
21. Puskesmas
22. PuskesmasPembantu (Pustu)
23. Posyandu
24. Midwife
25. Traditional Medicine
26. Other health centre - please specify
27. Church
28. Mosque
29. Other religious buildings, please specify
30. Administration Office, please specify

[COMMENT]

7. Availability and Condition of Other Infrastructure

a. Main Source of Water Supply (*circled the appropriated one***)**	
6. River or Lake	8. Springs (open, unprotected)
7. Springs (protected)	9. Private water source (private well)
	10. Others, please specify _____

IV. Source of Income

15. **Business:**

Type of Business	**Total**	**Source of Electricity** (write it down in each of the business types) 0. None 1. PLTMH (PembangkitListrik Tenaga Air/*microhydro*) 2. Waterwheel 3. Batteries, 4. Genset 5. Solar Panel 6. Others, please specify	**Gender of the business owner** (write it down in each of the business types) 0. Male 1. Female
Kiosk/Warong			
Store			
Wood Worker			
Building Worker			
Tailor			
Salon/Hair Stylist			
Flour Miller			
Rice Miller			
Wood cutter			
Auto workshop			
Welding Workshop			
Other, please specify: _____			

16. *Quality of Soil in the Village* *(fertility, acidity, erosion)*

Fertility level of the lands, in general	1. Highly fertile 2. fertile 3. Less fertile4. Not fertile
Erosion level	1. Frequently eroded 2. Rarely eroded 3. Never eroded

17. ***Village Market (open at least once a week)***

Is there a market in this village?
1. Yes, there is☐
0. No, there is not ☐where is the nearest market (distance)? _____km

V. Social Economy

Involvement of the community in village activities :

**explain the definition of organization. Better to ask SPV to accompanying the interview, If the organization is already set up (for the treatment area)*

Organization	**Type of Organization :** 3. Religious **4.** Non- religious	**Main Activities**	**Frequency of meeting per month**	**Number of participants attending, per meeting:** 1) 0-10 2) 10-25 3) 25-100 4) > 100

9.7.5 Regency (Sub-District) Official Qualitative Interview Guide

*When relevant, the qualitative research team appropriated and administered questions from the Regency (sub-district) Official Quantitative Instrument above in addition to those outlined in the qualitative interview guide.

1. Availability and conditions of basic infrastructure

Question	EQ	Theme
a. What percentage of villages in your regency are connected to roads?	1, 2	Community details
b. What are the main town centers (cities) in this regency? Please list.	1, 2	Community details
c. Please describe the majority of roads in your regency [asphalt pavement, stone pavement, earth pavement…] Can these roads be used year-round?	1, 2	Community details
d. Please describe the transportation options in your regency [bus/public transport, mototaxi, taxi, donkey cart, other…]	1, 2	Community details
e. How frequently is this transportation available for regency residents?	1, 2	Community details
f. What percentage of regency residents receive radio, mobile phone network, TV, internet mobile phone and internet landline reception?	1, 2	Community details
g. Please describe access to public, private, and informal health services in your regency.	1, 2	Community details
h. How would you describe maternal health services in your community (consider public and private facilities, Midwifes and traditional healers)?	1, 2	Community details

i.	What are the challenges health facilities face?	1, 2	Community details
j.	Do you expect health service quality to be affected by access to RE? Why?	1, 2	Community details
k.	Please describe access to public and private schools in your regency.	1, 2	Community details
l.	What are the challenges schools frequented by this village face?	1, 2	Community details
m.	Do you expect school service quality to be affected by access to RE? Why?	1, 2	Community details

2. ***Main energy sources and prices (other than electricity):***

Please describe in general the energy sources in your regency overall.

Energy source	Used by people?
Candles	1. Yes ☐ 0. No ☐ 2. Only in exceptional cases ☐
Gas (LPG)	1. Yes ☐ 0. No ☐ 2.Only in exceptional cases ☐
Diesel	1. Yes ☐ 0. No ☐ 2. Only in exceptional cases ☐
Petrol	1. Yes ☐ 0. No ☐ 2. Only in exceptional cases ☐
Kerosene	1. Yes ☐ 0. No ☐ 2. Only in exceptional cases ☐
Charcoal	1. Yes ☐ 0. No ☐ 2.Only in exceptional cases ☐
Firewood	1. Yes ☐ 0. No ☐ 2. Only in exceptional cases ☐
Batteries (large)	1. Yes ☐ 0. No ☐ 2.Only in exceptional cases ☐
Batteries (small)	1. Yes ☐ 0. No ☐ 2. Only in exceptional cases ☐

3. ***Electricity sources used by households in this regency*** *(car batteries, gensets, solar panels, PLTMH, traditional waterwheel (kincir) – individually vs. commonly used*

Electricity source	Approximate % of households owning this source	Individual or shared use?
Car battery		
Genset		
Solar Panel		
PLN*)		
Biodigesters		
Kincir		
PLTMH		

Question	EQ	Theme
4. Do you know what “Renewable Energy“ is? Please explain	1, 4	Sustainability, Preparedness
5. Do you think your regency should rely on RE? Explain	1, 4	Sustainability, Preparedness
6. Do you think Renewable Energy is better for the environment than alternative electricity sources? Explain.	1, 4	Sustainability, Preparedness
7. What is required to ensure longevity of mini-grids in your regency in your opinion?	1, 4	Sustainability, Preparedness
Income Generation		
8. Enterprises		
a. What types of enterprises are most common in this regency (also inquire boat production, honey making, and fishing)? Please list.	2	Productive Uses
b. If you are aware, what electricity sources do they use?	2	Productive Uses
9. Economic Opportunities		
a. What are factors hindering growth of economic activities in your regency?	2	Productive Uses
b. What type of training or support may help reduce them?	2	Productive Uses
c. What are typical productive activities pursued by women?	2	Productive Uses, Gender
d. How could economic activities of women be encouraged?	2	Productive Uses, Gender
e. Are there economic activities in this community, which may grow in case of electricity access? Why or why not may they grow?	2	Productive Uses
f. Do you expect any new or existing businesses would use the RE resource? In what ways? Do you anticipate that community members will start new business once the micro-grid is commissioned? If so, what kinds of businesses?	2	Productive Uses
10. Agriculture		
a. Describe the quality of land in the regency (fertility, acidity, erosion)	1	Community details

	Fertility – majority of land: 1. Very fertile 2. Fertile 3. Less fertile 4. Not fertile Erosion: 1. Often eroded 2. Seldom eroded 3. Never eroded		
	b. What are the main agricultural commodities (Product pertanian unggulan) in the regency?	1	Community details
	c. What type of value-addition and aggro processing is performed in the regency?	1	Community details
	d. Are there any particularities in agriculture in your regency?	1	Community details
11.	Security		
	a. What type of security problems do the communities in your Regency face?	1	Community details
	b. Are security problems increasing or decreasing?	1	Community details
	c. What is needed to improve security in your Regency?	1	Community details
	d. Do you expect access to RE to improve security?	1	Community details
12.	How would you generally describe members of your community with respect to: a. Motivation and work ethic b. Environmental consciousness c. Community engagement d. Gender equality	3, 4	Community organization, Preparedness, Environment
13.	How does your community generally address community-level problems or goals?	4	Preparedness, Sustainability
14.	Are there development projects in the regency? What do they do?	4	Preparedness, Optimism
15.	Have the general living conditions (particularly poverty level) in the regency changed within the last 2 years? *(Explain)* 1. Improved significantly ☐ 2. Improved slightly ☐ 3. Stayed constant ☐ 4. Deteriorated slightly ☐ 5. Deteriorated significantly ☐	4	Sustainability
16.	Why?	4	Sustainability
17.	What factors are hindering an improvement in living conditions in this regency? *(Explain)*	4	Sustainability
18.	Are there other particularities to note in the regency?	NA	NA
SPV (for treatment site Camat only)			
1.	What do you understand the SPV's responsibilities to be as a whole with respect to [grant] and the Solar PV facility in your area?	4	Preparedness
2.	If you are involved in the SPV, what are the specific responsibilities of your role? If you are not involved in the SPV, how would you describe your existing relationship with the members of SPV leadership?	4	Preparedness
3.	What challenges do you anticipate will occur with the SPV given your knowledge of your sub-district?	4	Preparedness, Sustainability
4.	What is your assessment of micro-grids as a resource for providing electricity to communities? Have you heard of them being used in other communities? If so, what have other communities experienced with this technology?	4	Preparedness
5.	Final comments/ Questions by the interviewee	NA	NA

6. Final comments by enumerator	NA	NA

9.7.6 Community Beneficiary FGD Guide

Question	EQ	Theme
Energy		
1. What type(s) of electricity source(s) do you use in your homes? [options to probe for are in HH survey Q.37. Note how many respondents have a modern electricity source.]	1	Energy Consumption
2. How long have you used these sources?	1	Energy Consumption
3. How much does this source(s) cost you/your family (per month, per year)?	1	Energy Consumption
4. Please explain if there are sources you have been disconnected from or have become non-functional. When did this occur, and why?	1	Energy Consumption
5. Please discuss challenges you face with accessing electricity in this village. Does this differ by HH/area in the village?	1	Energy Consumption
6. What is your HH main use for electricity (appliances, lighting, productive uses)?	1, 2	Energy Consumption, Productive Uses
7. Are you satisfied with the source(s) of electricity your family uses currently? What are the main advantages/disadvantages of this source(s)? Please discuss.	1	Energy Consumption
8. Please discuss what you think of micro-grids as a resource for providing electricity to communities - Have you heard of them being used in other communities? If so, what have other communities experienced with this technology?	1	Energy Consumption
9. Would you prefer other types of electricity? What and why?	1	Energy Consumption
10. Do you think electricity access can bring growth in economic activities? How?	2	Productive Uses
11. What else is needed in your community to raise economic wellbeing?	1	Energy Consumption
12. Do you think households should pay for energy from a RE mini-grid? What would be the best billing system? Why?	1	Energy Consumption
Equality, Gender, Security		

1. Who would benefit most from energy access in these communities?	1	Energy Consumption, Gender
2. Do you think female community members will be affected equally by electricity access as male members? How will electricity access change the life of women, and their rights and roles within the community?	1	Energy Consumption, Gender
3. Do you think electricity access can affect security in your community? Please discuss.	1	Energy Consumption
4. What do you think about mini-grids that are managed by a team of community members? How will such a management system affect payment morale within the community? How will it affect dynamics between community members?	4	Preparedness, Community Organization
Environment		
1. Which environmental issue concerns this community the most? Why?	3	GHG Emissions
Community (engagement and work ethic)		
1. Please discuss the main source of income for HH in this community. In your opinion, do individuals have a strong work ethic in this village (do they work hard)?	1, 2, 4	Preparedness
2. Please discuss whether your community/village has other groups/organizations like the SPV. How have these worked, and were they successful at managing a community good? How many of you have participated in a community group/organization/initiative?	4	Preparedness, Optimism
3. How does your community generally address community-level problems or goals?	4	Preparedness
4. Please discuss your village's previous experiences with donor projects, if any. Did you consider these projects a success? Why or why not?	4	Preparedness, Optimism
Project Details		
1. [Project name/grantee name] is working in this village to develop a Solar PV Facility. Please discuss the work they have done thus far.	NA	Project Details
2. Please discuss how you have interacted with [project name/grantee name] in the last 3 months. Have you attended any meetings/FGDs/events/activities or received information about the project goal? If yes, please discuss the purpose of these events and how you were invited.	NA	Project Details

3. If you are you aware of the SPV in this village, please discuss their role/function as related to the Solar PV Facility.	4	Preparedness
Conclusion		
1. In comparison with the situation 2 years ago, have the living conditions in this village improved? If yes, how? If not, why not?	1, 4	Sustainability

9.7.7 Enterprise KII Guide

ENTERPRISE QUESTIONNAIRE Impact Evaluation Baseline Study 2017 Green Prosperity Renewable Energy Grant	1 Date: _____ **SUB-VILLAGE NAME** **SUB-VILLAGE SITE** **INTERVIEWEE/ENTERPRISE NAME** **MALE/FEMALE** **OWNER OR MANAGER/STAFF EMPLOYEE** **INTERVIEWER NAME**

STARTING TIME:	

A. Basic Information and Customers

Q1. Line of business	1. Trading Restaurant / café 2. Domestic industry (furniture, handicraft, etc) 3. Services (workshop, machine shop, barber shop, make-up, tailor clothes, etc) 4. Transportation (excluding motorcycle taxi/ojek) 5. Others, _____
Q2. Enterprise age	

Q3. Type of electricity available
Q4. Since when is it available?
Q5. In case of solar panel, what's the size of the panel (kW)?

1	***None***	
2	***Connection to a micro-hydro***	☐ ***Since when (Month, Year)*** _____
3	***Car battery (without solar panel)***	☐ ***Since when (Month, Year)*** _____
4	***Solar panel (installed on roof)***	☐ ***Since when (Month, Year)*** _____ ☐ ***kW of solar panel***_____
5	***Solar panel (not installed on roof)***	☐ ***Since when (Month, Year)*** _____ ☐ ***kW of solar panel***_____
6	***Individual genset***	☐ ***Since when (Month, Year)*** _____
7	***Genset in the village***	☐ ***Since when (Month, Year)*** _____
8	***Genset shared with neighbors***	☐ ***Since when (Month, Year)*** _____

9	***PLN***	☐ ***Since when (Month, Year)*** _____	
10	***Individual traditional waterwheel***	☐ ***Since when (Month, Year)*** _____	
11	***Traditional waterwheel in village***	☐ ***Since when (Month, Year)*** _____	

Q6. Kind of products and services offered by the enterprise (USE CODES)

		Ranking	
1			
2			
3			
4			
5			
6			

CODE of Q.6

1. Sale of small products (for example cigarettes, batteries, petrol)
2. Food or Drinks
3. Furniture (Cupboard,Tables,Chairs,bedsteads)
4. Window and window frames
5. Doors and door frames
6. New clothing
7. Cloth repair and alteration
8. Rice hulling
9. Coffee milling/ processing
10. Coconut milling
11. Baking
12. Metal products
13. Welding products
14. Woven products
15. Hair cutting
16. Wedding styling
17. Make-up

Q7. Structure of customers	*This sub-village ___percent; This village ___percent; Other villages ____percent; Traders ____percent | Others _____percent Next city _____percent* **[Specify]** _____ *Number of Customers (supplied) per day:* _____

B. ENERGY AND PRODUCTION

		Q8. *Which of the following appliances does this enterprise use?* Appliance	Q9. *What powers the appliance?* a) Electricity b) Diesel/Petrol c) Mechanic d) Other, define.
	1	Lighting	
	2	Sewing machine	
	3	Refrigerator	
	4	Rice cooker	
	5	Carpentry equipment	
	6	Brush	
	7	Coconut grinder	
	8	Chili grinding machine	
	9	Blender	
	10	Mill	
	11	Other:	
	12	Other:	
	13	Other:	
	14	Other:	

Q.12 a
Do you separate the energy expenditure for your enterprise from the expenditure for the household?

1. Yes 2. No

		Q10. *Which of the following energy sources does this enterprise use for its production process (including lighting)? Multiple entries are possible.* **ENERGY SOURCE**	**Q11.** *For which of the following purposes do you use...[use Codes from Q11. or define]?* Lighting	Operating equipment SPECIFY	**Q12.** *In a regular month, how much does this enterprise spend on …?* Reg		
	1	PLTMH					
	2	Diesel/petrol for generator			Litre		
	3	Kerosene			Litre		
	4	Candles					
	5	Gas (LPG / LNG)					

	6	Charcoal / briquettes					
	7	Firewood					
	8	Car or other rechargeable battery					
	9	Solar Panel					
	10	Other:					

C. LIGHTING

Q13. Operation time of enterprise on regular day?	
Q14. *How many of the following lighting devices does this enterprise use?*	**Q15.** *What is the number of hours you use lighting per day?*
ENERGY SAVER	
INCANDESCENT BULB (ORDINARY BULB)	
FLUORESCENT TUBE (NEON)	
TIN LAMP (KEROSENE)	
HURRICANE LANTERN	
CANDLE	
BATTERY-RUN LANTERN	
GAS LAMP (PRESSURIZED)	
Other (specify):	

D. EMPLOYMENT

Q16. *How many employees does this enterprise have in total (including owner)*	
Q17. *How many of the employees work the more than 7 hours per day on 5 days?*	
Q18. *How many of the employees receive payment?*	
Q19. *How many of the employees are family members?*	

E. PRODUCTION AND BUSINESS EXPANSION

Q20. Would you purchase machinery/appliances in case of electrification?

Q21. Do you think micro-grid connection could improve your production and prices? If yes, how?
Q22. Are you currently in a high/low demand period compared to the rest of the year?

9.8 Informed Consent Scripts

9.8.1 Household Survey Informed Consent

MCC Indonesia Green Prosperity Project – Grant Facility Renewable Energy Portfolio Consent (Household Surveys)

"Hello, my name is [enumerator name], and I work for [Subcontractor], a research firm specializing in data collection in Indonesia. We are evaluating the Renewable Energy Portfolio of the MCC Indonesia Green Prosperity (GP) Project, which aims to combat environmental degradation and alleviate rural poverty. Our study is funded by the Millennium Challenge Corporation (MCC), a U.S. agency that provides assistance to other countries' development projects. This research is being carried out by [subcontractor] in collaboration with Social Impact, a management consulting firm based in the Washington D.C. area.

The GP Project is designed to support the Government of Indonesia's commitment to a more sustainable, less carbon-intensive future by promoting environmentally sustainable, low carbon economic growth. The evaluation will aim to measure impacts of the GP Facility program (specifically, Grant Window 3A, focused on Renewable Energy) and compare and contrast how different program elements operate. Ultimately this study will produce a report that will help MCC, MCA-I and the Government of Indonesia understand how to best improve rural electrification programs in Indonesia. This report ***will not*** *include anyone's name or identity, however.*

If you agree to participate, you will be involved in one of 990 household interviews, during which I will ask you about relevant dimensions of the household that might be affected by the new access to electricity. You were selected for participation in this survey randomly. These interviews are expected to take around 60 minutes to complete.

Any information you provide that can identify you will be kept strictly confidential by the parties conducting this study, including MCC and MCA-I employees, employees of the survey firm, and the researchers, to the maximum extent permitted by the laws of the United States and the laws of Indonesia. The information collected will be used for statistical purposes only and will not be used for determining any sort of benefits or punish you for anything, so please answer honestly.

Your participation is voluntary and you may choose not to answer any or all questions for any reason. In other words, you have the alternative not to participate and there will be no consequences for nonparticipation. You may ask questions at any time. To thank you for your time, you will be provided with [in-kind incentive] for completing all the interviews. More broadly, members of your community and country may benefit from this study by helping MCC, MCA-I and the Government of Indonesia understand how to best improve rural electrification programs in Indonesia. This study poses no risk to participants. At this time, the research team does not have plans to inform study participants of research findings.
You may contact [subcontractor POC], the [subcontractor POC title] in Jakarta, at [subcontractor POC email] or Leslie Hodel, Co-Chair of the Institutional Review Board at Social Impact Inc., at irb@socialimpact.com. If you have any questions, concerns or complaints about the study or your rights as a participant, please feel free to contact us at any time.

Do you have any questions? By saying "yes," and participating in this study, you are indicating that you have heard this consent script, had an opportunity to ask any questions about your participation and voluntarily consent to participate.

Will you participate in this research study? You may answer yes or no. [Note: consent will be obtained orally]

☐ Yes, I am willing to participate

☐ No, I am not willing to participate

9.8.2 KII Informed Consent Script

MCC Indonesia Green Prosperity Project – Grant Facility Renewable Energy Portfolio Consent (KIIs)

"Hello, my name is [enumerator name], and I work for Social Impact, a management consulting firm based in the Washington D.C. area. We are evaluating the Renewable Energy Portfolio of the MCC Indonesia Green Prosperity (GP) Project, which aims to combat environmental degradation and alleviate rural poverty. Our study is funded by the Millennium Challenge Corporation (MCC), a U.S. agency that provides assistance to other countries' development projects.

The GP Project is designed to support the Government of Indonesia's commitment to a more sustainable, less carbon-intensive future by promoting environmentally sustainable, low carbon economic growth. The evaluation will aim to measure impacts of the GP Facility program (specifically, Grant Window 3A, focused on Renewable Energy) and compare and contrast how different program elements operate. Ultimately this study will produce a report that will help MCC, MCA-I and the Government of Indonesia understand how to best improve rural electrification programs in Indonesia. This report ***will not*** *include anyone's name or identity, however. Our researchers will remove your name and other personal identifying information from documentation from this interview that will be saved for analysis.*

If you agree to participate, you will be involved in one of 50-78 Key Informant Interviews, during which I will ask you about the installation of Solar Photovoltaic Power (SPV) systems in your East Sumba community. You were selected for participation in this key informant interview based on your status as a community member who is knowledgeable about the implementation of SPV systems in your village. These interviews are expected to take around 60 minutes to complete.

Any information you provide that can identify you will be kept strictly confidential by the parties conducting this study, including MCC and MCA-I employees, and the researchers, to the maximum extent permitted by the laws of the United States and the laws of Indonesia. The information collected will be used for research purposes only and will not be used for determining any sort of benefits or punish you for anything, so please answer honestly.

Your participation is voluntary and you may choose not to answer any or all questions for any reason. In other words, you have the alternative not to participate and there will be no consequences for nonparticipation. You may ask questions at any time. To thank you for your time, you will be provided with [in-kind incentive] for completing all the interviews. More broadly, members of your community and country may benefit from this study by helping MCC, MCA-I and the Government of Indonesia understand how to best improve rural electrification programs in Indonesia. This study poses no risk to participants. At this time, the research team does not have plans to inform study participants of research findings.

You may contact Mike Duthie, the project's Principal Investigator at mduthie@socialimpact.com *or Erika Keaveney, Interim Co-Chair of the Institutional Review Board at Social Impact Inc., at irb@socialimpact.com. If you have any questions, concerns or complaints about the study or your rights as a participant, please feel free to contact us at any time.*
Do you have any questions?

By saying "yes," and participating in this study, you are indicating that you have heard this consent script, had an opportunity to ask any questions about your participation and voluntarily consent to participate.
Will you participate in this research study? You may answer yes or no. [Note: consent will be obtained orally]

☐ Yes, I am willing to participate

☐ No, I am not willing to participate

9.8.3 FGD Informed Consent Script

MCC Indonesia Green Prosperity Project – Grant Facility Renewable Energy Portfolio Consent (FGDs)

"Hello, my name is [enumerator name], and I work for Social Impact, a management consulting firm based in the Washington D.C. area. We are evaluating the Renewable Energy Portfolio of the MCC Indonesia Green Prosperity (GP) Project, which aims to combat environmental degradation and alleviate rural poverty. Our study is funded by the Millennium Challenge Corporation (MCC), a U.S. agency that provides assistance to other countries' development projects.
\
The GP Project is designed to support the Government of Indonesia's commitment to a more sustainable, less carbon-intensive future by promoting environmentally sustainable, low carbon economic growth. The evaluation will aim to measure impacts of the GP Facility program (specifically, Grant Window 3A, focused on Renewable Energy) and compare and contrast how different program elements operate. Ultimately this study will produce a report that will help MCC, MCA-I and the Government of Indonesia understand how to best improve rural electrification programs in Indonesia. This report ***will not*** *include anyone's name or identity, however. Our researchers will remove your name and other personal identifying information from documentation from this discussion that will be saved for analysis.*

If you agree to participate, you will be involved in one of 12 Focus Group Discussions, during which a facilitator will ask you about the installation of Solar Photovoltaic Power (SPV) systems in your East Sumba community and you and other beneficiaries will have the opportunity to provide responses. You were randomly selected among SPV beneficiaries to participate in this discussion. These discussions are expected to take around 60 minutes to complete.

Any information you provide that can identify you will be kept strictly confidential by the parties conducting this study, including MCC and MCA-I employees and the researchers, to the maximum extent permitted by the laws of the United States and the laws of Indonesia. The information collected will be used for research purposes only and will not be used for determining any sort of benefits or punish you for anything, so please answer honestly.

Your participation is voluntary and you may choose not to answer any or all questions for any reason. In other words, you have the alternative not to participate and there will be no consequences for nonparticipation. You may ask questions at any time. To thank you for your time, you will be provided with [in-kind incentive] for completing all the discussion. More broadly, members of your community and country may benefit from this study by helping MCC, MCA-I and the Government of Indonesia understand

how to best improve rural electrification programs in Indonesia. This study poses no risk to participants. At this time, the research team does not have plans to inform study participants of research findings.

You may contact Mike Duthie, the Principal Investigator, at mduthie@socialimpact.com or Erika Keaveney, Interim Co-Chair of the Institutional Review Board at Social Impact Inc., at irb@socialimpact.com. If you have any questions, concerns or complaints about the study or your rights as a participant, please feel free to contact us at any time.

Do you have any questions?

By saying "yes," and participating in this study, you are indicating that you have heard this consent script, had an opportunity to ask any questions about your participation and voluntarily consent to participate. Will you participate in this research study? You may answer yes or no. [Note: consent will be obtained orally]

☐ Yes, I am willing to participate

☐ No, I am not willing to participate

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ADVANCING DEVELOPMENT EFFECTIVENESS