OFF-GRID RURAL ELECTRIFICATION PROJECTS: A PRACTICAL APPROACH TO EVALUATING SUSTAINABILITY AND PROJECT SPECIFIC OUTCOMES

CLIENT ORGANIZATION: NUSOL CAPACITY FUND

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Table of Contents

Introduction: NuSol Capacity Fund and their need for an evaluation framework for rural electrification projects

NuSol Capacity Fund (NuSol) is a newly founded nonprofit organization based in Bellingham and Seattle, Washington. Their work focuses on rural electrification through the installation of off-grid renewable energy systems (primarily solar). NuSol's approach is unique in that they take a bottom-up approach to program development. Once a suitable community is identified, its residents are intimately involved in all stages of project planning and development. Residents are encouraged to enter into community debate regarding project design and decide collectively on the community's development priorities for light and electricity. Select community members are also trained in system maintenance to ensure the technical feasibility of the system once the installation team leaves.

NuSol recently completed the installation of their first rural electrification project in January 2011 in a small rural community (population 350) in the Andean Highlands of Peru. This specific project consisted of a 2.6 kW off-grid solar array of 18 solar panels that provides light and electricity to the community school and medical post. Additionally, the system powers a charging station where rechargeable lanterns (70 – one per household) are charged and distributed to families for use into the night.

Despite their recent success in Peru, NuSol as an organization is still in its formative stages of development. With a small volunteer staff, it is difficult to plan strategically beyond the immediate needs of identifying a community for its sophomore project and securing the necessary resources. However, in an effort to increase their accountability as an organization, and to continually learn from and improve their projects, NuSol identified their need for a program evaluation framework that can be applied to their most recent and future projects.

This paper will first review best practices and existing evaluation frameworks pertaining to sustainability and rural electrification. From this foundation, a comprehensive evaluation framework will be presented. Recommendations will then be made for customizing the evaluation strategy to meet the individual needs of NuSol and/or other similar organizations in the start-up stage.

The Need for Rural Electrification

Worldwide, there are more than 1.4 billion people that lack access to electricity, nearly 85% of which resides in rural areas (World Energy Agency, 2010). Remote areas disproportionately lack access to electricity for a variety of reasons, one of which is that traditional electrical grid extension is an expensive endeavor due to the geographic isolation and often-rugged terrain separating these communities from urban areas. However, because these isolated communities demand less electricity as compared to urban centers, off-grid electrification systems provide an innovative and cost-effective solution (Rieche et al., 2000).

Lack of Comparability Among Rural Electrification Projects – The Absence of Data

Existing literature regarding the evaluation of rural electrification efforts conclude that available data on these projects is scarce, and data that is available is project specific and therefore not easily compared (O'Sullican, Barnes (2006), Ilskog (2008)). This lack of consistent data is due in part to the geographical, cultural, and socio-economic differences between the various communities where rural electrification projects take place. In addition, the differing community needs and desires for electrification necessitate unique programmatic approaches in service delivery. A unified methodological evaluation practice for such projects is beginning to take form, primarily through the work of Ilskog (2008, 2008a) and Ilskog et al. (2008), but as these efforts have yet to be successfully transferred to the field, evaluators and decision makers still lack a common set of outcomes and indicators from which comparisons can be made.

Focus on Sustainability & the use of Indicators

One similarity among most if not all rural electrification projects is their focus on sustainable development. From an evaluation perspective, this is a platform from which the work of various organizations, programmatic differences aside, can be compared. However, an accepted definition of sustainability within the field must first be established.

The definition of sustainability is continually modified and refined. In 1987, the World Commission on Environment and Development found the term to mean "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"(Brundtland, 1987). This definition pertains specifically to the allocation of resources between generations; however, without a means by which this definition can be made operational through the application of a criterion for evaluation, this definition is irrelevant in practice (Bochniarz & Bolan, 2009).

In an effort to codify the definition of sustainability as it pertains to program evaluation, indicators were recognized in the 1992 Earth Summit as "important tools to increase focus on sustainable development and to assist decision-makers at all levels" (UN, 2005). Furthermore, "indicators enable managers to track progress, demonstrate results, and take corrective action to improve service delivery" (World Bank, 2004). In this way, indicators provide a solid basis for understanding the progress and goals of sustainable development initiatives. In 1995 the Commission on Sustainable Development (CSD) established a set of 58 indicators structured around a theme/sub-theme framework that attempted to comprehensively capture

all aspects of sustainable development (UN, 2005). Subsequent sessions of the CSD continued to refine the framework.

A theme/sub-theme framework is an organizational structure of characterizing project outcomes to be evaluated. The structure begins in the most general terms (outcome category), such as sustainability, and becomes increasingly more specific through the use of themes, sub-themes and individual indicators. This level of specificity increases the practicality and understandability of information to be evaluated. Figure 1 below provides a visual depiction of this structure.

Figure 1 - Theme/Sub-Theme Framework

Outcome Category	Theme	Sub-Theme	Indicator
			Indicator
		Sub-Theme	Indicator
			Indicator
	Theme	Sub-Theme	Indicator
			Indicator
		Sub-Theme	Indicator
			Indicator
	Theme	Sub-Theme	Indicator
			Indicator
		Sub-Theme	Indicator
			Indicator

In 2001, the concept of sustainability was specifically applied to energy development by developing a three-pronged description of impact areas, using the theme/sub-theme structure discussed above, to include economic, environmental and social sustainability (OECD/IEA, 2001). This refinement and specific application to energy use provided the users of evaluation information with various benchmarks or outcome categories from which to view evaluation data. Ilskog (2008, 2008a) develops the concept of sustainability even further, building upon the initial work of the UN framework, with a direct application to rural electrification evaluation. Ilskog incorporates five themes of sustainability, to include technical, economic, social/ethical, environmental, and organizational/institutional development, from which additional sub-themes and associated indicators are identified (Ilskog, 2008).

Ilskog (2008) defines these five main themes of sustainability as follows:

- **Technical Sustainability**: Relating to the performance, reliability and long-term feasibility of the energy system from a mechanical and community capacity perspective.

- **Economic Sustainability**: This component is recognized as the most fundamental for sustainability and relates to the financial sustainability of the project, including equipment, installation and maintenance costs. For example, the payments received for the services cover all operating costs, and also account for an accumulation of savings for re-investment when the economic lifetime of the equipment has been reached. Economic sustainability should also encourage economic development within the target population as a result of the intervention.

- **Social/Ethical Sustainability**: This component is recognized as the most complex and includes issues regarding the equitable distribution of electrification services, both for private and public use.

- **Environmental Sustainability**: This component can be interpreted from the local to global level. For example, improved air quality, improved cooking options, resource preservation, etc. within the target community and also the impact on a global scale.

- **Organizational/Institutional Sustainability**: This component looks at the management of the electrification project. For example, the degree of client satisfaction and the representation of both men and women in the decision making process.

Recognizing that the sustainability of NuSol's work is essential to their evaluation, both from an organizational standpoint and as a best practice in solidifying evaluation practices in the rural electrification field, this paper will incorporate the sustainability outcomes elaborated by Ilskog as a primary component of its framework.

Concerns with Ilskog's Evaluation Model

However, while the five themes of sustainability identified by Ilskog are comprehensive, this paper recognizes two areas of concern when applied to an evaluation framework for NuSol and other organizations in their early stages of development.

1. **'In-Country' Record Keeping** – As NuSol's initial project was conducted with an extremely geographically isolated community, the community members are the premier partner in ensuring the success of the project. NuSol's current practice is to build technical capacity of community members; therefore, keeping records of technical data pertinent to the evaluation may be a task that is assigned strictly to community members. Relying on these trained community members to maintain accurate records of technical aspects of the project may be an unrealistic expectation without additional training and accountability measures in place. If record keeping is

to be conducted by select community members, it is necessary to verify their capability through ample training. As a way to maintain the integrity of record keeping, offer continued education and training for these designated record keepers during site visits. Finally, as a continual accountability practice, coordinate the support of an in-country partner to monitor record keeping processes for accuracy.

2. **Organizational Capacity** – Another concern involves the capacity of the organization to conduct a thorough evaluation of all indicators recommended by Ilskog. Given the limited resources at the disposal of a start-up organization such as NuSol, it may be the case that time, staff, availability of information, or the number of allocated site visits becomes a constraint to an exhaustive evaluation process. To address this concern, this paper will discuss ways to tailor the evaluation strategy to match organizational ability to carry out the process.

Moving beyond Sustainability – Unique project impacts

As each electrification project is structured to maximize benefits to the target community, projects will vary in the kind of technical equipment used, the way it is used, and therefore the resulting impacts. While rural electrification projects should be held to sustainable development standards, there are potential project level impacts that organizations would be remiss to leave unaccounted as these unique project aspects may fall outside of the sustainability outcome category.

Based on Reiche et al. (2000) in their exploration of the impact of rural electrification systems in Argentina and 12 other solar home system projects, this paper also acknowledges an additional outcome category: 'project specific.' In addition to sustainability indicators, there are unique project specific outcomes that depend on the intended use of electricity. These indicators are incorporated into the recommended evaluation framework to provide a more holistic view of the project's impact.

It is important to recognize that the project specific portion of the evaluation will vary depending on the nature of the intervention. For example, a primary feature of NuSol's pilot project, decided upon by the partner community, is a recharging station for 70 LED lanterns to be used for household use after nightfall. Future partner communities may identify alternative needs for electricity, such as refrigeration or public lighting. The intended impact and associated outcomes of these potential interventions will vary and necessitate different evaluation approaches; therefore, it is important to tailor this portion of the evaluation individually.

Reiche et al. (2000) identifies three main ways in which rural electrification services were used among projects observed: domestic, productive, and public uses (Reiche

et al., 2000). This paper incorporates these themes as the basis for the project specific outcome category of the evaluation framework and are defined as follows:

1. **Domestic** – Relating to impacts within the household as a result of the intervention. Indicators include, but are not limited to, improved lighting, air quality, safety, and efficiency.
2. **Productive** – Relating to the household financial impacts of the intervention, including decreased spending on traditional energy related resources and increased monthly household income.
3. **Public** – Relating to impacts on community education, health, and development. Indicators include, but are not limited to, changes in reading habits and improved infrastructure.

Proposed Logic Model & Evaluation Plan

The logic model and evaluation plan are the most basic, yet most useful tools in terms of program evaluation. The *logic model* is used to depict a project's theory of change in a logical series of events ranging from project inputs to resulting outcomes. The *evaluation plan* is a similar tool used to demonstrate how specific data will be collected to demonstrate progress towards project outcomes.

Rooted in the theme/sub-theme framework elaborated above, this paper proposes a logic model and evaluation plan comprised of two outcome categories, *Sustainability* and *Project Specific*.

Several Outcome Themes further refine each of the above categories as seen here:

1. Sustainability
- *Technical*
- *Economic*
- *Social/Ethical*
- *Environmental*

2. Project Specific
- *Domestic*
- *Productive*
- *Public*

Each Outcome Theme is then deconstructed even further through the use of Sub-Themes as seen here:

1. Sustainability
- Technical
  - *Operational Feasibility*
  - *Community Capacity*
- Economic

        - *Project Costs Financed*
        - *Productive Uses*
        - *Employment Generation*
    - Social/Ethical
        - *Equitable Distribution*
        - *Availability in Public Spaces*
        - *Credit*
    - Environmental
        - *Community*
        - *Global*
2. Project Specific
    - Domestic
        - *Household Lighting*
        - *Quality of Living Environment*
        - *Household Safety*
        - *Efficiency*
        - *Information Dissemination and Communication*
    - Productive
        - *Household Financial*
    - Public
        - *Education*
        - *Health*
        - *Community Development*

Within each sub-theme, at least one indicator is identified to provide clarity and specificity to what kind of information is required to evaluate the subsequent sub-themes, themes, and outcome category. The proposed framework within this paper recognizes 37 indicators. A comprehensive logic model and evaluation plan based on NuSol's approach to project development is seen in Appendix A & B respectively.

Complete descriptions of each indicator can be found in Appendix C. Descriptions are based on a simplification of the indicator worksheets developed by the United Nations (UN, 2001, 2005). The format used in this paper is as follows:

- **Indicator Name** – Corresponds with indicator name on proposed logic model and evaluation plan.
- **Brief Description** – Explains the purpose of the indicator and what it measures.
- **Measurement Methods** – Describes the means by which data related to the indicator will be collected.
- **Limitations** – Addresses any issues, if present, regarding data collection, to include but not limited to organizational resource constraints and in-country influences.

It is important to recognize that the logic model, evaluation plan, and subsequent indicators should be revisited regularly and remain open to modifications as research and practice within the field of evaluation, sustainable development, and rural electrification continues to change and advance.

Customizing the Evaluation Strategy to Maximize Usefulness

Now that the logic model, outcome categories, themes, sub-themes, and subsequent indicators have been identified and defined, the paper will now discuss methods to customize the evaluation strategy.

While the logic model and evaluation plan discussed above provide a comprehensive overview of an exhaustive evaluation, it is important to acknowledge the concerns this paper raises regarding Ilskog's framework, specifically the constraints on organizational capacity. It is therefore vital to maximize the utility of evaluation data collected given resource constraints.

However, it is also important to avoid over-customization as this could:

a) Compromise the integrity of the evaluation framework by eliminating key indicators.
b) Disallow comparability of outcomes between project evaluations if customization varies greatly between projects.

Taking these considerations into account, this paper recognizes two strategies to maximize evaluation efforts that can be used independently or together in evaluation planning:

1. **Backward Mapping/Utilization Focused Evaluation Strategy** – Advocates for a collaborative approach in developing an evaluation strategy that engages numerous stakeholders who are interested in the evaluation findings.
2. **Hierarchical Evaluation Strategy** – Assumes a tiered and dependent relationship among outcomes where the most basic indicators facilitate the achievement of more sophisticated project outcomes.

Backward Mapping/Utilization Focused Evaluation Strategy

Elmore (1980) encourages a *backward mapping* approach when formalizing evaluation strategies. Backward mapping encourages evaluators to collaborate with stakeholders that will use the evaluation findings to best address their decision-making needs. Patton's Utilization Focused Evaluation (2008) method builds on backward mapping by providing a framework for prioritizing evaluation collection and analysis based on the criteria of who will use the data collected and for what purpose. By framing the evaluation strategy in this way, evaluators can collect the

most relevant and useful information for identified stakeholders. This approach also allows consideration for the availability of organizational resources and prohibits an overly ambitious evaluation.

In Appendix D: Utilization Focused Evaluation Planning Worksheet, this paper provides a planning tool that will help evaluators and stakeholders engage in evaluation planning discussions. The worksheet is divided into the following three stages:

- **Stage 1: Identify Audience and Focus** – In this stage, users or individuals interested in the evaluation findings are identified and their questions regarding what they want to know from the evaluation are brought forth.
- **Stage 2: Identify and Prioritize Evaluation Components** – Based on the intended users and what they hope to learn from the evaluation, evaluators and stakeholders prioritize outcomes and indicators with reference to the logic model and evaluation plan in Appendix A & B respectively. Prioritization is important as evaluation resources are often limited.
- **Stage 3: Develop Evaluation Design** – Once evaluation elements are prioritized, evaluators and stakeholders will decide how information is to be collected, by whom, and when. Proposed measurement methods and collection schedule are presented in the Evaluation Plan in Appendix B to aid in this stage.

See Appendix D: Utilization Focused Evaluation Planning Worksheet for a detailed description of how these stages are related and defined.

Limitations to Backward Mapping/Utilization Focused Evaluation

When tailoring evaluation for primary user groups, evaluations become unique. If turnover is to occur among primary user groups, so too will the desired information or findings shift. This volatility could eventually undermine the use of Backward Mapping/Utilization Focused Evaluation (Patton, 2008). As a remedy, it is recommended to work with a diversified group of primary users. In this way, the loss or replacement of one or two stakeholders will minimally impact the evaluation strategy (Patton, 2008).

Hierarchical Evaluation Strategy

Based on the work of Rossi, et al. (2004, p. 79-81), this strategy allows an understanding of interdependencies among project outcomes and indicators; this creates a form of triage in the assessment of a project, thereby maximizing evaluation efforts within a given period of time. At the most basic level, if the rural electrification system fails to function as intended after the installation team departs, all intended outcomes would become void. If the system itself is functional, but there is a community conflict regarding the distribution of rechargeable

lanterns, all outcomes related to personal, portable lighting become unattainable. It is this kind of logic that would allow the evaluation team to maximize their time in assessing a project by targeting the most fundamental indicators first.

In Appendix E: Hierarchy of Outcomes, this paper provides a tool that establishes logical relationships and prioritization to the indicators presented in the Logic Model and Evaluation Plan. This tool is divided into 7 tiers, the first being the most basic, while later tiers are more complex and dependent on the fulfillment of indicators in earlier tiers. The proposed hierarchy diagram also identifies indicators that are independent of a hierarchical relationship and therefore occur either prior to or simultaneously with other indicators.

See Appendix E for a detailed description of how outcomes and indicators are prioritized.

While these two strategies for maximizing evaluation usefulness are presented independently, this paper recommends using the Hierarchical framework as a tool to inform collaborative discussions with stakeholders. Patton (2008) recognizes what is deemed the *personal factor*, or the "presence of an identifiable individual or group of people who personally care about the evaluation and the findings it generates"(Patton, 2008). The Stanford Evaluation Consortium recognizes this factor as most important in creating evaluation that are impactful (Cronbach and Associates, 1980). Cronbach & Associates finds that "nothing makes a larger difference in the use of evaluation than the personal factor – the interest of officials in learning from the evaluation and the desire of the evaluator to get attention for what he knows"(Cronbach & Associates, 1980). Therefore, by using the Hierarchy of Outcomes as a tool to inform the Backwards Mapping/Utilization Focused Evaluation approach, the value added by the personal factor is maintained.

Data Collection Methodology

Once the most vital evaluation components are identified, it is important to understand how data will be collected. The Utilization Focused Evaluation Planning Worksheet in Appendix D touches on the idea of data collection methods; however, this section will discuss in detail the means by which data will be obtained.

Baseline Data

NuSol currently selects partner communities based on a criterion for electrification, to include local access to electricity, solar irradiation, and geographic isolation. This assessment is conducted in collaboration with in-country partner organizations and initial site visits from the NuSol installation team. During these initial planning visits, basic data should also be collected to serve as a baseline for comparing the direct impact of the electrification project upon follow up. The kind of baseline data collected will vary depending on project scope, but will include at least the most

basic information regarding current energy use habits, kinds of fuels used, household financial information, and overall community economic activity.

See Appendix F: Sample Baseline Data Questionnaire as an example survey/interview questionnaire to be administered upon initial planning site visits.

Post Installation Data

Ideally, once NuSol concludes the installation of the energy system and provides necessary training, an in-country partner would make regular visits to the community to ensure proper use and address any technical difficulties should they arise.

Within six months of installation, a NuSol evaluation team consisting of a minimum of two individuals should conduct its first evaluation site visit. Data collection methods may include interviews with community members, written surveys, physical inspections of energy system and other technical components, and reviews of any hand-kept documentation of system performance and use (Ilskog and Kjellstrom, 2008).

After the initial evaluation site visit, recurring visits should be conducted to ensure the achievement of sustainable development. As "sustainability is a matter of development over time"(Ilskog & Kjellstrom, 2008, p. 2682), a single visit is not sufficient to assess sustainability. Therefore, by collecting data over an extended period of time, or multiple site visits, longitudinal trends of sustainability indicators over a time series would become visible, providing a more accurate representation of sustainability.

See Appendix G: Sample Post Installation Survey/Questionnaire as an example survey/interviewing questionnaire to be administered upon follow up site visits.

Avoiding Bias

When conducting interviews and administering surveys, it is important to consider and attempt to minimize potential biases. Biases may arise in a variety of forms, to include:

- **Language and/or cultural differences** – When working with rural communities, there may be certain dialects or languages spoken by community members that require a translator (i.e. NuSol's initial project was conducted with a community that speaks primarily Quechua). When possible, interviews and surveys should be conducted by individuals that speak the native language of the partner community.

- **Unfamiliarity with administering surveys** – It is important to ensure the evaluation team is familiar with best practices regarding administering surveys and conducting interviews for evaluative purposes. In general, the evaluator should remain neutral and avoid leading questions of introductions.

- **Awareness of Evaluation** – In studies, when a subject is aware of being monitored, actions are often intentionally different than if the 'subject' was unaware of such observation. Known as the Hawthorne Effect, this phenomenon could appear in the context of a NuSol evaluation as extremely positive or negative responses to interviews/surveys in an effort to influence a certain response from the NuSol team (i.e. additional funding and support or perhaps discontinued assistance). This effect is not easily minimized as it is a reactive behavior of the subject, whether intentional or not; however, it is important to acknowledge its potential presence.

Who to Survey?

As NuSol's pilot project is conducted within a small community (70 households), it may be feasible, and statistically more useful, to conduct a household census survey when collecting data. As the populations NuSol partners with increases, sampling will become a useful means of efficiently and accurately gathering data from project sites.

Conclusion and Summary

This paper proposes an evaluation model based on best practices in the field of rural electrification and sustainable development evaluation. The models presented and strategies identified for customization allow for flexibility when crafting future project evaluation strategies.

1. Existing academic literature acknowledges the lack of a unified evaluation framework for rural electrification projects, resulting in inconstant and incomparable data among similar projects.

2. Most recently, Ilskog (2008, 2008a) has attempted to formalize the evaluation of rural electrification project against standards of sustainable development.

3. Because of the unique conditions present within communities and the differences in their needs for electrification, individual project will maintain a level of uniqueness that may be overlooked in evaluation without the inclusion of an additional outcome category that focuses on project specific outcomes.

4. This paper provides a comprehensive logic model and evaluation plan that represents an exhaustive evaluation process.

5. Evaluation components should remain open to future modifications based on evaluation and development trends and/or advancements.

6. As the intended audience of this paper is a start-up organization, it recognizes the importance of forming an evaluation strategy that is achievable within the available resources.

7. This paper proposes two strategies for customizing the evaluation strategy:

    a) Backward Mapping/Utilization Focused Evaluation and
    b) Hierarchical Evaluation Strategy

8. Data collection for the organization is recommended in two comparative phases:

    a) Baseline
    b) Post Installation

    If possible, it is also recommended that in-country partners make more regular site visits to ensure proper functionality of the energy system

9. Recommended data collection methods include interviews, surveys, physical inspection of equipment, and references to in-country data records.

10. When conducting surveys it is important to consider potential biases. Those identified by this paper are:

    a) Language and/or cultural differences
    b) Unfamiliarity with survey administration
    c) The Hawthorne Effect.

11. Sampling is encouraged when evaluating a project's impact on larger populations, however when dealing with relatively small communities, attempting a census survey may prove more useful.

Appendix A: Comprehensive Logic Model

(Based on the project design of NuSol – included in its entirety and separated for legibility over the next 3 pages – Left to right order: Situation, Inputs, Activities/Outputs, Outcomes/Indicators, Impact)

Situation (Problem or Opportunity)	Inputs (Resources you'll deploy to address the situation)	Activities/Outputs (Things you'll do with the resources you'll deploy to address the situation)	Outcomes / Indicators: Outcome Category	Theme	Sub-Theme	#	Indicators	Impact (Opposite state of the situation - The condition ultimately created by the results of the things you'll do with the
Lack of sustainable energy resources for rural, off-grid communities Opportunity for sustainable rural electrification projects to address electrification needs	Sustainable Fundraising and Financing Scheme Energy System Components (Solar Panels, racking, wind energy components, lanterns, etc. -- These inputs will vary based on project design) Installation Team (will vary in size, depending on nature of project) Various In-Country Partners (will vary based on location and development of in-country supply chain) Installation and Maintenance Curriculum	Installation of off-grid renewable energy system (could include various additives, i.e. lanterns, stoves, IT equipment, etc. -- Will vary based on project design) Host Community Training on System Maintenance and Repair	Sustainability	Technical	Operational Feasibility	1	System Functionality	Rural communities able to benefit from the availability of renewable solar energy Delivery of a technically, economically, socially/ethically, and environmentally sustainable rural electrification program
						2	System depreciation	
						3	Stable electricity usage	
						4	Compatibility with future grid services or expansion	
						5	Conformance with national/regional/industry standards	
					Community Capacity	6	Availability of support infrastructure	
						7	Readily available services	
				Economic	Financial	8	Capital and installation cost	
						9	Operation and maintenance costs *(linked with indicator 1 & 2)*	
						10	Share of profit set aside for re-investment (batteries, system repairs)	
					Productive Uses	11	Percent of electricity consumed by businesses	
						12	Percent of electrified households using electricity for income generating activity	
					Employment Generation	13	Businesses developed	
				Social/Ethical	Equitable Distribution	14	Percent of community with access to light	
						15	Percent of community with access to electricity	
					Availability in Public Spaces	16	Health centers with electricity and light	
						17	Schools with electricity and light	
						18	Public gathering areas with light and electricity	
					Credit	19	Micro-credit options available for renewable energy expansion	
				Environmental	Community	20	Percent of electrified households where renewable electricity has replaced other energy sources for lighting	
						21	Percent of electrified households where renewable electricity has replaced other energy sources for cooking	
						22	A unique environmental impact identified	
					Global	23	Quantity of renewable energy consumed	
			Project Specific	Domestic	Household Lighting	24	Improved brightness of light	
						25	Improved reliability from renewable light source *(linked with indicator 7)*	
						26	Improved duration of light from renewable light source	
					Quality of living environment	27	Improved air quality within households *(linked with indicators 21-24)*	
					Household safety	28	Improved safety within households	
					Efficiency	29	Increased availability of time for other household tasks *(linked with 7 & 26)*	
					Information dissemination and communication	30	Increased use of periphery devices within households	
				Productive	Household Financial	31	Decrease in monthly household expenditures on energy related resources	
						32	Increase in monthly household revenues *(linked with indicators 12-14)*	
				Public	Education	33	Increased time spent reading (change in reading habits) among youth *(linked with indicator 7 & 26)*	
						34	Infrastructure capable of accommodating electronic teaching resources *(linked with indicator 18)*	
					Health	35	Infrastructure capable of accommodating more advanced medical resources *(linked with indicator 17)*	
					Community Development	36	Improved public lighting *(linked with indicator 19)*	
						37	Improved / development of community security *(linked with indicator 19 & 37)*	

Situation (Problem or Opportunity)	**Inputs** (Resources you'll deploy to address the situation)	**Activities/Outputs** (Things you'll do with the resources you'll deploy to address the situation)
Lack of sustainable energy resources for rural, off-grid communities Opportunity for sustainable rural electrification projects to address electrification needs	Sustainable Fundraising and Financing Scheme Energy System Components (Solar Panels, racking, wind energy components, lanterns, etc. -- These inputs will vary based on project design) Installation Team (will vary in size, depending on nature of project) Various In-Country Partners (will vary based on location and development of in-country supply chain) Installation and Maintenance Curriculum	Installation of off-grid renewable energy system (could include various additives, i.e. lanterns, stoves, IT equipment, etc. -- Will vary based on project design) Host Community Training on System Maintenance and Repair

Outcomes / Indicators				
Outcome Category	**Theme**	**Sub-Theme**		**Indicators**
Sustainability	**Technical**	Operational Feasibility	1	System Functionality
			2	System depreciation
			3	Stable electricity usage
			4	Compatibility with future grid services or expansion
			5	Conformance with national/regional/industry standards
		Community Capacity	6	Availability of support infrastructure
			7	Readily available services
	Economic	Financial	8	Capital and installation cost
			9	Operation and maintenance costs *(linked with indicator 1 & 2)*
			10	Share of profit set aside for re-investment (batteries, system repairs)
		Productive Uses	11	Percent of electricity consumed by businesses
			12	Percent of electrified households using electricity for income generating activity
		Employment Generation	13	Businesses developed
	Social/Ethical	Equitable Distribution	14	Percent of community with access to light
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			17	Schools with electricity and light
			18	Public gathering areas with light and electricity
		Credit	19	Micro-credit options available for renewable energy expansion
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			25	Improved reliability from renewable light source *(linked with indicator 7)*
			26	Improved duration of light from renewable light source
		Quality of living environment	27	Improved air quality within households *(linked with indicators 21-24)*
		Household safety	28	Improved safety within households
		Efficiency	29	Increased availability of time for other household tasks *(linked with 7 & 26)*
		Information dissemination and communication	30	Increased use of periphery devices within households
	Productive	Household Financial	31	Decrease in monthly household expenditures on energy related resources
			32	Increase in monthly household revenues *(linked with indicators 12-14)*
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			34	Infrastructure capable of accommodating electronic teaching resources *(linked with indicator 18)*
		Health	35	Infrastructure capable of accommodating more advanced medical resources *(linked with indicator 17)*
		Community Development	36	Improved public lighting *(linked with indicator 19)*
			37	Improved / development of community security *(linked with indicator 19 & 37)*

Impact (Opposite state of the situation - The condition ultimately created by the results of the things you'll do with the
Rural communities able to benefit from the availability of renewable solar energy Delivery of a technically, economically, socially/ethically, and environmentally sustainable rural electrification program

Appendix B: Evaluation Plan

(Based on the project design of NuSol – included in its entirety and separated for legibility over the next 2 pages- Sustainability indicators represented in orange, Project Specific indicators in gray)

	Indicators	Data Collection Methods and Collection Schedule
1	System Functionality	**Primary:** Regular site visits and physical inspection from in-country partners **Secondary:** Biannual site visits and physical inspection from evaluation team
2	System depreciation	**Primary:** Regular site visits and physical inspection from in-country partners **Secondary:** Biannual site visits and physical inspection from evaluation team
3	Stable electricity usage	**Primary:** Remote monitoring via satellite **Secondary:** Regular site visits and physical inspection from in-country partners **Tertiary:** Biannual site visits and physical inspection from evaluation team
4	Compatibility with future grid services or expansion	**Primary:** System specifications will be assessed during project planning and continually reassessed during biannual site visits from evaluation team
5	Conformance with national/regional/industry standards	**Primary:** System specifications will be assessed during project planning and continually reassessed during biannual site visits from evaluation team
6	Availability of support infrastructure	**Primary:** Post instructional questionnaire conducted after initial training. Identification and assessment of potential or official in-country partners able to provide support
7	Readily available services	**Primary:** Post Installation Survey/Questionnaire during biannual site visit from evaluation team **Secondary:** Interviews with community members during biannual site visit from evaluation team
8	Capital and installation cost	**Primary:** Cost and payment structure should be established during project planning **Secondary:** New entry of microfinance institutions should be monitored during site visits from evaluation team
9	Operation and maintenance costs *(linked with indicator 1 & 2)*	**Primary:** Operation and maintenance costs will be determined during project planning **Secondary:** Evaluation team will assess the adequacy of existing operation and maintenance costs based on system depreciation
10	Share of profit set aside for re-investment (batteries, system repairs)	**Primary:** In-country partners will monitor and ensure sufficient savings structure during regular site-visits **Secondary:** Evaluation team will monitor and ensure sufficient saving structure during biannual site-visits
11	Percent of electricity consumed by businesses	**Primary:** Remote monitoring via satellite **Secondary:** In-country partners will assess energy use by businesses during regular site visits **Tertiary:** Evaluation team will assess energy use by businesses during biannual site visits
12	Percent of electrified households using electricity for income generating activity	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** Post Installation Survey/Questionnaire during biannual site visit from evaluation team
13	Businesses developed	**Primary:** Evaluation team will monitor new business development through interviews with community members during biannual site visits and conduct follow up interviews with business owners to assess direct impact of electrification
14	Percent of community with access to light	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** In-country partners will monitor community-wide access to light services during regular site visits **Tertiary:** Post Installation Survey/Questionnaire and interviews conducted by evaluation team during biannual site visits
15	Percent of community with access to electricity	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** In-country partners will monitor community-wide access to electricity services during regular site visits **Tertiary:** Post Installation Survey/Questionnaire and interviews conducted by evaluation team during biannual site visits
16	Health centers with electricity and light	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** In-country partners will monitor health center access to electricity and lighting services during regular site visits **Tertiary:** Evaluation team will monitor health center access to electricity and lighting services during physical inspection, Post Installation Survey/Questionnaire and interviews conducted during biannual site visits
17	Schools with electricity and light	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** In-country partners will monitor school access to electricity and lighting services during regular site visits **Tertiary:** Evaluation team will monitor school access to electricity and lighting services during physical inspection, Post Installation Survey/Questionnaire and interviews conducted during biannual site visits
18	Public gathering areas with light and electricity	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** In-country partners will monitor public area access to electricity and lighting services during regular site visits **Tertiary:** Evaluation team will monitor public area access to electricity and lighting services during physical inspection, Post Installation Survey/Questionnaire and interviews conducted during biannual site visits
19	Micro-credit options available for renewable energy expansion	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** New introduction of microfinance institutions will be monitored by evaluation team through Post Installation Survey/Questionnaire and interviews conducted during biannual site visits **Secondary:** In-country partners will monitor the new entry of microfinance institutions serving target population
20	Percent of electrified households where renewable electricity has replaced other energy sources for lighting	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits
21	Percent of electrified households where renewable electricity has replaced other energy sources for cooking	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits
22	A unique environmental impact identified	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to identify unique impact **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits (Data collection may vary based on nature of the unique environmental impact)
23	Quantity of renewable energy consumed	**Primary:** Remote monitoring via satellite **Secondary:** Regular site visits and physical inspection from in-country partners **Tertiary:** Biannual site visits and physical inspection from evaluation team
24	Improved brightness of light	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
25	Improved reliability from renewable light source *(linked with indicator 7)*	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
26	Improved duration of light from renewable light source	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
27	Improved air quality within households *(linked with indicators 21-24)*	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
28	Improved safety within households	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
29	Increased availability of time for other household tasks *(linked with 7 & 26)*	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
30	Increased use of periphery devices within households	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
31	Decrease in monthly household expenditures on energy related resources	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
32	Increase in monthly household revenues *(linked with indicators 12-14)*	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
33	Increased time spent reading (change in reading habits) among youth *(linked with indicator 7 & 26)*	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
34	Infrastructure capable of accommodating electronic teaching resources *(linked with indicator 18)*	**Primary:** Infrastructure would be determined during project planning **Secondary:** Evaluation team will conduct physical inspection of infrastructure during biannual site visits
35	Infrastructure capable of accommodating more advanced medical resources *(linked with indicator 17)*	**Primary:** Infrastructure would be determined during project planning **Secondary:** Evaluation team will conduct physical inspection of infrastructure during biannual site visits
36	Improved public lighting *(linked with indicator 19)*	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition
37	Improved / development of community security *(linked with indicator 19 & 37)*	**Primary:** Baseline Questionnaire or interviews with community members during planning site visits to assess pre condition **Secondary:** Post Installation Questionnaire/Survey or interviews with community members by evaluation team during biannual site visits to assess post condition

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Appendix C: Description of Indicators

Outcome Category: Sustainability

THEME: TECHNICAL

Sub-Theme: Operational Feasibility

1. **Indicator Name:** System Functionality
   Brief Description: Assesses the extent to which the rural electrification system is operating as intended. Energy is harnessed and distributed according to project implementation plan. Mechanical and technical components operate correctly.
   Measurement Methods: Site visits are encouraged on a regular basis with decreasing frequency as the target community becomes increasingly familiar with the energy system and its maintenance. In-country partners will conduct the more frequent site visits, while the organization's evaluation team will conduct biennial visits.
   Limitations: While the organization's evaluation team is preferred, smaller organizations may lack the staff capacity or resources to carry out site visits on a regular basis. In-country partners (NGOs, regional governmental agencies) may also be qualified to carry out site visits.

2. **Indicator Name:** System depreciation
   Brief Description: Assesses the wear and tear of the energy system over time and compares its actual condition with expected conditions based on average system lifespan.
   Measurement Methods: The evaluation team will conduct biennial site visits to examine the physical condition of the energy system and make recommendations for improving system care to ensure expected life cycle of all technical components.
   Limitations: While the organization's evaluation team is preferred, smaller organizations may lack the staff capacity or resources to carry out site visits on a regular basis. In-country partners (NGOs, regional governmental agencies) may also be qualified to carry out site visits.

3. **Indicator Name:** Stable electricity usage
   Brief Description: Assesses energy use patterns within the community and monitors for over-consumption.
   Measurement Methods: Usage patterns may be recorded and tracked on a weekly/monthly/quarterly basis by a technical measuring device on-site or manually by designated community/in-country partners. Depending on technical measuring components in place, energy use patterns may be monitored remotely via satellite. Depending on local technical capacity,

energy use patterns could be assessed regularly and recommendations made to ensure optimum usage levels. Otherwise, the organization's evaluation team will assess community use records and make recommendations during biannual site visits.
Limitations: Smaller organizations may lack the staff capacity or resources to carry out rigorous monitoring of energy use. Local capacity may also be limited depending on regional partners and local understanding of technical components. There exists the potential for remote monitoring via satellite, however remote monitoring equipment may become damaged.

4. **Indicator Name:** Compatibility with future grid services or off-grid expansion
Brief Description: Assesses the off-grid system's capability to accommodate future expansion and/or linkage with electrical grid expansion.
Measurement Methods: System specification will determine potential for expansion/linkage.
Limitations: In-country electrical grid expansion specifications may not be easily anticipated. Also, equipment used may be acquired from U.S. companies with incompatible voltage requirements.

5. **Indicator Name:** Conformance with national/regional/industry standards
Brief Description: Assesses project's conformance with best practices in technical performance and installation. Will most likely be addressed in the project development stage.
Measurement Methods: System specifications will be compared to industry standards and will be classified on a scale of 1 to 5 (one being completely unmet, 5 being completely met). Narrative explanation will also be provided.
Limitations: As a system continues on its expected depreciation schedule, new technologies may become available that make previous equipment outdated or obsolete.

Sub-Theme: Community Capacity

6. **Indicator Name:** Availability of support infrastructure
Brief Description: Assesses the community's technical understanding of energy system maintenance and repair and also addresses the proximity/likelihood of professional in-country technical assistance providers (either official or potential partners).
Measurement Methods: A post instructional questionnaire should be conducted after the installation team trains select community members using the developed capacity building curriculum. Follow up trainings should be conducted to ensure fidelity in maintenance procedures. Evaluation team and in-country partners will also identify potential or actual partner organization capable of providing support.
Limitations: It is assumed that those participating in the training will remain in the community to perform maintenance and repair. If trained community

members relocate or are unable to perform technical maintenance, additional training may be required to ensure supportive infrastructure.

7. **Indicator Name:** Readily available services
Brief Description: Indicator assesses the ability of the renewable energy system to meet community needs/demands for electricity and light in a timely and reliable fashion.
Measurement Methods: Availability of services will be addressed on the "Sample Post Installation Survey/Questionnaire" administered to community members on biannual site visits.
Limitations: 'Readily available' may be interpreted differently and should be defined based on the intent of the project.

THEME: ECONOMIC

Sub-Theme: Project Costs Financed

8. **Indicator Name:** Capital and installation costs
Brief Description: Assesses the finance structure for costs associated with system equipment and installation. To be completely sustainable, partner communities should finance all costs (most likely through micro-lending practices) and initial funders (if they are involved in finance structure) should be completely reimbursed for program related funding.
Measurement Methods: Financing structure should be assessed between organization, partner community, and other organizational partners prior to installation of energy system. New entry of microfinance institutions post installation should also be monitored.
Limitations: Depending on the availability of micro-finance institutions that serve the target community, finance and savings structures may be limited.

9. **Indicator Name:** Operation and maintenance costs
Brief Description: Assesses the costs associated with operating and maintaining the energy system. Indicator is closely linked to the performance of indicator 1, system functionality and indicator 2, system depreciation.
Measurement Methods: As estimated maintenance costs and community reinvestment levels are incorporated into project planning, the evaluation team will make recommendations for continued operation/maintenance costs depending on the necessary repairs needed to ensure system functionality. Opportunity costs of ensuring proper operation of system should also be considered.
Limitations: Smaller organizations may lack the staff capacity or resources to carry out site visits on a regular basis. In-country partners (NGOs, regional governmental agencies) may also be qualified to carry out site visits to monitor community costs to operation and maintenance.

10. **Indicator Name:** Share of profit set aside for re-investment
Brief Description: Assesses the extent to which community residents are accumulating savings from which to purchase replacement batteries and/or other system components. Saving schedule should be ensured through decided upon community accountability measures.
Measurement Methods: Regular site visits conducted by in-country partners and biannual site visits from the organization's evaluation team will monitor the savings schedule to ensure sufficient savings is being set aside to purchase new batteries based on expected lifespan of initial batteries.
Limitations*:* The concept of saving money may not be widely understood within the community. Also, unforeseen economic conditions may create a barrier for residents to continually set aside savings.

Sub-Theme: Productive Uses

11. **Indicator Name:** Percent/share of electricity consumed by businesses
Brief Description: Assesses the consumption of energy produced by local businesses.
Measurement Methods: Usage patterns may be recorded and tracked on a weekly/monthly/quarterly basis by a technical measuring device on-site or manually by designated community/in-country partners. Depending on technical measuring components in place, energy use patterns may be monitored remotely via satellite. Depending on local technical capacity, energy use patterns could be assessed regularly and recommendations made to ensure optimum usage levels. Otherwise, the organization's evaluation team will assess community use records and make recommendations during biannual site visits.
Limitations: Depending on the nature of the project, business development may not be within the intended scope of the project. Technical and/or remote monitoring equipment may become damaged.

12. **Indicator Name:** Percent of electrified households using electricity for income generating activity
Brief Description: Assesses household use of electricity as it pertains to income generating activities such as investment in revenue generating resources/equipment (i.e. sewing machine, stove, etc.)
Measurement Methods: The organization's evaluation team will administer household surveys to determine if electricity is being used within the household for income generating activities.
Limitations: None at this time.

Sub-Theme: Employment Generation

13. **Indicator Name:** Businesses developed
Brief Description: Assesses new business development as a result of reliable access to electricity and/or light.

Measurement Methods: Project development and planning should determine if a community business would be created directly relating to the energy system (i.e. individual responsible for monitoring the system or distributing lanterns). Biannual site visits from the organization's evaluation team will determine if new businesses have been developed since the installation of the energy system. Follow up interviews should be conducted with business owners to capture the impact electrification had on their business idea and development.
Limitations: Depending on the nature of the project, business development may not be within the intended scope of the project.

THEME: SOCIAL/ETHICAL

Sub-Theme: Equitable Distribution

14. **Indicator Name:** Percent/share of community with access to light
Brief Description: Assesses the percent/share of community households with access to light. During project development, the extent to which light will be distributed will be decided based on community needs and organizational capacity to provide the service.
Measurement Methods: The provision of light as intended should be monitored and ensured on a regular basis, depending on local capacity and partnerships. Otherwise, the organization's evaluation team will assess community access through surveys and interviews among community members during biannual site visits.
Limitations: 'Access to light' should be defined at the project level (i.e. lanterns, hard-wired switches, etc.) as it could be interpreted broadly.

15. **Indicator Name:** Percent of community with access to electricity
Brief Description: Assesses the extent to which distribution of electricity services reaches all community households. During project development, the extent to which electricity will be distributed will be decided based on community needs and organizational capacity to provide the service.
Measurement Methods: The provision of electricity as intended should be monitored and ensured on a regular basis, depending on local capacity and partnerships. Otherwise, the organization's evaluation team will assess community access through physical observation, surveys and interviews among community members during biannual site visits.
Limitations: 'Access to electricity' should be defined at the project level (i.e. wall plugs, auxiliary charging station derived from light source, etc.) as it could be interpreted broadly.

Sub-Theme: Availability in Public Spaces

16. **Indicator Name:** Health centers with electricity and light

Brief Description: Assesses the extent to which the community health center(s) are provided reliable light and electricity. During project development, the extent to which light and electricity will be provided will be decided based on community needs and organizational capacity to provide the service.
Measurement Methods: The provision of light and electricity to the community health center(s) as intended should be monitored and ensured on a regular basis, depending on local capacity and partnerships. Otherwise, the organization's evaluation team will assess access through physical observation, surveys and interviews among community members during biannual site visits.
Limitations: Depending on the nature of the project, the provision of light and electricity to health centers may not be within the intended scope of the project.

17. **Indicator Name:** Schools with electricity and light
Brief Description: Assesses the extent to which the community school(s) is/are provided reliable light and electricity. During project development, the extent to which light and electricity will be provided will be decided based on community needs and organizational capacity to provide the service.
Measurement Methods: The provision of light and electricity to the community school(s) as intended should be monitored and ensured on a regular basis, depending on local capacity and partnerships. Otherwise, the organization's evaluation team will assess access through physical observation, surveys and interviews among community members during biannual site visits.
Limitations: Depending on the nature of the project, the provision of light and electricity to schools may not be within the intended scope of the project.

18. **Indicator Name:** Public gathering areas with light and electricity
Brief Description: Assesses the extent to which public spaces are provided with light, electricity, or subsequent peripheral devices. During project development, the extent to which light and electricity will be provided will be decided based on community needs and organizational capacity to provide the service.
Measurement Methods: The provision of light and electricity to community spaces as intended should be monitored and ensured on a regular basis, depending on local capacity and partnerships. Otherwise, the organization's evaluation team will assess access through physical observation, surveys and interviews among community members during biannual site visits.
Limitations: Depending on the nature of the project, the provision of light and electricity to public gathering areas may not be within the intended scope of the project.

Sub-Theme: Credit

19. **Indicator Name:** Micro-credit options available for renewable energy expansion
Brief Description: Assesses the extent to which the target community has access to microfinance services for potential energy expansion if desired.
Measurement Methods: Community access to mico-credit institutions will be assessed during project development. New or renewed access to these services will be assessed during biannual site visits by the organization's evaluation team through community surveys or interviews.
Limitations: While microfinance services are auxiliary to the electrification project, and not necessarily provided or controlled by the organization installing the energy system, the presence of micro-credit institutions is a component of financial sustainability and should be assessed.

THEME: ENVIRONMENTAL

Sub-Theme: Community

20. **Indicator Name:** Percent of electrified households where renewable electricity has replaced other sources for lighting
Brief Description: Assesses the extent to which the energy system provided a replacement for traditional forms of energy, such as batteries, firewood, kerosene, etc.
Measurement Methods: The organization's evaluation team will conduct household surveys during biannual visits to determine if substitution of energy services occurred. This information will be compared to baseline survey data collected during project development or installation.
Limitations: None at this time.

21. **Indicator Name:** Percent of electrified households where renewable electricity has replaced other energy sources for cooking
Brief Description: Assesses the extent to which households have substituted traditional cooking systems with clean renewable energy alternatives. During project development, the extent to which renewable cooking services will be provided will be decided based on community needs and organizational capacity to provide the service.
Measurement Methods: The organization's evaluation team will conduct household surveys during biannual visits to determine if substitution of household cooking sources occurred. This information will be compared to baseline survey data collected during project development or installation.
Limitations: Solar energy systems are limited in their ability to provide cooking alternatives and therefore may be outside the scope of the project.

22. **Indicator Name:** A unique environmental impact identified

Brief Description: Assesses the extent to which the renewable energy services provide a unique environmental benefit for the target community. Unique environmental conditions would be identified and addressed in the project development stage.
Measurement Methods: May vary based on the unique condition. Could include surveys or interviews with community members or physical observation.
Limitations: The organization must be conscious of unique environmental situations during project development and incorporate them into their evaluation strategy if present and identified by the community as a development priority.

Sub-Theme: Global

23. **Indicator Name:** Quantity of renewable energy in consumed
Brief Description: Assesses the quantity of renewable energy consumed to demonstrate the local/national/and global impact of the community adopting renewable energy alternatives.
Measurement Methods: The organization's evaluation team will assess the system's energy consumption during biannual site visits based on records of technical measuring devices on-site or through manual record keeping by designated community/in-country partners. Depending on technical measuring components in place, total energy consumption may be monitored via satellite.
Limitations: In-country record keeping may be unreliable. Technical measuring devices may become damaged.

Project Specific Outcomes

THEME: DOMESTIC

Sub-Theme: Household Lighting

24. **Indicator Name:** Improved brightness of light
Brief Description: Assesses the extent to which community members acknowledge an improvement in brightness of light as compared to traditional light sources (i.e. fire, kerosene, etc.)
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting services.
Limitations: None at this time.

25. **Indicator Name:** Improved reliability from renewable light source

Brief Description: Assesses the extent to which community member feel their renewable light source is reliable and readily available. This indicator is closely linked with indicator 7, readily available services.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting services.
Limitations: None at this time.

26. Indicator Name: Improved duration of light from renewable light source
Brief Description: Assesses the extent to which renewable light alternatives provide an extended duration of light as compared to traditional lighting sources.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting services.
Limitations: None at this time.

Sub-Theme: Quality of Living Environment

27. Indicator Name: Improved air quality within households
Brief Description: Assesses the extent to which community members acknowledge an improved air quality within their households as a result of adopting renewable energy and lighting sources. This indicator is closely linked to the Environmental theme within the Sustainability category, indicators 21-24.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting and energy services.
Limitations: Depending on the kind of traditional energy source used prior to the installation of the renewable energy system, air quality improvements may be minimal.

Sub-Theme: Household Safety

28. Indicator Name: Improved safety within households
Brief Description: Assesses the extent to which community members recognize an improvement in household safety as a result of adopting renewable lighting and energy alternatives.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting and energy services.
Limitations: Depending on the kind of traditional energy source used prior to the installation of the renewable energy system, safety improvements may be minimal.

Sub-Theme: Efficiency

29. **Indicator Name:** Increased availability of time for other household tasks
Brief Description: Assesses the extent to which community members feel they have an increased availability of time that can be dedicated to other household tasks as a result of adopting lighting and energy alternatives. (Targeted more towards individuals that maintain the household) This indicator is linked with indicator 7, readily available services, and indicator 26, improved reliability from renewable light source.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting and energy services with a section specifically targeted towards opportunity costs.
Limitations: Indicator is highly dependent on the extent to which the renewable energy system replaced traditional energy resources.

Sub-Theme: Information Dissemination and Communication

30. **Indicator Name:** Increased use of periphery devices within households
Brief Description: Assesses the extent to which community members have adopted the use of external electronic devices not provided by the installation team, but as a result of the availability of electricity. Devices could include computers, TVs, radios, etc.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting and energy services. Post survey data will be compared to baseline data regarding use of electronics.
Limitations: Indicator is highly dependent on the extent to which periphery devices were used prior to the installation of the renewable energy system, and also the extent to which these devices are easily acquired.

THEME: PRODUCTIVE

Sub-Theme: Household Financial

31. **Indicator Name:** Decrease in monthly household expenditures on energy related resources
Brief Description: Assesses the extent to which community member are able to increase their purchasing power by minimizing their expenditures on traditional light and energy sources through the use of renewable alternatives.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting services with a section specifically targeted towards opportunity costs. Post survey data will be compared to baseline data regarding spending household habits.

Limitations: Indicator is highly dependent on the extent to which the renewable energy system replaced traditional energy resources.

32. **Indicator Name:** Increase in monthly household revenues
Brief Description: Assesses the extent to which community members see an increase in their household revenues as a result of the adoption of renewable energy alternatives. This indicator is closely linked with the Sustainability category's Economic Theme, indicators, 12-14.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting services with a section specifically targeted towards household income. Post survey data will be compared to baseline data regarding spending household income.
Limitations: Community members may be reluctant to share personal financial information.

THEME: PUBLIC

Sub-Theme: Education

33. **Indicator Name:** Increased time spent reading (change in reading habits) among youth
Brief Description: Assesses the extent to which youth spend more time reading after dark as a result of the adoption of renewable energy alternatives. This indicator is closely linked with indicators, 7 and 26.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting services with a section specifically targeted towards reading habits.
Limitations: Depending on the nature of the project, creating changes in reading habits may not be within the intended scope of the project.

34. **Indicator Name:** Infrastructure capable of accommodating electronic teaching resources
Brief Description: Assesses the extent to which schools are equipped with the infrastructure that would allow the introduction of electronic teaching resources. This indicator is linked closely with indicator 18, schools with electricity and light.
Measurement Methods: The provision of light and electricity to the community school(s) would be determined during project development. Therefore, the infrastructure would be known upon installation. The organization's evaluation team will monitor the infrastructure during biannual site visits to ensure it remains operational.
Limitations: Depending on the nature of the project, access to electricity in schools may not be within the intended scope of the project.

Sub-Theme: Health

35. **Indicator Name:** Infrastructure capable of accommodating more advanced medical resources
Brief Description: Assesses the extent to which medical facilities are equipped with the infrastructure that would allow the introduction of advanced medical resources requiring electricity. This indicator is closely linked to indicator 17, health centers with electricity and light.
Measurement Methods: The provision of light and electricity to the community health facility(ies) would be determined during project development. Therefore, the infrastructure would be known upon installation. The organization's evaluation team will monitor the infrastructure during biannual site visits to ensure it remains operational.
Limitations: Depending on the nature of the project, access to electricity in health centers may not be within the intended scope of the project.

Sub-Theme: Community Development

36. **Indicator Name:** Improved public lighting
Brief Description: Assesses the extent to which community members feel public spaces have improved lighting as a result of the adoption of renewable energy alternatives. This indicator is closely linked with indicator 19, public gathering areas with light and electricity.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting services. Public areas will also be visited and physically assessed for improved lighting as compared to pre installation conditions.
Limitations: Depending on the nature of the project, access to electricity and light in public gathering areas may not be within the intended scope of the project. Also, depending on the geography of the community, public spaces may be less frequented by all community members due to distance from households.

37. **Indicator Name:** Improved/development of community security
Brief Description: Assesses the extent to which community members feel an increased sense of security due to the adoption of renewable energy alternatives. This indicator is closely linked with indicator 19, public gathering areas with light and electricity and indicator 37, improved public lighting.
Measurement Methods: During biannual site visits, the organization's evaluation team will administer a household survey to assess client satisfaction with lighting services.

Limitations: Depending on the nature of the project, improving community security may not be within the intended scope of the project.

Appendix D: Utilization Focused Evaluation Planning Worksheet

PLANNING STAGES	PLANNING STEPS
STAGE 1 **IDENTIFY AUDIENCE AND FOCUS** IDENTIFYING WHO IS MOST INTERESTED IN THE EVALUATION INFORMATION AND INVOLVING THEM IN THE DEVELOPMENT OF THE EVALUATION STRATEGY WILL IMPROVE ITS USEFULNESS	**USERS - WHO IS MOST INTERESTED IN THE EVALUATION?** Consider internal (staff, board) and external (funders, policymakers, media) audiences. If possible, gather interested representatives to discuss how the evaluation strategy. **USES - WHAT WILL USERS DO WITH THE INFORMATION GATHERED?** Consider inform program strategy, demonstrate program impact, make funding decisions, generating 'lessons learned' for subsequent projects, etc. Engage users in identifying their priorities for how data collected would be used. **QUESTIONS - WHAT INFORMATION DO USERS WANT TO KNOW?** Consider the intended program outcomes and their importance to distinct Users of the evaluation information. Engage users in identifying specific questions they would like answered during the evaluation. Determine how this information relates to intended use.
STAGE 2 **IDENTIFY AND PRIORITIZE EVALUATION COMPONENTS** AS ORGANIZATIONAL RESOURCES AND TIME ALLOCATED TO PROGRAM EVALUATION ARE NOT INFINITE, IT IS IMPORTANT TO PRIORITIZE EVALUATION COMPONENTS	**IDENTIFY - WHAT COMPONENTS ARE MOST IMPORTANT TO USERS?** Consider the evaluation logic model, evaluation plan, and indicator worksheets developed to inform Users of intended program impacts. Allow users to identify most pertinent components as they relate to their intended uses and questions raised above. Allow for discussion to incorporate unaccounted indicators if they are identified. **PRIORITIZE – RANKING EVALUATION COMPONENTS** Consider the evaluation timeframe and resources allocated to the evaluation project. Allow Users to prioritize evaluation components identified based on what they feel is most important to their specific uses.
STAGE 3 **DEVELOP EVALUATION DESIGN** SELECT THE MOST APPROPRIATE DATA COLLECTION METHODS THAT WILL OBTAIN MOST RELEVANT INFORMATION AS IT PERTAINS TO USERS PRIORITIES	**SELECT METHOD – HOW WILL INFORMATION BE COLLECTED?** Consider the data collection methods identified in the Evaluation Plan that matches with prioritized evaluation components. Consider alternative data collection methods as appropriate, including focus groups, interviews, case studies, etc. **CODIFY EVALUATION IMPLEMENTATION – WHO WILL CARRY OUT EVALUATION? WILL RANDOM SAMPLES BE USED? WHEN WILL EVALUATION OCCUR?** Consider if primary users of information should be involved in evaluation implementation. Consider the 'personal factor.' What kind of preparations should be made prior to site visit? Will there be a need for a random sampling? What is the timeframe of the program evaluation? When will analysis and reporting occur?

Appendix E: Hierarchy of Outcomes

- *Diagram represents a proposed hierarchy and may be re-ordered based on evaluation strategy developed through strategic planning.*
- *Numbers within diagram represent corresponding indicator numbers represented on logic model*

TIER	INDICATORS	INDICATORS OUTSIDE OF HIERARCHY
1	**1.** System functionality **2.** System depreciation	Indicators Primarily Determined Prior to Evaluation ↓
2	**7.** Readily available service **3.** Stable electricity use **23.** Quantity of renewable energy consumed	
3	**14.** Percent of community with access to light **15.** Percent of community with access to electricity	
4	**20.** Percent of households where renewable electricity has replaced other energy sources for lighting **21.** Percent of households where renewable electricity has replaced other energy sources for cooking **16.** Health centers with electricity and light – **36.** Infrastructure capable of accommodating more advanced medical resources **17.** Schools with electricity and light – **35.** Infrastructure capable of accommodating electronic teaching resources **18.** Public gathering areas with light and electricity	**4.** Compatibility with future grid services or expansion **5.** Conformance with national / regional / industry standards **8.** Capital and installation cost
5	**24.** Improved brightness of light **25.** Improved reliability from renewable light source **26.** Improved duration of light from renewable light source **27.** Improved air quality within households **28.** Improved safety within households **29.** Increased availability of time for other household tasks **30.** Increased use of periphery devices within household **31.** Decrease in monthly expenditures on energy related resources **32.** Increase in monthly household revenues **33.** Increased time spent reading (change in reading habits) among youth **36.** Improved public lighting **37.** Improved / development of community security	Supportive & Growth Indicators // (To occur concurrently) ↓
6	**11.** Percent of electricity consumed by business **12.** Percent of electrified households using electricity for income generating activity **13.** Businesses developed	**6.** Availability of supportive infrastructure **9.** Operation and maintenance costs **10.** Share of profit set aside for re-investment **19.** Micro-credit options available for renewable energy expansion
7	**22.** A unique environmental impact identified* **Depending on significance of environmental factor, evaluation team may decide to increase priority.*	

Appendix F: Sample Baseline Data Questionnaire

1. What are your primary sources for electricity/energy/light?

2. What is your monthly household income?

3. How much of your monthly household income do you spend on energy related resources?

4. Do you use any electronic devices within your household (i.e. toaster, television, radio, etc.)?

(Question 5-6 to be asked of community leaders only)

5. Does your community have access to microfinance?

6. What are the predominant economic activities within the community?

Appendix G: Sample Post Installation Survey/Questionnaire

1. Are the electricity and/or light services provided through the renewable energy system available for use when you need them? (Indicator 7)
    - Never
    - Sometimes
    - Always

Define what this project considers 'access to light' and proceed with the following:

2. Do you currently have access to light in your household as provided through the renewable energy system? (Indicator 14)
    - Yes
    - No

Define what this project considers 'access to electricity' and proceed with the following:

3. Do you currently have access to electricity in your household? (Indicator 15)
    - Yes
    - No

If 'Yes' to question 2 or 3, then continue through question 15. If "No" to both question 3 and 4 then skip to question 16.

4. Has the electricity and/or light provided through the renewable energy system served as a substitute for [insert traditional method used – batteries, candles, firewood, etc.]? (Indicator 20)
    - Not at all, I still use [traditional method] often
    - Somewhat, I still use [traditional method] sometimes
    - Completely, I only use the new light sources

5. Has the electricity provided through the renewable energy system allowed you to change the way you cook? (Indicator 21)
    - Not at all, I still use [traditional cooking methods]
    - Somewhat, but I still use [traditional cooking methods] sometimes
    - Completely, I only use the new cooking methods

6. Is the light in your household provided by the renewable energy system brighter than [insert traditional method of lighting]? (Indicator 24)
    - No, not at all
    - No, not really
    - Yes, a little
    - Yes, a lot

7. Do you feel the light source provided through the renewable energy system is more reliable than [insert traditional method of lighting]? (Indicator 25)
    - No, not at all
    - No, not really
    - Yes, a little
    - Yes, a lot

8. Does the light source provided through the renewable energy system provide light longer than [insert traditional method]? (Indicator 26)
    - No, not at all
    - No, not really
    - Yes, a little
    - Yes, a lot

9. Do you feel that the air quality in your household has improved since using the new light and/or electricity sources provided through the renewable energy system? (Indicator 27)
    - No, not at all
    - No, not really
    - Yes, a little
    - Yes, a lot

10. Do you feel that your household is safer since using the new light and/or electricity sources provided through the renewable energy system? (Indicator 28)
    - No, not at all
    - No, not really
    - Yes, a little
    - Yes, a lot

11. Since using the new light and/or electricity sources provided through the renewable energy system, do you have more time for other household tasks? (Indicator 29)
    - No, not at all
    - No, not really
    - Yes, a little
    - Yes, a lot

12. Since using the new light and/or electricity sources provided through the renewable energy system, have you begun using other electronic devices? (Indicator 30)
- No, not at all
- No, not really
- Yes, a little
- Yes, a lot

If Yes, which ones?

13. Since using the new light and/or electricity sources provided through the renewable energy system, have you spent less money on [insert traditional energy use expenditures]? (Indicator 31)
- No, not at all
- No, not really
- Yes, a little
- Yes, a lot

If Yes, by how much?

If household has children, continue with question 14, otherwise skip to 15.

14. Since using the new light and/or electricity sources provided through the renewable energy system, have your children spent more time reading/studying? (Indicator 33)
- No, not at all
- No, not really
- Yes, a little
- Yes, a lot

If Yes, how much more time?

15. Since using the new light and/or electricity sources provided through the renewable energy system, have you used either for 'Income generating activity'? (Indicator 12)
- No, not at all
- No, not really
- Yes, a little
- Yes, a lot

If Yes, please explain.

16. Since the installation of the renewable energy system, do you feel that the 'public area' has improved lighting? (Indicator 36)

- No, not at all
- No, not really
- Yes, a little
- Yes, a lot

17. Since the installation of the renewable energy system, do you feel your community is safer?

- No, not at all
- No, not really
- Yes, a little
- Yes, a lot

If Yes, in what ways?

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