Renewable World

tackling poverty through renewable energy

Sustainability in Action:

A Practitioner's Toolkit

Renewable World

Developed for Renewable World by Annabel Yadoo & the Renewable World programme team, December 2011

Contents

1. Introduction

What is this toolkit?

This toolkit is a practical guide to addressing sustainability issues when planning, implementing and evaluating renewable energy projects for rural development. It contains the background information and assessment methodologies needed to evaluate the likely sustainability of projects both before and after implementation.

Who is it for?

Developed by an external consultant, Annabel Yadoo, the toolkit is designed for use by rural energy practitioners, project managers, Renewable World's staff, partner organisations and external consultants who wish to conduct project sustainability reviews.

Why is sustainability important?

Using renewable energy to improve access to modern energy services in rural areas can provide a host of benefits, not least improvements to healthcare, education, food security and income generation. In fact, access to modern energy services is often considered a prerequisite to achieving the Millennium Development Goals (DFID, 2002; GNESD, 2007). However, a project will only succeed in having lasting impact if it creates *sustainable* welfare benefits. All too often, past experience has shown renewable energy projects to be unsustainable, for example, the hardware may require spare parts that are too difficult to obtain in remote areas, the project may not meet local needs and cultural norms, the energy services may be too expensive for the intended users, or local operators may have not received sufficient training to be able to maintain the system to a high standard. As a result, the projects' impact will be at best significantly reduced and at worst nullified or harmful: having created new dependencies, a project's premature closure may have a detrimental impact on the community. This would not only be a waste of resources (financial, material and time) on the part of the donor and implementing agencies, but – arguably more importantly – it can leave beneficiaries with a negative impression of the technology and/or the implementing agencies involved, potentially even causing conflict.

How is this toolkit useful?

This toolkit provides a series of theoretical and practical assessment methodologies with which to improve the sustainability of both existing and future renewable energy projects. By assessing a project's sustainability, its strengths and weaknesses will be exposed and areas for improvement will be highlighted. While appropriate solutions will differ for each project, the toolkit will provide the guiding principles regarding what the adjustments could entail.

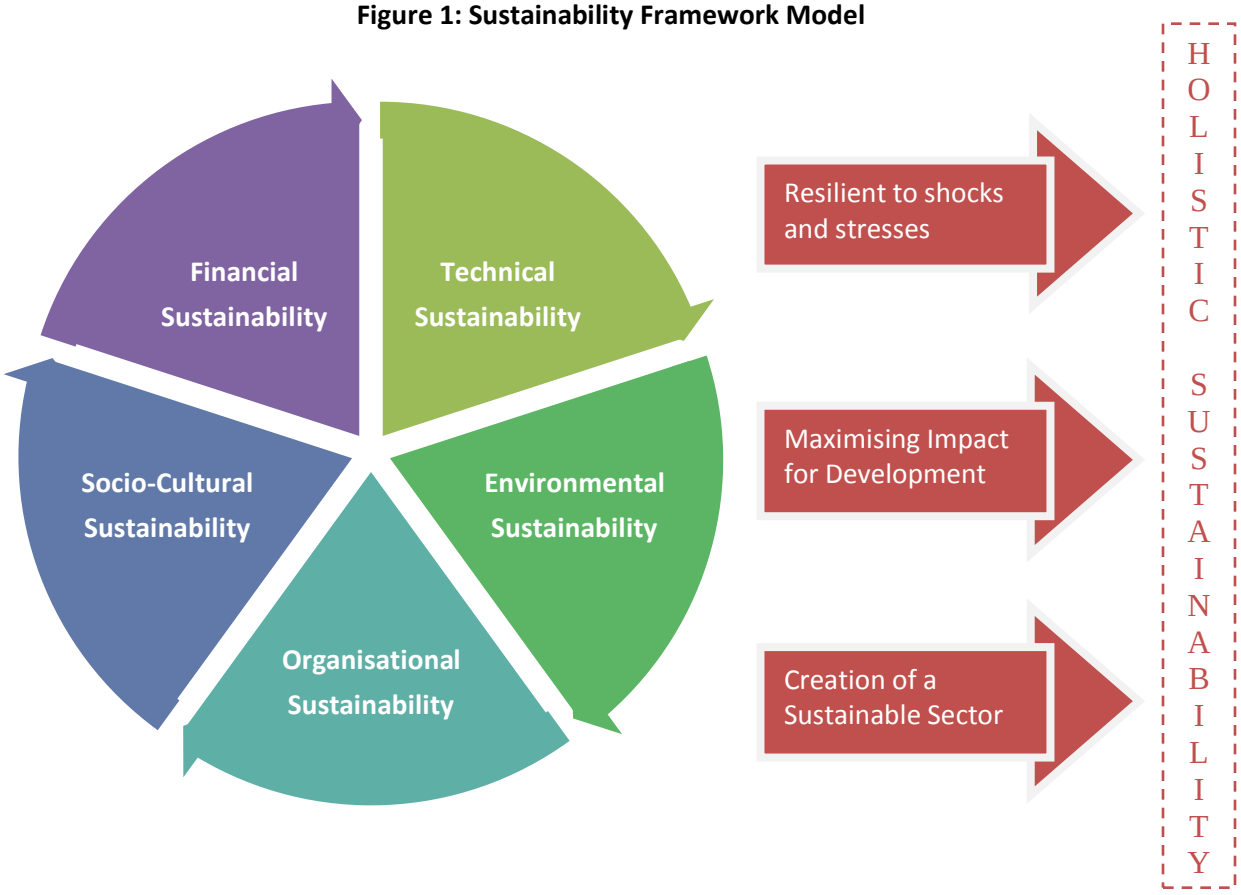
What does this pack contain?

An overview of the theoretical background to Sustainability is provided on pages 4-5, followed by project design guidelines on pages 5-7 and a project evaluation tool on pages 7-16. The toolkit ends with sample applications of the project guidelines and evaluation tool (pages 17-23).

2. The Theory

The concept of "Sustainability" and "Sustainable Development" can mean different things for different people. However, for the purpose of this toolkit, a holistic definition of sustainability has been adopted, based on the five pillars of Technical, Financial, Socio-Cultural, Environmental and Organisational Sustainability (Ilskog, 2008). Sustainability relies on the interaction of these five dimensions. A technically well-functioning low carbon system will not be sustainable unless it is also managed in a financially sustainable manner, is accepted and valued by the users, governed by effective organisations and does not adversely affect the local environment. Without any one of these dimensions, holistic sustainability and long-lasting development impact will not be achieved.

Figure 1: Sustainability Framework Model



Incorporating these five dimensions of sustainability will already go some way towards achieving holistic sustainability. However, to create a truly sustainable project, maximum impact and a supportive environment, particular care should also be placed on three additional areas: resilience, the creation of a sustainable sector and the ability to maximise development impact.

In the medium and long-term, renewable energy systems and the development impacts they deliver will only prove to be sustainable if they are also resilient to internal shocks and external stresses, for example, corrupt management, political meddling and pressures exerted by climatic change. Resilience is defined as 'the amount of change a system can undergo while maintaining its core

properties' (Leach, 2008) and therefore demands that an intervention places due focus on 'adaptive capacity/capability, institutional flexibility and diversity of responses' in order to reduce its vulnerability to adverse changes (Scoones, 2009). Adopting a similar medium and long-term view, the creation of a sustainable sector (including national level policies, access to financing and technical assistance, regulation and monitoring) will be necessary in order for the project's benefits to be replicated and scaled-up across the country and region. Development impact should also be maximised in order to enhance the value of the renewable energy intervention for both the users and funders. The delivery of welfare benefits will provide a greater incentive to the users to keep the system running, while donors, governments and social entrepreneurs are likely to become more inclined to scale-up and replicate the system elsewhere. Furthermore, Renewable World has had reason to believe that female empowerment and management leads to increased project longevity (personal comm. Jo Kelly, 2011).

3. Project Design Guidelines

Projects and programmes should always be designed with the idiosyncrasies of specific communities in mind, not least the various technical, financial, socio-cultural, environmental and organisational factors that should feed into the planning process. The following **Project Design Guidelines** are composed of a series of thought-provoking questions that are meant to probe the practitioner into considering key sustainability issues when designing new projects. The five dimensions of sustainability have been incorporated, together with strategies to strengthen resilience, maximise development impact and create a sustainable sector. As far as possible, the guidelines were designed to be applicable for a range of different renewable energy interventions. They are non-prescriptive since implementation models should always be designed with the specific areas of intervention in mind. It is intended that both Renewable World and its partner organisations ask themselves these questions when designing the implementation models of forthcoming interventions.

Project Design Guidelines

Technical

- Is the renewable energy system well-designed and constructed? Is good quality equipment to be used? Does it abide by recognised quality standards? Is it safe?
- Have predicted future climatic trends for the area (for example, rainfall patterns) been taken into account in the design?
- Will local people be trained (to a high standard) as technicians to operate and maintain the system? Will they be paid adequately for this service?
- Has an after-sales (external or internal) service been priced into the enterprise model?

Financial

- Will users contribute to set-up costs by providing unskilled labour or a financial payment?
- Will links with consumer or entrepreneur credit institutions (banks, micro-financing institutions, etc.) need to be built or improved?
- Will external investment (by way of grants, seed capital, subsidies, etc.) need to be provided? If subsidies are required, will they be targeted and time-limited (with a clear exit strategy)?
- Will user tariffs cover the ongoing operational costs?

- Will the energy services be affordable for all? Will user cross-subsidises be required?
- Will users' capacity to generate income be increased through use of the renewable energy technology or other development activities introduced by the intervention?
- Could/would users pay more for clean energy?
- Could/would users contribute a larger sums or borrow money to construct the system if grant money was not available?

Socio-Cultural

- Has the system been designed in tandem with its intended users, ensuring that the community's needs and customs are prioritized?
- How will social services and people's welfare be improved as a result of the renewable energy intervention?
- How does the project plan to involve the community in the implementation and ongoing operational stages?
- Who are the existing incumbents that might have their livelihoods displaced due to the intervention (for example, kerosene or charcoal sellers)? How should this be addressed?
- What type of community sensitization process will be used? Will it also incorporate information about energy efficiency?
- Will well-balanced information be provided to allow potential users to make an informed decision to participate or invest?
- Will demonstrations be required to raise awareness or convince potential users about the renewable energy technology's key features?
- Does Renewable World's partner have pre-established relationships with the community (trust, rapport, knowledge of local dialects and customs)?
- What type of community mobilisation process will be used? How will local support and buy-in be achieved?
- Is a high level of participation desired by the community? If so, how will this be achieved in a way that improves a sense of responsibility for the system?
- How will existing social networks and organisations be used by the energy business?
- How will the renewable energy technology be made desirable? Will it be attractively finished and packaged? Will it be user friendly (in terms of hardware, pricing systems and after-sales support services)?
- Have there been any previous projects in the community? Are they still operating? If not why not?
-

Environmental

- Are the proposed energy service(s) to be provided by a low carbon source or renewable energy technology?
- Will the energy intervention displace the actual or potential use of "dirty" fuels?
- What potential adverse local environmental impacts could result from the energy intervention? How will these be mitigated?
- How can users' appreciation of environmental issues be improved through the intervention?
- Are project inputs sustainable (i.e. water sources)

Organisational

- How will the renewable energy intervention be managed post-implementation? Will the management system be formalised and transparent?
- Have the responsibilities of the managers and operators been clearly defined? How will they be regulated and accountability enforced?
- Is the proposed management system compatible with local traditions and customs?
- How organized, united and cooperative is the community within itself? How will this affect the choice of management?
- Does the community require additional technical and managerial training before it is able to manage the system locally?
- How will tariff collection be enforced? Should payment clusters or pre-pay meters be used?
- How will energy efficiency be improved? Should mini-circuit breakers or micro-chips be used?

Maximising Impact

- In what ways will the intervention adopt a holistic approach to development?
- How will livelihoods be improved as a result of the renewable energy intervention? How will new income streams be developed?
- Are targeted training, seed capital and special tariffs required to incentivise productive uses?
- Is additional assistance required to help bring produce to markets?
- How will a diverse range of productive uses be encouraged and the over-saturation of local markets avoided? (composition issues)

A Sustainable Sector

- What political considerations need to be taken into account?
- Does Renewable World propose to build capacity within the sector as a whole? (For example, how will awareness of renewable energy technologies be raised amongst governments, financiers and local planning authorities? Is help required to set and administer appropriate subsidies, quality standards and power purchase agreements? Do the lending criteria of commercial banks need to be eased through guarantee funds? Are effective monitoring regimes required? Do national or regional technician training centres need to be established?)
- What roles will be assigned to different stakeholders (national governments, local authorities and local non-governmental organisations)?
- How will the intervention be regulated and monitored? Are local authorities or non-governmental organisations appropriate in this regard?
- Will local manufacturers be supported (if appropriate)?

4. Project Evaluation Tool

Ongoing monitoring and assessment of projects and programmes are an essential part of future improvements, as well as generating knowledge that could contribute to internal learning, research dissemination and marketing activities. This project evaluation tool provides a practical means of standardising sustainability assessments. The tool comprises a series of sustainability indicators which correspond to the five dimensions of sustainability and incorporate the additional considerations of resilience and maximisation of development impact that were included in the framework model. A separate set of Renewable Energy Sector sustainability indicators is also included. Each indicator is weighted between 1 and 3 according to the importance Renewable World attributes to them. A simple

scoring system is used to assess projects: a point is awarded every time an indicator has been achieved; no points are awarded if it has not been achieved and only half a point is awarded if it has been partially achieved. To calculate the score, these points must be multiplied by the corresponding weighting for each indicator. Scores are aggregated within the six categories and can be transposed onto a spider web diagram, creating a pictorial representation and facilitating the comparison of different projects.

Project Evaluation Tool

Sustainable Development Indicators				
Technical Dimension	**Financial Dimension**	**Socio-Cultural Dimension**	**Environmental Dimension**	**Organisational Dimension**
1. Service is reliable, disruptions are minimal (no more than one day a month) **(2)** 2. Service meets current demand capacity requirements of those who have access **(2)** 3. System is efficient and energy losses are minimised throughout the energy chain **(2)** 4. Support infrastructure (expertise, supply parts) is readily available to the community **(2)** 5. Appropriate maintenance system is in place and works effectively **(2)** *6. Advance notice about planned service disruptions is given to users* ***(1)*** 7. Service is safe to use and operate **(2)** 8. Generation capacity could be increased in future should demand levels increase **(1)**	1. Users perceive service to be affordable **(3)** 2. User energy tariff is equivalent or lower than what was spent previous to the energy intervention **(2)** 3. Flexible tariff structures or payment structures are available where necessary **(2)** *4. Collected income increases as a percentage of operating costs year on year* ***(2)*** *5. System is profitable, including capital costs plus depreciation* ***(2)*** 6. Governance and management system invests appropriately to maintain a high standard renewable energy system **(2)** 7. Energy service is used by a range of non-agricultural micro-enterprises **(2)** 8. Energy service is used to improve agricultural activities **(2)** 9. Local employment opportunities have increased due to the energy intervention **(2)** 10. Profits from micro-enterprises or livelihoods have increased due to the energy intervention **(3)**	1. Quality and/or access to education has improved due to energy service **(2)** 2. Quality and/or access to healthcare has improved due to energy service **(2)** 3. Users' health has improved due to energy service **(2)** 4. Women's burdens have reduced due to energy service **(2)** 5. Strong community cohesion present **(2)** 6. All households, local institutions and organisations who want it have access to the energy service **(2)** 7. Users' prioritised energy service needs have been met through the intervention **(2)** 8. Users are enthusiastic about the energy services delivered by the renewable energy system **(2)** 9. End users find the renewable energy system easy to use **(2)** 10. The majority of people in the community would like access to the energy service **(3)**	1. Energy service provided by the intervention is generated from a renewable energy source **(2)** 2. Energy service provided by the intervention has displaced actual or potential "dirty" fuels **(2)** 3. No serious adverse local environmental impacts have been identified **(2)** 4. Community awareness of environmental issues has improved **(2)** 5. Community behaviour towards environmental conservation has improved **(2)** 6. Environmental surroundings have improved as a result of the energy intervention **(2)** 7. The physical resources on which the renewable energy system relies are being managed in a way that is likely to promote continued access **(3)**	*1. Management of energy service is well organised with clear internal structures* ***(2)*** *2. There are incentives for managers for ongoing high performance* ***(2)*** 3. Local capacity for organisation and management is high and/or improved in the community **(2)** 4. High sense of responsibility for system by managers **(3)** 5. High degree of stakeholder non-financial participation if desired **(2)** 6. Strong and/or improved female empowerment through involvement in system management **(2)** *7. Low level of financial, material and/or human resource losses, including payment defaults* ***(3)*** *8. Users are satisfied with the management of the service* ***(3)*** *9.Transparent financial accounts are kept* ***(3)*** 10. There is an effective channel through which complaints about the service and/or management organisation can be made **(2)**

Renewable Energy Sector Sustainability Indicators

1. A network of technicians is available or is being made available at the national and/or district level to promote rural energy access **(2)**
2. A network of energy system managers and/or energy entrepreneurs is available or is being made available at the national and/or district level to promote rural energy access **(2)**
3. In-roads have been made to develop policy and regulatory frameworks to support rural energy access where necessary **(2)**
4. Communities' ability to influence national and/or district level decisions about renewable energy policies is strong and/or has improved **(2)**

How to Score Projects:

Each indicator is weighted between 1 and 3. Weightings are indicated in brackets in red, bold font.
1 point is awarded every time an indicator is achieved, 0 points if it is not achieved and 0.5 points if it is partially achieved.
To calculate the score, these points must be multiplied by the corresponding weighting for each indicator.
Scores are aggregated within each of the six categories and normalised according to the maximum number of points available for each category. For e.g., 11/22 = 5/10; 10/15 = 6.67/10, etc.
These normalised scores can be represented pictorially on a spider web diagram so that different projects can be more easily compared.

Italicised indicators are not applicable for individual user-operator/manager systems and therefore should be omitted when assessing such projects. In such cases, the total score for that indicator set should be normalised out of the remaining available points. For e.g., where financial indicators 4 and 5 are not relevant, the total score for that category should be normalised out of 18 rather than 22.

How to apply the tool

The tool should be used immediately following a project field visit. The assessor should aim to carry out the evaluation following a range of interviews, group discussions and observational walks with as many different project stakeholders as possible, such as the users, non-users, managers, community leaders, implementing agency and local government officials (where relevant). This is to ensure that their varying viewpoints and concerns can be incorporated into the project assessment. A sample set of questions is provided on **pages 11-13**, however these are not exhaustive and the assessor should follow their own instinct as to which issues require greater or lesser probing when they are in the field. Questions have been italicised if they are not applicable for individual user-operator/manager systems (for example, a solar home system that is managed by the household that owns it) and should be omitted when an evaluation is conducted on this type of system. To make it more practical, the questions are designed to be compatible with the amount of information expected to be gleaned from a two day field visit. However, in the case of larger user groups or communities, evaluations could be enhanced if a greater number of users (and non-users) are interviewed over a longer period of time.

After conducting the fieldwork, the assessor should be equipped with enough information with which to complete the project evaluation form (provided on **pages 14-16**). This form is *not* to be completed for every interview on an individual basis. Instead, it should be used to synthesise the assessor's evaluation of a project as a whole (that is, after all interviews have been conducted and all responses have been taken into account). The resultant scores are normalised according to the

maximum number of points available for each category. Any non-applicable indicators (for example, the italicised indicators that are not relevant for individual user-operator/manager systems) should be omitted. In such cases, the total score for that indicator set is normalised out of the remaining available points. The normalised scores can then be plotted onto a spider web diagram using Microsoft Excel or a similar software programme.

When to apply the tool

Generally speaking, sustainability assessments are only able to provide an indication of a project's sustainability at one point in time, although they may detect emerging trends which will affect the likelihood of a system to be sustained into the future. The Project Evaluation Tool has been designed to be first used approximately one year after a project has been implemented, thereby allowing time for users to start incorporating the energy services into their lifestyles and livelihoods. However, it is recommended that the tool is reapplied at subsequent annual intervals to provide a more thorough picture of the development impacts and sustainability trajectory for the project or programme under review. The different evaluations (year 1, year 2, year 3, and so forth) can be plotted onto the same spider web diagram in order to more easily track any changes over time.

Who should apply the tool

Ideally, the Project Evaluation Tool should be applied by a relatively objective individual who has the intention of providing a balanced view of a project or programme's outcome. This role could be filled by an independent researcher or a member of Renewable World's (or a partner organisation's) staff, provided that the organisation was sufficiently detached from the project's implementation phase to mitigate against potential conflicts of interest. Although every effort has been taken to make the assessment process as transparent and objective as possible, the attribution of indicator points ultimately relies on the assessor's interpretation of the fieldwork data. Therefore, a panel of three assessors could be used to strengthen the objectivity of the evaluation process. Similarly, if a comparison is to be made across different projects, the same person (or people) should conduct the various assessments in order to ensure greater consistency.

Assessor Questions for use with the Project Evaluation Tool

Preliminary Questions for Implementing Organisation

Where does the project take place? How many people (households) live in the community?
What are the community members' principal livelihoods?
What technologies are involved in the project?
When were these technologies installed and when did they start providing energy?
What former technologies/energy sources do they replace?
Does everyone who wants it have access to the energy/project? If not, why not?
How was the project funded? How are the project's ongoing operational and maintenance costs met?
Who are the key stakeholders in the community (i.e. who should we particularly seek to interview)?
What are the local governance structures within the community?
How is the energy used in the community (what are the instances of productive uses of energy)?
Is the energy used by local institutions and organisations (for e.g. schools, health centres, community centres, businesses)? If not, why not?
How is the energy system managed? Are women involved in its management in a meaningful way?
Does the management organisation have a clear internal structure?
Have there been any problems (technical/managerial/financial/social/environmental) with the project?
Are the physical resources on which the renewable energy system relies being managed in a sustainable fashion?
Are there any causes for conflict within the community?
Are there differences based on caste/income levels/local power structures within the community?
Has there been any need for the implementing organisation to intervene in the project since its initiation? What caused this need?
Are there any other issues we should know about in advance of the field visit?
How does this project fit into your wider plans for sector development on a national/district level? (For e.g. are you building a network of technicians/energy system managers/energy entrepreneurs, developing policy and regulatory frameworks, increasing communities' ability to influence renewable energy policy decisions?)

Questions for Users (Community Members/Households)

How long have you had the energy system?
Is it easy and safe to use?
What do you use it for? (Household uses, any micro-enterprise and/or agricultural use?) If used for productive ends, how have these affected profits?
Are you happy with the capacity of the system? Does it fulfil your current energy needs? If not all energy needs are fulfilled, does the energy service meet your prioritised energy needs?
How do you feel now that you have the energy system? (Have education/healthcare/your family's health improved? Have female burdens lessened?)
How often do you have problems with the system? How reliable do you find the system? How often are you prevented from doing what you want to do due to service disruption?
How are the problems fixed? Who fixes them? Do you have to wait a long time for it to be fixed?
Do you pay for it to be fixed? (If not) Do you think you should pay for it to be fixed?
Is there a regular maintenance system in place and is it effective?
Are you given advance warning if the service will be disrupted for maintenance?
(If relevant) Have you ever changed the battery? Are you saving money to change the battery in future?
What energy sources did you use before this new technology?

How much did you used to spend on energy?
How much do you spend on energy now?
How do you feel about this amount? Is it affordable?
Are you happy with how the energy system is managed?
Do the system managers/technicians assist you when you ask them for help?
How could the energy system's management be improved?
Do you feel responsible for the parts of the system that are in your care?
Are you happy with the level of participation that you have in the energy system? (For e.g., would you want to be part of the managing committee?)
Who would you complain to if there was a problem with the energy service (or its management)?
(Where interviewee has a local business) How does/could energy improve your business? What is needed to make this happen? What are/would be the local impacts of this energy usage (for e.g., improved incomes, more employment opportunities, improved welfare)?

Questions for Energy System Managers

How is the management organisation structured? Are there clear internal structures? Do women play a meaningful role?
Do you feel responsible for the system?
Are there incentives to encourage you to continue to perform your role well?
Is the system easy and safe to operate?
How do you think the system is doing?
What could be improved?
What problems have you had? Why have you had these problems?
How can these problems be solved?
Do you think you have enough capacity to respond to technical problems? Are there any limitations?
Are supply parts and assistance easily available? If not, why not?
Does the current energy system meet the needs of the local people?
Is the system producing as much energy as it should or are there energy losses?
Is there a regular maintenance system in place and is it effective?
Do you notify users when you stop the system for maintenance? How much advance warning is given?
Could generation capacity be increased in future should demand increase?
Are there any problems collecting payment from users?/ Is there a high level of staff turnover?/ Are system components ever stolen or vandalised?
(If there are) Why are there these problems? What do you do about it?
Are flexible tariff structures (for example, user cross subsidies) or payment structures (for example, micro-credit) available to those otherwise unable to meet energy payments?
Are transparent accounts being kept?
Is there enough money to pay for operation and maintenance costs? If not, what are you doing about it?
Are revenues (collected income) increasing as a percentage of operating costs year on year?
Does the system create any profit after paying for operation and maintenance costs? Does this need to go towards paying for its capital costs? (Where applicable) Do any profits remain after repaying capital costs?
What is your future vision for the system? Are you able to re-invest profits in the system to achieve this?
Has education/healthcare/user health/female empowerment/cooperation within community/local employment opportunities/local environment improved?
Have women's burdens lessened?
Do all households who want it have access to energy? If not, why not?

How do you think the people without access can benefit from the system?
Are the users happy with the system and the level of service being offered?
In which ways can other institutions within the community help your work and project sustainability?
Is the community able to organise itself/manage initiatives well?
Do general community members actively participate in the project? If not, why not?
Are the physical resources on which the renewable energy system relies being managed in a sustainable fashion?

Questions for Community Leaders

How is energy currently used in the community? What other uses of energy would you like to see?
How would you as community leaders respond to this use of energy?
Has education/healthcare/user health/female empowerment/cooperation within community/local employment opportunities/local environment improved?
Have women's burdens lessened?
Is the energy service desirable, i.e. do the majority of community members wish to have access?
Do all households who want it have access to energy? If not, why not?
How do you think the people without access can benefit from the system?
Does the system meet people's energy needs?
Are the users happy with the system and the level of service being offered?
Are people taking better/worse care of the environment as a result of the intervention? Has community awareness and/or behaviour towards environmental conservation improved? Have any adverse local environmental impacts been identified?
Are the physical resources on which the renewable energy system relies being managed in a sustainable fashion?
Does the energy system's management body work effectively? Are they acting responsibly?
Are transparent accounts kept by the managers?
Is there a maintenance system in place and is it effective?
Is the community able to organise itself/manage initiatives well?
Do general community members actively participate in the project? If not, why not?
Who could you or users complain to if there was a problem with the energy service (or its management)?

Questions for other Local Institutions, where present (for e.g., school teachers, nurses, etc.)

How is energy used in your institution? How does it benefit from the project?
What are the positive and negative impacts of these uses of energy?
How could further benefits be gained?
If your institution is not connected to the energy system, why is this and how could it benefit from access?

Questions for non-Users

Would you wish to have access to the energy system?
If so, why are do you not have access to the energy system?
What do you currently use (and spend) to meet your energy needs?
What would be required for you to gain access to the energy system?

Project Evaluation Form

Name of Community:

Number of Households:

Assessment Time Period:

Total Number of Interviews Conducted:

No. of Observational Walks:

No. of Group Discussions:

No. of Interviews with Users:

No. of Interviews with non-Users:

No. of Interviews with Managers:

No. of Interviews with Implementing Agency:

Technical Sustainability Indicators	Weight	Score
1. Service is reliable, disruptions are minimal (no more than one day a month)	2	
2. Service meets current demand capacity requirements of those who have access	2	
3. System is efficient and energy losses are minimised throughout the energy chain	2	
4. Support infrastructure (expertise, supply parts) is readily available to community	2	
5. Appropriate maintenance system is in place and works effectively	2	
6. Advance notice about planned service disruptions is given to users	*1*	
7. Service is safe to use and operate	2	
8. Generation capacity could be increased in future should demand levels increase	1	
Total (out of 14)		

Financial Sustainability Indicators	Weight	Score
1. Users perceive service to be affordable	3	
2. User energy tariff is equivalent or lower than what was spent previous to the energy intervention	2	
3. Flexible tariff structures or payment structures are available where necessary	2	
4. Collected income increases as a percentage of operating costs year on year	*2*	
5. System is profitable, including capital costs plus depreciation	*2*	
6. Governance and management system invests appropriately to maintain a high standard renewable energy system	2	
7. Energy service is used by a range of non-agricultural micro-enterprises	2	
8. Energy service is used to improve agricultural activities	2	
9. Local employment opportunities have increased due to the energy intervention	2	
10. Profits from micro-enterprises or livelihoods have increased due to the energy intervention	3	
Total (out of 22)		

Socio-Cultural Sustainability Indicators	Weight	Score
1. Quality and/or access to education has improved due to energy service	2	
2. Quality and/or access to healthcare has improved due to energy service	2	
3. Users' health has improved due to energy service	2	
4. Women's burdens have reduced due to energy service	2	
5. Strong community cohesion present	2	
6. All households, local institutions and organisations who want it have access to the energy service	2	
7. Users' prioritised energy service needs have been met through the intervention	2	
8. Users are enthusiastic about the energy services delivered by the renewable energy system	2	
9. End users find the renewable energy system easy to use	2	
10. The majority of people in the community would like access to the energy service	3	
Total (out of 21)		

Environmental Sustainability Indicators	Weight	Score
1. Energy service provided by the intervention is generated from a renewable energy source	2	
2. Energy service provided by the intervention has displaced actual or potential "dirty" fuels	2	
3. No serious adverse local environmental impacts have been identified	2	
4. Community awareness of environmental issues has improved	2	
5. Community behaviour towards environmental conservation has improved	2	
6. Environmental surroundings have improved as a result of the energy intervention	2	
7. The physical resources on which the renewable energy system relies are being managed in a way that is likely to promote continued access	3	
Total (out of 15)		

Organisational Sustainability Indicators	Weight	Score
1. Management of energy service is well organised with clear internal structures	*2*	
2. There are incentives for managers for ongoing high performance	*2*	
3. Local capacity for organisation and management is high and/or improved in the community	2	
4. High sense of responsibility for system by managers	3	
5. High degree of stakeholder non-financial participation if desired	2	
6. Strong and/or improved female empowerment through involvement in system management	2	
7. Low level of financial, material and/or human resource losses, including payment defaults	*3*	
8. Users are satisfied with the management of the service	*3*	
9. Transparent financial accounts are kept	*3*	
10. There is an effective channel through which complaints about the service and/or management organisation can be made	2	
Total (out of 24)		

Renewable Energy Sector Sustainability Indicators	Weight	Score
1. A network of technicians is available or is being made available at the national and/or district level to promote rural energy access	2	
2. A network of energy system managers and/or energy entrepreneurs is available or is being made available at the national and/or district level to promote rural energy access	2	
3. In-roads have been made to develop policy and regulatory frameworks to support rural energy access where necessary	2	
4. Communities' ability to influence national and/or district level decisions about renewable energy policies is strong and/or has improved	2	
Total (out of 8)		

5. Applying the Project Design Guidelines and Evaluation Tool

Pre-Implementation

Let us assume that one of Renewable World's partner organisations, Renewables for Development (RFD), has written a proposal to install solar home systems and a solar photovoltaic (PV) community water pumping station in Santa Rosa, a community with whom they have built up strong relations and trust. Keen to ensure that the project is sustainable, Renewable World starts the process of asking itself (and re-asking RFD) the list of questions which make up the Project Design Guidelines. RFD had already seen the guidelines but found it difficult to address all the sustainability issues that had been highlighted; RFD is pleased to have the opportunity to work collaboratively with Renewable World to improve the proposal.

Renewable World could use its network of industry experts to verify that the technical designs and construction plans are sound and that good quality equipment would be sourced. It could approach research institutions and national or international climate resource banks to investigate the predicted climatic trends for the area and how they may affect the future need or capacity of the proposed system. Renewable World and RFD could also investigate ways to ensure that local people could be trained as solar technicians to maintain the service to a high standard. Alternatively, if the system was to be established as a private enterprise, it is important to ensure an efficient after-sales support service has been factored into the business plan.

RFD could also conduct a socio-economic feasibility study to verify users' willingness and ability to pay for the proposed system. The scheme's financial viability may require users to contribute to the initial costs in an up-front payment however this may price some potential users out of the market. Consumer credit may not be available to ease this burden and Renewable World or RFD may need to consider providing loan guarantee funds to local banks or raising awareness about the technologies amongst government officials and micro-financing institutions to encourage them to provide subsidies or debt financing for low carbon technology applications.

Renewable World could ensure that RFD selected the technologies after a rigorous assessment process that included an environmental assessment, the consultation with intended users, a balanced explanation (and demonstration, where necessary) of the different technological options and the prioritisation of the communities' needs, customs and desires. The intervention should be designed in a way that prioritises use of the renewable energy technology to increase livelihood incomes and improve social services. This may require additional funds for training, seed capital (for appliances or goods) and establishing market supply chains. The implementation approach could consider incorporating a further community mobilisation process so that the intended users are kept engaged in the installation process and subsequent system operation. The mobilisation process could also incorporate training or education about other areas for development that may be relevant for Santa Rosa (for example, greater gender equality or local environmental protection).

If the community is well organised and wishes to manage the ongoing operation and management of the renewable energy system, they should be trained and allowed to do so. However, if

there is no cooperative culture within the community, an alternative management system could be designed, for example, a local micro-enterprise could be set up. Whichever management system is deemed to be most appropriate for the community in question, efforts should be made to ensure that it is transparent and formalised, with both managers and users aware of their responsibilities to one another. Accountability needs to also be enforced, preferably by a third party with experience in dispute resolution such as an external civil society organisation or the local district government.

Renewable World could also consider ways to use this project as a launch pad to meet wider aims of building up the sector as a whole. For example, if local governments and banks are found to be unfamiliar and therefore unwilling to lend for renewable energy technologies, Renewable World and RFD could provide them with more information and demonstrations. If there is a shortage of qualified solar technicians, Renewable World could consider setting up training courses at designated solar centres in rural areas, and so forth. Both organisations could consider building up wider institutional infrastructure to complement their own activities, particularly if energy poverty is widespread in the country of operation. Where local planning decisions are made by decentralised government authorities, these stakeholders could be given a role to ensure that systems remain sustainable and the projects can be replicated elsewhere.

Post-Implementation

Let us now assume that the solar home systems and solar PV water pumping station were installed in Santa Rosa two years ago and Renewable World has sent a representative (or set of representatives) to assess their ongoing performance. Following a full two days of interviews with the energy kiosk manager, local government officials in charge of regulating its activities and community members renting the solar home systems or irrigating their land from the water pumping station, the assessor(s) perform(s) the assessment using the Project Evaluation Tool.

Technical Dimension

Technical Sustainability Indicators	Weight	Score
1. Service is reliable, disruptions are minimal (no more than one day a month)	2	1
2. Service meets current demand capacity requirements of those who have access	2	0
3. System is efficient and energy losses are minimised throughout the energy chain	2	2
4. Support infrastructure (expertise, supply parts) is readily available to community	2	2
5. Appropriate maintenance system is in place and works effectively	2	2
6. Advance notice about planned service disruptions is given to users	1	1
7. Service is safe to use and operate	2	2
8. Generation capacity could be increased in future should demand levels increase	1	1
Total (out of 14)		**11**

As reflected in the above scores, the service is generally operating to a high technical standard, although there are some unplanned disruptions, particularly during the rainy season (the indicator is only partially met). Having access to solar home systems has made local users want to use electricity in other ways, such as to process their crops before they take them to market. The current technologies are unable to provide enough electricity to power these larger loads; therefore the demand capacity indicator has not been fulfilled.

Financial Dimension

Financial Sustainability Indicators	Weight	Score
1. Users perceive service to be affordable	3	3
2. User energy tariff is equivalent or lower than what was spent previous to the energy intervention	2	2
3. Flexible tariff structures or payment structures are available where necessary	2	2
4. Collected income increases as a percentage of operating costs year on year	2	2
5. System is profitable, including capital costs plus depreciation	2	0
6. Governance and management system invests appropriately to maintain a high standard renewable energy system	2	2
7. Energy service is used by a range of non-agricultural micro-enterprises	2	0
8. Energy service is used to improve agricultural activities	2	2
9. Local employment opportunities have increased due to the energy intervention	2	2
10. Profits from micro-enterprises or livelihoods have increased due to the energy intervention	3	3
Total (out of 22)		**18**

The system is generally doing quite well financially; the tariffs charged to users to rent the solar home systems or use the water pump are affordable whilst still allowing the energy kiosk to raise enough revenue to re-invest in the system's upkeep. However, while the water pump is used by farmers to irrigate crops and has improved their agricultural yields (and subsequently their income, allowing some to expand and take on hired help), neither technology has led to the creation of new micro-enterprises, nor would the project have been financially viable without initial grants.

Socio-Cultural Dimension

Socio-Cultural Sustainability Indicators	Weight	Score
1. Quality and/or access to education has improved due to energy service	2	2
2. Quality and/or access to healthcare has improved due to energy service	2	2
3. Users' health has improved due to energy service	2	2
4. Women's burdens have reduced due to energy service	2	2
5. Strong community cohesion present	2	0

6. All households, local institutions and organisations who want it have access to the energy service	2	2
7. Users' prioritised energy service needs have been met through the intervention	2	1
8. Users are enthusiastic about the energy services delivered by the renewable energy system	2	2
9. End users find the renewable energy system easy to use	2	2
10. The majority of people in the community would like access to the energy service	3	3
Total (out of 21)		**18**

There have been several positive welfare outcomes as a result of the intervention. Children can more easily do their homework at night if their parents rent a solar home system rather than using poor quality kerosene lamps. The nurse at the health post is also able to treat patients more easily at night by use of electric light. Women and children no longer need to travel great distances to collect water and this frees up their time to attend to other chores or go to school. The solar home systems come with explanatory diagrams that make them easy to use and there is always a pump attendant present to assist with use of the water pump. However, while the community is highly enthusiastic about the system and it met their initial priorities, these have since been expanded and several users expressed the desire to start using electricity to set up barber shops and engage in other productive activities which they believe could earn them extra income. Moreover, the intervention had not actively sought to improve intra-community relations; neighbourly disputes and other minor conflicts have continued.

Environmental Dimension

Environmental Sustainability Indicators	Weight	Score
1. Energy service provided by the intervention is generated from a renewable energy source	2	2
2. Energy service provided by the intervention has displaced actual or potential "dirty" fuels	2	1
3. No serious adverse local environmental impacts have been identified	2	2
4. Community awareness of environmental issues has improved	2	2
5. Community behaviour towards environmental conservation has improved	2	2
6. Environmental surroundings have improved as a result of the energy intervention	2	2
7. The physical resources on which the renewable energy system relies are being managed in a way that is likely to promote continued access	3	3
Total (out of 15)		**14**

While both the solar home systems and solar PV water pumping station rely on low carbon energy sources (solar energy), some members of the community have bought diesel generators to power larger electrical equipment such as grain mills and therefore the indicator has only been partially

met through the intervention. No other adverse environmental impacts were noted, and users' care of the local surroundings (for example, litter disposal) had significantly improved following an awareness raising educational drive conducted by the implementing agency as part of the community mobilisation process.

Organisational Dimension

Organisational Sustainability Indicators	Weight	Score
1. Management of energy service is well organised with clear internal structures	2	2
2. There are incentives for managers for ongoing high performance	2	2
3. Local capacity for organisation and management is high and/or improved in the community	2	2
4. High sense of responsibility for system by managers	3	3
5. High degree of stakeholder non-financial participation if desired	2	2
6. Strong and/or improved female empowerment through involvement in system management	2	0
7. Low level of financial, material and/or human resource losses, including payment defaults	3	3
8. Users are satisfied with the management of the service	3	3
9. Transparent financial accounts are kept	3	1.5
10. There is an effective channel through which complaints about the service and/or management organisation can be made	2	2
Total (out of 24)		**20.5**

The system is well run and users are satisfied that the energy kiosk manager (a member of the local community) fulfils his duties and responsibilities. The solar home systems have all been integrated with a micro-processing chip that allows the manager to control usage and disable systems when tariffs have not been paid. This ensures a low level of payment defaults. However, no women are involved in managing or regulating the renewable energy system as a gender focus had not been adopted during the project's implementation. Although the manager keeps a record of financial accounts, there is also room for improvement in this domain.

Renewable Energy Sector

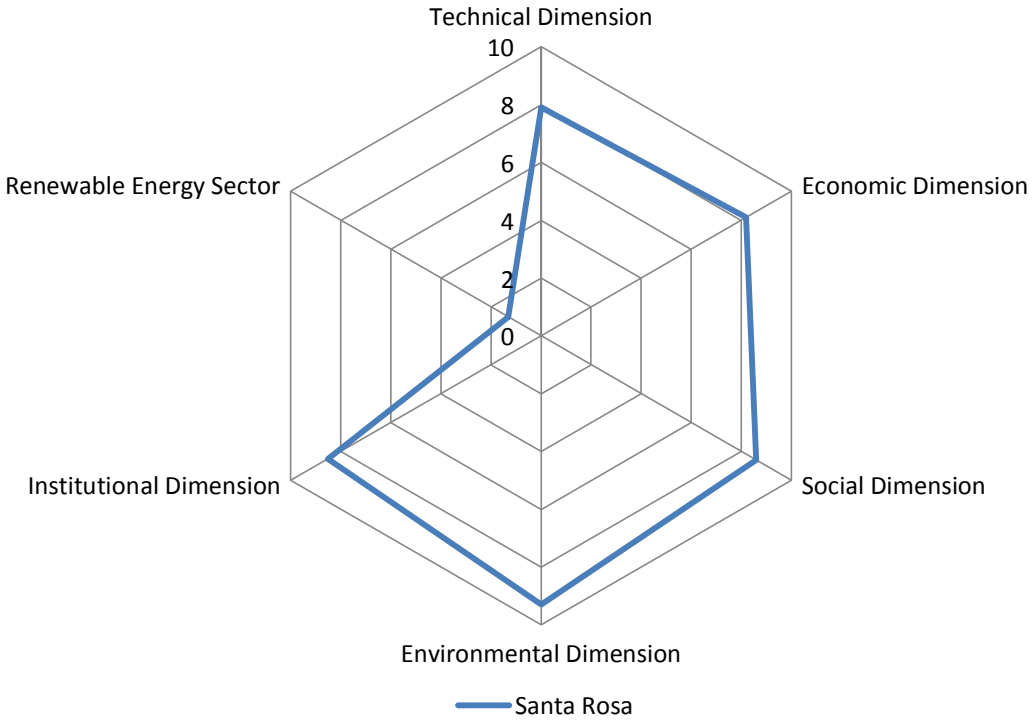
Renewable Energy Sector Sustainability Indicators	Weight	Score
1. A network of technicians is available or is being made available at the national and/or district level to promote rural energy access	2	0
2. A network of energy system managers and/or energy entrepreneurs is available or is being made available at the national and/or district level to promote rural energy access	2	0
3. In-roads have been made to develop policy and regulatory frameworks to support rural energy access where necessary	2	0

4. Communities' ability to influence national and/or district level decisions about renewable energy policies is strong and/or has improved	2	1
Total (out of 8)		**1**

The project has not been placing enough attention on creating a sustainable renewable energy sector. There is a shortage of entrepreneurs who would be technically and financially able to replicate the model elsewhere in the country and more development assistance is required to provide technical training and enable access to commercial financing. Moreover, although the people of Santa Rosa can speak confidently about renewable energy to local politicians – and have even started to lobby for more favourable policies for solar PV technologies – this is not true of surrounding communities, nor the country as a whole.

Having gathered the data and filled in the six indicator tables, the assessor is able to plot the results on a spider web diagram, aggregating scores according to the different sustainability categories:

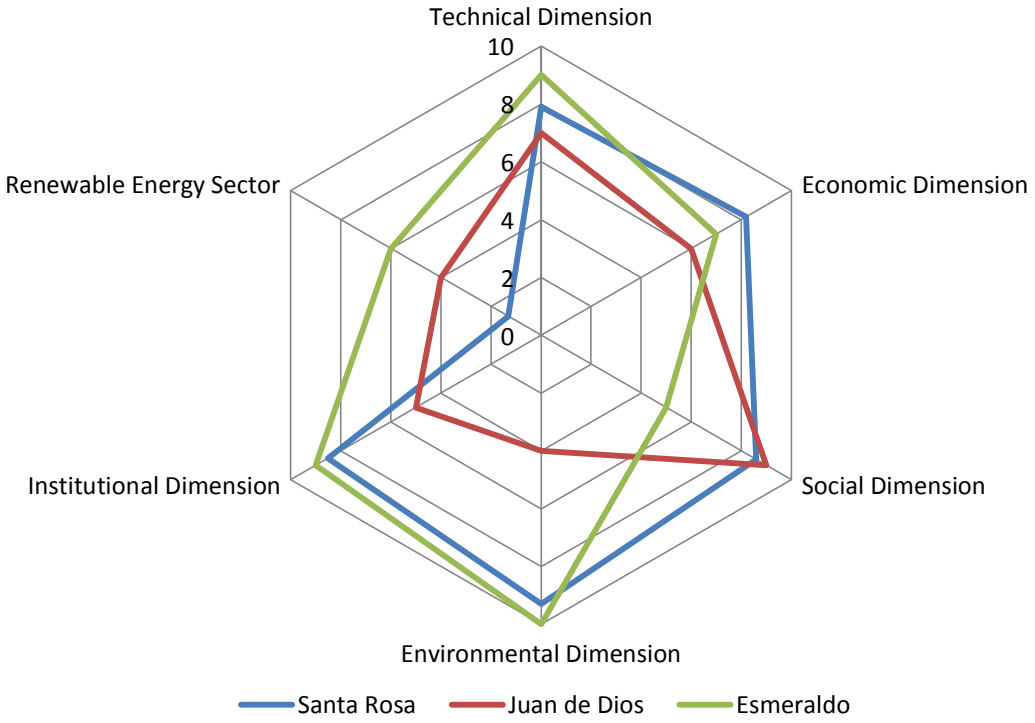
Figure 2: Sustainability Evaluation for Santa Rosa



In their experience of applying sustainability indicators, Ilskog and Kjellström found that aggregating indicators across the different sustainability dimensions tends to obscure interesting discrepancies between dimensions (by balancing out disparate values) (Ilskog and Kjellström, 2008). Therefore, when comparing the sustainability of multiple interventions, it is best if the image of each spider web (and the values for the six categories) is presented in its entirety. If the sustainability of

other interventions were to be compared with the one that took place in Santa Rosa, the amalgamated spider web diagram may look something like this:

Figure 3: Project Evaluations for Santa Rosa, Juan de Dios and Esmeraldo



At a glance, **Figure 3** shows the observer that while Juan de Dios had scored most highly in terms of social-cultural acceptability and benefits, it was the least sustainable of the three schemes after the five other categories were taken into account. On the other hand, Esmeraldo had the highest overall level of sustainability. The assessor could then return to the indicator tables to deduce why this should be the case.

The indicators used in the Project Evaluation Tool have been formulated in such a way that one category of sustainability should not need to be traded-off for the sake of another. The practitioner's goal is to expand all six categories of the sustainability web. However, due to limited time and financial resources, in practice development organisations may choose to prioritise one or two of the categories over the others. It is worth reiterating that in order to achieve holistic sustainability and deliver maximum development impact, focus needs to be placed on all six categories.

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