Renewable Energy to Reduce Poverty in Africa

Toolkit for Planning Decentralised Renewable Energy Projects

Final Version

5th August 2010

Target Audience	**Christian Aid Programme and Partner Staff**
Objectives	• **Introduce key concepts in planning decentralised renewable energy projects** • **Summarise technology and financing options** • **Provide project tools and links to further information**
Outcomes	**Users able to take first steps in planning and promoting pro-poor, commercially sustainable decentralised renewable energy applications**
Contents	
Date	5th August 2010
Revision	Final Toolkit
Authors	Drew Corbyn, Steven Hunt, Teo Sanchez
Reviewers	John Chettleborough, Richard Ewbank

Introduction

This toolkit is intended to be used as a resource by Christian Aid Programme and Partner Staff in order to enable them to design and plan decentralised renewable energy projects better. The toolkit should be equally useful to staff designing energy access projects, as well as those integrating energy access elements into projects with wider objectives (e.g. secure livelihoods).

The toolkit aims to:

- Provide a resource that can be used to increase the awareness of staff and partners of the opportunities provided by pro-poor energy interventions
- Provide practical guidelines and advice that can be used to assist project planning, proposal development and review processes.

It is intended to support the ongoing development of a body of work on pro-poor energy that supports the development of the Pan Africa Narrative and helps us achieve the vision and objectives set out in *Turning Hope Into Action*.

The toolkit is not intended to be prescriptive. It provides case studies and guidelines that can be adapted to the context of particular countries.

The toolkit is designed as a gateway to a series of other resources, tools, organisations, approaches and technologies which can be explored in more depth via links, as relevant to the particular project context. The toolkit is arranged so as to guide users through the key considerations linked to designing renewable energy projects, with links to further information provided throughout as well as a comprehensive references section in the annexes. The toolkit is provided as a PDF file with clickable links, which can be downloaded, e-mailed or transferred on CD or memory sticks for easy dissemination.

Although it does not aim to be a complete guide in and of itself, the toolkit aims to guide practitioners towards best available practice in the sector, and in this way to assist Christian Aid in optimising planning and promotion of pro-poor and commercially sustainable decentralised energy installations.

1. Rationale

The importance of energy access in combating poverty and meeting the Millennium Development Goals has been increasingly recognised in the last decade. Detailed studies[1] have shown how meeting the MDGs is contingent on an increase in access to energy as summarised in the table below:

Table 1: Energy services contribution to MDGs.[1]

MDG	Energy Services Contribution
To halve extreme poverty	Access to energy services facilitates economic development - micro-enterprise, livelihood activities beyond daylight hours, locally owned businesses, which will create employment - and assists in bridging the 'digital divide'.
To reduce hunger and improve access to safe drinking water	Energy services can improve access to pumped drinking water and 95% of staple foods need cooking before they can be eaten. Irrigation, aided by energy access, can increase local food production. Energy installations that pump water in drought prone areas can increase the resilience of livestock.
To reduce child and maternal mortality; and to reduce diseases	Energy is a key component of a functioning health system, for example, lighting health centers, refrigeration of vaccines and other medicines, sterilization of equipment and transport to health clinics. Improved lighting and cooking units can significantly reduce the incidence of respiratory diseases: a major killer of under fives in Africa. Improved access to energy increases the retention of health workers in remote areas.
To achieve universal primary education; and to promote gender equality and empowerment of women	Energy services reduce the time spent by women and children (especially girls) on basic survival activities (gathering firewood, fetching water, cooking, etc.); lighting permits home study, increases security and enables the use of educational media and communications in schools, including information and communication technologies (ICTs).
Environmental sustainability	Improved energy efficiency and use of cleaner alternatives can help to achieve sustainable use of natural resources, as well as reducing emissions, which protects the local and global environment.

Lack of energy access is a form of poverty, but it also contributes to perpetuating the cycle of poverty. Lack of access to modern and convenient forms of energy in particular reduces people's ability to work themselves out of poverty via income generating activities, many of which are based on energy. Poor and polluting energy services create health problems which undermine productivity and strain household resources. The poor often pay a 'poverty penalty' effectively paying more for energy services than more wealthy consumers.

Improved energy access contributes to creating new product and service opportunities, improve the efficiency and viability of existing activities, and reduce the opportunity costs associated with ineffective forms of energy. Many modern energy services will also save households significant sums of money which can be re-invested into other development needs.

Table 2: Energy Services and Income opportunities.[2]

Energy Service	New income opportunities	Improvement of Existing activities	Opportunity Cost saving
Lighting	Sale of improved lighting products. Micro enterprises at home possible through improved lighting, street lighting maintenance	Later opening of shops and cafes	Creating opportunity for night time activities, improved health / financial savings from reduced dependence on kerosene and other lighting fuels
Cooking	Manufacture & sale of improved stoves and fuels	Cleaner and more cost effective cooking	Avoided time in wood collection and pot cleaning, improved security for women, increased access to education for young girls who would otherwise need to collect firewood
Refrigeration	Selling ice, ice-cream etc. Storage & sale of milk, meat & other perishable food products	More livestock products sold, markets opened in areas where livestock exist due to storage facilities	Food no longer wasted, cash flow improved in livestock areas where assets are tied up in animals
Heating	Process heat for new industrial processes	Improved comfort within hotels and cafés	Time saved in collecting wood for heating
Communications	Internet cafes, phone charging	Finding best prices at various markets, obtaining meteorological or livelihoods based information	Distance walked to charge phones, cost of charging phones
Irrigation & water for livestock	Growing new kinds of crops, increasing number of crop cycles in a year, income from livestock water pumps	Better yields, increased resilience to drought	Time spent manually watering crops, time spent walking livestock to find sources of water (and livestock losses)
Agro-processing	Adding value via processing agricultural products	Increasing throughput and lowering costs	Time spent manually grinding/pounding etc reduced labour for women / young girls & increase in time for education, other income generation and recreation as a result
Manufacturing	Welding and metalwork enabled	Improved quality and speed of carpentry	Time saved in hand making repetitive designs

Access to energy enabling improvement in the efficiency of existing development activities (such as agriculture via irrigation) and diversification of livelihoods, via opportunities such as those above, is crucial also in enabling people to be more resilient to the impacts of climate change. Energy access can help reduce reliance on rain-fed agriculture as a single source of income.

However, with world fossil energy prices high and fluctuating, many African countries spending large proportions of their foreign reserves on fossil fuel imports, and the critical global issue of climate change meaning that carbon reductions must be contained, fossil fuels cannot be considered a complete or long term solution to the expansion of energy access which is required to combat poverty. Renewable energy based on indigenous energy resources of water, wind, sun, biomass and geothermal resources offer the potential to address at least part of this problem. Particularly in rural areas far from the likely reach of the electricity grid in the foreseeable future, decentralised renewables can be a cost effective and responsive energy resource on which to build rural development. Such solutions have minimal local environmental impacts, and although often entailing relatively high initial capital costs, can offer reductions in operating and lifetime costs versus a fossil fuelled scenario, even where likely increases in fossil fuel prices into the future are not taken into account.

However decentralised renewables bring with them their own challenges. These include the intermittency of some renewable sources meaning that energy storage (e.g. batteries) can be required, with solar for example. Attention to maintenance and management systems is also often required in rural areas to ensure that systems stay in productive operation over their lifetimes. Such issues, and opportunities, are discussed in more detail in the next section.

2. Applying renewable energy

Renewable energy is energy that comes from a source that cannot be depleted, such as the sun, rivers and wind, or can be quickly replenished, as with biomass and human inputs. Renewable energy technologies (RETs) convert energy from the renewable source to provide a useful energy service.

Energy services are commonly grouped by three energy vectors: **modern fuels, electricity** and **mechanical power**. Modern fuels provide for the energy services cooking and heating (as well as transport); electricity enables lighting, cooling (including refrigeration) and communications; and mechanical power provides for many processing and productive uses. Table 3 outlines the suitability of common RETs that are applicable for meeting the energy needs of poor people in developing countries. The RETs are grouped by source: **biomass, solar, water, wind, human and liquid fuel**. This toolkit will focus on RETs that are suitable for the full range of energy services, but will not include transport.

Biomass is a general term which covers a wide variety of material of plant or animal origin. Biomass energy is harnessed through improved cook stove technology and used for cooking and heating. **Solar** energy technologies use the sun's power for generating electricity, drying, heating and cooling (through evaporation). Energy in **water** can be harnessed in many ways; water energy technologies can be used for generating electricity, agro/food processing and water pumping. **Wind** energy technologies capture power in the wind for electricity generation and water pumping. **Human powered** water pumping technologies such as the treadle and foot pumps are used to gain access to groundwater for potable water and irrigation. **Liquid fuel** technologies such as the multifunctional platform use an engine to generate mechanical power that can be used for agro/food processing, water pumping or generating electricity.

Table 3: Applicability of RETs for different energy services

	Modern fuels		Electricity				Mechanical power		
	Cooking	Heating	Lighting	Cooling	Comm's	Home appliances	Water pumping	Agro/food processing	Manuf-acturing
Improved cook stoves	xxx	xxx						xx	
Biogas	xx	xx	x	x				xx	
Solar PV			xxx	xx	xxx	xx	xx		
Solar lanterns			xxx						
Solar thermal	xx	xx		x					
Solar drier								xx	
Small hydro generators			xxx	x	xxx	xxx		xxx	xx
Hydraulic ram pump							xx		
Water current turbines				x	x	x	xx	x	
Small wind turbines			xx		xx	xx		x	x
Wind pumps							xx		
Treadle and hand pumps							xx		
Multifunctional platform			xx	xx	xx	x	xx	xxx	xx

x – possible but not usually preferable, xx – applicable but limited xxx – suitable

There are two main types of decentralized renewable energy systems for electrification: **individual** (one power source for one client) and **collective** (one power source for several clients). Individual systems employ technologies that generate a low amount of energy (up to a few hundred watt-hours per day) that can meet the electricity needs of a single household. Collective systems employ technologies that generate significantly more energy that can meet the electricity needs of a number of households and small enterprises.

Table 4: Applicability of different RETs for types of electrification

	RETs used for electrification					
	Solar PV	Solar lantern	Small hydro generators	Water current turbines	Small wind turbines	Multifunctional platform
Individual	xxx	xxx	xx	x	xx	
Collective	x		xxx	xx	xx	xxx
Cost (per kWh)[3]	$1.5 - 3.5	-	$0.2 – 0.6	-	$0.3 - 0.8	$0.3 - 1.2

x – possible but not usually preferable, xx – applicable but limited xxx – suitable

Collective systems include mini-grids and battery charging stations. Mini-grids distribute electricity to households with electrical wires, and battery charging stations rely on individuals charging batteries at a central point and using in their house. Mini-grids are more suitable for larger systems for ease of use and greater energy availability. Battery charging stations is a common model for areas with sparsely populated households.

Indicative costs for some RETs used for electrification have been included in Table 1Table 4; costs are quoted in kilowatt hours (kWh), a unit of energy. Price ranges are significant due to market conditions, different types of technologies and the local natural resource.

2.1. Biomass energy technologies

Biomass is a general term which covers a wide variety of material of plant or animal origin, such as wood and wood residues, agricultural residues, animal and human faeces, all of which can yield useful fuels either directly or after some form of conversion to improve fuel properties. The conversion process can be physical including drying (eliminating moisture) and size reduction (compacting or densification), thermal (as in carbonization) or chemical (as in biogas production). The end result of the conversion process may be a solid, liquid, or gaseous fuel.[4]

Technology name	Sustainable charcoal production
Location	Nyanza Province, Kenya
Initiation date and duration	2002 – 2008
Financial report	Embassy of Finland and the Christian Agricultural and Related Professional Association (CARPA)
Project initiator	Youth to Youth Action Group and Thuiya Enterprises Ltd.
Beneficiaries	Farmers, Household energy users, Community based organizations
Case study resources	Policy Innovation Systems for Clean Energy Security (PISCES), FAO, World Agroforestry Centre, GTZ.

Background and project description


Photo: Fridah Mugo

Although potentially renewable, depleted forest resources in many African countries continue to be exploited at a higher rate than their supply is renewed. Natural forests dramatic decline is having increasingly negative effects on women and children who are tasked with providing household fuel, and leading to rapid local environmental degradation. Whereas rural people rely on wood for fuel, charcoal is a mainly urban fuel. Charcoal made from wood and produced by rural people as a source of income, meets 80% of urban households' energy needs in Eastern Africa. Through historic neglect and the perceived negative environmental impact, many market actors in the charcoal value chain do not engage openly in the charcoal industry. The Youth to Youth Action Group and

Thuiya Enterprises initiated the community-based afforestation project to enhance the livelihoods of the local communities through sustainable charcoal production.

Technology

There are a range of improved kilns developed for use in developing countries[5] that can produce charcoal with conversion efficiency up to 30% (for every 100kg of wood, 30kg of charcoal is produced). This gives a yield three times greater than the traditional earth mound kiln with an efficiency of only 10%. Charcoal is produced from wood by a process called carbonization. The process is made more efficient by pre-drying the wood and controlling the temperature and length of time of carbonization. The project uses Half-orange type kilns funded with an initial grant from the donor and constructed by a private contractor trained by the Ministry of Energy. The project promotes certain fast growing trees that can be harvested for charcoal after 6 years of growth.

Delivery model

This model aims to take into account the complete charcoal supply chain, bringing benefits to poor people at every stage. Rachar Agroforestry Initiative for Development (RAID), a farmer umbrella community based organisation (CBO), provides support services to farmers and charcoal producers. Individual farmers plant fast growing tress on their own private farms and can sell the wood to charcoal producers after 6 years. Only the farmers who planted trees are allowed to harvest them. This is enforced by RAID who grows all the seedlings and records those who have planted trees. Kilns are owned and operated by three CBOs; members of which receive wages for producing charcoal. Any interested buyer can purchase charcoal from the producers and transport it to any area of their choice. RAID is expected to identify and negotiate better prices on behalf of the charcoal producers.

The farmers also collect revenue from non-timber forest products (NTFP) such as honey, livestock and fast-growing crops in the initial 6 years before harvesting the wood for charcoal. RAID provides technical advice to support NTFP livelihoods and facilitates farmers groups to reduce transaction costs. Moi University and Kenya Forestry Research Institutes are providing leadership in agro-forestry research to increase wood yields and develop NTFP livelihoods.

Finance mechanism

The initiative follows a business model; every actor in the supply chain collects reasonable revenues. Once established, the supply chain is sustainable provided a sound enabling environment exists. The initiative does not require high capital investments and can be integrated with other enterprises. The Embassy of Finland and CARPA provided initial funding for mobilization of groups in the supply chain. Seedlings producers, farmers and charcoal producers were organised and trained to manage the new practices by Youth to Youth Action Group. Operational costs for actors in the supply chain (such as seedlings for farmers, wood and wages for charcoal producers) are now covered by revenue generated from the process. RAID receives an income of $160 from the donor for every hectare of tree planted.

Livelihood Benefits

The project delivered total financial benefits of US$ 2 million for all key actors from 200 hectares of forest in the six-year tree planting rotation period. Revenue was collected by all actors in the supply chain (3 seedling producers, 540 farmers, 3 community based charcoal producers, transporters and retailers). NTFP strengthen the charcoal value chain by making the wood farming process more lucrative, thus reducing the costs of wood and charcoal to producers and retailers.

Policy Influence

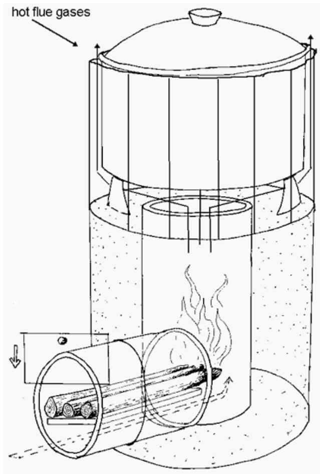
The current initiative has not maximised its potential because the business environment is not well developed. Corruption is endemic, especially in the transport stage in which drivers are subject to regulatory harassment from officials. The project aims to influence government policy to develop an enabling environment to ensure policies and regulatory issues can allow the emergence of a charcoal sub-sector.

2.1.1. Improved cook stoves

Efficient and clean burning cooking stoves range from artisanal or semi-industrially produced clay and metal wood fuel stoves to cookers using plant oil, ethanol or biogas. The most widely used technologies of all these stove categories are improved woodstoves and charcoal stoves, since they are more affordable, and the fuel is common in most markets.

Woodstove. A clay artisanal model. Photo: GTZ Malawi.

Charcoal stove (Jiko). A clay/metal model. Photo: GTZ Kenya



A rocket stove diagram. APROVECHO

Improved stoves may take many shapes. However, the two main technical principals are always the same: improved combustion and improved heat transfer to the pot. Stoves may be mobile such as the clay stove or Jiko (pictured above), or in-built such as the Lorena (pictures in the case study). The two main advantages of ICS are: a reduction in indoor air pollution - with huge benefits to people's health (particularly women and children); and a reduction in fuel required for cooking - with associated savings on time spent collecting firewood, money spent purchasing fuels, reduced impact on forest resources and reduced carbon emissions.

Technology Name	Improved Cook Stoves (ICS)
Location	Global - projects exist in most developing countries
Financial support	Many organizations are funding ICS programmes
Beneficiaries	Women and children
Case study resources	HERA - GTZ Household Energy Programme. HEDON - Household Energy Network. APROVECHO – Stove research center.

Background and project description

Cooking energy accounts for about 90 % of the energy consumed by households in Africa. Biomass fuels such as firewood, charcoal, dung and agricultural residues are often the only energy source available, especially for low-income groups and in rural areas. In recent years, several efficient, clean-burning stoves have been developed in different regions that can help to reduce fuel use and create a clean kitchen environment. Scaling-up the use of these remains the big challenge. GTZ's cookstove programme in East Africa is an example of a successful model. Acceptance of cookstoves is dependent on a range of social, cultural and economic factors, including affordability and ease of use. Experience from many parts of the world has shown that stove technologies have 'niche' regions and communities.[6]

Stove market development

Experience from many different household energy initiatives has shown that a commercial approach is usually the most successful and sustainable way of promoting improved cooking technologies. To create an effective market system for improved cook stoves, project activities and outputs on the supply and demand side are important. Market development activities are typically funded by donors.

To ensure more efficient and quality stoves are on the market, activities include: stove technology development, training of stove producers, stove quality control and improving marketing capacities for stove retailers. To establish greater demand for the stove, household energy awareness campaigns and mainstreaming policies in the public sector are important.

In many countries a wide range of stoves are available from local producers and imported from other countries. A project should begin with a market assessment of locally available stoves. Stove technology development may be necessary to ensure a locally acceptable and desirable model. Stove technology development should involve specialists, possibly from a company, research organization or academe, to develop a design building on existing knowledge and based on extensive field testing with beneficiaries. Production can be up scaled by training local manufacturers and artisans.

In-built rocket Lorena – double pot, chimney, mud/bricks. Photo: GTZ

Selling stoves

Stoves are typically sold through markets, stores or mobile artisans providing a potential new micro enterprise opportunity. Mobile artisans specialise in in-built stove designs since this requires on site manufacture.

Stoves vary in price from US$4 – US$50. Financial mechanisms may be needed to make some improved stoves more affordable to poor people. Micro-credit arrangements and instalment payment schemes by retailers can facilitate this. Subsidies can be used to bring down the total cost to the end user. Alternatively arrangements could be made to enable payment by instalments in recognition of the cash flow problems of the poor.

Some groups are investigating using carbon finance to provide programme support and subsidise the cost of stoves.[7]

Livelihood Benefits

The evaluation of a GTZ project in Uganda that has delivered more than 400,000 improved cook stoves shows significant benefits for individual households. A family using the improved stove:

- Saves, on average 3.1 kg firewood per day;
- Those who gather fuel save, on average, seven hours per week in cooking time and on the collection of firewood; time that can be spent on other activities including income generation;
- Those who purchase fuel save 26 EUR per year on fuel, which is equal to an extra month's pay;
- 50% of women reports suffering less eye irritation, coughs or accidental burns;
- Stove producers and artisans have benefited from new stove technology, training programs and income from manufacturing, selling and constructing stoves.

In many regions women and girls are at risk of physical assault and rape whilst collecting firewood. Reducing the amount of time spent collecting firewood helps to reduce this risk.

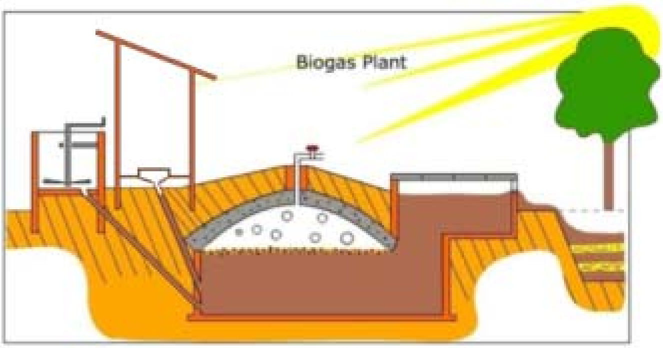
More resources available in the **Programme Impact & Learning PPE** folder

- GTZ Experience exchange on marketing of GTZ household energy interventions
- HEDON Stoves and Gender
- HEDON woodstoves market creation

2.1.2. Biogas

Domestic biogas systems convert animal manure and human excrement at household level into small, but valuable, amounts of combustible methane gas. This 'biogas' can be effectively used in simple gas stoves for cooking and in lamps for lighting. The plant consists of a digester to mix and store the ingredients and a container for the resulting biogas. At least two cattle or six pigs are required to produce enough biogas to meet a household's basic cooking and lighting needs. Investment costs of quality biogas plants vary between EUR 200 and 900, depending on plant size, location of construction and country. [8]

Figure 1: A typical biogas plant: SNV



Use of biogas saves time on cooking processes and firewood collection. Biogas burns very efficiently, without producing smoke or soot; reducing resulting respiratory and eye problems. The residue of the process, bio-slurry, can be easily collected and used as a potent organic fertiliser to enhance agricultural productivity.[8] A number of organizations are promoting biogas projects in Africa.[9][10]

2.2. Solar energy technologies

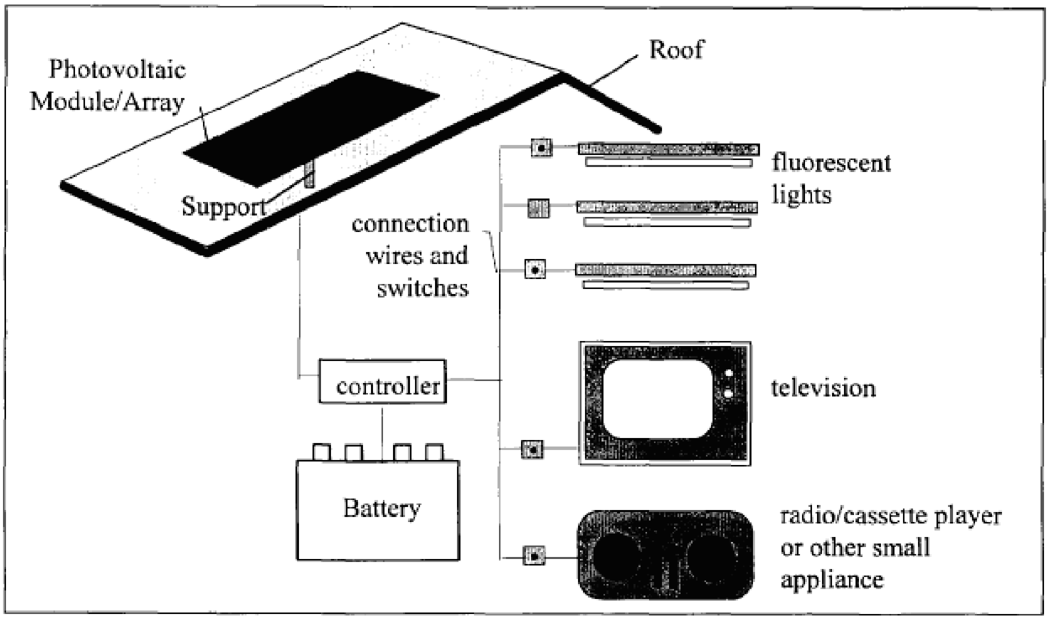
Solar energy can be used for generating electricity, drying, heating and cooling (through evaporation). Solar energy is most useful in areas of high and consistent sunshine. Assessing the technical viability of solar energy technologies is relatively simple because the sun is a reliable source

2.2.1. Solar photovoltaic (PV)

Solar PV panels convert sunlight directly into electricity. Solar PV is most appropriate for low power requirements (a few watts up to a few kW), such as lighting (with energy efficient light bulbs), radio, television, charging mobile phones, refrigerators, small appliances and electric water pumps. A battery is usually required to store the energy for usage during the evening. The panels can last more than 20 years and provide a reliable supply of power with low maintenance requirements. Solar PV has a high capital cost and the batteries (if included) require maintenance and replacement during the life of the solar panel.

The energy available from a solar panel is dependent on the amount of solar radiation that is incident on the panel (the amount the panel 'sees'). Given the power output of the solar panel (in Watts Peak) and the level of solar radiation for the area (the kWh/day), the average available daily energy can be estimated. The level of solar radiation at a site is dependent on the latitude and local climatic conditions. It is a predictable variable; it has been mapped for all parts of the world and data is available online.[11] For applications such as vaccine refrigerators or electric water pumps for potable water, the daily energy requirement is known and a system designer can calculate the size of solar panel required.

Figure 2: Typical system components of a SHS: World Bank[12]



Solar home systems (SHS) are a package designed for households and cottage industries, and typically comprise of a small solar panel and mounting, rechargeable batteries for energy storage and battery charge controller. The retail price of a SHS ranges from about US$100 to US$500 for 10 W to 50 W systems, respectively.[13] The installed cost of electricity from solar PV ranges from US$1.5 – 3.5 per kWh.[3] A list of solar suppliers in Africa can be found in Annex 3. Special training is required for the caretaker of the system. A SHS with a 50W solar panel in an area with a good solar resource can power four energy efficient lights for up to five hours a night.

There are a wide range of battery types available, with varying usages, performance, maintenance requirements and cost.[14] There is no such thing as a universal battery; a single type of battery cannot cover all applications. Batteries should be well matched to the application to ensure good performance. Some batteries require regular maintenance to ensure good performance and long life. Batteries have a life span significantly less than that of solar panels and can be expensive to replace. The owner or operator should be made aware of the importance of proper maintenance, trained with maintenance activities, and have access to maintenance supplies and replacement units.

Portable solar lantern products are the most affordable form of PV lighting available and currently in widespread use across Southern Asia and East Africa. A number of models are available that are high quality, durable and relatively low cost. These products are suitable for mass marketing models that use local retail networks and can potentially be used to support the development of new micro enterprises where appropriate. An example of this is the Christian Aid supported ToughStuff pilot project in Kenya (see the PPE intranet site link below) or the D.light Design.[15]

Technology Name	Solar home systems (SHS) and solar lanterns
Location	Sub-Saharan Africa
Financial support	Netherlands Ministry of Foreign Affairs. DOEN Foundation (Netherlands National Lottery)
Project Initiator	Rural Energy Foundation (REF)
Output	57,000 SHS and 36,000 solar lanterns sold
Beneficiaries	332,000 gained access to electricity
Energy services provided	Lighting
Resources	REF. Ashden Awards.

Background and project description

More than 70% of sub-Saharan Africa (SSA) has no access to electricity, and in rural areas this often exceeds 95%. Access to energy products is hindered by poor market-supply chains, low awareness of existing technology and lack of access to finance for entrepreneurs and end users. REF has helped facilitate access to solar-powered electricity in SSA by training and supporting rural retailers.

Marketing a solar lantern: Ashden Awards

Technology

REF promotes SHS (typically 11 to 50 Wp, costing between US$250 and 630) and solar lanterns (1-10Wp, costing between US$25 to 90). The solar panels and solar lanterns are all imported; no local manufacturers exist and high quality and relatively low-cost are available on the international market.

Training and support to market actors

REF identifies retailers and distributors in rural and urban areas, trains them in solar energy technology, marketing, sales and business administration, and helps them start up and expand businesses selling solar energy products. Trained retailers who commit to growing a rural solar business and meet REF quality standards may use the SolarNow brand name, and benefit from SolarNow promotional activities undertaken by REF. SolarNow technicians are trained to assemble, install and repair solar products. REF has supported 200 retailers achieve SolarNow status across Africa.

Selling solar products

REF stimulates financial institutions and other commercial actors to extend credit to smaller retailers (to increase their stock), to small businesses generating income from renewable energy (such as phone charging stations, barbershops, etc.), and to end-users (for them to purchase, for example, a SHS). REF stimulates demand for solar energy products through large awareness campaigns using the SolarNow brand.

REF has developed tripartite arrangements with banks in which SolarNow retailers and customers may obtain access to bank loans and microcredit. If the client has saved a certain amount (typically 30-50% of the purchase price of the solar home system for a customer), the client can obtain a loan. The client typically repays most of the loan with of the solar home system in one to three years through savings in kerosene and batteries. REF provides a limited guarantee to the financial institution, based on which the financial institution can issue a loan without collateral.

REF operations cost about 5% of the value of SolarNow sales, or a cost of EUR 2.20 per newly connected person. REF's activities are funded through grants from the Netherlands Ministry of Foreign Affairs and the DOEN Foundation.

Benefits

- Typical kerosene savings for a household of one litre per week ;
- Businesses of 200 SolarNow retailers continue to grow, and provided employment for around 200 local technicians;
- Better quality of light gives opportunity for study, income-generation and leisure activities. Electricity for radios, televisions and mobile phones improves communications and access to information.

More resources available on the **PPE intranet site** **(document library)**:

- Details of the Kenya ToughStuff pilot project (small scale solar)
- Links between food security and solar powered irrigation

2.2.2. Passive solar

Passive solar technology is widely used for heating water and cooking food. Solar cookers and collectors concentrate the sun and convert it directly to heat. They are useful in areas with strong sun and requirement for an alternative energy source due to biomass fuel shortages. Several high-quality and efficient solar cookers are available at a relatively modest cost, although cultural resistance to change and more limited cooking practices, as well as a wider understanding of the technologies, still remain a challenge for wider acceptance.[16] These factors have limited the penetration of solar cookers. Solar cookers and collectors are often available through suppliers of solar PV products (see Annex 3 for more information) on a commercial basis.

Solar dryers can dry a wide range of agricultural products for preservation. The basic principal of a solar dryer is that air is heated by the sun in a collector, and then passed over the produce to be dried. There are three basic designs, each with its advantages and disadvantages: solar cabinet dryer, tent-dryer, and solar tunnel dryer.[17] Solar dryers are only useful during short periods of the year when crops are harvested and need to be dried.

Evaporative cooling is a method of cold storage for fruits and vegetables which is simple and does not require any external power supply. Generally, an evaporative cooler is made of a porous material that is fed with water.[18] Common designs include the zeer pot and the static cooling chamber.

Whilst the needs for solar dryers and evaporative cooling are widespread, commercial models are yet to prove successful. The technology is often considered relatively expensive and of limited application. A number of NGOs are distributing passive solar products to vulnerable communities as part of food security and livelihood programmes.

2.3. Water energy technologies

2.3.1. Hydro-power

Water power can be harnessed in many ways; the most common way is to use a turbine which is turned by water moving in a controlled manner.[19] The output from the turbine can be can be used directly as mechanical power or connected to an electrical generator to produce electricity. Mechanical power is suitable for some productive livelihood activities including food processing such as milling or oil extraction, sawmill, carpentry workshop, small scale mining equipment, etc. Electricity can be supplied to homes directly through an electrical distribution system or by means of batteries that are periodically recharged at the point of generation.

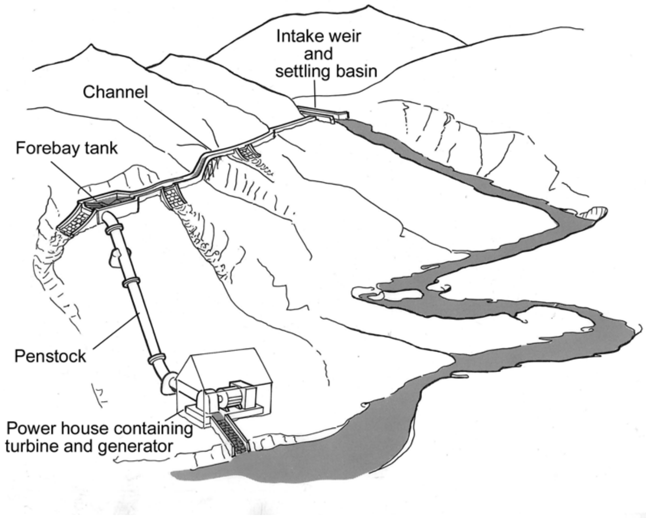


Figure 3: Layout of a typical micro-hydro scheme: Practical Action

Systems are categorized by their power output; pico-hydro (less than 10kW) and micro-hydro (10kW up to 300kW) are suitable for supplying power to a household or community. The power is dependent on the volume of water and the available head of falling water.

Small systems can provide energy without requiring large and expensive dams. The best geographical areas for exploiting small-scale hydro power are those where there are steep rivers flowing all year round, for example, the hill areas of countries with high year-round rainfall, or mountain ranges and their foothills. Hydro power can be the most cost effective of decentralized RETs; the installed cost of electricity ranges from US$0.20 – 0.60 per kWh.[3]

Hydro power projects require careful assessment and design by an experienced technical person. Local caretakers are usually trained in the technical operation and maintenance of a system and are linked to other service providers including suppliers of spare parts etc. For community systems a local organization is required for management of the system – and the development of leadership and management capacity is an important requirement for success. Finance of community projects is a key consideration given the high capital cost of a system.

Technology Name	Micro-hydro power
Location	Peru
Initiation Date and Duration	1993 - ongoing
Financial support	Inter-American Development Bank (IADB), Practical Action
Project Initiator	Practical Action (PA)
Overall Output	50 micro-hydro schemes installed
Beneficiaries	30,000 people with HH electricity connection and 100,000 more people indirectly benefitting through services and businesses powered by schemes
Energy services provided	Electricity for households and small businesses
Resources	Practical Action website and publications[20][21]

Background and project description

This project has been running since 1993 in the Andean region of Peru. It combines the provision of appropriate finance with technical assistance to make possible the implementation of micro-hydro schemes for electricity generation at village and community levels. The clients are farmers, local business families, local authorities and groups of organized people who want access to electricity and are committed to install a micro-hydro scheme. Electricity is used for a range of productive uses and/or for village electrification. The Inter-American Development Bank (IADB) facilitated the start of that project by providing a soft loan to PA plus part of technical assistance funds of the 6 first years. Presently the technical assistance is funded by a range of individual or small funds from the UK.

Technology

Micro-hydro power is a local energy resource, which can be usefully harnessed for rural energy demands from small rivers, where there is a drop of a few meters and the flow rate is more than a few litres per second. Hydro is usually the cheapest of all electrification options for isolated communities, where hydro resources exist. It is a mature technology, widely proven and now manufactured in a number of developing countries. Hydro power can generate electricity and mechanical power 24 hours a day, and is suitable for household usage, health and education centres, communication and small and medium enterprises.

Delivery model

PA has developed two social management models to enable the implementation and sustained micro-hydro projects in Peru. Roles and responsibilities are clearly defined for all actors in the project.

The first model involves the local government as the owner of the micro-hydro system and recipient of the loan. A Local Power Enterprise (LPE) is developed and contracted to operate the system and sell electricity to consumers, an Assembly of Users (comprised of local individuals) represents consumer interests in dealing with stakeholder issues, and consumers (individual households and businesses) that use the electricity. The second model establishes a local cooperative, business or individual as owner of the micro-hydro system on a more standard commercial basis. The owner also operates the system and sells electricity to consumers. In both cases the consumer tariffs pay for operation and maintenance of the system and operator wages.

Practical Action provides organizational development trainings and technical assistance for the implementation of the scheme. Productive end uses are actively promoted through work with users to identify electricity businesses and trainings. Careful recruitment of personnel from the local community for roles in the LPE and Assembly is important to ensure non-partisan and responsible management of the system. Coordination with local and national government encourages an enabling environment through reduced regulatory problems.

Finance mechanism

Practical Action established a finance scheme for the programme that used a revolving fund to accelerate implementation of projects. An IADB loan to PA totaling US $1 million was used as a seed fund for a revolving loan. This has been leveraged to US$4 million, making a total investment of US$5 million for the programme. PA is administrator of the revolving fund and will pay back the loan to IADB in full.

An individual micro-hydro project is financed through a combination of loan and grants. Grants are sourced from a variety of local sources including small amounts of up-front capital from local investors, government funds and national NGOs. The loan is committed to the project providing the grants have been secured. The loans range from US$10,000 to US$50,000, issued to the owner with an interest rate of 10% and a 5 year pay back. In the local government owner model, the loan is repaid from revenue from the scheme and internal government funds. In the business owner model the loan is repaid from revenue from the scheme and additional contributions from the owner.


Photo: Matt Barker

The revolving fund has enabled up to 7 micro-hydro projects to be implemented at any one time. A challenge has been to secure collateral for loans to both the local government and private entities. This has required securing property titles for individuals and agreements with local government.

Livelihood Benefits

More than 300 small enterprises and services have been created including milk chilling, milling, carpentry, ice-making, tools repairs, dental services, shops, cafes, internet services, battery charging and others.

More resources available in the **Programme Impact & Learning** PPE folder

- Kenya micro hydro case studies

2.3.2. Water pumping

Water power can also be harnessed to pump water for a potable supply or irrigation. Hydraulic ram pumps operate automatically, using a large amount of water falling through a low height to pump a small amount of water to a much greater height. Appropriate models are available that can provide a reliable and affordable of supply for rural areas. [22] Water current turbines use the energy in a flowing river or canal as the source for the water pump. It floats in the free stream of the river and pumps water onto the bank.[23] Water powered pumping technologies can provide a cheap and reliable supply of water in the right situation. Projects require careful assessment and design by an experienced technical person and regular maintenance from a trained local user.

2.4. Wind energy technologies

Wind power can be harnessed for both generation of electricity (wind generators) and irrigation (wind pumps). The amount of energy produced from wind energy technologies is variable because it is dependent on the wind speed, which is constantly changing. [24] A good assessment of the wind resource, that may include wind speed measurements, is important for wind energy projects. Wind maps present wind resource data based upon wind speed measurements and computer modelling. Figure 4 shows a wind map for an area of Kenya. Areas with a good wind resource (high average wind speeds) can be identified by colour. A wind map is useful for high level identification but verification by site visits and measurements may be required.

Figure 4: Wind map from an area of Kenya (colours relate to average wind speed bands): SWERA.[25]

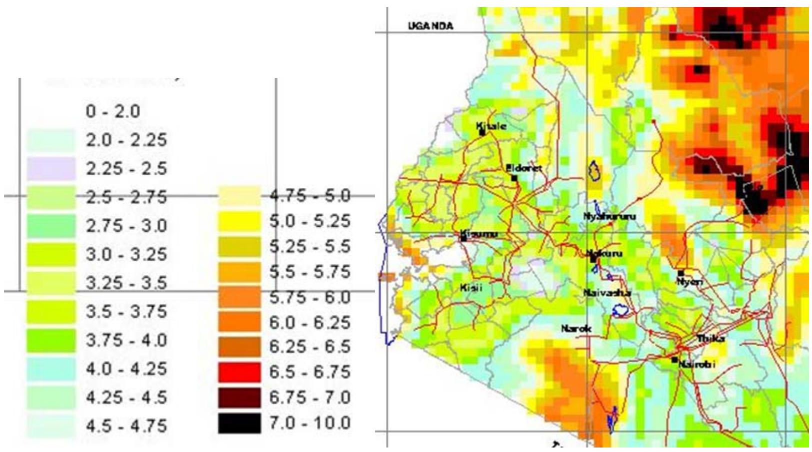


Table 5: Resource potential for different wind speeds: E-mindset4

Average annual wind speed	Possibilities for wind energy use
Below 3 m/s	Not usually viable, unless special circumstances exist
Between 3 and 4 m/s	May be an option for wind pumps; unlikely to be viable for small wind turbines (SWT)
Between 4 and 5 m/s	Wind pumps may be competitive with diesel pumps: SWTs may be viable
More than 5 m/s	Viable for wind pumps and SWTs
More than 6 m/s	Excellent potential for wind pumps and SWTs

Wind energy technologies require careful design by an experienced technical person to match the wind resource, technology and application, and regular maintenance from a trained local user.

2.4.1. Small wind turbines (SWTs)

SWTs convert energy in the wind to electricity using blades coupled to a generator. They are most appropriate for low power requirements (a few watts up to a few kW), such as lighting (with energy efficient light bulbs), radio, television, charging mobile phones and small appliances. They are also used with electric water pumps and small agro-processing machinery. SWTs are only suitable in areas with moderate - high average wind speeds.

Appropriate technology models are available[26] (100W up to 5 Kw) and have been used in a number of developing countries.[27] Horizontal and vertical axis models are used, although the horizontal axis model is more common. They can be a cheap alternative to solar PV in areas with a good wind resource; the installed cost of electricity from a SWT ranges from US$0.30 – 0.80 per kWh.[3] SWT systems include batteries and charge controller and require regular maintenance from a trained operator.[28] SWTs are often combined with solar PV panels and/or diesel generators to ensure a reliable supply in times of low wind speeds.

 A horizontal axis wind turbine: Practical Action	 A vertical axis wind turbine: Paul Gipe[29]

SWTs are yet to be widely accepted in developing countries due to the complexity of assessing wind resources, high maintenance requirements compared to solar PV and lack of awareness of the technology. SWTs are available through some international retailers of small-scale renewable energy products but are rarely found in developing countries. blueEnergy in Latin America is an example of an NGO implementing SWT projects. They deliver projects on a community service delivery model (significant project costs coming from grants) and a commercial service delivery model.

2.4.2. Wind pumps

Wind pumps harness the power in the wind to drive a mechanical pump to lift groundwater. They have low operating costs so can be cheaper to run than a diesel powered pump. They are suitable for village and livestock water supplies, and irrigation. Wind pumps are effective at lower wind speeds than SWTs. There are manufacturers in several developing countries promoting wind pumps on a commercial basis, including the Kijito wind pump in Kenya.[30]

The Kijito wind pump in Kenya: Practical Action

2.5. Human powered water pumping technologies

A wide range of human-powered water pumping technologies is in common use to gain access to groundwater. Foot, hip and hand operated pumps are used for household water supply and irrigation in developing countries. Most of them are positive displacement pumps using reciprocating pistons or plungers.[31] Human powered pumps are low cost, simple and cheap to maintain for a trained operator. They have lower pumping heads and volumes than other water pumping devices (diesel, solar, water or wind powered). Human powered water pumping technologies are suitable in most regions.

Hand pumps are commonly used for household supply. They can pump water from a depth of up to 45m. Foot and hip pumps are more suitable for irrigation because they are more comfortable for the operator to use for prolonged periods. They have lower pumping heads than hand pumps but can deliver a greater flow.[32]

Treadle pumps have proved to be very popular with poor farmers' in Africa. They have been successfully promoted on a commercial basis by a number of NGOs and businesses. Kick Start is an NGO promoting foot and hip pumps to farmers' across Africa through offices in Kenya, Tanzania and Mali.[33] IDE is another organisation promoting treadle pumps. [34] IDE has been very successful in South Asia and now has operations in Africa. IDE works with local micro-finance organisations to allow poor farmers to gain access to finance to purchase the product.

2.6. Liquid fuel technologies

The internal combustion (IC) engine has been used for many decades in developing countries playing a very important role in providing power for rural communities. Many stand-alone units are used for milling, small-scale electricity production, water pumping, etc. They are readily available, off-the-shelf in most major towns and cities in a range of sizes to suit various applications. There is usually a well-established spare parts and maintenance network, both at urban and rural centres.[35]

Diesel engines can be adapted to run on biofuels and oils that can be grown locally.[36] Sustainable cultivation of a local biofuel crop can support the local economy and isolate the system against high and fluctuating diesel prices. Jatropha, a shrub originally from South America, has been shown to be a promising crop for producing biofuel, although challenges in domestication of the plant remain and other oil plants also offer potential. However, the shrub is well known in different parts of Africa and is used to create living hedges against wind soil erosion, to protect vegetable gardens, and to pen in livestock. Jatropha seeds are pressed to produce the oil.

Experience in Mali with has shown some potential benefits and challenges of using jatropha as a fuel.[37] A key challenge is to produce a sufficient level of biofuel (the vegetable oil) cost effectively to fuel the adapted diesel engine over time. 3-4 kgs of Jatropha seeds, corresponding to 3-4 metres of hedgerow, is required to produce 1 litre of jatropha oil. Growing enough jatropha to power a generator may in some cases lead to conflict over land ownership over newly planted land; be an additional burden for women and children who have to harvest, transport and process the seeds; and lead to gender conflicts between men who traditionally plant hedges and women who collect seeds.

However production of jatropha oil can also reduce cash outflow for fossil fuels from an area and add value to local resources. Various additional benefits can be realised from growing jatropha; it is a low-input plant so can be grown on relatively low-fertility soils (although not without yield decline); jatropha plants can act as a barrier against the wind and soil erosion as living hedgerows; the by-products can be used for organic fertiliser or livelihood enterprises such as soap production; use of jatropha as a fuel (if no fossil fuel inputs are used) is carbon neutral and may be eligible for carbon finance.

Technology	Multifunctional Platform (MFP)
Location	Mali
Initiation Date and Duration	1st phase: 1993 – 2004. 2nd phase: 2008 – ongoing
Financial support	1st phase: UNDP, GEF, DANIDA, ADB, NORAD. 2nd phase: Gates Foundation
Project Initiator	United Nations Development Programme (UNDP)
Overall Output	1st phase: ~450 MFPs installed. 2nd phase: 600 MFPs by 2012 (includes Burkina Faso and Senegal)
Beneficiaries	1st phase: ~80000 clients (mostly women)
Energy Services Provided	Grinding, de-husking, battery charging, water pumping, oil pressing, welding machines, carpentry tools, and lighting through mini grids
Resources	UNDP Energy. Mali Folkecenter.

Background and project description

The MFP was piloted in a joint project by the United Nations Industrial Development Organization (UNIDO) and the International Fund for Agricultural Development (IFAD) in two West African countries, Mali and Burkina Faso. It was aimed at reducing time spent on the repetitive and energy-intensive domestic non-productive tasks allocated to women, such as grinding, de-hulling, and water fetching. Existing grinding mills in the traditional private sector were costly and their services not adapted to women's need. In 1996, UNDP and the Government of Mali began providing support to existing platforms and set out to install diesel-fuelled multifunctional platforms across Mali.

Technology

A MFP – engine and agro-processing devices shown: UNDP

The multifunctional platform provides a source of mechanical and electrical energy, powered by a diesel engine of 8 to 12 horse power (hp), that is mounted on a chassis and to which a variety of end-use equipment can be added. The configuration of equipment modules – such as grinding mills, huskers, battery chargers, electric water pumps, vegetable or nut oil presses, welding machines, carpentry tools, and mini electricity grids for lighting – is flexible and can be adapted to the specific needs of each village. The advantages of the technology are its simplicity, reliability and multiple uses. The MFP can also be powered by locally produced jatropha vegetable oil. This can reduce cash outflow from the community and lower exposure to diesel price fluctuations – particularly important for remote communities.

Delivery model

Installation of a platform is demand-driven. A duly registered women's association has to request it, with the active support of the village community. Female ownership and management is requirement to maintain the project's explicit focus on rural women. Before a platform is installed a feasibility study is undertaken using participatory approaches by local project partners to ensure the firmness of the demand, ability of the villagers to pay for the services, to inform the villagers about procedures, and to confirm technical opportunities. The study informs project planning, allows a business plan to be developed, and provides baseline data for monitoring and evaluation. After initial literacy training, the association elects a women's management committee, whose members are then trained in managerial and entrepreneurial skills to ensure the technical and economic viability of the platform. Male artisans in rural areas were trained in mechanical and electrical installation, maintenance and welding so that they could take advantage of the energy provided to develop enterprises that supported the maintenance of the platform through the paying of energy fees.

Finance mechanism

At an estimated cost, of US$4,500 for engine, rice de-huller, stone mill, and housing for the platform as well as for feasibility studies, and trainings for women operators, the platform is comparatively cheap to buy, install, maintain, and replace. Between 40 and 60 percent of the cost is financed by the women's association, often with financial support from the rest of the community. A one-time subsidy of approximately US$ 2,500 is provided by the project (about US$ 1,000 for the cost of studies and training and US$ 1,500 to subsidise the cost of equipment and installation partially). Prices of the services are set to ensure the financial sustainability of the multifunctional platforms as well as maximum affordability for local end-users.

The women's association operates the MFP and charges users, the vast majority of which are women, for the services. Prices of the services are set to ensure the financial sustainability of the multifunctional platforms as well as maximum affordability for local end-users. Prices are similar to those of the traditional cereal mills.

Photo: UNDP

Livelihood Benefits

- An increase in the average annual income of platform users by US$ 68, representing a 56% increase in rural Mali;
- Average saving of 2.5 hours per day of the time women spends on activities such as manual grinding and water pumping, which can be spent on other income-generating activities;
- Reduced seasonal liquidity problems and mitigate adverse shocks (e.g., natural, economic, or political disasters) by improving health, generating additional non-farm income during the dry season, raising the total net income of households, and empowering women to participate in economic decision making;
- Provides employment (and new income opportunities) for women operating the multifunctional platform;
- Women have also been able to improve their health. The platform project led to a rise in the number of prenatal visits to health clinics due to an increased income and reduced time spent on domestic activities and reduced drudgery and hard manual labour thanks to platform services;
- Increased level of girls' attendance in primary school and improved proportion of school children completing primary education is possible due to reduced time spent on domestic activities

Bio-energy (e.g. biofuel, charcoal etc) case studies available

PISCES / Practical Action / FAO Small scale bio-energy initiatives report on the **Programme Impact & Learning PPE site**

3. Investment finance and end-user finance

3.1. Investment finance for an NGO or enterprise

Investment finance is an important consideration for an NGO project or enterprise seeking to establish or scale-up a renewable energy project. Investment finance is required to purchase fixed assets and to use as working capital during the start-up period. Fixed assets are assets that have a life more than one year and generally have a high cost, such as equipment, vehicles or owned premises. Working capital is the money required for operations in advance of payment from customers, such as salaries, supplies and overheads. [38]

This chapter will describe the three kinds of external finance: **grants, equity and debt** and discuss advantages and disadvantages. Profits are also a source of internal finance. If the NGO or enterprise is already operational, a portion of the profits can be retained for further investment.

Grants do not require repayment; in essence they are gifts of money. They are the cheapest forms of finance although they usually include strict conditions on how the money can be spent and the time frame in which it can be spent. Grants may come from multilateral or bilateral donors, charitable foundations, corporations or individuals (see Chapter 5). Grants are usually provided as a one-off payment to help launch a new project or enterprise. They can play a very important role 'buying down capital' or covering some or all of the initial costs of capital investment which would be difficult to recoup from revenues. Funding agencies can be willing to provide a grant that will help establish a financially sustainable operation such as this but are generally unwilling to continue providing grants when they believe operations can be sustained by selling a product or service profitably.

Table 6: Advantages and disadvantages of different types of finance. Adapted from Ashden Awards. [38]

Type of Finance	Advantages for enterprise	Disadvantages for enterprise
Grant	• No need to repay	• Grant sizes are typically quite small, and donor procedures cumbersome, meaning lots of time can be spent chasing small amounts of money • Donors have a limited appetite for continued funding of the same activity – requiring innovative ideas or other funders
Equity	• The risk is shared with the investor • Payback is more flexible than debt • Investor more likely to be active and supportive	• Investors require high returns – equity can be difficult to obtain and expensive • Negotiation and due diligence processes are time consuming • Some control and ownership is relinquished to the investor
Debt	• Easy to arrange compared to equity – especially with a good track record • Retain complete control and ownership	• Difficult to obtain without a good track record or collateral • Repayment schedules are typically inflexible • Can be difficult to obtain for start-up enterprises

Equity is the money invested in an enterprise by investors (including founders) with the expectation of getting a future return. An equity investor will exchange money for shares; effectively owning a percentage of the company. If the enterprise is successful the shares will return a dividend payment to the equity investor from the profits. Risk is shared with the equity investor; if the enterprise becomes bankrupt, the equity investor can only take a share of the assets remaining after other creditors have been paid. Equity is more flexible than debt since the repayments are linked to operating profits. Investors are therefore more likely to be active in providing support to the enterprise.

Quasi-equity financing is a financing term for funding that is technically "debt" but has some of the characteristics of equity financing, such as unsecured funding with flexible repayment terms.[39]

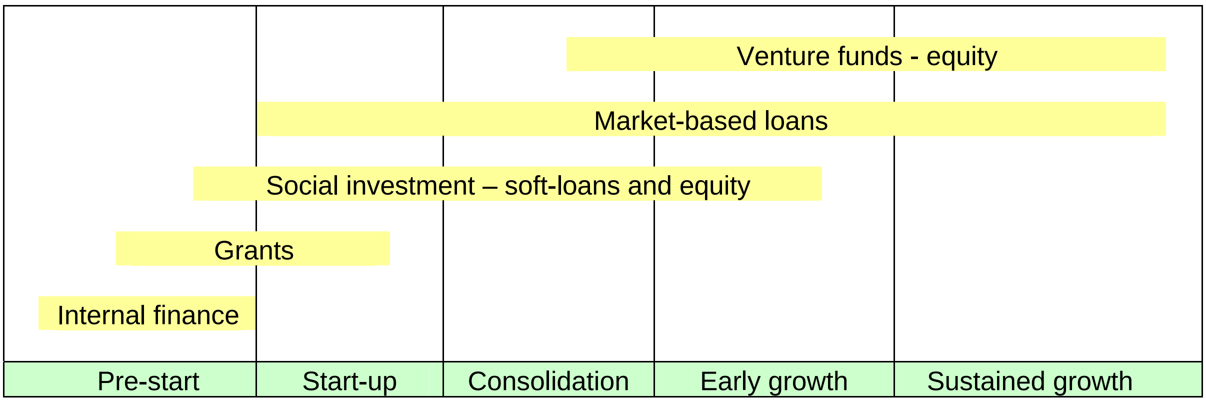
Debt is money lent to an enterprise; the amount of money borrowed and the interest on the amount has to be repaid to the lender. Unlike equity, the lenders do not own a share in the enterprise. To ensure the loan can be repaid the lender requires strict criteria relating to the profitability of the project and proportion of debt compared to other finance sources is met.

Finance for an NGO project or enterprise may be obtained from a single or combination of finance types. All of the projects described in the previous section involved grant funding at some point, either in the early stages of the project or more extensively through the initiative lifecycle (which may involve several "projects"). However, none rely entirely on grants and blend grants with other types of finance in some aspects of the implementation or delivery model, particularly with regard to energy enterprises active within the wider model. Investment for a sustainable energy enterprise typically follows the stages of growth described in Table 7. Enterprises use a mix of internal finance, grants, equity and debt.

NGOs typically rely heavily on grants. Using equity and debt may be appropriate to increase the available finance for a project and encourage financially sustainable operations.

A finance expert should be consulted to discuss the best financial framework for a particular project or enterprise.

Table 7: Typical stages of growth for an enterprise. Adapted from Ashden Awards.[38]



3.2. Operational models

NGOs and enterprises have developed innovative operational models to provide potential *customers* with access to finance (commonly called "micro-finance") for purchasing energy products and services. This is often necessary given poor people's lack of purchasing power, access to formal finance added to typically limited awareness of energy products and limited capacity of the private sector in developing countries. There are three main successful models commonly used:

- **The one-stop-shop model** – a single organisation providing both the energy product and the finance to the customer. This model allows the organisation to control and manage all aspects of the business. The enterprise must have strong capacity with both finance and energy products.

Photo: GS

Grameen Shakti. GS has used its Grameen Bank microfinance experience to establish one of the largest and fastest growing rural renewable energy companies in the world. GS promotes ICS and biogas plants, and has installed more than 300,000 SHS to rural households in Bangladesh. GS installs SHS to customers for a down payment and monthly repayments. GS engineers provide continued after sales service. Other key activities include advocacy and promotion, technology development and community involvement.[40]

- **The partnership model** – the energy enterprise provides the energy product and technical services, and a separate finance organisation provides credit to the end user and manages the repayment. This model allows both organizations to stick to their core expertise but requires good coordination and management for a successful partnership.

Photo: Selco

SELCO Solar Pvt Ltd. SELCO is a social enterprise established in India to provide sustainable energy solutions and services to under-served households and businesses. SELCO provides technical services (products, installation and after-sales services) and linkages to appropriate finance institutions for customers. SELCO works with solar PV, solar thermal and improved cook stove technologies. SELCO has forged partnerships with nine regional rural banks, commercial banks, NGOs and rural farmer cooperatives that provide finance to end users.

- **The franchise/dealership model** – an organisation provides credit for the energy product to franchises and/or dealers for them to sell to customers.[41] The dealer or franchise may also provide technical services. This model is a way of increasing sales networks to reach more customers, especially in remote regions. The dealer or franchise must have the capacity to provide a quality service and manage repayments from the customer.

Solar technical training: REF

Rural Energy Foundation (REF) – solar PV case study (Chapter 2). REF arranges credit to solar product retailers and customers through an agreement with local financial organization. This entails proper selection of financial institutions to partner with, careful selection of retailers, micro-entrepreneurs and saving customer (groups), training and accompaniment of the bank employees, and intense business coaching of the retailers.

Further information on these operational models and other less common models are discussed in an Ashden Awards End-User Finance Report.[38]

3.3. End-user finance mechanisms

Renewable energy products in general suffer from high initial costs compared to fossil-fuel based energy technologies. While life-cycle costs may be far less than those of conventional energy options (which usually have high operational costs via fuel costs), renewable energy products' high capital costs make them unaffordable to many poor people. Innovative end-user finance mechanisms are required to increase access for poor people and increase sales volumes for energy enterprises, which in turn lowers costs. There are three successful mechanisms commonly used:

- **Consumer finance** – the energy product is purchased on credit by making an initial down payment and financing the balance with periodic payments on the capital and interest. The customer is responsible for maintenance following the warranty period provided by the dealer. Lending to individuals and peer groups is usually done with simple and informal financial assessments. In this case, the customer is often required to make a large down payment since loan defaults are less likely if a large investment has already been made. The product is commonly used as collateral for the loan. Lending for larger projects, to CBOs say, is more complex and requires more thorough financial arrangements.

  The Renewable Energy Foundation solar PV case study in Chapter 2 describes how individual consumers obtain loans to purchase solar products through a tripartite agreement with REF, the retailer, and a local financial organization.

Energy end-users, as well as being individuals, may be organised into groups to facilitate the finance mechanism and delivery models.

Peer group lending typically involves between three and ten people from a group of relatives, neighbours or colleagues and often women, forming a peer group.[42] An individual group member can obtain a loan to purchase an energy product. Members of the group can only obtain subsequent loans once the initial loan has been repaid, thus encouraging high repayment rates. Peer group lending is typical for inexpensive energy products such as solar lanterns or cook stoves. The product is usually used as collateral for the loan.

Community based lending requires an organisation representing the community (such as an NGO, enterprise or local government unit) to be the proponent of the loan. Community based lending is typical for larger projects, such as micro-hydro, since large loans are required and not accessible for individuals. In-kind contributions from the community, and sometimes loan guarantees by supportive partners, are typically required as collateral to secure the loan.

- **Leasing** – the company provides the energy service for a monthly fee paid by the customer through a service agreement. The company owns the hardware and ensures the maintenance for the period of the agreement, typically 5 years. Ownership and maintenance is transferred to the customer when the agreement period expires. The monthly fees are lower for leasing than consumer finance since the repayment period is longer.

- **Energy Service Company (ESCO)** – ESCOs are similar to leasing companies except that the ownership never transfers to the customer. The service contract is ongoing; the company provides the energy service and is entirely responsible for maintenance, and the customer pays a monthly fee.

Subsidies are a feature of many rural energy access projects and are often used to make finance more accessible to poor end users. Subsidies can be provided by grants from donors, or through pro-poor payment initiatives.

Donors often provide grants to programmes or projects to reduce the cost of the product or energy service to the beneficiaries, usually through capital equipment subsidy, or reducing the cost of finance (e.g. loan guarantees or providing for low interest loans).

Pro-poor payment initiatives can be designed so that the poorest of the beneficiaries receive the product or energy service at a lower cost than other end-users. This can be done with reduced energy usage tariffs and connection charges for different income groups; this can be subsidised by high income groups or profits from energy enterprises. A participative design of the initiative is essential to ensure an equitable and acceptable scheme.

The subsidy should be designed to be effective at increasing energy access for poor people, in a cost efficient and equitable manner while stimulating rather than destroying markets in energy products and services.

Revolving funds are often used to provide loans to energy users at low interest rates. A seed fund is established from a grant, from which customers can borrow money. Original borrowers replenish the fund to enable subsequent borrowing. This financing structure is suitable for micro-lending on products to households, as well as to larger lending to organisations for infrastructure needed to provide energy services.

Practical Action has demonstrated how a revolving fund can accelerate implementation of micro-hydro projects (Peru case study). This model encouraged local groups to secure a grant / loan mix to finance projects. The loan is revolving between projects; new projects can be undertaken when an existing project has completed repayments.

4. Project funding sources

This chapter provides an overview of funding and financing sources for NGOs and enterprises to target in order to raise money for RE initiatives. There are a wide range of potential sources that provide grants, equity or loans; key sources are discussed and contact details provided in Annex 1. Funding opportunities, particularly grants, are ever changing thus requiring devoted resources to keep up-to-date with current opportunities.

Table 8: Matrix of finance sources for NGOs and small enterprises.[39]

	Grants	Equity investments	Soft-loans	Market-based loans	Carbon finance
Multilateral agencies	x	x	xx	xx	xx
Bilateral agencies	x	x	xx	xx	
National institutions	xx		xx	xx	
Local investment		xx		xx	
Foundations and charities	xx		xx		
Social investment		xx		xx	
Carbon traders					xx

x – applicable but limited. xx – applicable.

4.1. International multilateral agencies

Funding is available through international multilateral agencies such as the World Bank (WB), United Nations (UN) Agencies, European Commission (EC), or the African Development Bank. This type of funding is usually for large projects at a national or regional level and consists of loans at an interest rate or payback periods below commercial averages, and sometimes grants.[39] Funding is generally only made available for governments although certain opportunities exist for NGOs and enterprises.

- The UNDP administers the Global Environment Fund **Small Grants Programme** (UNDP- GEF -SGP) that funds NGOs and CBOs to implement small-scale renewable energy projects in developing countries.[43]
- The UNEP's Rural Energy Enterprise Development (REED) initiative operates in Africa as **AREED** to develop new sustainable energy enterprises that use clean, efficient, and renewable energy technologies. AREED offers rural energy entrepreneurs a combination of enterprise development services and start-up financing.[44]
- The Program on Scaling-Up Renewable Energy in Low Income Countries (SREP) is a targeted program of the Strategic Climate Fund (SCF), which is within the framework of the Climate Investment Funds (CIF).[45] SREP pilots programmatic interventions in selected low income countries that greatly increase the use of renewable energy to support economic development and improve access to modern, clean energy.[46] Grid and off-grid electricity applications including small hydro or biomass-based power, wind and solar powered systems, and geothermal. Cooking and heating applications including sustainable community forests, improved cook stoves, geothermal heating, and biogas or other renewable-based fuels.

4.2. Bilateral agencies

Developed countries provide funding for developing countries through development programmes such as the UK Department for International Development (DFID), the United States Agency for International Development (USAID). There are a number of bilateral donors, notably USAID, DGIS (Netherlands), KfW (Germany) and SIDA (Sweden) who have included renewable energy technologies in their programmes and projects. Funding is generally only made available for governments although certain opportunities exist for NGOs and are generally advertised via their websites and local offices.

4.3. National institutions

In most countries the government is supposed to provide a range of basic services including electricity, the reality is that neither local nor central governments provide that services, generally because lack of money and because they do not see the poor and/or isolated as a priority.

4.4. Local investment

Commercial financing organizations, such as agricultural or development banks, are able to provide finance for energy projects given a compelling business case can be made. **Error! Bookmark not defined.** Investment from these sources is currently not significant since loans are expensive (local market conditions apply in terms of payback period and interest rates, which can often be high), members of staff are not trained to assess energy projects, and they are not interested in small projects because the transaction costs are high.

4.5. Social investment

There are a growing number of sources of finance specifically for enterprises that provide social benefits and target poverty alleviation. Some of these are specifically for energy enterprises.

- **E+Co** provides business development support with both debt and equity investments to small and growing clean energy businesses in developing countries.[47]
- **Acumen Fund** is a non-profit venture capital fund with a focus on delivering affordable, critical goods and services – like health, water, housing and energy – through innovative, market-oriented approaches. They aim to combine small amounts of philanthropic capital, with large doses of business acumen, to build enterprises that serve vast numbers of poor people. Acumen Fund has projects in East and Southern Africa.[48]
- The **Sustainable Energy Finance Directory** is a free-of-charge online database of lenders and investors who actively provide finance to the sustainable energy sector worldwide, although their focus is on developed countries.[49]
- **Ecobank Foundation** finances social projects in Africa. Ecobank sets aside 1% of group's profits after tax to support social initiatives. Ecobank

is interested in entrepreneurial approaches to rural development in Africa, possibly including energy related initiatives.[50]

- **Good Capital** is an example of a social venture capital fund that offers financing for non profits and for-profit social enterprises. It is a potentially viable option for energy enterprises that can demonstrate financial sustainability in the long run. [51]

4.6. Foundations and charities

There are a number of private foundations and charities that provide funding for RETs in developing countries. They vary considerably in their size, scope and funding models. A number of multinational corporations also have corporate social responsibility (CSR) programmes that give grants and awards through company programmes or partners.

- The **Africa Enterprise Challenge Fund (AECF)** is a private sector fund, backed by some of the biggest names in development finance and hosted by the Alliance for a Green Revolution in Africa (AGRA). Their aim is to encourage private sector companies by offering large grants for new and innovative business ideas. The AECF is open to proposals from all countries in Africa and offers Funding Windows targeted at specific economic sectors (including renewable energy and rural financial services). Each window has a special focus but the overall field is the set of value chains linking rural areas to their local and international markets, in services as well as goods. [52]
- **WISIONS** is an initiative by the Wuppertal Institute supported by the Swiss-based foundation ProEvolution. It was launched in 2004 to promote practical and sustainable energy projects. WISIONS awards small-medium grants to NGOs in developing countries through its annual Sustainable Energy Project Support (SEPS).[53]
- The **Koru Foundation** is a UK based charity that provides a link between companies in the European renewable energy sector and energy poor communities in the developing world. Koru obtain funds from supporters in Europe for local partner NGOs in East and Southern Africa, South Asia and Latin America to implement community based renewable energy projects.[54]
- **Shell Foundation** is an independent charity created by Royal Dutch/Shell to provide capital in the form of grants or soft loans for a range of socially responsible projects all over the world. The Shell Foundation has six programme areas; including **Aspire** which helps small and medium enterprises in Africa with business development assistance and risk capital.[55]

4.7. Carbon finance

Carbon markets are a space where buyers and sellers come together to trade a commodity – greenhouse gas reductions.[56] Projects that mitigate carbon emissions may be able to benefit by selling the savings as carbon credits to make the project more viable. There are two primary carbon markets:

- The larger **compliance market** comprises of buyers (including business and governments) who have to comply with legal caps on the total amount of carbon they can emit. The mandate comes from international agreements such as the Kyoto Protocol and EU Emissions Trading Scheme;

- The smaller **voluntary market** comprises of companies, individuals or governments who voluntarily purchase carbon credits (known as Verified Emission Reductions) to offset their own carbon emissions.

The voluntary carbon market is growing rapidly and has supported small scale renewable energy projects that contribute to pro-poor outcomes. It has however generated a great deal of controversy. Many observers consider it to be a distraction from the task of reducing worldwide emissions, perpetuating business-as-usual by enabling people to salve their conscience as they continue to pursue their high-carbon life-styles.[56]

There are also practical difficulties in ensuring that delivering carbon reductions is profitable and not weighed down by a bureaucratic verification process. If carbon finance is to be considered it is critical that it is addressed early in the business planning process as it can take a very long time, and generally revenues arrive well into project operation, meaning that capital must usually be raised elsewhere.

Carbon Finance Africa is a website which aims to facilitate and stimulate the carbon sector in Africa. It does this through an innovative matchmaking facility which assists project developers in finding financial partners and their counterparts in sourcing carbon projects in Africa. The website includes general information on climate change and carbon finance as well as country-specific information on the investment climate and carbon finance in South Africa. The website is currently focused on South Africa, the biggest carbon market in Africa to date, but aims to include other high-potential countries.[57]

5. Monitoring and evaluation

Renewable energy projects aim to improve the economic, social and environmental conditions of beneficiaries. Monitoring and evaluation (M&E) are important management activities to measure progress and success of a project. Successful M&E can enable reflective organizations to design projects that are effective and efficient in meeting their development aims. The need for M&E is general to all projects and a formal requirement of many donors.

Project teams developing M&E schemes for energy projects face some specific challenges and difficulties, as compared to other types of projects, for instance water, agriculture, health or education projects because:

- Energy services are necessary in the production of food, clothing, health services, etc. As a result, the **causal chain** leading from energy to an improvement in people's lives is often longer and more complex than for other projects.
- Energy services often bring improvements in several areas. For instance electricity can be used to pump water, to refrigerate vaccines, to weld metals, etc. Thus, M&E for energy projects faces the challenge of **measuring improvements in more than one area**.

- The positive impacts of access to energy often may become manifest many years after the project ends. Thus, reliable M&E for energy must often **extend in time** even beyond the project life cycle.
- The positive effects of energy often require many other inputs. For instance energy can contribute to revenue-generating activities. But for these activities to be created, appropriate raw materials, markets, skills, transportation, etc. must also be available, or made available by other development activities. Therefore, M&E in energy projects must propose a scheme to **attribute the improvements** to the different factors that were present, in order to identify the specific impact of energy. [58]

The Monitoring and Evaluation in Energy for Development (M&EED) guide proposes an approach based on an input-output-outcome-impact analysis approach. Each stage is considered in sequence; indicators and data collection methods are developed alongside potential challenges and peculiarities of each observable.

A wide range of indicators and methodologies are applicable to energy projects. The indicators used are particular to the type of energy service provided, technology used and objectives of the project.

Table 9: Examples of indicators applicable to ICS and micro-hydro projects

Improved cook stoves (ICS) [59]	Micro hydro power for electrification[58]
Fuel consumption (type of fuel, amount of fuel, money spent on fuel, etc.)	Number of clients connected or volume of sales
Cooking practices (type of food, frequency of cooking, etc.)	Continuity of service and voltage stability
Women's workload (time spent collecting firewood, time spent cooking, other work areas, etc.)	Productive activity (new or improved activities) and direct employment
Number of producers / distributors of stoves	Tariff collection rate of users

It is important to focus on gender in M&E since in many developing countries women are particularly affected by lack of accessible and affordable energy services due to their traditional roles, household responsibilities, and low social and political status.[60] Gender considerations should be included in the project design and planning process, and specifically recognized in M&E activities.

Data collected should be disaggregated by gender to determine whether there are differing impacts on men and women. Specific indicators can be gender focused to recognize separate needs and concerns of men and women. They may be quantitative (e.g. number of girls attending school) or qualitative (e.g. attitudes towards cooking tasks). Identification of appropriate gender-sensitive indicators for particular energy projects will depend on an analysis of existing conditions within the target area and an understanding of the differing roles of men and women within that specific culture.[60]

A number of M&E Toolkits have been produced specifically for energy projects in developing countries:

Table 10: Monitoring and Evaluation toolkits

Title	**A Guide to Monitoring and Evaluation for Energy Projects**
Toolkit	Monitoring and Evaluation in Energy for Development (M&EED) International Working Group
Focus	Energy access projects. M&E design at early project stage
Description	This Guide proposes a step by step approach to building project-specific monitoring and evaluation procedures. The Guide also includes thematic modules from electrification from different sources, improved cook stoves and institutional support. They are based on an input-output-outcome-impact approach, with each module looking over the four aspects in sequence. It looks at the relevant indicators and the units where applicable, and point out a certain number of problems or particularities of each observable. The modules simply propose a common framework on which evaluations may be constructed. The guide is intended for projects for which the M&E method has not already been determined by a project donor or stakeholder. The guide was developed by the M&EED Group, as a contribution to the progress of energy access projects.
Title	**Monitoring and Evaluation of the Impact of Renewable Energy Programmes**
Toolkit	Renewable Energy and Energy Efficiency Partnership
Focus	RE projects. M&E design at early project stage
Description	This toolkit describes how to listen to users, take account of their opinions and make them active players in the installation and delivery of renewable energy systems. The approach intends to help practitioners and donors to forge strong 'partnerships' with users rather than let them remain only as 'recipients'. The content of the toolkit is not technology specific. It provides a clarification of participation in monitoring and evaluation processes, design of an M&E system, and the usage of participatory tools and methods. The toolkit addresses, in particular, how social equity can be included in the M&E process.
Title	**Monitoring & Evaluation: Some Tools, Methods & Approaches**
Toolkit	The World Bank
Focus	Generic. Tools, methods & approaches for M&E
Description	An overview of a sample of M&E tools, methods, and approaches, including their purpose and use; advantages and disadvantages; costs, skills, and time required; and key references. The document discusses: • Performance indicators • The logical framework approach • Theory-based evaluation • Formal surveys • Rapid appraisal methods • Participatory methods • Public expenditure tracking surveys • Impact evaluation • Cost-benefit and cost-effectiveness analysis
Title	**Measuring successes and Setbacks. How to Monitor and Evaluate Household Energy Projects**
Toolkit	GTZ. HERA Household Energy Programme
Focus	Household Energy (particularly ICS). M&E planning and implementation

Description	This manual tries to make a case for the advantages of doing comprehensive, rather than bitty and irregular, M&E. It offers advice and ideas about planning and doing M&E and suggests methods for carrying out the various tasks. But first we will explain how to find your way around the sections.
Title	**Gender and Energy for Sustainable Development: A Toolkit and Resource Guide**
Toolkit	UNDP and ENERGIA
Focus	Gender and energy. Section on indicators incorporating gender and energy sensitivity
Description	This toolkit and resource guide outlines the linkages between gender and energy in the context of sustainable development and provides suggestions and materials on how to address energy poverty by integrating gender and energy sensitivity into development programmes, projects, and policies.

6. Summary and recommendations

Renewable energy resources can be a cost effective and responsive resource on which to build rural development. There are a range of mature appropriate RETs that empower people in meeting their energy needs. A range of effective operational models and end-user finance mechanisms have been established and the climate for raising investment finance and working capital is well mapped.

However, decentralised renewables bring with them their own challenges; there is no "one size fits all" answer to renewable energy projects. Practitioners should consider the key dos and don'ts of decentralised renewable energy projects.

DO:

- **Assess energy needs and priorities of end users**. First assess the needs and resources of the beneficiaries, and the available local natural resources. Participation of beneficiaries is essential during the consultation process. Projects should aim to target the priorities of the beneficiaries and meet their basic needs first.

  Women and men may have different energy needs due to traditional gender roles, household responsibilities, and low social and political status; assessment, planning and design activities should include a focus on gender issues.

- **Encourage ownership of the technology.** Participation from beneficiaries during all stages of the project cycle is important in encouraging a sense of ownership and increasing their understanding of the technology; the users should be involved in assessments, planning, implementation and M&E activities. The project should ensure a formal hand over of the technology to the user, user representatives within an agreed governance structure or an operating energy enterprise. It is advisable to do so in writing, stating ownership and responsibilities of the different stakeholders.
- **Build local capacity to operate and maintain the technology.** Proper operation and maintenance (O&M) procedures are essential in ensuring energy technologies can continue to work for their full life. Local capacity to manage O&M is therefore very important. The project needs to consider

who will be responsible for the technology on a day-to-day basis, and in the event of a failure, and the key skills they require. This may be an individual of a household with an improved cook stove, a group of operators of a community micro-hydro system, or a local technical services company. Training programs should be designed to provide hands-on experience and knowledge of regular maintenance tasks, the life span of equipment, where to get spare parts and how to diagnose problems and carry out repairs.

- **Promote productive end-uses.** Productive energy end uses are highly desirable to realize increased benefits from the project. Encouraging diversified and improved livelihoods through the provision of energy can lead to improved economic and social conditions. However, it is important to assess the economic situation of the beneficiaries in order to design an appropriate intervention.
- **Ensure project staff have specific experience with renewable energy.** Many people understand very little about energy, especially about electricity and electricity generation systems. A skilled person is required to promote understanding about the basic principles of energy, costs, investment needs and benefits of RETs. Technical competence is very important in ensuring robust and efficient installations.
- **Use appropriate technologies.** Energy projects should identify technologies that are appropriate in terms of affordability and capacity of local people to operate and maintain. Technologies should be inexpensive to purchase, operate and maintain whilst retaining high quality. This may involve use of locally manufactured or imported technologies. Development of local manufacturing capacity can ensure that skills are developed and spare parts for maintenance and repair are available locally, and encourage local employment. Importing goods can ensure the availability and high quality of products and reduce purchase costs and (particularly true for solar PV panels and products in Africa). This should be determined on a country and project specific basis with respect to the locally available capacity, technology type and project objectives. Ensuring local capacity for continued operation and maintenance is essential for every project.

DON'T:

- **Start with a technical solution**. Do not approach a project with a fixed idea and a technical solution - there is no “one size fits all” technology. First assess the needs and resources of the beneficiaries, and the local natural resources. The full range of technologies should be considered and the most appropriate solution identified with respect to social, cultural, technical and financial aspects. Participation of beneficiaries is essential during the consultation process.
- **Hold pre-conceived ideas of the beneficiaries**. Do not pre-judge what people like or dislike, or what they consider priorities in their development. Organize consultations with beneficiaries’ to discuss their point of view on energy and the project. Do not assume that a community is uniform and harmonious; often rivalries and power asymmetries exist in groups. It is important to understand the social and cultural context and encourage improved relationships. Do not assume that women and men are equally affected by lack of accessible and affordable energy services.

- **Neglect financial sustainability.** A sound financial assessment and plan is critical to sustainability at a project and programme level.
- Operation and maintenance or replacement of parts of RETs requires working capital. An assessment of the beneficiaries' capacity and willingness to pay is important. For larger systems user tariffs may be required to fund O&M; a local organization or enterprise should have the capacity to collect a tariff and manage the funds. Awareness raising may be required to communicate to people why tariffs are important.
- At a programme level, a sustainable financial model is required to enable replication and up-scaling. Diversifying income streams to include product sales can reduce the reliance on grants from donor agencies.

Annex 1: A project planning framework

	Project activities	Comment / tools
Pre-project planning	Beneficiary assessment	Identifying the energy needs and financial resources of the beneficiaries • Rapid appraisal methods (Key informant interview. Focus group discussion. Community group interview. Mini-survey)[61] [62]
	Energy resource availability assessment	Identification of all the potential RE resources and organizational/institutional capacity in the area: • E-mindset energy planning tool. Renewable Energy Resource Assessment.
	Technology assessment	Identifying appropriate RETS that can match the beneficiaries needs and local resources • E-mindset energy planning tool. Matching Energy Supply and Demand. • RETScreen clean energy project analysis software • RE-Toolkit to design and improve RE projects
Project design	Designing an operating modality	Identifying the most suitable operating model and partners: Understand the different modalities; assess capacity of organisation and partners to complete activities; identify objectives of the project. • Different Business Models for Providing Finance to End-Users[41]
	Designing end-user finance mechanisms	Identifying the most suitable end-user financial disbursement scheme • End-user finance strategy checklist[41]
	Project planning	Design of specific project activities. Determine roles and responsibilities of project stakeholders. • Work plan • Budget [63] [64] • Gantt charts • Logical framework [61] • Participatory Monitoring and Evaluation tool (Chapter 4) • Gender mainstreaming toolkit[60]

	Obtaining funds for project activities	Determining the appropriate types and sources of finance and obtaining funds • Business plan [63 64] • Financial assessment [63 64]
	Establishing the management infrastructure	Formulate agreements and assign staff: • Recruiting • Terms of reference • Contracts
Project implementation	Capacity building	Capacity building of stakeholders through trainings and workshops. **Staff and local partners:** Technology awareness. Project activity skills. Defined roles and responsibilities. Empower with resources. Introduce management systems. **Beneficiaries:** Technology (operation and maintenance). Organizational development (for community based organizations). Financial management.
	Implementing project activities	Implement project activities designed in project planning stage
	Monitoring and evaluation	Continued monitoring of project activities. Possible mid-project evaluation (Chapter 4).
Post-project	Evaluation	Evaluation of the project with project stakeholders (Chapter 4).
	Information dissemination	Knowledge sharing and policy advocacy

Annex 2: A financial planning framework

A robust business or project plan is the fundamental roadmap for a new business or project. A good business or project plan will do the following:

- Shows that the proposed business is a serious initiative, undertaken by capable entrepreneurs who understand and have control of the essential elements that will ensure success;
- Increases the chances that an entrepreneur will be able to attract investors, lenders, partners, strategic allies, suppliers and key staff;
- Forces the entrepreneur to collect, in one place, all of the thinking and research that has gone into the development of a proposed business.[63]

A business or project plan includes elements on all aspects of the operation, including a financial plan. Preparing a financial plan is a major undertaking requiring skilled personnel. This section aims to provide an introduction to the elements of a financial plan; linked resources should be studied for more detailed information on how to prepare a financial plan.

A financial plan is a key management tool for planning, monitoring, and controlling the finances of a project or organization. It estimates the income and expenditures for a set period of time for your project or organization. Your budget can serve a number of important purposes, including:

- Monitoring the income and expenditures over the course of a year (or a specific project time frame)
- Helping to determine if adjustments need to be made in programs and goals
- Forecasting income and expenses for projects, including the timing and the availability of income (such as additional grant funds)
- Providing a basis for accountability and transparency.[64]

Elements of a financial plan include a Budget, Balance Sheet and Cash Flow Statement. The Budget identifies main income and expenditure streams for the project. The Balance Sheet is a presentation of what your business owns (assets) and what it owes (liabilities) at a specific date. It is important that assets and liabilities balance for the viability of the business or project. The Cash Flow Statement is designed to explain the change in the amount of cash during a given period. It shows when you generate revenue and whether or not expenses can be paid.[63] The Cash Flow Statement is also required for further financial analysis for methods such as Internal Rate of Return (IRR) and Net Present Value (NPV).

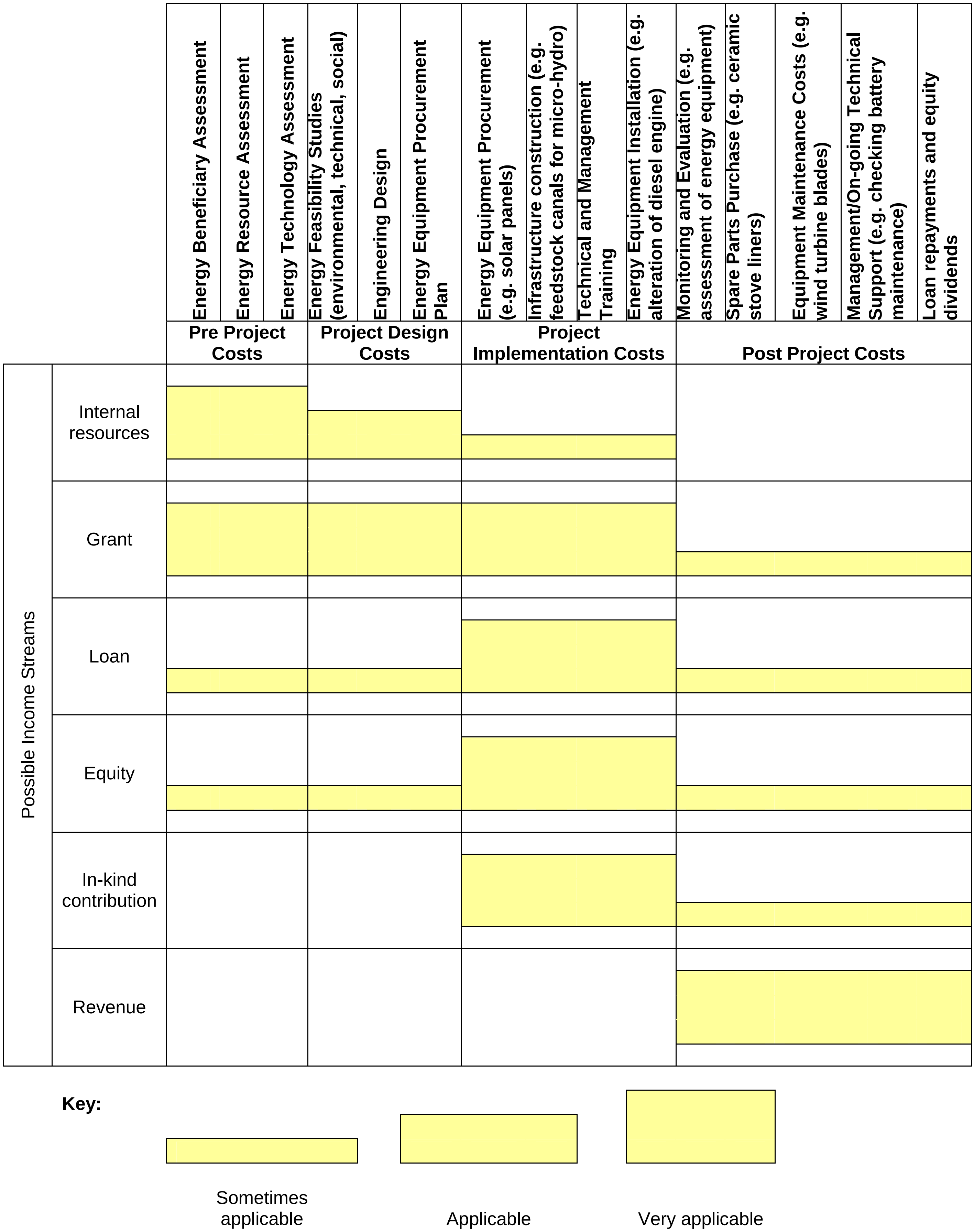
The following table outlines key components to consider when producing a budget for a RE project.

Table 11: Components of a budget.[64]

Component	Description
Income:	All income streams should be included in a financial plan. This may include internal finance, grants, loan, equity, in-kind contribution and revenues. Income may be known or estimated.
Expenses:	Expenses should be itemized and include capital/investment and operating costs, for example, premises, equipment, staff wages and travel. Budget Headings: Make sure that the same budget headings or categories are consistent throughout the organization, for both income and expense items. This will simplify your bookkeeping and help with reporting and financial reviews. Headings may include: staff salaries, rent, utilities, telephones, equipment, insurance, fuel, travel, fees for expert consultants, etc.
Currency:	Be sure to note what currency and exchange rate you are using when presenting your budget to a funder. Some may require you to convert your currency into the US dollars or other currency.
Contingency funds:	Include a line item that will incorporate fluctuation of costs or unexpected expenses.
In-kind (non-monetary) contribution	It is helpful to show the costs or services contributed by your organization (such as salary for the program manager, or labor to construct a facility). Funders see in-kind contributions as evidence of the organization and community's commitment that could lead to sustainability.
Notes:	Keep notes to record the budgeting process. Notes explain how and why budget calculations are made. Combined with the budget, notes can serve as a clear guide for your organization's spending and decision-making. Budget clarity and notes also mean that as circumstances change, revisions to a budget can easily be made to reflect changing realities. It also helps in case the activity is audited.

The figure below describes a possible finance model for an NGO project; with typical project costs and potential income streams. It is designed to help us think about Balance Sheets and Cash Flow Statements throughout the project cycle. Project costs are grouped by project cycle stage (defined in Annex 1). The diagram shows the applicability of possible income streams at different stages of the project cycle. As described in Chapter 4, a project may obtain finance from a single or combination of sources.

Figure 5: Applicability of income streams during the project



Annex 3. References and additional resources

References and additional resources are organised according to their position in the Toolkit. References appear as numbers. Additional resources that are not referenced in the text appear as bullet points. Clickable links are provided where available.

1. Rationale

[1] Energy for the Poor, DFID, 2002. Energy and the Millennium Development Goal, Modi, McDade, Lallement and Saghir, 2006.

[2] Unpublished to date, will be in the Poor People's Energy Outlook 2010, Practical Action/UNDP.

2. Applying Renewable Energy

[3] The Hidden Energy Crisis. How Policies are Failing the World's Poor. PA Publishing. T. Sanchez. 2010

[4] Module 2. Energy Planning. E-mindset. Energising the Millennium Development Goals - Setting the Enabling Environment in Southern Africa. 2009

- Moduel 1. Introduction to Energy. E-mindset. 2009

2.1. Biomass energy technologies

[5] Charcoal in Africa. Importance, Problems and Possible Solution Strategies. GTZ, 2008. Dr. A Seidel.

- www.biocoal.org/3.html Low-cost retort kiln called "adam-retort" or ICPS (Improved Charcoal Production System)

[6] Appropriate mud stoves in East Africa. Practical Action East Africa. 1997. S. Gitonga.

[7] Carbon Markets for Improved Cooking Stoves. A GTZ guide for project operators.2010.

[8] www.snvworld.org

[9] Sky Link Innovators, Kenya. www.ashdenawards.org/winners/Skylink10

[10] Africa Biogas Partnership Programme. www.snvworld.org

Case study one – Sustainable charcoal production:

- Policy Information Systems for Clean Energy Security (PISCES)
- World Agroforestry Centre

Case study two – Improved Cook Stoves:

- GTZ Household Energy Programme HERA
- HEDON Household Energy Network
- APROVECHA
- www.bioenergylists.org
- www.aprovecho.org

2.2. Solar energy technologies

[11] www.swera.net

[12] RETToolkit: A Resource for Renewable Energy Development. World Bank. 2008.

[13] Rural Energy Foundation www.ruralenergy.nl

[14] Practical Action Technical Brief. Batteries

[15] D.light www.dlightdesign.com

[16] Practical Action Technical Brief. Solar cooking and health

[17] Practical Action Technical Brief. Solar Drying

[18] Practical Action Technical Brief. Evaporative cooling

Solar energy suppliers in Africa	
Kenital Solar Energy	Range of solar PV products and auxiliaries
	Nairobi, Kenya www.kenital.com
Madison Solar Engineering	Range of solar PV products, auxiliaries and solar cookers
	Zimbabwe www.madisonzim.com
Solarman Company	Range of solar PV products and auxiliaries
	Khartoum, Sudan www.solarmanco.com
More suppliers and links	Practical Action Technical Brief. Solar Photovoltaic Energy

2.3. Water energy technologies

[19] Practical Action Technical Brief. Micro-hydro power

[20] Electricity Services in Remote Rural Communities: The Small Enterprise Model. Practical Action Publishing. T. Sanchez.

[21] The Hidden Energy Crisis. Practical Action Publishing. T. Sanchez.

[22] www.aidfi.org. Alternative Indigenous Development foundation Inc.

- Practical Action Technical Brief. Hydraulic Ram Pumps

[23] PAC / UNDP. Mechanical Power

Case study three – micro-hydro power:

- Practical Action website

2.4. Wind energy technologies

[24] Practical Action Technical Brief. Energy from the wind

[25] www.swera.net

[26] Hugh Piggot www.scoraigwind.com

[27] BlueEnergy

[28] Practical Action Technical Brief. Wind Power for Electricity Generation

[29] www.wind-works.org

[30] Practical Action Technical Brief. Wind pumping

2.5. Human powered water pumping technologies

[31] Water Aid. Technology Notes www.wateraid.org

[32] Practical Action Technical Brief. Human and Animal-Powered Water Lifters for Irrigation

[33] Kick Start www.kickstart.org

[34] International Development Enterprises www.ideorg.org

2.6. Liquid fuel technologies

[35] Practical Action Technical Brief. Diesel Engines

[36] Practical Action Technical Brief. Liquid Biofuels

[37] www.undp.org/energy

Case study five – multifunctional platform:

- www.malifolkecenter.org/

3. Investment finance and end-user finance

3.1. Investment finance for an NGO or enterprise

[38] Investment: A guide for sustainable energy enterprises and NGOs. D. Irwin. Ashden Awards. 2009.

[39] Financing options for renewable energy and energy efficiency. AFREPREN

[40] Grameen Shakti

3.2. Operational models

[41] End-user finance: A guide for sustainable energy enterprises and NGOs. Arc Finance Ltd. Ashden Awards. 2009

3.3. End-user finance mechanisms

[42] Financing Renewable Energy Projects. A guide for development workers. Intermediate Technology Publications. 2007.

- www.grameen-info.org
- www.selco.org

4. Project funding sources

4.1. International multilateral agencies

[43] www.sgp.undp.org

[44] www.areed.org

[45] www.climateinvestmentfunds.org/cif/srep

[46] www.climatefundsupdate.org/listing/scaling-up-renewable-energy-program

4.3. National institutions

[47] www.eandco.net

[48] www.acumenfund.org

[49] www.sef-directory.net

4.6. Foundations and charities

[50] www.ecobank.com

[51] www.goodcap.net

[52] www.aecfafrica.org

[53] www.wisions.net

[54] www.korufoundation.org

[55] www.shellfoundation.org

- www.fondation-poweo.org
- www.greenempowerment.org
- www.gvepinternational.org

4.7. Carbon Finance

[56] Making the voluntary carbon market work for the poor. A. Chapple. 2008. Forum for the Future.

[57] www.carbonfinanceafrica.org.za

- www.mdgcarbonfacility.org

5. Monitoring and Evaluation

[58] A Guide to Monitoring and Evaluation for Energy Projects. Monitoring and Evaluation in Energy for Development (M&EED) International Working Group.

[59] Measuring Successes and Setbacks. How to Monitor and Evaluate Household Energy Projects. GTZ. HERA Household Energy Programme.

[60] Gender and Energy for Sustainable Development: A Toolkit and Resource Guide. UNDP and ENERGIA. 2004.

[61] Monitoring and Evaluation: Some tools, methods and Approaches. World Bank. 2002.

Annex 1. A project planning framework

[62] *Rapid Appraisal Methods*. The World Bank, Washington, D. C. K. Kumar (1993).

Annex 2. A financial planning framework

[63] The Business Plan. AREED Toolkit: A Handbook for Energy Entrepreneurs. African Rural Energy Enterprises Development (AREED).

[64] Budgeting. The Social Development Civil Society Fund (CSF). The World Bank.

Other available toolkits

- RETToolkit: A Resource for Renewable Energy Development. World Bank. 2008.
- AREED Toolkit: A Handbook for Energy Entrepreneurs. African Rural Energy Enterprises Development (AREED).
- Rural Energy Enterprise Development (REED) Entrepreneur Toolkit. A Handbook for Energy entrepreneurs. USAID.
- Community Renewable Energy Toolkit. Scotland Government Publication.
- Sustainable Energy Regulation and Policymaking for Africa. Renewable Energy and Energy Efficiency Partnership

Other resources and networks available online:

- https://practicalaction.org/practicalanswers Technical information for development. A wide range of downloadable Practical Action appropriate technology Technical Briefs plus a Technical Enquiry service.
- http://www.practicalactionpublishing.org Practical Action Publishing builds on the skills and capabilities of people in developing countries through the

dissemination of information via book and journal publishing. It operates a worldwide mail-order service, and hosts the Development Bookshop online.

- PISCES. The Policy Innovation Systems for Clean Energy Security (PISCES) is a five year initiative funded by the UK's Department for International Development (DfID). PISCES is working in partnership with Kenya, India, Sri Lanka and Tanzania to provide policy makers with new information and approaches that they can apply to unlock the potential of bioenergy to improve energy access and livelihoods in poor communities.
- EnergyDev is a network for promoting dialogue and exchange of knowledge and skills to deliver sustainable energy systems and services. We encourage integrated thinking about all types of energy usage, from hydrocarbons to solar to biomass.
- GVEP International (Global Village Energy Partnership) is an international non profit organisation seeking to reduce poverty through accelerated access to modern energy services. The GVEP International aims to connect its wide network of partners to facilitate delivery of the finance, skills and knowledge they need to provide sustainable modern energy services in rural and peri-urban areas of the developing world.
- ENERGIA is the international network on gender and sustainable energy, founded in 1996. ENERGIA works in Africa and Asia through and with regional and national gender and energy networks. They work from the contention that projects, programmes and policies that explicitly address gender and energy issues will result in better outcomes, in terms of the sustainability of energy services as well as the human development opportunities available to women and men.
- HEDON Household Energy Network. The HEDON website connects practitioners, policy-makers, funders, and business-owners actively pursuing a cleaner, affordable and more efficient household energy sector unite to share their experiences, learn from one another, and create new knowledge.
- REEEP Digital Library. The Renewable Energy and Energy Efficiency Partnership (REEEP) digital library offers an array of information in the field of Renewable Energy and Energy Efficiency. These range from policy papers and case studies to presentations that are produced by REEEP funded projects spanning the entire globe. New information is added regularly.
- Ashden Awards. Knowledge Centre and Case Study Database.
- Increasing Energy Access Through Enterprise. This USAID resource presents information and tools that help small and growing energy service enterprises.
- HERA. GTZ Household Energy Programme.
- Tips for Civil Society Organisations. Social Development civil Society Fund. The World Bank. 2007

Toolkits / Manuals available on the SALT PPE site:

- Appropriate Household energy Technology Development: Training Manual – ITDG

- Mini Grid Design Manual.
- REED Toolkit: A handbook for energy entrepreneurs: UNDP
- Renewable Energy Toolkit: World Bank
- Renewable Energy services for developing countries: Recommended practise and key lessons: IEA International Energy
- Lighting Africa financing guide (household small scale solar)
- Using micro finance to expand access to energy services (SEEP)
- Gender and Energy Toolkit
- GTZ Stoves marketing toolkit