A Guide for Entrepreneurs on Income Generating Activities: Applications of Clean Energy Technologies for Productive Uses

October 2002

Prepared by

Financed by:

A Guide for Entrepreneurs on Income Generating Activities: Applications of Clean Energy Technologies for Productive Uses

October 2002

Table of Contents

Introduction

Energy improves the quality of people's lives by providing lighting, clean water and healthier cooking methods. Clean energy improves the environment and health by replacing dirty fuels or wood usage. Finally and perhaps most important energy can be used to stimulate economic activity. Energy can be used to improve production resulting in income generation

This manual focuses on income generating activities incorporating clean energy technologies. The first chapter defines income generating activities. The second chapter outlines technology options and applications of clean energy technologies for productive uses. The third chapter is designed to stimulate an entrepreneurs' thinking on how to expand his or her business by promoting income generating activities in the market. The thesis is that promoting income generating activities will result in increased spending power by customers thereby increasing the entrepreneur's customer base and revenues. The fourth chapter describes E+Co's Productive Use Container concept and experiences.

I. Income Generating Activities Defined

When jatropha oil is used to power a grinding machine to produce grain more efficiently…
When solar PV powers lighting to extend a tailors workday…
When animal waste produces gas for cooking in a rural restaurant…

For our purposes, an income generating activity, also known as a "productive use activity" is defined as the use of energy to produce income. This manual is specifically focused on the incorporation of ***clean energy*** for income generating activities.

Examples of increased income generated from the incorporation of a specific clean energy technology abound, consider an entrepreneur who purchases a solar powered grinding machine to grind corn. The biodiesel (jatropha) driven machine allows the entrepreneur to efficiently grind more cornmeal resulting in an additional amount of cornmeal sold and an increase in income.

It is important to note that this manual's definition does not cover any use of energy, which contributes to the development of communities or improvements in the quality of life. Hence, uses of energy such as lighting for schools does not fit the definition above, unless the schools organized a revenue generating activity, such as offering night classes or setting up a "community movie business".

Income Generating Activities:
Use of clean energy to produce an income.

Why the focus on income generating activities?

People who currently do not have access to modern energy services, "the energy poor," need such services to improve their standard of living. People currently spend money for candles, batteries, and wood. They also devote valuable human resources – the time to collect wood -- in order to meet their energy needs. Often, these traditional forms of energy are not only costly from an economic perspective, but also harmful to the local environment.

Many people in the rural areas cannot access clean reliable energy and often cannot afford the prohibitive upfront costs. Opportunities to increase economic activities must be especially promoted in these areas.

Productive uses of energy generates revenue to help cover the costs of the equipment, reduce the financing risk, and increasing the penetration of clean energy technologies.

II. Technology Options and Applications

Annex 1 provides a summary of solar, wind, biomass/biogas and geothermal energy technologies for generating electricity and energy. A summary of the technologies are listed below.

Clean Energy Technology	Description	Potential Uses
Solar PV	Photovoltaic (PV) energy technology involves the direct conversion of sunlight into electricity by means of a solar panel. A panel consists of a number of solar cells electrically connected to each other and mounted in a support structure or frame. The electrical output is dependent on the level of sunlight that falls on the panel.	• **Solar Water Pumping** • **Lighting to expand business hours** • **Generate electricity to power small applicances/tools** • **Electric Fences** • **Telecommunications** • **Water Desalination** • **Cooling**
Solar Dryers	Solar thermal energy systems capture the sun's energy and convert it into a manageable source of heat. The heat can be used directly or indirectly.	• **To dehydrate agricultural products resulting in a longer shelf life.**
Biomass/Biogas	Plant or animal matter is used directly as a fuel or converted into gaseous or liquid fuels. Biomass typically refers to agricultural or municipal organic waste, forestry byproducts, wood or process waste or special purpose energy crops. Biogas can be sourced from animal waste, municipal waste landfill and sewage treatment or by pyrolysis of straw, risk husks and other residues.	• **Biogas generated from animal waste can be utilized for cooking for restaurants, laundering, etc.** • **Electricity to power various income earning activities.**
Wind and Wind Hybrids	The wind is used to drive a rotor (blades) that is connected through a power shaft to an electric generator. As wind speed increases with height above the ground, wind turbines are mounted on towers. The amount of energy a wind turbine produces depends on the wind speed and the diameter of the rotor.	• **Water pumping** • **Electric fencing**
Geothermal	In geological zones that have been volcanically active, steam and/or hot water can be extracted through deep wells to provide a direct or indirect heat source for electric power generation. The available heat can also be used for process steam, drying or general heating requirements.	• **Drying fruit products**

Applications and Enterprise Examples

With access to energy, the opportunities to create sustainable businesses, increase income and improve the quality of life are large. Below are examples of some businesses, which incorporate clean energy technologies:

- **Tele-Boutiques**: advances in telecommunications technology makes starting a small tele-comm business possible. An entrepreneur can establish a single line, voice only telephone line and a high speed, internet cable with a solar powered satellite connection and charge for phone calls and internet access. The business can easily expand as the number of customers grow.
- **Ice making, cooling or refrigeration to preserve products**: having the means to keep food cold provides business opportunities. Perishable products can be transported longer distances to market and can be preserved additional periods of time for sale. This is especially important for fisherman. An entrepreneur selling solar equipment can promote the solar cooling equipment to his/her clients.
- **Water Pumping/Irrigation**: water is essential not only for drinking but for agricultural production. To increase agricultural production, farmers can install solar water pumps to provide reliable, stable sources of water. An entrepreneur selling solar home systems can introduce the water pumping products to farmers and can approach community councils on establishing a community water business. A business can also be established selling water to households.
- **Corn Meal**: jatropha seeds can be pressed into an oil to run a grinding machine or small motor. An entrepreneur can establish a community-grinding mill and charge farmers a fee for grinding the corn and other products.
- **Fruit Drying**: fruit, vegetable and meat products can be dehydrate to be sold year round, even after the growing season has ended. Drying fruit products minimizes the waste of fresh products not sold, provides a market for products unsuitable for sale (due to bruising, etc) and provides food products year round. Fruit, vegetables and meat can be dried using solar dryers or heat generated from geothermal resources..
- **Cattle, Buffalo or Goat Raising:** a rancher can improve the production of beef or dairy products by controlling the feed of his animals. Solar electric fences can be installed on a farm to manage how much and what the animals eat. A controlled diet results in a higher quality and greater quantity of product.

USISS, Mali

Solar dryers are used to dry meat, onions and mangos. The mangos are dried and sold after the fresh harvest season. The onions are dried and can be used as a meat seasoning or as a base for a soup and in sauces. The solar dryer is a simple, affordable technology developed by university students and manufactured locally.

Solar Panel is connected to an electrifier that powers an electric fencing system.

Buffalos grazing in controlled, intensive rotational grazing. Increasing their weight, and productivity while conserving nature by using less pasture as well as playing a role in eliminating invasive species.

IDEAAS – Quiron Project – incorporates solar powered electric fences into buffalo raising and increases productivity of mozzarella cheese by over 149%.

Red Ceramics Manufacturer in Bolivia: the organization switched fuel sources from used oil and sawdust to natural gas to preserve the jobs of the workers (factory closing was threatened for environmental reasons), improve the quality of bricks resulting in increased earnings and establish a healthier work environment.

III. Incorporating Income Generating Activities into A Clean Energy Enterprise.

For developers of clean energy services, incorporating productive uses into your market can be critical to the sustainability of your business. It can mean the difference of a customer being able to afford your services or not. By incorporating income-generating activities among your customer base, you can enhance the economic sustainability of your business in three ways:

- ***Increased number of customers*** – The success of a business depends on a sufficient number of households having enough disposable income to buy a service. By encouraging income generating activities for households with currently low disposable incomes, the customer base is being expanded.

- ***Increased sales relative to cost of operations in a given market*** – Promoting income generating activities may allow the distribution of fixed costs over greater sales. Concentrating sales in one community, for example, and servicing various customers with different products will result in increased sales with only incremental increase in operating costs compared to selling only one product in four or five communities.

- ***Risk reduction*** – An income generating activity can reduce at least two sources of risk to a clean energy business. First, customers with increased income will have a greater ability to make regular payments for services. When customers don't pay their bills, an entrepreneur is faced the difficult choice of repossessing equipment or discontinuing service. Nonpayment for any business is a concern. An income generating activity can mitigate this risk.

  Second, by diversifying products and services among different types of applications (household uses, income generating activities, community uses), the dependence on any single source of revenue is reduced. The more revenue flows can be diversified, the less vulnerable you are to external factors that affect revenues (such as poor weather affecting farmers' disposable income).

How do you assess the implications of income generating activities for your business?

As an entrepreneur develops a business plan (for assistance in preparing a business plan, see E+Co's Toolkit at www.areed.org), the market assessment should evaluate the application of income generating activities.

Initial questions to ask:

What activities employ the majority of the local population?

How could energy increase the productivity and income of those businesses, farmers or individuals?

What services do the local population need? What services do they desire?

What is the most viable form of energy that can be introduced to improve the productivity of local businesses and service the needs of the local population?

In addition to the energy source, what equipment is needed? What, if any, financing sources exist for the clean energy equipment and non-energy equipment?

Scenario 1: Meeting telephone needs of a Rural Community

An entrepreneur is distributing telecommunications equipment and many rural community members have inquired about his equipment but cannot afford the upfront cost. The entrepreneur approaches the local shop owner of a small restaurant and suggests he establish a tele-boutique to service the community's telecommunications needs. He could offer to partner with the owner for a percentage of the fees earned.

Scenario 2: Apiculture(1) Production Improvements

A primary industry in a rural area of Alagoas, Brazil, is bee production. Incorporating solar drying and solar heating into the bee process results in a higher quality price and increased revenues. An entrepreneur selling solar PV equipment could approach the bee keeper to introduce him to the solar heating and drying process.

1 Apiculture refers to bee and pollen production and harvesting.

Tables 3 and 4 present common productive uses and their impact on individual and community increases in income.

Table 3
Income-Producing Uses of Electricity

PRODUCTIVE USES BY CATEGORY	BENEFIT TO CUSTOMER FROM PROVISION OF ELECTRICITY	HOW USE AFFECTS CUSTOMER'S ABILITY TO PAY FOR ELECTRICITY
AGRICULTURE/LIVESTOCK		
Water-pumping for crops and animals	· Decreased labor time relative to hand pumping · Improved health of crops and livestock · Increased area of cultivation or number of animals	Increased revenues from increased agricultural production
Grinding, pressing, shelling	· Decreased labor time relative to processing by hand · Ability to process larger quantities · Increased quality of product	Increased income from higher output and higher quality
Drying	· Decreased drying time · Less spoilage · Increased quality of product	Increased income from reduced losses from spoilage and more value added
Electric Fences	· Improved control of feed for animals · Less spoilage of grazing areas due to rotational grazing · Increased protection of livestock	Increased income by production of higher quality product due to improved digestion of animals.
Refrigeration	· Increased quality of product · Increased allotted time from collection to market	Increased income by timing delivery of produce to market
Communications	· Direct sales to distant merchants through phone connection · Better knowledge of markets through internet/email connection · Information on latest technologies and processes through internet connection	Higher price for product from improved market information
SMALL BUSINESS		
Wood, metal, textile	· Increased rate of production from power tools · Improved quality and consistency of product · New services and products	Increased income from higher output and quality
Entertainment	· New business from playing music and videos · No generator noise	New source of income
Lighting	· Open more hours · Attracts night business · Increased security and visibility	Increased income from longer business hours
Communication	· Direct sales to distant merchants · Better knowledge of markets · Information on latest technologies and processes · Sales of communications services	Increased income from new markets and eliminating middlemen Income from new business
Food	· Decreased spoilage and cold drinks from refrigeration/freezing	Increased income from sales of new food items

	from refrigeration/freezing · Decreased preparation time and effort · Greater selection of menu items from toasting, blending, mixing	
TOURISM/RECREATION/COMMERCIAL		
Lighting	· Greater comfort of customers from elimination of generator noise	Increased income from more customers
Cooking	· Substituting a higher cost fuel for a cleaner source.	Reduced operating cost from different cooking process.
Communication	· Enhanced customer services from phone and internet	Increased income from more customers
Entertainment	· Greater range of offerings from ability to play music and videos	Increased income from more customers
Heating	· Enhanced comfort of customers by providing space heating and hot water	Increased income from more customers

In addition to thinking about individual income generating activities, a community as a group may need services.

Table 4
Community Uses of Electricity

COMMUNITY USES	**BENEFIT TO COMMUNITY FROM PROVISION OF ELECTRICITY**	**HOW USE AFFECTS COMMUNITY'S ABILITY TO PAY FOR ELECTRICITY**
Water	· Improved health from safe water from pumping or purification	Improved health leads to higher productivity from less time caring for and being sick
Lighting	· Street lighting leads to greater sense of security and status	Increased status of community leading to more traffic and business passing through
Communication	· Telecommunication services results in greater connection with relatives and friends, faster response to emergencies, better information about outside events that affect community life	Reduced need to travel outside community increases stability of customer base
Health	· Health care improved by clinics after dark and vaccines being refrigerated	Improved health leads to higher productivity from less time caring for and being sick
Education	· Better education for children and night classes for adults through lighting and communications	Increased education improves income potential

How do you attract customers with an income generating activity?

- ***Marketing***

First you must identify the customers that will benefit from the income generating activities. These may be business people, crafts-persons, NGOs, farmers, ranchers, or even the community as a whole. In order to attract people in your market area with potential productive uses for electricity, you need to convince them that they can increase their income from becoming customers. You will need to show how a given productive use affects their income or ability to pay for electricity. Table 3 gives several examples of how income generating activities enhance customers' ability to pay for electricity.

Once you have identified the potential productive uses in your service area, you can work to integrate them into your business plan. For existing processes that can be improved through the use of energy, you should work with the target customers to show them the benefits of electrification. The method you use will depend on the customer but important points to raise are:

- how the value of their business will be improved through increased quality or quantity of product?
- how this will increase their income by more than the cost of your services/product?

You can also work with them to acquire financing they might need as discussed below.

- ***Providing financial and other assistance***

For income earning activities that seem appropriate for your market but are not yet present, you must find candidate entrepreneurs and interest them in the potential income to be generated from the new activity. For ventures that are close to your own experience and expertise, you may want to consider starting a new enterprise activity.

If productive uses are critical to the sustainability of your business, you may decide to play a role in financing them. This role ranges from providing information to users on how to obtain financing, to incorporating the financing in your business operations. For community applications, you may need to identify government or international sources of financing.

For community and some productive applications, you may need to identify potential sources of support in relevant sectors. There may be government or private programs to support agricultural development, handicraft production, women's education, street-lighting, local health clinics, refugees from natural disasters, etc. Any source of support for specific activities that need electricity would need to be coordinated with support for electricity production itself.

Worksheet 6 is intended to help you understand the implications of productive uses for your business.

Worksheet 6
Implication of Productive Users

Question	Implications for your business
Given the productive uses you have identified in your market area, what are the potential added revenues and risk benefits for your business from productive uses of electricity in your market area?	
What additional requirements, if any, do productive uses impose on the services you plan to provide?	
What, if any, role is needed for your business to help finance productive uses?	
How can you structure payments for community and income-generating applications within the rural community so that their benefits and costs are fairly distributed?	

For help filling out this worksheet see Table 3.

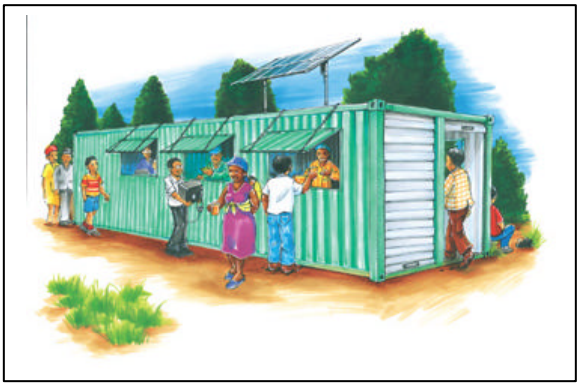
IV. Productive Use Container

E+Co specializes in the financing and support of modern energy-based enterprises in developing countries. With an extensive portfolio of 60 investments in 34 countries we have come to learn the needs of the energy poor, how to solve them and in doing so, contribute to the development of sustainable communities. A sample 24 E+Co enterprises provides clean energy to over 200,000 people in 15 counties…and counting. The Productive Use Container (PUC), an approach to packaging economically viable microenterprises, and model business plans was borne out of E+Co's commitment to promoting entrepreneurship in the developing world. The PUC succinctly captures the E+Co approach, linking sustainable energy initiatives with income generating opportunities. The PUC was showcased at the World Summit on Sustainable Development (WSSD) and is now being tested.

While the nature of the businesses and their locations may vary, all support the E+Co principle of putting energy to work. The PUC is no different, utilizing energy for the promotion of entrepreneurship.

The productive use container (PUC) pictured below is an integrated, remote business platform developed to promote rural enterprise in under-resourced areas. Developed in South Africa, the PUC represents an innovative contribution to the field of productive use and a positive endorsement of the capacities of renewable energy.

The PUC design includes five micro-businesses, all self-contained, which are powered by a photovoltaic electricity system. The use of a freight container was motivated, in part, by the obvious infrastructure that exists for transporting containers across South Africa, as well as their availability and relative ease of conversion.



While over a third of the world's population does not have access to modern energy services, the challenge faced is not simply the expansion of these services but, rather, the linking of this process with income generating opportunities. Access to energy services implies that such services are affordable. For many households in the developing world, this is simply not the case. The PUC represents an initiative that is designed to render access – and opportunity – more affordable by making an explicit link between energy and income generation.

All too often, the link between energy and socio-economic development is implied rather than empirical. The PUC illustrates this relationship in a far more pragmatic and tangible way. Using photovoltaic (PV) electricity, the PUC has the capacity to power a range of electrical applications that would otherwise be very expensive, if not impossible, to

operate in the unelectrified areas that the PUC targets. These electrical applications form the basic mechanics of the businesses that have been developed for the PUC.

The selection of businesses to occupy the Productive Use Container (PUC) was made on the basis of an identified set of priority areas for business intervention in Developing Countries. In addition, the range of businesses represented, demonstrate the applicability of the PUC to different sectors of the small business economy. The businesses include:

Juice shop: Food-processing offers a value adding opportunity that contributes to the reduction of post-harvest losses in the Developing World. The juice shop utilises locally grown, surplus fruit in its operation.

Cellular phone shop: Telecommunication technologies need to be extended to remote regions in developing countries. Improved communication can play a significant role in business, education, health and civic development initiatives.

Electrical repairs and technical support shop: The expansion of energy services in rural areas requires sufficient technical support in order to achieve sustainability. Improved energy services have been identified as key socio-economic and environmental development indicators.

Business services: The development of business support services will contribute to the necessary service infrastructure that broader economic growth requires.

Barber: Modern energy services can benefit the social service sector by offering greater diversity of applications and promoting energy efficiency.

Consideration was given to the appropriate business mix, ensuring that each business would profit from a degree of co-dependency. Additionally, the consolidation of businesses within one container promotes opportunities for opportunistic consumers, as opposed to having to appeal directly to conscious needs.

The challenge to promoting enterprise in the developing world is, at least in part, being able to recognize the set of obstacles that entrepreneurs face. While the provision of secure premises and a reliable energy supply certainly addresses some of these needs, there are a myriad of other issues, financing and business development assistance included, which need to be considered if such initiatives are to be sustained.

The PUC is a turnkey development that acknowledges the holistic requirements of enterprise development. Integrated into the PUC plans are a package of financial services that offer crucial support for the aspirant entrepreneur. Business plans, including projected cash flows, have been developed for each of the PUC's businesses, entrepreneurs will receive on-going enterprise development assistance and financing is available directly from E+Co. Integrated support services places the PUC concept in a better position to address the barriers impeding entrepreneurial development in the Developing World.

The PUC was developed out of a used shipping container. The container is 12 meters in length, 2.4 meters wide and 2.6 meters high and weighs some 4 tons. The picture shows the container being delivered to a site in Pretoria where the modifications were made.

Floors plans and shop designs developed by E+Co provide the basis for the conversion of the container into a PUC. The floor plans of the businesses were designed to maximise space and, in doing so, lower the proportional set-up costs of the respective businesses. Serving hatches and roll-up doors are just some of the design attributes geared towards this end.

Modifications were extensive as the purpose of the container slowly transformed from cargo transit to an integrated business centre. Windows, hatches, air vents and doors were cut and installed. Steel partitions were created to separate the businesses and shelving and work surfaces were fitted.

With a fresh coat of paint, the PUC starts to emerge out of the container. Canary yellow was chosen to ensure the PUC stood out like a beacon at the World Summit on Sustainable Development. Productive use would have its stage *and it would be pure gold.*

The PUC was delivered to the Ubuntu Village at the WSSD where it became an operational and living exhibit. The PV system was installed during the conversion of the container. Boards providing a brief explanation of each of the businesses were mounted on the container. Students were employed to operate the businesses for the duration of the summit.

A side view of the barbershop and the juicer at work.

A 1000Ah of storage capacity will ensure the system has sufficient power for at least four days without relying on incoming power through the modules. The regulator, inverter and contingent electrical components are mounted in the electrical repairs shop. The business plans have been developed around the proprietor of this business owning the system and selling power to the other businesses within the container. The Container is an example of a physical set up. Such a clean micro-enterprise business center could also exist in small rural traditional structures.

The importance of the PUC's contribution to the productive use field lies in its progress from conception through to implementation. Productive use research is all too often academic and detached, resulting in very few concrete projects and programmes capable of applying the paper assumptions that prevail. Indeed, the PUC's greatest success is that it will contribute to entrepreneurial development rather than merely acknowledge a need for such initiatives.

The greatest challenge in the productive use sector is to move beyond the idea phase and commit to projects and programmes that can promote livelihoods on the basis of the provision of sustainable energy services. The need for productive use projects has been acknowledged and the productive capacities and limits of energy sources are understood; it is now a time for action. The PUC, like all initiatives, started as an idea yet that idea has grown into a livelihood for five families. This challenge is, at the same time, the greatest reward.

The PUC will be implemented in northern KwaZulu-Natal, a province on the eastern seaboard of South Africa. A six-month monitoring and evaluation period will follow where the concept and functional requirements of the PUC will be assessed and refined. The objective is to replicate, in partnership with other development organizations and funding agencies, the PUC on an international level.

Annex 1 - Resources

Clean Energy Technologies

Solar PV:

- http://www.shell.com
- http://www.raps.co.za
- http://www.fsec.ucf.edu/PVT/index.htm
- http:// www.eren.doe.gov/pv
- http://www.pvpower.com
- http://www.solarpv.com
- http://www.sunlightpower.com/upvg/pv_what.htm

Hydropower:

- http://www.geocities.com/wim_klunne/hydro/
- http://www.tamar.com.au/ (click on Hydro turbine section)
- http://www.domme.ntu.ac.uk/microhydro
- http://www.powerflow.co.nz/

Biomass:

- http:// www.shell.com
- http:// www.nrel.gov/research/industrial_tech/biomass.html
- http:// www.ott.doe.gov/biofuels/what_is.html
- http:// www.eren.doe.gov/re/bioenergy.html
- http:// www.nrel.gov/lab/pao/biomass_energy.html

Wind and Hybrids:

- http://www.bergey.com
- http://www.energy.ca.gov/earthtext/wind.html
- http://www.nrel.gov/clean_energy/wind.html
- http://www.eren.doe.gov/wind/web.html
- http://www.britishwindenergy.co.uk/frames/index.html

Business Plan Assistance

E+Co's Toolkit: www.areed.org

Productive Use Equipment and Partnerships

The Sustainable Village: www.sustainable village.com

Annex 2

Clean Energy Technologies

Annex 3 – Income generating activities in Lesotho

How to run a guest facility in a remote village of Lesotho when there is no grid power

Land locked by South Africa and hidden within the majestic walls of the of the Drakensberg and Maluti mountain ranges one can find the independent state of Lesotho. This mountainous kingdom boasts both the highest and lowest point of any country in the world.

Lesotho's primary natural resource is water and its economy is based on subsistence agriculture, livestock, and remittances from miners employed in South Africa. More than two-thirds of the country is inhospitable with the other third suffering severe overgrazing, soil erosion and soil exhaustion. The country seems to be buckling under the pressure caused by poor environmental management and general governance.

A view BBCDC against the majestic Maluti mountain

A ray of hope can be found in the very remote south east corner of Lesotho some 370kms from Maseru in the form of the Bethel Business Community and Development Centre (BBCDC). Ivan Yaholnitsky a former Canadian peace-corp worker, fell in love with the country and became determined to make a difference. Ivan was able to secure a 7-hectare piece of land from the Roman Missionary Church in 1987. The ultimate aim was to develop a centre to impart relevant rural skills, carry out research and development into energy efficient and appropriate technology and to aid in the general development of the locality. As one travels along the long and treacherous dirt road surrounded by rugged terrain and sparse vegetation BBCDC greets you bursting with life and a hive of activity. By implementing the practices of biological engineering, ecology, environmental management systems and use of renewable energy, the land is now healthy, regenerated and self sustaining.

The training centre grew rapidly and has become renowned for being a haven within an area with little resources and no access to electricity. Ivan soon recognised the opportunity for developing commercial activities and approached E+Co in 1997 and then once again in 2001 for financial assistance to develop BBCDC commercial renewable energy activities.

Today the centre boasts one of the most impressive examples of a renewable energy productive use application with its "Eco-guest" facility and conference centre. Using passive solar design the Eco-guest facility is a fully fledged income generating facility that not only adds to the centre's income but also affords students the opportunity to gain valuable on the job experience in the daily running of such a facility. The centre consists of various buildings built by the students over the past few years making use of as much building materials from local resources as possible.

The differenct energy needs of the "Eco-guest" facilities are met nearly entirely through various forms of renewable energy technology. Hot water is obtained from roof integrated solar water heaters. Lighting and electricity for appliances in the facility is delivered by PV solar electricity systems.

Director's solar passive house

Kitchen with bread oven in foreground

The "Eco-guest facility prides itself in providing delicious meals consisting of a variety of dishes and food stuffs. While Solar cookers are used to prepare dishes during the day, solar driers are used to dry surplus fruits and vegetables cultivated on the property. Cooling for storage is obtained from an energy efficient solar PV powered freezer and an eight square metre evaporative cooler built by the centre's craftsman. Both kitchens are also equipped with solar chimneys for added ventilation and space cooling.

Space heating in the sleeping quarters is taken care of by solar thermal under floor heating and a solar powered circulation fan. LPG gas is used to meet the heating requirements in deep winter and cooking in times of bad weather.

The Dormitory

Potential guests for the "Eco-guest Facility" come from diverse backgrounds. Government officials who work in the area make use of the facility as a stop over. BBCDC would be an ideal place for researchers interested in development, permaculture, solar energy utilisation or restoration ecology. In the past BBCDC has hosted a number of interns using the facility as a means for knowledge dissemination and learning. BBCDC has also hosted a permaculture course for the United States peace corps in July and will host a seminar on water resources development and restoration ecology.

Solar pump for water supply

The facility currently consists of the following amenities:

- Guest Flat:
  Fully self contained with kitchen and bathroom.

- Conference Centre:
  Includes 4 bedrooms, that can sleep 8-12 people, two bathrooms and a spacious classroom.

- Dormitory**:**
  Sleeps up to 24 people in a backpacker's type lodge.

- Dining Room:
  BBCDC has a commercial kitchen and dining room that can cater for all meals and situations. The dining room seats 24 people, and can provide packed lunches, short order meals and meet any other preferences if given sufficient notice.

Kitchen/classroom

Just recently a kitchen/classroom building was completed on the BBCDC campus. It includes a roof integrated solar water heater, a solar chimney for ventilation, day lighting, and 300 watt photovoltaic power system, which is configured to provide up to 900 watts of pure sine wave 220 volt AC power throughout the building. This power supply will operate a bread dough mixer, sewing machines, computers, lights and other appliances

Solar drier used for food preservation

Solar cooker preparing dessert!

The BBCDC “Eco-guest Facility” is an excellent example of how income generating opportunities can be created in the most remote areas facing the greatest obstacles. It also shows how the application of various forms of renewable energy can meet the day to day needs of a guest facility and small conference centre enabling it to become sustainable, create much needed employment and act as a catalyst for growth in an infrastructure poor rural community.

For more info contact eco@energyhouse.com or visit our website www.energyhouse.com

Annex 4

Model Productive Use Business Plans