December 2014

COMBINING ENERGY ACCESS AND CLIMATE PROTECTION

HOW ENERGY CAN BE PROVIDED WITH SUSTAINABLE ENERGY, REDUCING EMISSIONS AND INCREASING WELLBEING

www.inforse.org

INFORSE - International Network for Sustainable Energy in cooperation with ENDA - Energie-Environnement-Développement, Senegal; INSEDA - Integrated Sustainable Energy and Ecological Development Association, India; Mali Folkecenter Nyetaa, Mali; CRT-Nepal; Grameen Shakti, Bangladesh; and CDI - Climate Development Initiative, Uganda.

INFORSE
International Network for Sustainable Energy

Combining Energy Access and Climate Protection:

How Energy Can be Provided Sustainably, Reducing Emissions and Increasing Well-being

Table of Contents

Published by International Network for Sustainable Energy, INFORSE, 2014.

Introduction

This publication highlights sustainable energy solutions that improve energy access and livelihood even as they reduce greenhouse-gas emissions. It was produced *by INFORSE, the International Network for Sustainable Energy*, in cooperation with *ENDA/INFORSE-West Africa*, *INSEDA/INFORSE-South Asia*, as well as other INFORSE members as *Mali Folkecenter*, *CRT Nepal, and Grameen Shakti*.

Many people have contributed to this publication, and we thank them for their contributions. The primary contributors to each case are listed at the start of the case on which they worked, as well as at the contact details on the last two pages.

Updated in December 2014, and May 2014.

Editors:
Gunnar Boye Olesen, INFORSE Secretariat, INFORSE-Europe, SustainableEnergy, Denmark
Djimingue Nanasta, INFORSE-West Africa, ENDA, Senegal,
Raymond Myles INFORSE-South Aia, INSEDA, India, and
Judit Szoleczky, INFORSE/INFORSE-Europe Secretariat

Text advice: Niki Fowler

For an electronic copy of this publication and other INFORSE materials, see www.inforse.org, direct URL: www.inforse.org/energyaccess-climate.php3

The cases were collected in the framework of the Programme ***"Southern Voices on Climate Change".*** The Programme was organised by a consortium of five Danish NGOs, Climate Action Network, and IIED. It is coordinated by CARE Denmark and funded by the Danish International Development Agency (DANIDA). INFORSE activities also include INFORSE-South Asia, INFORSE-Africa, INFORSE-Europe, and the Danish INFORSE member "Sustainable Energy" (in Danish: VevarendeEnergi).

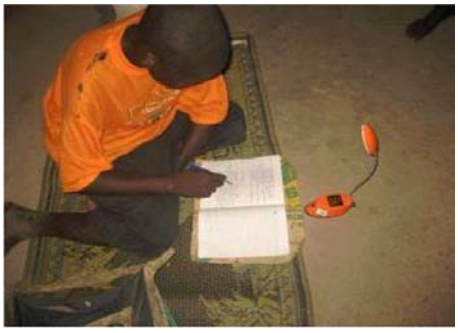
"Southern Voices on Climate Change" Project Link: www.southernvoices.net

INFORSE-Asia: www.inforse.org/asia

INFORSE-Africa: www.inforse.org/africa

Publication: "Combining Energy Access and Climate Protection", 2014:
www.inforse.org/energyaccess-climate.php3

See also the previous publication: "Energy Access", 2012:
www.inforse.org/energyaccess.php3



Energy Access and Climate Protection - Overview and Summary

by Gunar Boye Olesen, INFORSE

Sustainable Energy Access

Energy access, that is access to clean, adequate and affordable energy, that is a key factor in development, poverty reduction, and improvement of living standards. In the household, access to clean cooking and good lighting are basic for improvement of living conditions, reduction of illnesses caused by smoke, and extension of activities after sunset. In addition, electricity for mobile phones, radios, televisions, and computers improves livelihoods. It supports access to better education, and may lead to additional income generation.

Energy for uses in production and services is just as vital for poverty reduction as is household energy. Agriculture, production, shops, health clinics, and schools all benefit from adequate energy access.

In developed countries, as well as in most cities in developing countries, energy for households, production, and services are mostly provided *via* electricity networks as well as, sometimes, through gas and heat networks. Unfortunately, many efforts to extend networks to the majority of the world's poor have failed thus far, in particular in Africa and South Asia. Here, the costs of grid extension have simply made it unaffordable for the majority. Additionally, many rural grid extensions have provided erratic power that satisfies neither household needs nor stable production. As a result, about a billion people still lack adequate access to energy, even for basic needs such as cooking and light.

Compared with the grid-based solutions, local energy solutions often provide much more affordable and often also less interrupted power for essential energy needs and services. An improved, more efficient cookstove with a chimney can be the difference between illness from smoke and healthy lives as well as between long walks to collect firewood in diminishing forests and the ability to supply wood from local sources. Biogas for cooking can supply even remote settlements to which gas networks and bottled gas (LPG) are unavailable or unaffordable and will remain so in coming decades. Solar electricity can power lighting, mobile phones, *etc*., much better than kerosene lamps or a power grid over which power fails when it is needed the most.

It is for these reasons that NGOs throughout the developing world are promoting local, sustainable energy solutions, when central solutions are unavailable, interrupted, or unaffordable. In spite of the benefits of central solutions, and in spite of large successes with them in some countries, they are still far from providing energy access to all.

Universal energy access will require concerted actions at many levels. It is possible, however, at a small cost to global society and in a sustainable way, if it is based on local sustainable energy solutions where the centralised solutions are not working properly. Unfortunately, it cannot be expected to occur without support within a reasonable time.

Energy Access and Climate Change

Compared with alternatives, sustainable energy solutions for energy access generally have lower effective greenhouse-gas emissions:

- Improved cooking stoves can reduce wood use by about 50%. In many African countries, where deforestation and degradation of woodlands are major contributors to greenhouse-gas emissions, reduced wood use is key to reducing CO_2 emissions. Improved stoves emit a considerably lower volume of particulates than do traditional cooking fires. Around mountain areas with glaciers, their use reduces deposits of black soot from cooking smoke on the ice, a distinct contributor to climate change.
- Biogas plants can replace fossil gas such as LPG as well as direct use of cow dung as fuel. The CO_2 emissions of fossil gas are then replaced with a renewable, carbon-neutral gas source. The use of biogas instead of dried cow dung increases the carbon that is returned to the soil, as the biogas sludge contains half the amount of carbon in the dung and is returned to the soil as a valuable plant nutrient. When biogas prevents storage of cow dung in pits, it reduces methane emissions from uncontrolled anaerobic processes in the pits. To achieve net GHG-emission reductions, however, it is critical that methane losses from the biogas plants and biogas use be kept to a minimum.
- Solar electricity can replace kerosene used for light. It also can replace diesel to power, *e.g.*, pumps, agricultural machines, and even mini-grids for smaller towns. In countries whose central power supply is based on fossil fuel, especially in the case of coal, solar electricity will also reduce CO_2 emissions compared with grid connection. The same is true of other renewable power options such as sustainable use of windpower and hydro-power.
- Solar drying can be used to make hygienic products, such as dried fruits, that can replace food dried or produced with fossil fuels.
- When wood is very scarce, and the environmental degradation from continued wood use is large, replacement of wood with LPG can reduce overall GHG emissions. For many poor users, however, this replacement is only possible if LPG is subsidised on a permanent basis. Once the subsidy ceases, many will go back to the cheaper wood, irrespective of the global environmental problems this causes.

Even though GHG reduction is limited for each installation, the cumulative potential reduction is very high, as there are hundreds of millions of small installations worldwide. In one case covered in the present publication, "One woman - one lamp", just the replacement of kerosene lamps with solar lanterns in the country of Mali could eliminate more than 400,000 tons of CO_2 emission per year. This is a small savings compared with many reduction potentials in developed countries, but it comes with added benefits in the form of fundamental improvements of living conditions.

Barriers to Sustainable Energy Access

Even though the sustainable energy solutions for energy access have been known for a few decades, almost a billion people in the world still lack adequate energy access. There are a number of reasons for that: The focus of governments, international development agencies, and the private sector is primarily on the centralised and fossil-fuel-based solutions.

- Subsidies to fossil-fuel interests and for grid extensions are far higher than subsidies and technical support for local, sustainable energy solutions. This continues in spite of the proven benefits of the local solutions, locally as well as for the global climate. The environmental costs of fossil fuels should also be considered when evaluating the different options.
- Even though the local sustainable energy solutions have existed for a few decades, the solutions are still developing fast. For example, a solar lantern is now available in Mali for

30USD, whereas the price was more than twice of that a few years ago. With proper financing, it will now be available to many who could not afford it before. The quality of the light from the lamps has also improved. Technologies improve and prices are reduced.

- Local, sustainable energy solutions succeed when the users are trained in their correct use. Maintenance and spare parts must be within reach of the users.
- Even though local solutions are cheaper than central solutions, many poor people cannot afford the up-front cost, which is typically higher than that of the traditional alternative. Some kind of financing mechanism and, in some cases, subsidies typically are needed for large-scale success.
- Even in a large success, as the case of the Anagi stove in Sri Lanka, technical assistance continues to be needed to maintain the viability of the technology and quality production.

Overcoming the Barriers

Successful dissemination of thousands or even millions of sustainable energy installations shows that the barriers can be overcome. Key to overcoming barriers and to successful integration include:

- Attention to local solutions by governments and by the international society. A government agency must be in charge of off-grid energy access, for which purpose it must be staffed and financed sufficiently. Civil society organisations must be involved to bring in their experiences and use their capacities to disseminate solutions. Civil society can also help to ensure transparency and improve outreach to, for instance, women and poor people.
- Resources, including funding for subsidies, must be applied to local solutions to at least the same extent as they are to centralised solutions and fossil-fuel use. Use of resources must be guided well to optimise dissemination and user satisfaction, and should be protected from misuse.
- Exchange of knowledge, insights from experiences, and technologies must be promoted. For each type of solution, experts in each country must be able to build on the latest developments and successes around the world.
- Dissemination must include training of installers and users, as well as provision for availability of spare parts and maintenance.
- Quality of products must be sufficiently high. A combination of training and controls must ensure the continued quality of the delivered products and installations.

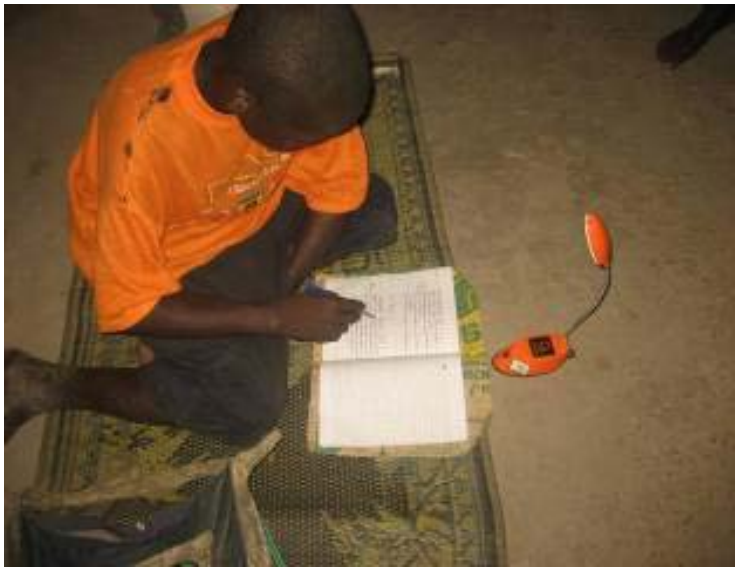
When the sustainable energy-access solutions are also climate-mitigation solutions, climate funding can provide some of the resources needed for the above tasks. This can be made a part of future climate agreements, but it can also be included in existing climate funding: national funding, multi-lateral funding and voluntary CDM credits. It is crucial to the success of sustainable-access solutions that both the climate and the development impacts be valued.

The UNFCCC climate-technology mechanism could contribute additionally to the facilitation of the exchange of knowledge, experience, and technologies. This must include solutions from the North as well from the South. It should support possible improvements, adaptations, and optimisations of technologies and solutions to the specific national or, eventually, local conditions.

Development of Good Practices

A good practice can be defined for purposes of this document as "an individual or group practice whose implementation in a given context can best achieve technical and economic performance of development sectors (agriculture, livestock, forestry, energy, *etc.*) and/or social benefits (socio-economic organizations, communities or groups of communities, *etc.*) in a context of climate risk.''

The aim for a description of a good practice is to identify this process so that it can be learnt from and shared with others with a view to re-using it. Read some examples in this publication.



CASE STUDY - Mali

Solar Lantern for Rural Household Lighting and Cell Phone Charging

by Mahamadou K. Diarra
Mali-Folkecenter Nyetaa

Summary

Mali is a developing country; the electrification rate is below 12% in rural areas. Currently, large parts of population are dependent on poor-quality products to satisfy their energy needs. These products e.g., kerosene lamps and candles, have negative impacts for the population's health and environment. It should be noted that women and children are their main users. The rural people spend significant resources on their day-to-day domestic energy needs. This increases poverty in rural areas and thus increases vulnerability to the negative effects of climate change.

In fact, the recent development of lighting technologies, such as energy-saving light bulbs, light-emitting diodes (LEDs) with small solar panels of capacity between 5 to 10 watts, etc., has opened the way to cleaner and more economic lighting solutions, especially for rural households.

The "One Woman - One Solar Lamp" initiative was funded by Christian Aid's pro-poor energy innovation fund to develop sustainable, non-exclusive distribution and marketing networks for energy services for poor people. It focuses on rural women (300 people), improving impacts on global climate and generating income for 5 local entrepreneurs in rural and peri-urban areas of Mali. The initiative also facilitated the finance mechanisms by providing a 20,750 USD guarantee fund with a local microfinance institution to allow women sufficient access to credit.

Present greenhouse-gas savings	Investments costs, and savings	Potential greenhouse-gas savings in Mali
1000 solar lamps in 500 units saves each 0.2 ton of CO_2/year from avoided kerosene use, in total 200 tons/year.	For 30 USD/lamp, (+ new battery every 3 years). Saving 80 litres of kerosene as well as dry batteries and cell-phone charging.	With just 2 million lamps, Mali can save 400,000 tons of CO_2/year. The potential is very important, with possible sale of more than 4 millions lamps.

Description, Development and Background Situation

In several areas in Mali, women are responsible for buying kerosene, as well as for carrying wood for the family, sometimes accompanied by their children. They spend a lot of money, time and energy to carry out these activities. "The One Woman - One Solar Lamp" concept is an innovative initiative developed by MFC Nyetaa in partnership with Christian AID, to promote a suitable business for clean-energy, low-cost technological solutions for rural areas in Mali. The goal is to support the women faced with the challenge of climate change, by substituting their kerosene lamps with solar lanterns. This is made possible by building a solar lantern supply chain, and providing micro credits in collaboration with a non-profit microfinance institution. This is, of course, based on delivery of a high-quality product to the end users.

The lighting product was selected, in collaboration with the social enterprise ACCESS SARL (the distributor), according to the criteria of quality and reliability. The product is composed of two lamps and a cell phone charger. The distribution was organised to the sales points and to women's cooperatives by ACCESS SARL. Nyetaa Finances SA, a micro-finance institution, was in charge of the credit facility for the women's groups.

The women have been organised into mutually supportive groups of 15 to 20 people by the micro-finance institution. They have a weekly meeting to exchange information, and also collect money (0.21 USD per person). These activities involve more than one hundred villages and 150 groups of women around the Districts of Bougouni and Kati. They take a loan through Nyetaa Finances, and ACCESS SARL provides the product. More than five hundred women have been able to purchase the solar lamp in this way. The lamp costs 15,000 FCFA (30$USD), and the lifetime is approximate 10 years for the lamps, 20 years for the solar panel, and 3 years for the batteries. The maintenance cost is very low, just battery replacement every 3 years.

Socio-Economic impact:
The solar lamps is cost 30 USD and the savings is 144 USD (only kerosene) up to 242 USD (incl. dry batteries and cell-phone charging), the pay-back time is around 3 months (as torches and some kerosene will be still needed during rainy seasons). This business is sustainable and needs no subsidy. But it is good to make it with social non-profit enterprise.

Environment impacts:
For the savings, each lamp (two light points) saves 80 litres of kerosene that produces 0.2 tons savings of CO_2. The theoretical potential of 2 million lamps is 400,000 tons of CO_2, just in Mali, and just based on current consumption.

Effect on Poverty Reduction, Obstacles, and Dissemination

More than 500 women benefitted from the product. Improvements included better living conditions, environmental aspects from reduced use of kerosene, economic aspects (increased income reduced cost of energy for lighting), as well as significant social and education benefits. At night, 30% use it for commercial purposes for charging cell-phones. In the daily market, the cell-phone is charged around 0.21 USD, and with different connection ports, some women might recharge around 5 cell-phones per market day, as well as one or two during an ordinary day. The initiative improves the women's income and living conditions. Several additional activities and products also result, such as reparation of the lamps, and selling food and other items at night.

In the villages, people use kerosene lamps (cost 11 USD, duration 1 year) and Chinese torches (4 USD, duration one month) for lighting. This equipment will be removed frequently by the users. The yearly consumption of kerosene is 144 USD (around 80 litres), and 9.80 USD for the dry batteries for the Chinese torches.

The initiative has stock limits considered by many women as obstacles, because the project partners fixed the quantity at 550 units. The product also has registered some weakness as recharge problem during the rainy season because of the lack of sun. Besides, the lamps have a battery charge of 12 to 500 hours, depending on the setting level. Consumers have a choice of four positions: bright (40h), brighter (20h), brightest (12h) and bed (500h). During the rainy season, it will be better to use the less-bright level to save energy.

The dissemination included sharing of information with several stakeholders involved in energy and in women's and children's welfare. Leaflets and other communication tools were used.

Effects on Greenhouse-Gas Emissions (Fossil Fuel)

According to the Indian solar equipment provider D-Light, one kerosene lamp consumes around 80 litres each year, which represents 0,2 tons of CO_2/year. With 1000 solar lamp-units sold in the village (each box has 2 lamps, with total of 2x500=1000 units), that avoids 200 tons of CO_2 emissions (1000 units x 0.2 ton = 200 tons/year). The CO_2-reduction of 0.2 ton is per lamp, not per litre of kerosene. Between the project's start and 2013 the initiative, consumers have avoided more than 32,000 tons of CO_2.

The product produces a good quality of light, and no smoke, which is better for user's health. It will allow children to study in the evening in better conditions and with better impact on the global climate due to the saved CO_2 emissions from kerosene.

Analysis of the Costs as Climate Mitigation Measure

A household in a rural area invests yearly 11 USD kerosene lamps and 40 USD (approx. 4 USD x 10 month) in Chinese torches for their daily lighting solution, for a total cost of investment around 51 USD. For yearly operation, they expend 144 USD for kerosene, 49.60 USD for dry batteries, and 37.8 USD for cell-phone recharge. Total cost is 242.4 USD. So the initiative can allow avoiding the latter expense by purchasing one solar lantern, which costs 30 USD with two lighting point, and telephone charging.

Analysis of the Potential for Scaling Up for instance to National Level, and to Replicate in other Countries

Lack of access to electricity is more severe in sub-Saharan Africa where 500 million peoples do not have access to any modern form of energy, particularly in rural areas where national electricity access rate is around 2%. Mali is no exception, with electricity coverage standing in 2009 at around 60% in urban areas and falling to about 12% in rural areas, where the majority of the population live. At current electrification rates, the majority of

people living in rural areas, especially the poor, will continue to have no access to modern energy services for the next decade at least. From the 12,000 Malian villages, less than 300 have received electricity so far, with support from AMADER[1] and other organisations. The Malian market can absorb more than 2 million solar lanterns in the rest of the villages, which live without energy. That will reduce emissions of 400,000 tons of CO_2 and will contribute to climate-change mitigation.
The lessons and experience from this initiative are documented and have been shared with energy stakeholders. The social enterprise ACCESS SARL has planned to import one container of 2,400 lamps. At the local level, the AMADER also encourages the public private partnerships to increase access to lighting products in rural areas. At the international level, this business model (cash and credit option through microfinance and women's cooperative) will allow the Lighting Africa project managed by the World Bank to increase energy access for women.

Estimate of Support Needed for Scaling Up; Grants, Loans, Capacity

The financial mechanism is a key requirement for the initiative to be scaled up. The pilot phase showed that the business model is sustainable as long as the social enterprise and the financial institution have a guarantee fund to import more products and to allow women to generate collateral. Based on this analysis, the government must encourage this type of initiative with incentives or grants and with a large-scale communication and marketing.

How this Case Can Contribute to Climate Mitigation

This case is important to improve livelihoods, but it also contributes to climate mitigation. It does so in its present form, but it could do it much more if brought to national or regional levels, together with other, similar initiatives.

Present greenhouse-gas savings	1000 solar lamps in 500 units save 0.2 ton of CO_2/year each from avoided kerosene use, in total 200 tons/year
Potential greenhouse-gas savings in Mali	If all people without electricity in Mali replace kerosene with solar lamps, a total of 2 million lamps will save 400,000 tons of CO_2/year. Since not all in Mali can afford light all days, the actual savings will be lower, but in an expected future when all can afford light, this will be the savings.
Investments costs	80 USD/lamp (+ new battery every 3 years)
Savings	80 ltr of kerosene as well as dry batteries and cell-phone charging, 144 USD (only kerosene) to 242 USD (also batteries and phone-charging).
Resources needed for large-scale dissemination	Expanded supply network of quality lamps. Expanded micro-loan facility. Nation-wide repair facilities. - Government certification to control import of good quality of product, and laboratory to control the quality. - Government can support private sector with innovative business model for more expansion.

1 AMADER : Malian Agency of Rural Electrification and Household Energy

CASE STUDY - Mali

Jatropha Oil Production for Local Energy Use

By Mahamadou K. Diarra
Mali-Folkecenter Nyetaa

Summary:

Mali is landlocked with low opportunities for export, and costly imports due to the large overland distances of more than 1000 km from the coast. This also applies to fossil-fuel imports. The country spends more than 450 million USD (*data from DNE, 2007*) each year to import fuel, and this increases by 34% every year. Biofuel from Jatropha has been considered as one of the potential solutions to reduce the fossil-fuel imports.

The MFC Garalo Bagani Yelen Project was an innovative initiative representing a new paradigm in sustainable decentralised energy production. Less than 17% of Malians have access to formal electricity services, and in rural areas where two thirds of the population live it is less than 12%. To address these problems MFC has setup a 300 kW of integrated village electricity production and distribution system, supplying a village of 10,000 people, powered by pure plant oil (PPO) derived from Jatropha seed grown locally around the village of Garalo. This initiative is centred on the local production, processing and use of Jatropha oil in the form of electrical energy.

The village of Garalo is located 215 km from Bamako in the south of Mali, at a strategic crossroads for trade and hence has a lively main high street with many small businesses including wood and metal workshops, providing services to people in the village and those passing through. The population is estimated in 2005 to be 10,000 people, and 80% are farmers and engaged mainly in agriculture (mostly millet, sorghum and rice, as well as cotton for income generation), raising cattle, and fishing.

The initiative allows 450 farmers in different villages surrounding Garalo to grow Jatropha (1000 ha) on their own fields and to sell the seed to a Jatropha cooperative, which processes the seed to high quality oil. The cooperative then sells the pure oil to the energy supplier (ACCESS SARL). Currently more than 400 clients benefit from energy for 10 hours per day for business, lighting, and improvement in health and security conditions.

Present greenhouse-gas savings	Investment costs and savings	Potential greenhouse-gas savings in Mali
200,000 litres of strength vegetal oil saves 540 tons of CO_2/year from avoided Diesel use,	For 0.46 USD/kWh, (+6 USD for monthly fix tariff) saving 110 litres of diesel/day (39600 litres/yr), and other indirect fuel like kerosene.	Only for 5 million litres of fossil fuel (gasoil) of SVO, Mali can save 13,500 tons CO_2 / year.

Description, Development and Background Situation

In 2003, the government of Mali developed a rural electrification programme based on a Public-Private-Partnership model to increase energy access rates in rural areas to 25% by 2015. Villages like Garalo, situated relatively far from the national grid, were unlikely to get connected. But the rural electrification program presented a new opportunity.

Socio-Economic impact:
The sales of Jatropha seed allow the farmers to diversify their income sources. The kg of seed costs 0.16 USD. With the clean energy, the population can have some new activities for the productive use of energy.

Environment impacts:
For the savings, the use of Jatropha oil for this initiative can save each year 540 tons of CO_2. That avoids the use of fossil fuel for rural electrification.
The reforestation, with Jatropha planting, adds to carbon sequestration old and degradable field.

The Garalo Bagani Yelen is the result of a request from the commune of Garalo for the provision of electricity to its 10,000 inhabitants and was developed by MFC and a consortium of international partners. The infrastructure for power generation and distribution consists of 3 x 100 kW diesel generating sets, modified to run on pure Jatropha oil, placed in a power house, and a 13 km mini distribution grid with integrated street lighting. The pure plant oil (PPO) fuel is delivered to the generators from a press house located on-site containing a mechanical screw press, a three-stage 0.5-micron oil filtration system, and a 9,000-litre storage tank. To provide the feedstock, 1,000 hectares of pure and intercropped Jatropha plantations were established across 450 smallholdings using existing agricultural technology and practices. A tree nursery with the capacity to produce 1,000,000 Jatropha seedlings was established within the municipality to supply smallholders with all of the plants they required to establish their plantations.

Various service packages are available for customers with different needs, e.g., single-phase 230 volt domestic supply of 5 Amps, or 10 Amps, and for business & industrial users, a 380 volt three-phase supply of 10 Amps or 15 Amps. Every client has a meter at their house or place of business, and monthly readings are made to calculate billing amounts. Each customer is pays a flat monthly fee (fixed according to the rating of their meter) towards the Garalo village street lighting; the public lighting grid has its own electricity meter to allow this.

The electricity tariff is composed of a fixed monthly operational charge for public lighting and the cost of the kWh consumed by the client, 0.46 USD/kWh + 6.00USD. About 450 clients are currently connected to the grid.

Photos: Jatropha tree and seed, a generator set

Effect on Poverty Reduction, Obstacles, and Dissemination

The local communities had multiple direct and indirect economic benefits from Garalo Bagani Yelen. As Jatropha seed producers, they will benefit from a new source of revenue (0.16USD/kg of Jatropha seed), which can be developed in harmony with their existing agricultural practices. This is increasingly important as more and more farmers in the Garalo's village are abandoning cotton, which has been the main cash crop in the area for decades, due to low prices on subsidised international markets, and problems with the internal Malian cotton producing mechanisms. This can also offset the cost of paying for the electricity service, making it more affordable. In a diesel project, rural electrification is a net drain on the household economy.

Local Small and Medium Enterprises and Small and Medium Industries (SMEs and SMIs) such as metal and woodwork shops, restaurants, and other shops and services are able now to develop, improve and expand their facilities and their businesses, due to the access to electricity.

In a rural electrification project, anywhere from 50-90% of the running costs are for fuel. If spent on diesel, this money leaves the village and leaves the country to pay for costly fossil-fuel imports, which must be transported thousands of kilometres inland to Mali. So the micro-economics and the macro-economics are unattractive. With an equivalent Jatropha-powered project, this money is re-injected into the local village economy.

During the implementation, the main obstacle was the pole installation in some part of the village where streets are tiny or non-existing. This makes it difficult to cover all of the village.

After implementation, Garalo Bagani Yeelen developed communication materials and used them for large-scale dissemination nationally & internationally, through meetings, articles and the World Wide Web and at an international conference.

Effects in Greenhouse-Gas Emissions (Fossil Fuel)

The clean low-carbon electricity produced in the village improved domestic living conditions and security with lighting, TV and radio. Many new income-generating activities were available thanks to the presence of electricity.

In addition, there are the environmental benefits of a low-carbon energy supply, which significantly reduces CO_2 emissions compared to a comparable diesel system.

The project planted more than 1000 hectares of Jatropha, and had estimated CO_2 emission reductions of around 10,000 tons/year. The replacement of diesel and kerosene in addition to the reducing CO_2 savings (of 100%) and others, eliminates handling of dangerous gas. In one hectare on Jatropha, the average harvest is 800 kg of Jatropha seed; these make 200 litres of Jatropha oil (around 4kg/litre). The projected annual production is estimated at 200,000 litres of biofuel (strength vegetal oil) by year, that replaces diesel with an emission rate of 2,7 kg/litre, eliminating 540 tons of CO_2 annually. Nationally with the Jatropha oil, Mali can reduce its greenhouse-gas emissions significantly.

Analysis of Proposal as Climate Mitigation Measure

Besides the rural electrification aspect, the Jatropha plant and oil are also one of the key mitigation measures to reduce the use of fossil energy such as kerosene, and gas oil. It also contributes to reforestation for carbon sequestration. The plants are very adaptable in semi-arid areas, and do not need chemical fertilisation, or lot of water to grow. The expansion of Jatropha production can contribute to national energy autonomy, and job creation. It does allow the country to reduce its trade-balance deficit (in 2011, Mali imported 904,100 TEP m^3 of fuel around 89 bi-millions USD) and its greenhouse-gas emissions. In fact, the politicians, through the creation of Malian Agency of Biofuel, must encourage the involved actors through incentives such as tax exempt for imported materials, rules and directives for national strategy, and training centres or modular cources about the technical aspect of oil process in schools, universities or institutes.

Analysis of the Potential for Scaling Up, for instance to a National Level, and to Replicate in Other Countries.

Biofuels are not a magic solution to all the problems of climate change as was hoped by some, and as has been well documented. But for certain niche uses like rural electrification projects, there is no doubt that local biofuel production and use can be the engine for new economic development. Thus this project has strategic importance and a high level of replicability throughout Africa and the South.

Estimate of Support Needed for Scaling Up; Grants, Loans, Capacity-Building

The Jatropha speculation and sale of seed to external purchasers is a problem. For scaling up, the government must protect the cooperatives against seed speculation, which can increase the seed price. In time, as the volume of seed produced increases, this speculation will become proportionally smaller. Demand for seed for planting seems to be declining.

For the massive expansion of biofuel as a solution to reduce the fossil-fuel importation and to reduce the greenhouse-gas emissions, the government should develop some criteria and directives for a long-term biofuel strategy.

CASE STUDY - Togo

Solar Lamp for Households

"A Household - A Solar Lamp" Project on Assembly and Distribution of Solar Lamps.

By Romuald Sambiani and Yaovi Lowanou Kogbe, ATODES/Ed.

Summary

The project involves the assembly of solar lamps in Togo from imported parts from Germany and their introduction in rural and peri-urban areas to replace oil lamps, paraffin lamps, candles and generators. These lamps are environmentally friendly and economically profitable in the medium and long terms. The six (6) villages covered by the distribution of these lamps are: Gboto and Tokpli (Prefecture of Tabligbo), Kpessou and Aveve (Low Mono Prefecture), and Sévagan and Vokoutimé (Vo Prefecture). The project was designed and implemented by the Togolese Association for the Development of Solar Energy / Environment Development (ATODES / Ed).

The beneficiaries of this project are many and varied:

- Women (merchants, dressmakers, hairdressers, etc.).
- Children (pupils, students)
- Shops and taverns
- Churches, places of revelry
- Family ceremonies (weddings, funerals, etc.).

The advantages for the beneficiaries of the lamps and the project are as follows:

- Availability of quality light and environment-friendly equipment at low cost and accessible to all.
- Extension of business overnight.
- Students will study longer at night.
- Improved health for women and children through the removal of oil and kerosene lamps and their smoke.
- Disappearance of unwanted fires caused by oil lamps, candles, etc.
- Avoidance of greenhouse-gas emissions (CO_2) generated by oil lamps.

Present greenhouse-gas savings

In a year, a solar lamp used will save 72 liters of kerosene and avoid 216 kg of CO_2

Investments costs, and savings

A lamp, a panel and an adapter will cost € 67.08.
In a year, a solar lamp used will save 72 liters of kerosene and avoid 216 kg of CO_2
The monetary saving on kerosene is about € 55 a year.

Potential greenhouse-gas savings

For a lifetime of 10 years, in 2022 with 600 solar lamps disseminated, a positive saving of over 432,000 liters of kerosene is expected for a reduction of over 1,300 tons of CO_2.

Background of the Project

In remote villages that are far from the national power grid, there is a serious problem of lighting in households, night markets, etc. Often the deplorable socio-economic conditions, lack of financial resources do not allow these people to get adequate light sources.

These people use oil lamps, kerosene lamps and candles that emit a lot of unhealthy smoke that can cause lung disease. The low purchasing power of the population is also a major obstacle to the diffusion of solar lamps.

Thus, ATODES/Ed's strategy of implementation of the project was based on flexible payment terms that will benefit many other villages.

The expected impacts of the project are manifold. In environmental terms, the use of solar lamps should reduce to some extent the greenhouse gas emissions (CO_2) from oil and kerosene lamps. At the social level, solar lamps produce more light and allow the extension of day time activities, as well as bring health improvement, since they do not emit harmful smoke. Economically and financially, solar lamps are profitable.

This project is in line with the support programme of traditional energy management and promotion of renewable energy in Togo (Component 2, Ministries for Environment and Energy).

Socio-Economic impact: The completion of this project will not only contribute to the reduction of CO_2 emissions, but also will reduce poverty and ensure access to energy, especially in rural areas. It will support new strategies to promote renewable energy.

This project will open up many opportunities: jobs, extension of nocturnal business, extension of hours of study forpupils and students at night, better health through the removal of smoke from oil and kerosene lamps, etc.

Environment impacts: The main environmental benefit associated with the use of solar lamps is the avoidance of greenhouse gas emissions (primarily CO_2) compared to conventional options.

Apart from the technical assembly of the lamps, the following activities were undertaken to ensure the dissemination of the lamps:

a) Awareness - Information - Education – Training
Meetings, working and demonstration sessions were held on:

- the consequences of the use of oil lamps, kerosene lamps and candles on health and the environment.
- uses and benefits of solar lamps, with good effect on health and the environment.

Finally, documents and fact sheets for the dissemination of solar lamps (to be made available to the public to popularize solar energy in all regions of the country) have been developed and distributed.

b) Solar lamps' and solar panels' assembly;

c) Identification of households for subscription;

d) Establishment and training of management committees;

e) Distribution of solar lamps to households who subscribed;

g) Monitoring the use, maintenance of lamps and solar panels at the end of each month;

h) Preparation and submission of reports with pictures.

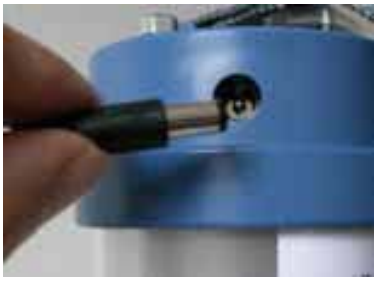
The innovative technical approach of the project was to assemble the lamps on site in Togo, in the assembly workshop established by ATODES / Ed, in order to reduce costs. Thus, the association was able to establish a partnership with the German Association SOLUX e.V which transmits to the technical team all the needed instructions for installation, repair and maintenance and provides the components of the lamps and adapters.

SOLUX – LED - 100

The lamps are robust, with a lifetime of 10 years. In addition, with the adapters, the panels serve to recharge cell phones and meet other urgent needs of rural people. Prices are as follows:

- Lamp and panel : 40,000 FCFA or 60.98 €
- Adapters : 4000 CFA or 6.1 €

To offer payment facilities, ATODES/Ed proposed affordable reimbursement modalities to beneficiaries (payment by installments, sales to daily rental credit). Thus, beneficiaries pay daily with the money saved on kerosene (100 F CFA equivalent to € 0.15) with a view to completing the repayment of the lamp within 18 months.



Results released from the dissemination campaign:

- Number of lamps distributed: 350 (150 in households, 200 sold outside the project).
- Number of subscribers: 150 households.
- Revenues obtained:
  200 lamps and adapters sold outside of the project:
  8,800,000 CFA, equivalent to 13,416 €.
  150 lamps and adapters to beneficiary households in the current project:
  540.000 CFA francs, corresponding to 823 €.

ATODES / Ed plans to replicate the project by setting up distribution points in other regions of the country.

Impacts

- The project "A Household, A Solar Lamp" would save millions of gallons of kerosene and reduce emissions of carbon dioxide (CO_2). Access to the lamps will be facilitated by a system of renting of solar lamps to the most needy, by way of "leasing". The main environmental benefit associated with the use of solar lamps is the avoidance of greenhouse-gas emissions (primarily CO_2) compared to conventional options. This reduction can indeed be significant when the solar option replaces a conventional solution using the combustion of petroleum products.
- From our own experiments in a village:
  - A solar lamp used for a month for lighting in households (in replacement of a kerosene lamp) saved 6 liters of kerosene and prevent the emission of 18 kg of CO_2.
  - In a year, this solar lamp used will save 72 liters of kerosene and avoid 216 kg of CO_2.

- Because the lifetime of the solar lamp is 10 years, in 2022 with 600 solar lamps we will have a positive saving of over 432,000 liters of kerosene and a reduction of over 1,300 tons of CO_2.

- Indeed, every eighteen (18) months we will supply other villages with 600 other lamps and the resulting saving of kerosene and reduction of CO_2 emissions will be enormous.
- The completion of such a project allows ATODES / Ed to capitalize on these experiences in advocacy and promotion of the use of solar lamps to reduce CO_2 emissions.
- It also allows people to discover a new source of energy and gain a good quality of light that will allow them to go about their activities overnight.
- It involves all the local players who have the necessary skills for the implementation of the project. It also involves the user populations in decision-making, in the conduct of project activities to ensure the management of the economic activity that has been developed, and in ownership of the designed products.
- The completion of this project will not only contribute to the reduction of CO_2 emissions, but also to reducing poverty, ensuring access to energy, especially in rural areas. It will support new strategies to promote new and renewable energy.
- The development of solar energy in Togo should guarantee access to energy at low cost even to the poorest. As a result, households will save money due to a reduction in the use of kerosene. This surplus could then be used to improve their living conditions.
- This project will open up many opportunities: jobs, extension of nocturnal business, extension of hours of study for students at night, better health through the removal of smoke from oil and kerosene lamps, etc.
- The potential reduction of greenhouse-gas emissions is considerable. The prospective replicate this project in other regions will reach many more families and targets.

Present greenhouse gas-savings	In a year, a solar lamp used will save 72 liters of kerosene and avoid 216 kg of CO_2
Potential greenhouse-gas savings in Togo	For a lifetime of 10 years, in 2022 with 600 solar lamps disseminated, a positive saving of over 432,000 liters of kerosene is expected for a reduction of over 1,300 tons of CO_2
Investments costs	A lamp, a panel and an adapter will cost € 67.08 all together.
Savings	- In a year, a solar lamp used will save 72 liters of kerosene and avoid 216 kg of CO_2 - The monetary saving on kerosene is about € 55 a year.
Resources needed for large-scale dissemination	Extension of the assembly unit and an increase in the revolving fund.

Sustainability and Replicability

- In the strategy used, the funds collected from beneficiary households were applied to the maintenance and reimbursement of the solar lamps as planned for 18 months. Once the reimbursement is completed, such charges collected will also be used to fund other lamps and solar panels for other villages in the country in order to continue the use of "solar energy" to solve the environmental, health and poverty problems.

- The project covered a period of 18 months. After 18 months, the lamps become the property of the households and the project is extended to six other villages. And so on, until the last village in Togo, the main objective being to replace traditional lighting with these environmentally friendly and economically profitable solar lamps in the medium and long term.

However, to expedite the process and ensure sustainability of the dissemination of these lamps over a long period (10 years), ATODES/Ed will need the support of other funding partners.

Picture: An oil and kerosene lamp that people used to have.

CASE STUDY - Senegal

Baking Ovens: Improved Hybrid Ovens Using Gas/Woodfuel

By Djimingue Nanasta, ENDA

Summary

Faced with the need to find alternative solutions to achieve fuel savings and to reduce the ecological footprint of the value chain of traditional bakeries, ENDA Energy, Environment, Development initiated an outreach programme for improved ovens that can run on LPG, woodfuel, charcoal and biogas in traditional bakeries and through a research-action-training-coaching approach. The objective of the dissemination of improved mixed gas / wood / biogas ovens is to develop and make available economic models of improved ovens and to ensure energy conservation for food sovereignty as well or to strengthen the resilience of SMEs to address the impacts of climate change.

In terms of energy consumption, traditional ovens face two major constraints. On the one hand, they consume a large amount of wood (0.4 kg of wood per loaf of 35-40 cm, representing 30% of the cost of bread); and secondly, the furnace temperature is estimated empirically.

The improved metal oven is composed of two parts, a fireplace that acts as the combustion chamber and the baking chamber. The proposed metal oven has several advantages: 1. the existence of three different models as needed or requested by the business-men. All the models can be adapted to run with wood-fuel (wood, charcoal), butane gas, or biogas. 2. Ability to control the temperature (thermometer). With these ovens, the cooking temperature can be limited to 200^0 C for a savings of 50% of firewood compared to the traditional ovens (0.2 kg of wood per loaf of bread) and cooking time is reduced by more than 30%. Thus the avoided deforestation can be estimated to 0.22 ha per year per oven at least.

The two-year program of ENDA aimed a diffusion of 300 ovens to 300 economic operators. These are collective or individual operators. Beyond these, the program also explored community centers such as 'daara' and schools with boarding.

Present greenhouse-gas savings	Investments costs, and savings	Potential greenhouse-gas savings
50% of wood can be saved, 0.2 kg wood/bread equal to 0.6 kg CO_2/bread. Reduce deforestation with 0.22 ha/year per oven.	Ovens cost 700,000 CFA F (1100 €, big), 500,000 CFA F (medium), 375,000 CFA F (600 €, small). Saves 50% wood.	The potential savings will be 66.4 ha per year for the project. For 1000 units, the estimation is 221 ha saved per year.

Presentation of the Case Study and the Context

Traditional bakeries are widespread in Senegal. They are run with wood as fuel and compete even with modern bakeries in some urban centers.

Socio-Economic impact:

Improves bakeries and reduces their wood use, which in turn improves the situation for bakery owners.

Environment impacts:

Reduces wood use that reduces deforestations and therefore also CO_2 emissions. Reduces local air pollution because of reduced wood use and better combustion

In 1977, in order to protect the investment of modern bakeries, and promote the establishment of new bakeries in the region, as well as to fight against desertification, a bill (77-38) was passed to prohibit the establishment of traditional bakeries in towns of over 10,000 inhabitants. It is clear that this prohibition is not fully complied with and it would be rather wiser to try to 'modernize' those traditional bakeries by promoting improved ovens. This is possible and would have an even larger impact in terms of environmental protection and reduction of GHG emissions.

A large number of traditional bakeries are spread across all regions (Kaolack, Kolda, Fatick and Tambacounda, etc.) and it is difficult to identify them all. They involve a large number of women.

In addition to the production of bread, the proposed metal ovens are also a technological opportunity for active roasters in the field of peanut butter, cashew nuts, sesame, coffee, etc.

Thus, compared to roasting specifically, the potential is estimated at more than 50 economic operators interested in baking in each major city, and around 20 in other areas. Hence, a potential market exists of more than 200 models of small marketable ovens for the pilot phase.

This technology can also be used to develop local pastry which is an important market segment, since these types of ovens can be an alternative due to lower expenses.

Most ovens used in traditional bakeries are built of clay with a dome resting on a flat surface, which constitutes the table. In some bakeries, this flat surface has been modified and replaced by a tile system to retain heat longer.

With conventional ovens, bakers are always exposed to smoke, and sanitary conditions are not always met to optimize product quality. The sale of finished products is based on a chain of resellers installed in some surrounding villages and at daily or weekly markets. In general, each baker operates in isolation, facing the professional constraints individually.

This programme aims to promote access to a type of oven that is greatly improved: the metal box can have several compartments, and can take various alternative energy sources (wood, charcoal, biogas, LPG). Given the costs of ovens available, the financial barrier may be partially lifted by the involvement of micro-finance institutions. And to facilitate the adoption of these ovens and increase the number of users, funding mechanisms have been designed with micro-credit for women's groups in the framework of this programme of ENDA.

Analysis of the Effects of the Outreach Programme on Development and the Fight Against Poverty

Reducing the consumption of wood fuels and replacing them with new improved baking ovens contributes significantly to the preservation of the environment. Moreover, the large-scale popularization of this oven will modernize and formalize the traditional bakery sector. It will especially help create jobs for rural youth and slow down the rural exodus.

Thus, the socio-economic impacts associated with the introduction of improved ovens can be felt on many levels. Women are very involved in the management and operation of traditional bakeries in most regions of Senegal. The adoption of improved efficient firewood stoves allows savings on energy as well as gains on productivity. With the use of these ovens, heating and cooking times are reduced significantly (about 30%), resulting in savings for managers. Thus, these savings allow women managers of bakeries to have a higher profit margin for their families. In terms of climate change, the ovens-dissemination programme can achieve fuel savings, reduce environmental footprints of the value chain, and achieve energy conservation in a context of enhancement of resilience to climate-change impacts.

Photo: An example of a traditional baking oven

Perspectives

The pilot program of dissemination of improved ovens has good prospects because of the demand for bread is increasing and due to the rising prices of raw materials in the economic crisis. Rural exodus is raising more and more populations in the urban areas or suburbs of Dakar, and these populations require the type of bread called ''Tapalapa'' made by traditional bakeries. So there are real possibilities of popularization of these ovens not only to bakers, but also to the roasters. Until recent years, traditional bakery was an economic activity that was undertaken most in areas that were remote from Dakar. The growing consumer interest in the improved ovens offers business opportunities for operators of traditional bakeries, many of which exist today in Dakar. Although a comprehensive survey has not been made, we can estimate that it is possible to go beyond the initial target of 300 ovens to disseminate, and target to disseminate, 1000 to 1500 units across the country.

To achieve this target for the improved ovens, a communication plan and training in management for the target audience has been established and will be strengthened. A partnership framework was also developed to ensure production equipment. Finally, the funding mechanism for micro-credits is called upon to facilitate the acquisition of ovens by the target audience.

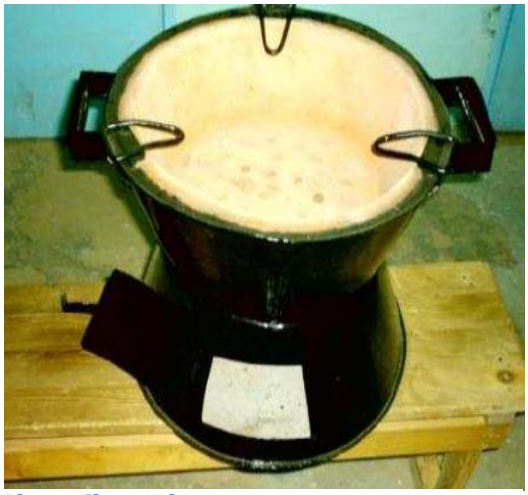


Photo: Charcoal stove

CASE STUDY - Senegal

Impact of the Removal of Subsidy on LPG

The Case of Dakar in Households, Small Production Companies and Market Services

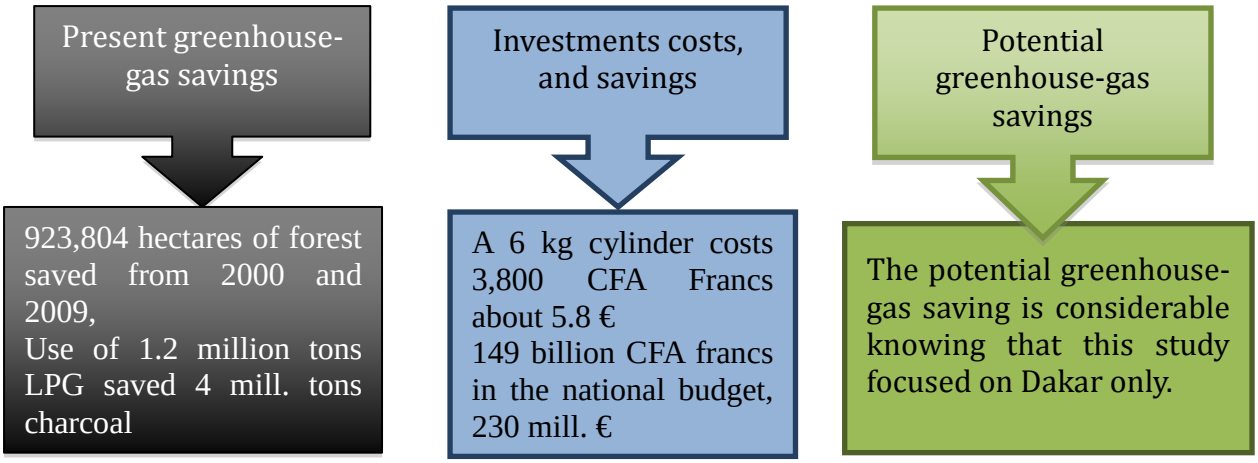
By Djimingue Nanasta, ENDA

Summary

This case study on a programme promoting butane gas, a process called 'butanisation' in Senegal, and specially the impact of the removal of subsidies, is to show the process of large-scale distribution of butane gas and how the subsidy reform affected household behavior as well as small the activities of production companies and of market services. The study shows that the butane-gas subsidy policy initiated in Senegal for three decades has produced satisfactory results both in terms of the promotion of a new clean energy and in preserving the plant cover. This policy brought savings in the national budget by avoiding the expense of reforestation of degraded forests.

At the household level, the removal of gas subsidies has caused a return to charcoal, which seems cheaper, with a utilization rate increasing from 77.8 % to 90.2 %. Thus, there has been an increase in expenditure for the acquisition of cooking energy. The share of cooking energy in food expenditure increased by 3.7 %, while at the same time the share of LPG in energy expenditure has declined by 11.2 %, which is due to purchase by households of small quantities of charcoal. The removal of the subsidy has also contributed to the deforestation of nearly 77.4 hectares of forests from 2009 to today. Thus, the return to charcoal also triggered a return to improved stoves.

It is therefore recommended to develop strategies to supply the domestic market with clean and affordable energy solutions for cooking with stable prices.



Presentation of the Case and the Context

The complete removal of the subsidy to LPG by the State of Senegal in 2009 put an end to the policy of 'butanization', that is to say, the promotion of butane gas as clean energy and preservation of the vegetation cover of the country, which was seriously threatened by logging.

So it is important to investigate and identify the direct and indirect effects of the removal of subsidy, including on households. It is in this context that this case study aimed to analyze the impact on the poor in urban and peri-urban areas, especially on households, small production companies, and merchant services. Importantly, this case study will show how the lifting of the subsidy influenced access to LPG, forms of energy, and energy equipment. The objectives of the study are, among others, to evaluate the effects of the subsidy removal and then to make recommendations to stakeholders and policy-makers.

The ultimate goal of energy policies initiated in Senegal is to satisfy national energy needs as well as to comply with the acts and decisions adopted within the framework of international and sub-regional cooperation (CILSS, UEMOA, ECOWAS, etc.). Since 1998, the energy sector has undergone several reforms.

In the area of domestic energy, given its fairly specific nature, a policy strategy was also developed in 2008. Its purpose was to promote the development of the sub-sectors of domestic fuels and rural electrification in view of their economic, social and environmental impacts. It aims, among other objectives:
- to integrate logging into a system of rational management of forests,
- to promote effectively other alternative energies,
- to rehabilitate the institutional, regulatory and tax framework in the light of past and / or current experiences, and
- to capitalize on experiences for dissemination of best practices.

Socio-Economic impact: The use of butane gas allowed avoiding the expense for reforestation of degraded forests due to the production of charcoal and firewood.

Environment impacts: The forest cover was preserved to a great extent by the use of butane gas.

The introduction of the subsidy for butane gas was undertaken in Senegal since 1974 mainly in order to reduce pressure on forest cover, a traditional source of energy for cooking (wood and charcoal). It was a measure to extend the use of butane by users from all socio-economic groups because of the massive use of traditional biomass.

Link to Climate Change and Analysis of theEeffects

In terms of impact on the preservation of vegetation and in the fight against climate change, consumption of butane gas amounted to 1.2 million tons between 2000 and 2009. It is supposed to have saved nearly 4 million tons of charcoal.

This gives a savings of CO_2-emissions of around 1.4 million tons/year, if the wood harvest is depleting forests and there is no re-growth of the wood used for charcoal. Since there is deforestation in Senegal, the reduction of charcoal use can lead to reduction of wood use to a more sustainable level, where re-growth is possible on the level of the wood harvest.

The CO_2 reductions are estimated with the assumption that use of 0.12 million tons of LPG/year creates 0.4 million tons of CO_2/year, while use of 0.4 mill. tons of charcoal/year creates 1.2 million tons of CO_2/year and the production of charcoal from wood creates additionally 0.6 million tons of CO_2/year. The emission reductions are then around 1.2 + 0.6 - 0.4 = 1.4 million tons CO_2/year.

The relation between the budget costs and the CO_2 savings are that the annual subsidy budget of CFA Franc 16.5 billion (€ 25 million) led to savings 1.4 mill. tons of CO_2 from charcoal, equal to 18 €/ton of CO_2, and to related reductions in deforestation.

On the economic plan, the use of butane gas has led to savings in the national budget by avoiding the expense for reforestation of degraded forests due to the production of charcoal and firewood.

The comparative analysis of the relative changes in consumption of cooking energy showed that between 1997 and 2004, there was a fluctuation in the consumption of wood products and a continued increase in butane gas. This change in forest products is the result of the implementation of a new policy of rational management of forest products by setting annual harvest quotas, and for butane gas, it is linked to the policy of promoting LPG in households.

However, the removal of the subsidy resulted in a significant change in the mix of energy for cooking in households, the overall rate of use of butane has experienced a recession from 97.4 % to 85.2%, with coal and wood that have increased from 77.8% to 90.2 % and 12.8 to 16.8 %, respectively. Behavior change has resulted in a return to coal and firewood at the household level. It also means that coal increased in the scale of importance of energy cooking.

Thus, the removal of the subsidy has had effects on the different uses of domestic energy. It has resulted in a change in the behavior of households with regard to the offer of energy services. Despite the tax exemption granted to butane as an accompanying measure, the transition to this product has been discontinued especially among the poor, who turned back to coal, a move that was mainly dictated by their financial means, since they can buy small amounts coal.

The removal of the butane gas subsidy has also had negative effects on the forest cover. It has led to the resurgence of charcoal and firewood. At the level of small production companies and commercial services, the removal of the subsidy was characterized by a reduction in the monthly consumption of butane gas.

Lessons and Recommendations

The 'butanization' policy initiated by Senegal put in coherence two key sectors of our development, namely the energy and forestry sectors. The intent was to meet the energy needs of the population while preserving forest resources through increased involvement of local communities, and thus to fight against desertification and climate change.

From 2000 to 2009, consumption of 1.2 million tons of LPG helped preserve 923,804 hectares of forests and the economy of 149 billion CFA francs on the national budget, that is, 16.5 billion per year (corresponding to the annual amount of the grant).

The removal of the subsidy was marked at the household level by the return to charcoal, which seems cheaper because it is bought in small quantities. The rate of use of charcoal has increased from 77.8% to 90.2 %, an increase of 12.2%. There has also been a change in

the priority given to cooking energy with the fall of gas as the main energy, and the rise of the position of the charcoal.

Despite the tax exemption (VAT and custom duties) given to butane, the transition to this product has been discontinued, especially among the poor. These have switched to the use of charcoal, given their limited financial resources and the opportunity for the acquisition of the wood-fuel in small quantities.

The main recommendations are as follows:

- Developing sourcing strategies of the national market through economies of scale will help reduce the cost of LPG by improving national logistics;
- Extend the mission of the Special Support Fund to domestic energy fuels such as butane gas;
- Study the possibility of return to the subsidy for the 2.7 kg of LPG through the establishment of technologies that are suitable for local cooking habits by industrializing the production of accessories;
- Review the chain of distribution of butane gas;
- Promote the concept of 'energy shops' for the local supply of gas;
- Promote energy efficiency in poor households as well as in small production companies and commercial services in urban areas with a view obtaining definitive transition to butane gas;
- Promote the use of improved cookstoves and alternative energy sources such as biogas in the households.

Photo: Small biogas plant

CASE STUDY - India

Carbon Credit for Household Biogas Plants

by Raymond Myles, INSEDA, India

Summary:

INSEDA's Gold Standard VER (Voluntary Emission Reduction) project was aimed at mitigating greenhouse gases (GHGs) via household bio-digesters and at increasing the efficiency rate of the biogas plants by bundling household anaerobic biogas plant installed in the rural areas of Kerala and Madhya Pradesh. Biogas generated from the bio-digesters helped in replacing firewood used for domestic cooking purposes, thus improving the quality of air in the cooking space and also reducing the drudgery imposed on women.

This project perfectly illustrates the immense benefits to be gained for participants in the Gold Standard VER process and the potential for sustainable, nationally appropriate mitigation activities. However, the present process of the lengthy registration, verification, and certification has serious shortcomings, particularly for the project developers. The extensive reliance on external agencies for the detailed documentation of every step is prohibitively expensive; problematic, given a rural setting; and time-consuming for small-project developers.

The absence of funding or a financial safety net (for instance, the lack of a provision allowing advance payments from buyers to ease monetary pressures on participants) can impede the smooth functioning of the process.

It is recommended that, in keeping with the constraints of grassroots needs and finances, Gold Standard process should be reformed and simplified, and a funding process should be put in place. Without addressing these concerns, the most valuable mitigation projects (which are in rural areas) will end up being excluded from this process. It is also recommended that there be further appropriate capacity-building of NGOs and other grassroots stakeholders involved in the carbon credit project.

Present greenhouse-gas savings	Investments costs, and savings	Potential greenhouse-gas savings
4,000 biogas plants save 16,000 tons of CO_2 in project areas in the Indian states of Kerala and Madhya Pradesh	Investments are 300 € / plant, and can then save costs of other cooking fuels (mainly reduced work) and can receive 100 - 150 € of climate credits over 10 years	The involved NGOs could support the development of 10,000 biogas plants/year, leading to extra savings of 40,000 tons/yr, after 10 years this will add up to 400,000 tons/yr of GHG

Introduction

The Integrated Sustainable Energy and Ecological Development Association (INSEDA) is the national organization formed by the Indian grassroots NGOs in 1995 involved in the promotion of renewable energy, with sustainable-energy-based eco-village development (EVD) programmes for over 18 years. However, INSEDA's special emphasis and focus has been on the implementation of biogas technology development and promotion in rural areas of India. For more than 6 years, INSEDA has been involved in the development of carbon-credit project, for small-scale household biogas plants under the Gold Standard Voluntary Emission Reduction (VER). The participants involved under this VER project are INSEDA and its member and partner NGOs from two Indian states, namely, Kerala and Madhya Pradesh (MP).

Socio-Economic impact:
The replacement of traditional fuel with gas from bio-digesters from domestic farm animals and other wastes:
- removes some drudgery from the lives of rural women in the collection of fire wood, and in cooking.
- reduces indoor pollution.

The residues (slurry) is a valuable plant nutrient and soil enricher.

Environment impacts: Reduces greenhouse gas (GHS) emissions by displacing unsustainable firewood for cooking, reduces uncontrolled methane emissions, and eliminates black carbon from households.

This project has been developed under the Gold Standard VER. Like a Certified Emission Reduction (CER), a VER (Voluntary Emission Reduction) is also a tradable commodity and refers to reduction of one ton of greenhouse gas (GHG). The difference between a CER and a VER is that, while CERs are generated according to standards and requirements of the Kyoto Protocol and UNFCCC, VERs are independently verified by a third party according to criteria that confirms that the emission reductions are real, measurable and credible.

A Gold Standard (GS) project ensures that the project is sustainable, flexible and transparent through a participatory approach with initial and main local stakeholder meetings.

2. *Description of the Case, its Development and the Background Situation*

a). Purpose of the project activity:

The purpose of this ongoing project is to contribute towards sustainable development through the effective utilisation of gas from household biogas plants (which were built in a decentralised manner by NGO members and partners of INSEDA) and to switch over from biomass like firewood to clean renewable energy generated from utilizing animal wastes and other organic wastes in the rural areas of Kerala and Madhya Pradesh.
The project activity is generation and utilisation of clean and environmentally friendly gas from the household (family size) bio-digesters (plants) from domestic farm animals and other locally available organic wastes. This will improve hygienic conditions in the rural areas and will also lead to reduction in greenhouse gas (GHS) emission by displacing conventionally used firewood for cooking, and thus contributing to the mitigation of Climate Change.

In addition, these household biogas plants (bio-digesters) will also reduce the drudgery in the lives of rural women as experienced in collection of fire wood, in cooking and in indoor pollution. It will also contribute positively to the overall empowerment of women and adolescent girls in rural India.
The residues, biogas-digested manure in slurry form, which are discharged after giving the environment-friendly and non-polluting gas from the bio-digesters, would be used as enriched organic fertilizer, increasing water-holding capacity of the soil and improving the soil for crop production.

b). Description of the Project

The biogas project activity is located in rural areas of Kerala and Madhya Pradesh (MP). Consumption of firewood for household purposes in the rural areas is the main cause of deforestation in the project areas of Kerala and Madhya Pradesh. The project has around 4,000 household biogas plants in various districts of two states of Kerala and Madhya Pradesh. In each of 4,000 households, a biogas plant unit is installed, protecting the trees, and reducing the release of greenhouse gases (GHS) to the atmosphere, contributing positively towards the mitigation of climate change. The biogas units are of different sizes (1, 2, 3, 4 & 6 m^3 capacity), depending on the number of persons in the household and the availability of dung from their domestic farm animals. Biogas is generated in the bio-digesters (plants), into which bovine (cattle & buffalo) dung (manure) and other organic waste is fed and is allowed to be digested under anaerobic (in the absence of air) conditions for a prescribed number of days. The biogas thus generated is composed of a mixture of 55-60% methane (CH4) and 35-40% carbon dioxide (CO_2) plus traces of other gases. It is utilized for household purposes, mainly for cooking (using stove with specially designed burners) and to some extent for lighting (specially designed lamps with mantle).

Apart from the initial and main stakeholders' consultations, the project cycle for a Gold Standard (GS) project is not very different from a regular Clean Development Mechanism (CDM) project. It is essential however, that the project is sustainable, without negative environmental impacts, and compliant with UNFCCC additionality requirements.

c). Project Contribution to Sustainable Development

This biogas project has the goal of disseminating of biogas technology to improve socio-economic condition of the rural people and to reduce GHG emissions. In addition, the project is also helping to improve living standards of rural people. Advantages of the project are summarized below:

Environmental well-being:

- Using biogas as an energy resource contributes to clean environment.
- Organic wastes are transformed into high-quality enriched bio-manure/fertilizer.
- Hygienic conditions are improved through reduction of pathogens by utilizing the animal and other organic wastes in the bio-digesters.
- The global environment is improved by reducing deforestation and improving biodiversity.
- The high-quality manure produced will lead to improvement in soil conditions.

Socioeconomic well-being:

- This project provides employment opportunities to local people during construction and maintenance of the biogas plants.
- It improves the economic level of the local community.
- It reduces cooking times, thus enabling women to take up other activities.
- It is increase overall health situation by reducing smoke and soot in the kitchen, thus eliminating health hazards from indoor air pollution.

Technologically well-being:

- Better, field-tested biogas plants, mainly the most popular India-fixed model approved by the Ministry of New and Renewable Sources (MNRE), improve biogas yields.

d). Steps involved in Gold Standard Cycle for Validation and first Verification

- INSEDA started the dialogue with its members and partners for developing biogas carbon-credit projects in the middle of 2007.
- Started collection of data on the biogas technologies built by INSEDA members and partners, using a standard form; and compiling them and creating database in late 2007.
- Organised and participated in initial meeting with the local stakeholders in early 2008.
- Initiated development of Project Design Document (PDD) and Passport and submitted to Gold Standard Foundation (GSF) for pre-feasibility assessment in February 2009.
- Meanwhile also initiated baseline survey in MP and Kerala using independent external organisation to authenticate the information submitted by INSEDA members and partners to ensure that they were correct.
- Received positive pre-feasibility assessment from GSF in September 2009.
- After receiving the positive pre-feasibility assessment report from GSF and after completion of baseline survey, revised the PDD and the Passport.
- Proceeded with the main stakeholder consultation in Madhya Pradesh (MP) and Kerala in October 2009. INSEDA also sent letters to invite several international agencies as well as the representative of GSF to participate in both the stakeholder consultations/meetings. In the stakeholder meeting, shared the revised PDD and the Passport.
- Prepared a report after the meeting for the consultation with the local stakeholder.
- Identified the DOE (Designated Operational Entity, an evaluator) accredited by UNFCCC and signed agreement in March 2010 for carrying out validation of the INSEDA biogas project.
- Process of validation was started by DOE with the visit of the validator to the two project states (MP and Kerala) in May 2010.
- PDD and the Passport were finalized along with local stakeholder consultation report.
- Final PDD and Passport was uploaded on the INSEDA website in September 2010.
- Organised a meeting the stake holders in MP and Kerala in October 2010 to share the final PDD and Passport with them. INSEDA also sent invitation letters to several international agencies and representative of GSF to participate in these two meetings.
- At the same time, during the period from May 2010 to May 2011, answered various queries raised by the validator, as well as collected and sent additional supporting documents to fully satisfy validator to finalize the validation report.
- Successful completion of the validation process and report was uploaded onto the website of the Gold Standard Foundation (GSF) in June 2011 for their internal review.
- After review of validation report, some queries were raised by the GSF in the middle of August which were satisfactorily answered by the end of August 2011.

- Received formal letter of communication from the Gold Standard Foundation (GSF) on September 15, 2011, stating that our project, "GS 666: Installation of Biogas Plant by INSEDA Members and NGO Partners", is officially registered with the Gold Standard with effect from September 2009 for a 10-year period.
- Based on the formal undertaking by INSEDA to GSF, the project was uploaded onto the GS website, changing the project status on the registry.
- Meanwhile INSEDA appointed the same DOE that had done the project validation on July 26, 2011 to undertake the verification based on field visits to a certain percentage of biogas plants in MP and Kerala.
- The DOE visited the sites of biogas plants in MP during February 2012 and in Kerala in April 2012, to verify that a certain percentage of plants covered under the project for allotment of VER prepared their reports for the issuance of VER credits to INSEDA.
- Based on the on-site verification in MP & Kerala and on clarification of various points, as well as on submission of monitoring report and other documents, DOE finalised the verification report in July 25, 2012 for submission to GSF for issuance of VER credits to INSEDA.
- The DOE's verification report supported by monitoring report and other documents were uploaded on the website of GSF by the end of July 2012 for internal review. The Gold Standard communication received was that the INSEDA project status had changed to 'Registered, verification process complete, ready issuance of VER by GS'.
- After an internal review period of four weeks, GSF sent many queries by the end of August 2012, to be responded to by INSEDA. It took another two months to fully satisfy all the queries raised by the GSF.
- Finally, GSF issued VER credits to INSEDA for a period of two years, Sept 2009 to September 2011, in the second week of November 2012.
- Based on the VER credits, our buyers paid the appropriate fees to GSF, after which the VER issuance was credited to INSEDA.
- The buyers transferred the money for the entire VER due to us in the INSEDA bank account during the third week of November 2012.
- On its part, the INSEDA transferred the amount due to each stakeholder as per the percentage share agreed. The members and partners of INSEDA (whose names were registered in the PDD) were also given the shares their respective plant owners and were listed in the project documents.

e). Second verification for issuance of next one year VER by GSF to INSEDA

- Since November 2012, INSEDA started the verification process for getting issuance of VER credits for the next one year period, starting from September 2012.
- The verification by the DOE was completed on September 16, 2013, and the verification report with supporting documents was uploaded onto the website of GSF on September 18, 2013 for a minimum internal review period of three weeks.
- After the review period INSEDA received few queries and clarifications from GSF, which we have answered during October and November 2013.
- Now we are awaiting the registry of the next set of VERs by the GSF to INSEDA for the 1 year period i.e. Sept 2011 to Aug 2012.
- Once the VERs are registered by the GSF, we will ask our buyers to disburse the next payment to INSEDA, as per the agreement.
- Soon after that, INSEDA will initiate the process for the third verification, which is already due for the period September 2013 to August 2014.

3. Analysis

Carbon-credit projects can bring considerable socio-economic benefits to rural people in India, in South Asia, and in other developing countries, but as mentioned, in the present form it faces many problems and barriers. At present the CDM, Gold Standard, and other registering bodies of the carbon-credit projects use mechanisms, which are not only too cumbersome, but also time-consuming, as it takes as much as 3-5 years. Presently, it is very heavily loaded in favour of highly paid external consultants, as it involves detailed documentations, baseline surveys and other regular field surveys, validations, verifications and monitoring, etc. Because of all of these, the transaction cost becomes too high and the main project developer is at the mercy of these highly paid external consultants, not knowing till the end (which could take up to 3-5 years or more durations) whether the carbon-credit project will be approved for registry or not? If for any reason the project falls through at any of the stages, the project developer has to pay heavily, and if a small developer is involved, it risk financial loss and bankruptcy, as well as a loss of credibility with the other stakeholders. In this process, the real stakeholders (project developer/holder and the local NGOs with meagre resources as well as the poor end users) suffer, and mistrust is generated amongst them due to these delays.

It is very clear that the whole process of registering the carbon-credit projects has been designed by the registration agencies to be time-consuming and resource-guzzling for the stakeholders, like the project developers, the members, partners and the end users. After clearing each step successfully one wonders if it was worth going through it, and whether the next step will be cleared or not. The majority of NGO groups/networks working in the developmental programmes/projects operate on meagre resources and try to reach the normally unreachable target groups in difficult situations. Their concern is to deliver the best to the target groups in as cost-effective a manner as possible, as their resources, both in term of manpower and finances are very limited. At the same time, NGOs also have to maintain their credibility with the local people, as they have to continue working with them regardless of external support, as that is what they have chosen to do. Therefore, in spite of good work, they could never do fool-proof documentation of the entire process. On the other hand, the carbon-credit projects are heavily loaded in favour of over-documentation, perhaps not required so much for registration, but more to protect the registration agencies themselves and their reputation. Because of too much dependence on the approach, many very good grassroots projects which have very strong social dimensions perhaps will never get registered as Gold Standard projects, as the people managing and working for such groups are very far from the grassroots realities.

For the dissemination of household biogas plants, which is a highly decentralised programme, and very relevant to be consideration for carbon-credit, only those who have long practical experience of implementing such projects can understand the many socio-economic benefits that provides to the rural communities, without even studying such elaborate documents like the PDD, Passport, and other reports based on new studies by highly paid external experts.

From the step-by-step process of validation, and verification for the GS registration for the INSEDA biogas project, described above, it becomes clear that there is a need for capacity-building of NGOs and other grassroots stakeholders involved in the carbon-credit projects, to fully understand these requirements of the certification agencies that need to be followed strictly. Most NGOs operating at the state level and the small stakeholders don’t have the expertise or resources to send their functionaries for capacity-building to prepare the carbon-credit projects and, later on, to complete the entire process leading up to registration. Moreover, the capacity-building of NGOs and the other smaller stakeholders should be ably backed by good socio-technical organizations with expertise and experience in both theoretical and field-level practical knowledge as well as by financial resources to act as development-oriented consultants to bundle carbon-credit projects by combining a number of small-scale decentralised units/systems. The job of socio-technical organisation acting as project consultant would also be

required to do hand holding as well as to guide and assist NGOs and other stakeholders at important stages of the process. They should also help to prepare monitoring reports, answering all the queries of DOE and international registration agencies satisfactorily to ensure that the project fulfils all the requirements of the registration and issuance of VER/CER credits.

The average greenhouse gas (GHG) reduction per house biogas plant of 2 m3 capacity (if properly fed with cattle manure, and properly operated by its owner) would be 4 tons per year. Under the INSEDA biogas gas carbon credit project, over 4,000 household biogas plants, 1, 2, 3, 4 & 6 m3 capacity (mainly 2 & 3 m3 capacity) were included from the two states, namely Madhya Pradesh (MP) and Kerala. These biogas plants generate over 20,000 VERs annually. If the support were available, then an average of 10,000 household plants/year can be built by the NGO members and partners of INSEDA in these two states of India.

4. Conclusions and Recommendations

Looking backwards why we (INSEDA members and partners) got involved in the carbon-credit project for household biogas plant, and why we continued going through the cumbersome process for registering the project, the reasons were several. One of them was that INSEDA's external consultants were so good in marketing the idea of carbon credit that they sold us the moon in terms of this project, and also we were able to find a very credible and trusted buyer, the First Climate, as buyers. The First Climate (FC) signed the agreement with INSEDA in May 2008 to buy the VER generated from our bundled household biogas project, and ever since have been providing moral support. The FC also agreed to take care of some of the cost on validation, verification and registration etc., as well as provided INSEDA with some advance funds at the very advanced stage of verification and issuance of VERs. Their top executive even visited the project sites in MP, which is one of INSEDA biogas project states, to understand the project and realities at the grassroots level, meeting and talking with the local poor owners of the biogas plants about the direct and indirect benefits. They also made a movie to build awareness in people in the western countries and for promotional aspects. Another reason for continuing the process and not giving up in the middle was because of the faith and expectations of our grassroots members and partners in INSEDA, who along with INSEDA had spent meagre resources for collection of data, field-level information, documentation, and development of this biogas project and in organising various stakeholders meetings, along with their own commitments to their end users, mainly the rural biogas plant owners. Therefore, in spite of five years of long wait, we continued in the entire process and took it to the logical end.

In view of the above, we would like to recommend that the entire process of registration should be completely revamped, to cut down the roles of high-cost external consultants, reducing in the transaction costs as well as project registration time by at least one fourth of the present duration. There is also a need to provide some kind of "Development Fund" or "Revolving Bridge Fund", in the form of grant from the donor groups, which could be used for capacity-building and to sustain the NGO project holders, members, and partner grassroots NGOs until the project is registered.

The registering agencies should be reviewed to ascertain what proactive role they can play and how they can become NGO-friendly and provide hand-holding role, especially in the case of socially relevant carbon-credit projects for highly decentralized applications.

Based on over five years of process-oriented involvement in developing its own carbon-credit project, INSEDA now has in-house expertise and practical field experience to develop carbon-credit projects for registration by the international certification agencies, both CER and VER, using a step-by-step process-oriented approach. INSEDA can act either as socio-technical organisation for the capacity-building of NGOs, provide consultancy to NGOs in developing carbon-credit projects, or act as a partner organisation in any joint development of carbon-credit projects, starting from inception until the registration and issuance of VER/CER credits.

CASE STUDY - India

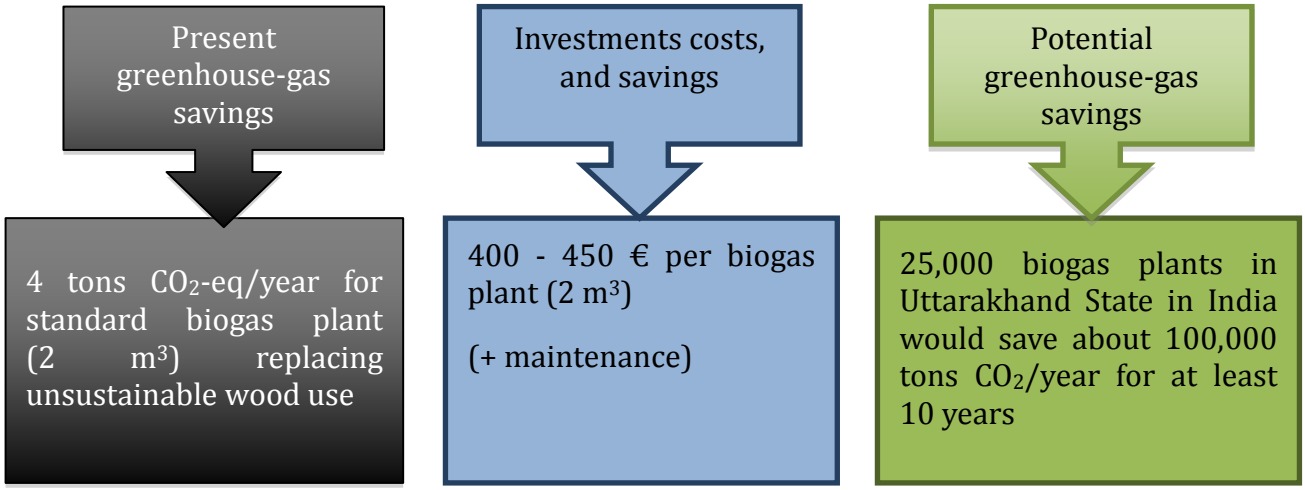
Bamboo Used at Biogas, Solar within Eco-Village Developments

By Raymond Myles, Secretary General, INSEDA and Zareen Myles, Executive Director, WAFD

Summary

A renewable-energy based eco-village development project is a joint effort of WAFD (Women's Action For Development) and INSEDA (Integrated Sustainable Energy and Ecological Development Association) to demonstrate how several such actions at the grassroots level can effectively mitigate the negative effects of climate change. This project is based in six villages of Rani Chauri area of Tehri Garhwal district of Uttarakhand state. The project villages are situated at a height of 5,000-7,000 feet above sea level, in the Sub-Himalayan mountainous region of India, and is a prime example of promoting green community living using innovative low-carbon strategies and commonly found resources in uncommon ways.

This case study briefly discusses the processes and strategies for promotion and implementation, mainly by utilizing eco-friendly bamboo building material and renewable-energy based sustainable eco-village development (EVD) actions. It demonstrates how a large number of such local people-centered solutions can contribute effectively to low-cost, affordable solutions for climate-change mitigation. It also illustrates how this process, assisted by the capacity-building of 'end users', makes these interventions sustainable and enduring even after the withdrawal of the external agencies (NGO partners) at the conclusion of the project period. Bottom-up approaches to climate mitigation and adaptation, like the organization of receptive communities into eco-villages, helps them evolve their own responses to climate change-challenges.



I. Introduction

While policies and strategies to deal with climate-change issues are being given some urgency in global, regional and national forums, the negative impacts of these changes are already being felt amongst the most vulnerable populations of the world.

To address this issue effectively at the grass-roots level, the approaches followed by *WAFD (Women's Action For Development) and INSEDA (Integrated Sustainable Energy and Ecological Development Association)* were to take villages as the smallest units for integrated development, by implementing renewable-based, environmentally benign and eco-friendly low-cost affordable actions.

Socio-Economic impact:
Biogas and other cooking solutions reduce the need to collect firewood and yield a cleaner cooking environment as well as good fertilizer. Solar drying enables better treatment of harvests.
Water collection increases resilience to drought.

Environmental impacts:
Cooking solutions replace use of wood, which reduces overuse of forests and other trees, and thus contribute to reduce CO_2-emissions. Use of biogas sludge for fertiliser enriches soil.

The rationale of WAFD and INSEDA for choosing villages as the smallest units for interventions (especially in India) is that they are usually at the fringes of policy-making and are also the first to be impacted by climate-change effects. Village communities are also ideal for illustrating the concept of contextually appropriate, small-scale innovations for climate-change mitigation and adaptation, which can be replicated easily in other villages with appropriate modifications.

The key to success for these projects is the participation of families living in these villages. This also involves their active participation to ensure that they are trained, their capacity is built and skills up-graded so that they can be actively involved in the implementation of development activities meant for their benefit.

This project has been developed and built upon by the 8 years of experience that WAFD and INSEDA gained in implementing a joint program of eco-village development (EVD) in the state of Rajasthan in India. These EVD projects were undertaken in 12 selected villages of the Bharatpur district in Rajasthan. After learning extensively from these projects, both of the NGOs in January 2011 launched similar programs in the ecologically fragile Himalayan sub-region of India. Thus now we are having a total of about 10 years of experience in EVD programs. The first program on EVD, which lasted over a period of 8 years in 12 villages in Bharatpur was funded by the Finnish Ministry for International Cooperation (FMIC), Finland through the Students Union of the University of Jyvaskyla, Finland.

How this Case can Contribute to Climate Mitigation

This case is important to improve standard of living, but it also contributes to climate mitigation. It does so in its present form, but it could do it much more, if scaled up to national or regional levels, together with other, similar initiatives. In the table below, focus is on biogas, but solar cooking, solar drying and other solutions used in the EVD project also contribute to reduced greenhouse-gas emissions.

Present greenhouse-gas savings	A 2 m^3-capacity household biogas plant (rated to generate 2 m^3 biogas per day, when fed with 50 kg fresh cattle manure daily) saves 4 tons of CO_2-equivalent/year from avoided use of unsustainable wood, avoided LPG, avoided use of cow-dung cake for cooking, and avoided uncontrolled methane emissions.
Potential greenhouse-gas savings	If all people with animals enough and space for biogas in the Uttarakhand state had a biogas plant, a total of 25,000 biogas plants would be built, then savings would be 100,000 ton of CO_2-equivalents/year, given that alternative is unsustainable use of biomass.
Investments costs	400 - 450 €/ biogas plant (2 m^3 capacity) (+ maintenance)
Savings	Typically, one biogas plant saves 2 tons of wood or 400 kg LPG per year (If 25,000 household biogas plants of 2 m^3 capacity are installed in Uttarakhand, savings would be 50,000 tons wood or 10,000 tons LPG/year).
Resources needed for large-scale dissemination	At the present cost, it would require about 800,000,000 INR (Approx. 11,000,000 €) for 25,000 units of Grameen Bandhu biogas plants plus investment in capacity-building, administration, and post-installation follow-up services for at least 3 years. External funding required is 30-50% of this, ca. 4-6 mill. €, which would save 1 mill. tons of CO_2-eq over 10 years (given replacement of unsustainable biomass use), equal to 4-6 €/tons.

II. EVD Project in Villages Surrounding Rani Chauri in Tehri Garhwal Dist. of Uttarakhand

The EVD project in the Rani Chauri area of New Tehri district was prepared jointly by WAFD, INSEDA and ASDA (a Helsinki-based NGO) as a two-year pilot project. The preparation work was just after that the old Tehri Garhwal district headquarters had been submerged after the construction of the Tehri Dam and all the offices moved to the New Tehri district. The work was based on intensive participatory exercises with local people from the proposed target villages, and was sanctioned by the Finnish Ministry for International Cooperation (FMIC), Finland, to be implemented with effect from January 2011.

After the project was sanctioned by FMIC, WAFD & INSEDA conducted a systematic baseline survey of the target villages using two designed formats, one for the village level survey and second for the household survey in the target villages.

The baseline survey was used to create a digitized database. The detail surveys confirmed some of the important inputs given by the local people during the participatory planning of the pilot project of 2 years duration, followed by the planning, formulation and implementation of the main project of 3 years duration.

The target villages are situated at a height of 5,000 to 6000 ft. (1,500 - 2,000 m), above sea level, in two adjacent blocks (namely, Chamba and Narendra Nagar) of the New Tehri district of Uttarakhand State in the sub-Himalayan region of India.

III. Background & Reason for undertaking SEVD project in Rani Chauri (Tehri Garhwal)

1. Due to the construction of the Tehri Dam, which submerged the old Tehri Township completely, people in the target villages (located only 20 km from the dam) mentioned that:

- Weather pattern had changed and rains had become erratic as well as unpredictable, either too much or too little.
- The natural habitat of the wild animals and birds were destroyed, as a result of the submergence of many villages and forest lands in the lake, on the up-stream side of the Tehri dam. These displaced wild animals and birds then moved towards these villages, attacking destroying the standing crops of the villagers for their survival.
- Climate change has been responsible for the low yield from the traditional crops grown by them.
- Males from these village have gone to urban centers within the Uttarakhand as well as to other states for jobs.
- Women, children and older people are left in the villages, and the burden of agriculture, livestock-rearing and looking after all the work of the house, etc., falls on the women.

2. Women walk long distances to collect the firewood, fodder for animals, and water.

3. The livelihood of the women is affected, as there are no regular income-generating activities.

4. The women get low prices for their agricultural produce, as they lack the skills and resources to preserve and process the agricultural and horticultural produce for value-addition so as to increase the shelf-life, to get better market prices.

5. In view of this, WAFD and INSEDA have undertaken this project for the sustainable development of the villagers through the integration of scientific organic farming, rainwater storage, low-cost renewable energy and income-generating activities by “Promoting People Centered, Renewable Energy Based Eco-Village Development (EVD) For (i) Energy, (ii) Water and (iii) Food Security and (iv) Generating Sustainable Livelihood for Local Community.

6. In addition to the above, to demonstrate the “Local Solutions for Climate Change Mitigation”, which can be taken up by the local people, especially the women. These solutions show and teach them how to have a sustainable life style, through low-carbon, on-farm and off-farm income generation within their own villages. This is possible by using the upgraded skills they learn through the capacity-building activities of the EVD project.

IV. Overall Objective of the SEVD project

1. **The overall goals** of this renewable-energy-based eco-village development (EVD) in the existing project (in Tehri Garhwal district in Uttarakhand state) are the same as in our earlier project in Bharatpur in Rajasthan state. These are:

- To promote people-centered, renewable-energy-based sustainable village development in 6 selected villages in the Himalayan sub-region of India by integrating renewable energy as well as environmentally benign and eco-friendly low-cost affordable technologies,
- To focus on those technologies, which are simple and affordable to help in improving their lives as well as to augment their livelihoods.
- To train the target families, through capacity-building activities, for future actions for combating the negative impact of climate change, through mitigation and adaptation innovations that can be undertaken easily with their existing resources.

2. **NGO Cooperation:** The WAFD (an NGO operating at the grassroots level) and INSEDA (a socio-technical NGO operating at the national level) have been working as partners in the field of promotion of appropriate rural technology for the past about 18 years. Together, they have been involved in the implementation, transfer, demonstration and promotion of socially relevant technologies which could fit into the local social and cultural environment, rather than following a purely technology-oriented approach. Thus, they have drawn heavily on the long and practical field experience of other grassroots partner NGOs in understanding the local people and local situations in developing and transfer a technology.

3. **Bamboo:** Recognizing bamboo as one of the most eco-friendly and environmentally benign materials, for the last 18 years, INSEDA has been working in the design, development, testing, promotion of different rural technologies in partnership and close collaboration with WAFD (Women's Action for Development) in villages of Bharatpur district in Rajasthan state, and now in the villages surrounding Rani Chauri in Chamba block of New Tehri Garhwal district in Uttarakhand state. Bamboo presently is brought from neighbouring districts/states, but if large-scale implementation of this technology is taken up then it can also be grown in this district/state.

4. **Green technologies:** The main objective of working with bamboo as the building material in these two project areas which have different agro-climatic conditions (where WAFD was already operating) was to design and develop eco-friendly green technologies to provide clean cooking energy, rain-water harvesting from the rooftops of the rural houses and storage, compost units for organic agriculture, solar drying and water heating, as well as greenhouses for vegetable cultivation and nursery raising etc. At the same time, such bamboo-based technologies would be comparatively stronger, affordable, user-friendly, and would provide employment to local artisans and rural women in the project area during construction/building, after providing them appropriate training. The people would be able to use these to enhance their existing income, remove drudgery, improve their nutrition as well as quality of life.

V. Technologies Implemented in Rural Areas in Rajasthan State Uttarakhand State within the Eco-VillageDdevelopment (EVD) Project

1. Biogas plants: These are made from bamboo-reinforced cement mortar (BRCM), and provide clean cooking energy for the house, saving traditional cooking-fuels such as firewood, cow dung cakes, LPG gas etc. Biogas-production also provides excellent composted manure as a by-product to be used in kitchen gardens/fields. A 2-m^3 BRCM biogas plant built in Rani Chauri area of the project (fed daily with 50 kg cattle manure mixed with 50 liter of water) produces sufficient gas for cooking for a family of 6-8 persons and costs INR 32,000-35,000 (400 -450 €). One 2-m^3 Grameen Bandhu biogas plant would save approximately 4 tons of CO_2 equivalent/ year.

Pictures: Bamboo basket as reinforcement for cement dome for biogas, biogas plants under construction, finished biogas plant covered with soil

2. Solar Dryer: These easily portable low-cost solar dryers are made from bamboo and polyethylene for drying fruits, vegetables, spices & herbs cleanly and without traditional sources of energy. They also save time and are easy to use. The cost of this bamboo solar dryer is INR 1,500 to 1,600 (19-21 €).

Pictures: Constructing solar dryer solar dryer in use, example of dried material

3. Roof -Top Rain-Water Harvesting Unit (RWHU): The RWHUs also use eco-friendly and environmentally benign bamboo as the main building material for building bamboo-reinforced cement mortar (BRCM) storage tanks for the RWHUs to harvest (collect) and to store rainwater from the roofs during rainy seasons, thus reducing women's drudgery of carrying water over long distances. Depending on the roof area of houses, the RWHU built using BRCM tank of 1,000 liters capacity cost INR 8,000-10,000 (100- 130 €), and the 5,000 liters capacity RWHU is built for INR 30,000-35,000 for an individual rural family (400-470 €).


Pictures: Bamboo reinforcement under construction, finished water tank with tap

4. Solar water heater: These easily portable low-cost solar water heaters/dryers made from bamboo and polyethylene to heat water for a household. The cost of this bamboo solar water heater is INR 1,500-1,800 (20-24 €). It is used for taking baths or pre-heat water for cooking.

5. Composting baskets: Almost all rural areas have a problem of unsanitary conditions due to organic waste being thrown on the street corners or on open dumps. Those farmer families who don't have the required number of domestic farm animals to have enough dung for a biogas plants, or don't have enough resources to install even the smallest-capacity plant, normally dump their animal dung in pits or heaps above ground to make manure in an unhygienic manner. For such families, WAFD/INSEDA is promoting simple compost baskets. These portable compost basket units are fabricated with woven bamboo strips. They are used for making excellent composted manure from any biodegradable waste from the kitchen gardens & agricultural fields. The cost of each woven bamboo basket (I meter diameter and 1 meter height), which produces enough composted manure for 1 Nali (220 sq.yd.), comes to INR 1,400-1,600 (18-21 €). (Note: 22 Nali = 4,840 sq. yd. = 1 Acre).

Composting basket in use

6. Solar Poly Green House (SPGH) -The SPGH is fabricated using very good quality, UV-stabilized polyethylene. The comparatively low-cost SPGHs is either used at a nursery to raise high-value vegetables and fruit trees before planting in the field or, by individual families, for growing vegetables year-round for their own consumption for better nutrition or to sell. The SPGH of 2 m. width, 15 m. length & 2.5 m. height costs INR 30,000-35,000 (400-460 €).


Pictures: Polyester greenhouse from outside, and inside.

VI. Sustainability and Replication of the SEVD (Sustainable Energy based Eco-village Development) Project

Two NGOs, WAFD and INSEDA, have been implementing renewable-energy-based sustainable "Eco-village Development-EVD" projects jointly in a few selected villages in India since 2002. They serve as model "Demonstration-cum-Training Villages", for the capacity-building of NGOs and development organizations who would be interested in replicating them in their areas of operations, with appropriate modifications.

Even after the funding from the FMIC has ceased, both WAFD and INSEDA have continued their interventions in Bharatpur district. These activities involve mostly local women volunteers from those villages to disseminate their learning to other women in their villages. They hope to motivate at least 1-2 of those 12 villages to implement most of the components of EVD project using their own and other local resources for mobilization, motivation, awareness, meetings and training for women volunteers in Bharatpur, to spread the concept and project component of EVD in other villages. Thus, this project has exemplified the concept of sustainable and enduring multi-stakeholder learning.

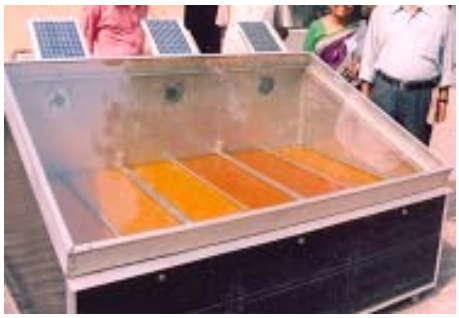
The same approach is being followed by WAFD and INSEDA in the villages around Rani Chauri area in the Tehri Garhwal district of Uttarakhand.

VII. Analysis of the SEVD (Sustainable Energy based Eco-village Development) Project

In order to address the issues of climate change and sustainability and their effects on the day-to-day lives of the poor at the grassroots (in the villages' communities), the model that WAFD and INSEDA have adopted is that of "Eco Village Development". It is one of the successful approaches for the following reasons:

- This model *targets the village,* which is the smallest unit for interventions because in India the village communities illustrate the concept of appropriate small-scale innovations for climate-change adaptation. They can be replicated easily in other places, with appropriate modifications.
- *Focusing on developing capacities of the women leaders* and on giving them training as well as on upgrading their existing skill base, has shown that even after stopping of funding these, women can carry the program forward on their own. Our experience in Bharatpur shows that these women leaders can motivate other women in their own and surrounding villages to implement and adopt some of these components of EVD. The most common are the adoptions of organic farming and kitchen gardening. These activities give immediate results, as they can see the changes in their land, and they can get vegetables not only for their own families but to sell as extra produce to earn some money.
- *The key to success of this model is that it is easily replicable*. It is easily learned and uses simple durable technologies, with locally available material that is environmentally friendly. It also fulfills felt needs such as clean, cheap energy for cooking, storing rainwater so as to use it, drying of fruits and vegetables for future use, etc.
    - The activities have impacts on climate mitigation and adaptation. Rainwater-harvesting is measure for adapting to more erratic rainfall, while renewable energy like biogas is a mitigation measure, reducing needs for unsustainable firewood and fossil fuels, while also limiting uncontrolled methane emissions.

- To address the issues related to climate change and sustainability effectively at the grass-roots level, one of the approaches could be to take villages as the smallest units for integrated development, by implementing renewable-based, environmentally benign, and eco-friendly low-cost affordable actions. WAFD and INSEDA's rationale for choosing villages as the smallest units for interventions (especially in India) is that they are usually at the fringes of policy-making and are also the first to be impacted by climate change-effects. Village communities are also ideal for illustrating the concept of contextually appropriate, small-scale innovations for climate-change mitigation and adaptation, which can be easily replicated in other villages, with appropriate modifications.
- The key to success for these projects is the participation of families, especially women living in these villages. This involves their active participation to ensure that their capacity is built and these skills upgraded so that they can be actively involved in the implementation of development activities meant to benefit them. Thus, they will continue to implement what they have learned on a sustainable basis, even after the withdrawal of the external development agencies.



CASE STUDY - India

Solar Dryers for Income Generation

By Lalitta Balakrishnan with inputs from Madhu Bajpai and other colleagues, AIWC

Summary

Solar dryers were tested in four places in India. The activities were carried out by the All India Women's Conference (AIWC), a non-profit NGO, which has 150,000 members in 500+ branches. The solar dryers can dry fruit and vegetables in sufficient quantities to create livelihood for one person. The dried fruit and vegetables are of good quality and can replace fruit and vegetables dried with electricity or gas.

Present greenhouse-gas savings	Investments costs, and savings	Potential greenhouse-gas savings
One dryer can dry 4 kg/day. If used 250 days/year it will dry one tons, and save 3.24 tons of CO_2, if it replaces electric drying. AIWC has 4 dryers, in total are 161 dryers	Dryer with infrastructure and installation costs 210,000 INR = 3,000 € Profit (example): 670 INR/day (10 €/day)	If 800 dryers are installed, and are replacing electric drying, the savings will be 2,500 tons CO_2/year

Introduction

All India Women's Conference (AIWC) is one of the oldest and pioneering Women's not for profit organization. AIWC was established in 1927 in India by an Irish Lady, Margaret Cousins, for the education & emancipation of women, along with eminent Indian women like Sarojini Naidu, Rajkumari Amrit Kaur, and others. It has more than 150,000 members and 500-plus branches across the country working for the empowerment of women. Amongst many projects AIWC has undertaken one of the important programs is implementing application of renewable energy technologies with the objective of making them a tool of women's self-reliance, through various low-carbon technologies for over four decades.

India is the only country which has a separate Ministry of New and Renewable Energy, Govt. (MNRE) at the centre for promotion of renewable-energy technology. AIWC has collaborated with the Ministry for the successful implementation of the projects, being identified as one of the Nodal Agencies.

Drying of Fruits and Vegetables

Drying of fruits and vegetables is a well-known practice in India. Sun drying is widely practiced. But, hardly 2% of the country's horticultural produce, i.e., fruits and vegetables, are processed. Countries like Thailand, Philippines, USA, process more than 70% of their produce.

Solar Drying Technology

Solar dryer technology can be utilized in small-scale food processing industries for producing hygienic, high-quality food products. It will also promote renewable energy sources as income-generating units, apart from saving the world from the ill effects of climate change. Thus, with a vision to enhance incomes of women from economically poor strata in rural India, to promote a renewable energy source, and to produce a quality value-added food product, AIWC came out with the project "Income generation for poor women through solar dryers in Andhra Pradesh, Kerala, Tamil Nadu and Delhi". The one-year-long pilot project was conducted successfully in four places: Delhi, Trivandrum, Chennai and Hyderabad. After a lot of consultations, a SDM-50 type solar dryer was selected, and the pilot project was implemented with the installation of four solar dryers at Chennai, Hyderabad, Trivandrum and Delhi.

Socio-Economic impact:
Creates livelihood for one person for each dryer.

Environment impacts:
If solar drying replaces drying by electricity or fossil fuel, it reduces CO_2 emissions.

The project was implemented through AIWC Head quarters, New Delhi, Women's Indian Association, Chennai, Priyadarshini Mahila Samajam, Trivandrum and AI.

Usually a minimum of 4 solar dryers will be chosen for one economic unit, but in our case, we tried out the project in four different regions with funding from Asian Development Bank Small grants programme, in 1984-85. Although there are many cheaper models, we had selected the SDM-50 solar dryer, developed by the NGO *"Society for Energy, Environment & Development" (SEED)* from Hyderabad after 10 years of intensive research under the leadership of Prof. Ramakrishnan Rao, who is still helping us with the project whenever needed.

In Puducherry, where the project of solar drying is being launched as a follow-up, there are many "Self Help Groups" (SHG), who are supplying mid-day balanced meals (Poushtik Ahaar) under the ICDS Program. Further, all the solar-dried projects, including "Aam Papad" (mango bars), are being marketed by the Renewable Energy Agency of Puducherry. Hence, with mitigation of global warming, we believe that this project will prove to be successful in Puducherry and can contribute locally and globally to post-2015 Millennium Development goals.

Objectives of the Project

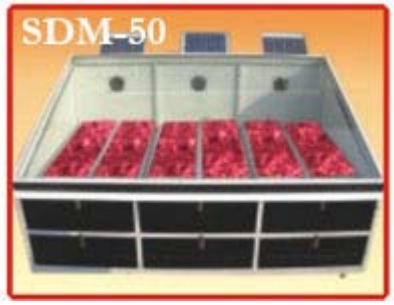
- The solar energy application as a value addition device for the fruit- and vegetable-processing industry at a micro level, especially fruit bars/rolls.
- Assurance that SHG members (mostly women) can operate this modern equipment with zero energy cost & maintain the equipment themselves with minimum help.
- Saving enormous quantity of fruits and vegetables which perish all over the rural areas due to lack of preserving, processing & marketing facilities.
- Helping all the Asian countries who are already preserving their produce into value-added & hygienic products.

The one-year long pilot project was carried out in two phases:

1. Training and installation of dryers in four locations. More than one hundred women have received intensive training in all the aspects of solar drying, and another two hundred women, including members of SHGs, have been given full orientation and short training.
2. To carry out production on experimental basis.

Experiments were done with different products in different locations based on available resources and demands along with the validation of technology. Mango bars, Ginger powder, Margosa powder and Fenugreek powder for diabetic patients and desiccated coconut powder were few of the products. Details of each product were systematically filled in a cost analysis. One of the key outputs of the project is a matrix that gives details of profitability, and marketability of various solar dried products across seasons.

SDM-50 Solar Dryer for Food Processing and Dehydration **- A brief note on the technology**



Solar dryers (SDM-50 Model)

- The construction of the solar dryer involves a metal cabinet made of aluminum alloy with a glass window on top. The stainless-steel trays are provided in the cabinet to hold the material to be dried in the solar cabinet dryer.
- Thermostat control sets temperature in mixed solar and electrical mode.
- Closed trays are provided for easy loading and unloading of product.
- Solar photovoltaic (PV) fan circulates air in the cabinet.
- A special glass filter is provided to block Ultra Violet (UV) radiation and to reduce the solar intensity for special applications.
- The product is clean and hygienically prepared, meeting cleanliness specifications of ASTA of USA.
- The temperature achieved in the cabinet is in the range or 40-65°C on clear sunny days.
- The temperature difference between the ambient and inside cabinet is 15-30°C on sunny days.
- The dryer is rain-proof, dust-proof, rodent-proof and insect-proof due to fixation of an EPDM gasket, which can be replaced easily as needed.
- The moisture control in the product can be achieved by the regulation of drying time based on the intensity of solar radiation.
- The critical size of the micro-enterprise is 4 solar dryers (SDM 50 Model) with a minimum capacity of 4,000 kg (4 tons) per annum of fruit bars/rolls.
- It is modular and scales well to any amount of demand.

Advantages of the Technology

We can dry, prepare and preserve the following food items:

- Many kinds of cereals like wheat, barley, etc. and their associated products- flour, maida, rice wafers, tapioca wafers, sevia, noodles, legmes; (green leaves like kasturi methi, pudina, drumstick leaves); root vegetables – potatoes, etc., other vegetables; fruits and their pulp; sweets, Mango bars; kadi masala powder/kadi leaf powder, ginger powder, masala & condiments, black pepper, dry tomato slices/powder, dry basil leafs, dry drumstick leaves, cured green chillies, cured bitter gourd, herbal plants, papad, forest products; fish, meat; coconut and many other products could be processed in less time. Though this dryer is expensive (about 11/2 lakhs), if 4 dryers are bought and run by SHG's, there is big scope for earning very good income through supplying to local and foreign markets.
- Most of all, when we are talking of food security, we could not only save tones of produce going to waste but provide good income for the women. In addition we could distribute nutritious food to our children and mothers. We could also help in mitigating global warming through the use low-carbon technologies.
- If the food-processing technology is introduced at the micro-level, it will help to preserve perishable food products as well as create opportunities for increased rural employment. SHG members will be able to operate with zero energy cost and maintain the equipment themselves with minimal difficulty.

Estimated Budget (Model Budget)

For an economically viable project for 4 tonnes (approx.) annual production capacity of fruit bars at solar food processing centre:

ITEM NO.	EXPENDITURE INCURRED	COST IN RUPEES
1.	Capital Investment, Equipment & Machinery Cost- Four (4) solar dryers – SDM-50 Model Ex – works price @ 1,25 ,000/- * 4 nos. and packing , transportation , Installation at site and insurance costing Rs. 1, 00,000/-	600,000
2.	Processing & Packing Equipment, Utensils Kitchen including gas stove and cylinder, Food Processor, Hot sealing machine, Price labeling machine, Hot air gun (for shrink pack), Other items	50,000
3.	Infrastructure, Construction of platform for 4- solar dryers (including labor & materials) , Office , processing & stores This is optional where basic infrastructure is not available.	150,000
4.	Installation Supervision & Organizing (15 days intensive training)	50,000
5.	Trainers Training, One time training to trainers at Pondicherry for processing of mango bars for 16 persons for 3 days excluding travelling & accommodation.	30,000
6.	Follow-up Inspection by Central Office (including travel & accommodation), Project Director, Secretary.	120,000
7.	Evaluation & Report	100,000
8.	Honorarium for supervision 2 ,000/- month for 1 yr (by members & staff of the local Branch)	24,000
9.	Administrative cost, Miscellaneous	117,800 60,000
	GRAND TOTAL	1,301,800
	Grand Total in USD (Exchange Rate 1USD = INR 61.285)	**$21,241.739**

Product Preparation and Marketing

The products were identified on the basis of season, fruits and vegetables available in the local market and market survey.

The branch in Tamil Nadu experimented with tomato powder, curry leaf powder, kasuri methi and bitter gourd powder. Delhi pilot dried tomato slices, kasuri methi, mango bars, kadi masala powder, tomato powder, amla powder and ginger powder. The members at Delhi dried basil, pudina and drumstick leaves apart from mango bars. Simple dry kadi leafs having medicinal values were also produced. The kadi leaves dissolved in water provide cure for BP problem in human beings. Kerala branch performed very well and experimented with curd green chilies, curd bitter gourd, black pepper, rice wafers and tapioca wafers. With their own efforts they have purchased one more dryer for their branch.

The details of each product were recorded systematically in a cost analysis report prepared specially for the project.

Marketing Details: The prepared products were sold at the calculated prices based on the production and depreciation cost. A percentage of packed products were supplied as samples to retailers and canteens for testing. All of the solar dryer units have been promoting marketing through known linkages. At Delhi, packs of tomato slices were distributed as samples to specialty outlets and restaurants. Other products were sold through the AIWC counter at the main branch. Mango bars, methi leaves and ginger powders sold extremely well.

The market study at Chennai and related experiences reveal that mango bar toffee can be marketed through school canteens and can fetch a good profit. At Chennai, marketing was done through school canteens, Red Cross Society, other NGOs, and local contacts. The Kerala unit tried to market the products through linkage and local sources. At each of these places, only one solar dryer was used, which helped us with the cost analysis.

Findings

All four pilots tried to prepare dried food products out of raw materials available locally. Some products managed to earn profit and a few incurred losses. The reasons for profit and loss varied among products. In this chapter, we analyzed the causes for profit and losses incurred by different products.

All of the products were selected carefully for availability of raw materials, but because of differences in marketing forecasts and actual consumers' preferences, few products faced loss. This section is an attempt to analyze performance of each product separately.

Composition of mango fruit mix for one layer. Usually, 3 layers are laid for one 100-gram packet of mango bar.

Financial impact of one load of mango bars:

Raw material weight	38 kg (mango pulp, sugar, pectin, citric acid, etc.)	
Cost of raw material &	1,200/-	$ 18.84
Other expenses per load		
Mango bar Yield /Output	17 kg	
Sale price per Kg	Rs 110/-	$ 01.72
Sale price per 17 Kg	Rs 1870/-	$ 29.36
Net Profit Per Load 17Kg	Rs 670//-	$10.52
No. of Batches Per Annum	70	
Net Profit Per Annum	Rs. 46,900/-	$ 744.44

(according to 2004 AIWC - ADB Project)

The Chennai branch produced 122 kg of mango bars and was able to sell 90 kg. The Women's Indian Association is making 100 g, 25 g, and 10 g bars, which is marketed through Red Cross Society and school canteens. The Delhi Pilot project produced 33 kg and sold 32 kg. Market survey reveals that small packets of mango bars of 20 g might be sold through canteens at Chennai and Delhi. Thus the hygienically prepared mango bars are available for the school children (all of these are from pilot projects).

All together, mango bars gained a profit of 70%. The Tamil Nadu pilot procured 91% profit, as the branch sold small packets of Rs 5. These small packs provide a greater profit margin. The Delhi unit made 100 g packs and sold at Rs 15 per pack.

During interaction sessions with the members of SHG groups, including those who had taken the training of producing mango bars, we found the members willing to produce and sell small packs of mango bars to the school children of small towns whose pocket money is only Rs 1.00 per day.

Products	**Tamilnadu#**	**Delhi#**	**Kerela***
Tomato powder	25	-47	
Curry leaf powder	-43		
Kasuri methi	-467	35	
Mango bar	91	15	
Bitter gourd powder	-33		
Bitter gourd chips	-55		
Ginger powder		-1	
Kadi masal powder		23	
Curd green chillies			35
Curd bitter gourd			9
Black pepper			10
Rice wafers			20
Tapioca wafers			20

** It is assumed that all the quantity prepared is sold.*
 # Based on actual production and sales record

The matrix shows that the profit percentages for the different products in three pilots. The same product is appreciated in one place but faces huge losses in a different state because of the variation of the food habits, cost of raw materials, etc. Thus, selection of products to be prepared in the solar dryer units must be made very carefully, based on the availability of the raw materials in local markets, consumer's preferences, and food habits.

Learning

This two-year research project brought out both technical and non-technical problems which created the base for upgrading the program and the solar dryer for further extension.

Some of the technical problems are listed below:

- Chennai unit faced the problem of insect penetration. The reason was found to be a crack in a rubber tube.
- Thermocol packing used for fixing thermometer got damaged in Delhi unit, which increases the risk of mixing of the small pieces with the material being dried as well as risk of breakage of thermometer.
- Fans used were not of good quality. Now AIWC Hyderabad branch has managed to change them.

Non-technical problems included those which were faced during production and marketing:

- record keeping was very difficult in the units where the users were mostly semi-literate, belonging to economically poor section of society.

All of these problems were set right by SEED.

The local advocacy role in the project:

- Whenever enough awareness was given to women and the general public of the benefits of using the solar dried products, great demand was created.
- At the level of disadvantaged strata of the society (the poor), the income generation aspect of the solar dryer project was appreciated and there was a great demand for further programmes.
- At the governmental level, the efforts taken by AIWC and partners to inform the officials at all levels, including Ministers, lead the Government of India to announce a substantial subsidy of 50% in the price of the SDM-50, which has been approved by Ministry of New and Renewable Energy, and the subsidy is still in operation. This has helped many self-help groups, and NGOs apart from AIWC branches, to procure this solar dryer and start income generation programmes for rural women and other interested persons. But this help has not been used as much as expected, since the request for subsidy has to be routed through the State Government Departments, who do not give priority to this programme. This, despite to great importance for stopping the big wastage of rural produce, giving decent income to women and men, saving of energy, and mitigation of global warming.
- The fast-food joints are more than ready to buy the tomato powder, ginger powder, and tomato slices dried in solar dryers, once they come to know that they are available, since they realize the value of these solar-dried products.
- The Hyderabad branch, which is continuously running the project successfully even now, is trying new products all the time, like pasta. Recently, with the help of SEED, they have brought additional technology, of fixing dehumidifiers in the cabinet along with the fan to prevent the moisture from going to the top layer, where it might grow fungus. This helps a lot in drying of fish.
- The AIWC Hyderabad is also in the process of preparing “Ragi Malt “for mid-day meal (for school children) at Tholikatta village in collaboration with the SEED and funding from the Government of India. They prepared nutritious drinks also for school children and have got an all-India market.

Solar drying is continued in four states and recently AIWC has conducted a Solar Training Programme in collaboration with SEED at AIWC's headquarters.

It is estimated that one ton of fruit processing eliminates about 3,240 kg of CO_2 emission. Currently there are about 161 solar dryers operational in India that produce about 165 tons of fruit bars. This results in reduction by 500 Mt of CO_2. Use of solar energy will reduce the requirement of electricity to up to 1,188,000 kWh in a year, which corresponds to 119 lakhs (190,000 USD) of power-saving at the rate Rs. 10/kWh (0.16 USD / kWh). At current prices, about 44 lakhs (69,576 USD) have been invested for setting up of dryers.

In the next five years we anticipate significant growth in the establishment of solar dryers and enhancement of dryers’ capacity. With this, we envisage operation of more than 800 dryers of different capacities that can process more than 2700 tons of fruit bars. This may require an investment of 12 crores (1,897,533 USD) and 30 lakhs (47,438 USD) (including current investment), which can eliminate about 2,500 Mt of CO_2 emissions and may result in saving of Rs. 22 crores (3,478,810 USD) in terms of electricity valued at Rs. 10 per KW (0.16 USD / kW). The resources required for this would be primarily, private finance or own funding.

Conclusion

It is concluded that the pilot may be replicated in A- and B-grade cities of India and other Asian countries, as market is available for hygienic products. Self-Help Groups (SHGs) and individual women should be encouraged to take up the enterprise after proper training. The greatest positive factor of the enterprise is that it doesn't involve full-time engagement and thus could be taken up by daily laborers, housewives, or other women engaged with some other active source, for SHGs or individuals. Apart from this, it saves an enormous amount of rural produce from perishing.

Finally, it is concluded that the solar dryer use is suitable for wealth creation among poor women and plays a great role in reducing global warming. This could be easily replicated in all countries growing large amount of fruits and vegetables along with medicinal plants and with fish, which could be turned into value-added and hygienic products by solar drying.

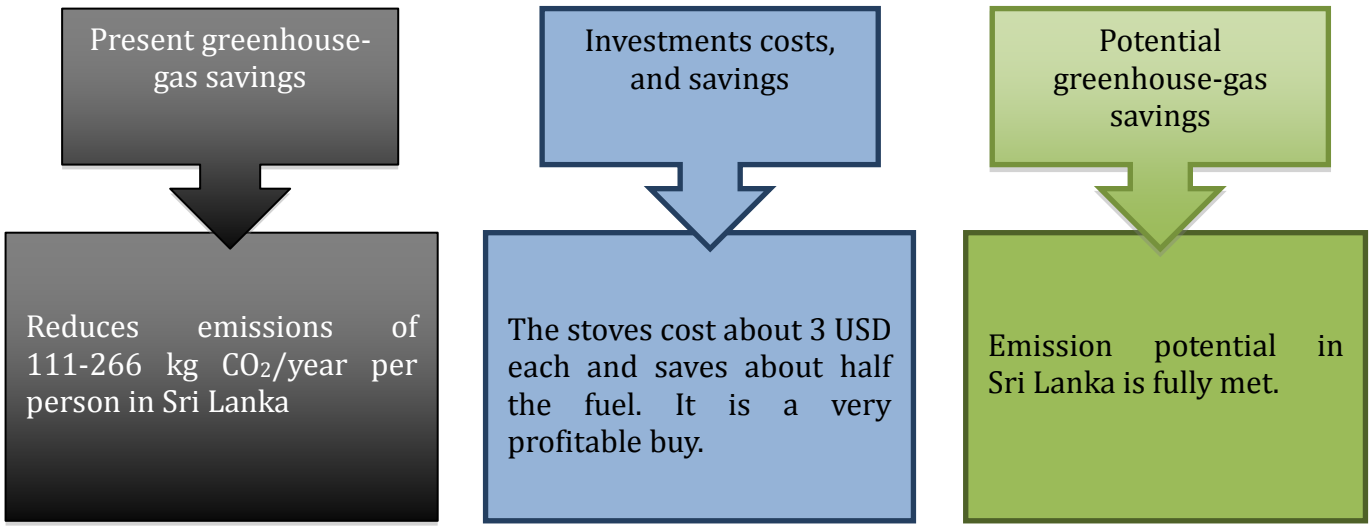
CASE STUDY - Sri Lanka

"Anagi" Improved Cookstoves Commercialisation

By R. M. Amerasekera, IDEA

Summary

Sri Lanka's stove programme can be identified as one of the few large-scale successes in the developing countries' quest for sustainability. The stove dissemination is fully commercialised and several studies have established that its production and social marketing process has reached sustainability in Sri Lanka. At present, over 300,000 stoves are produced annually by 185 rural potter families and marketed by a network of private traders dispersed throughout the country. The stoves are demanded and traded like any other commercial product in the market without any external influence or intervention. However, to reach this level of success, several strategically structured moves with consistent efforts were employed over a period of nearly 30 years by several organisations.



Background of Stove Development Activities

In Sri Lanka, several improved cooking stoves projects have been implemented over the period 1979 to date by a number of organisations. Looking back, the interventions can be broadly divided into three phases of development:

Phase 1: Design Stage	1979 - 1983
Phase 2: Dissemination	1985 - 1990
Phase 3: Commercialisation	1987 - 1996
Phase 4: Diversification and reaching the poor	1996- 2005

These are not planned phases of one project but characteristics of different projects building up from the stage where the previous left off. To make a long story short, this paper will emphasize the activities of the third phase, namely commercialization, which led to the sustainable stage, which is where Sri Lanka is now.

The commercialisation phase consisted of two projects. Urban Stove Programme (USP) in the City of Colombo 1987/1988, Rural Marketing Stoves Programme Phase 1, 1991/1992 and Phase 2, 1995/1996. Phases 1 and 2 covered twelve districts in the country.

The main implementing agency of the dissemination stage was the Ceylon Electricity Board (CEB) under the auspices of the Ministry of Power and Energy, deriving funds from several donor agencies, mainly from the Dutch Government. This project covered 12 districts. The stove selected for dissemination was the two-piece two-pot mud-insulated pottery-liner stove developed by the previous Sarvodaya - ITDG project. During the project period of 1985–1990, nearly 400,000 stoves were disseminated as against a target of 500,000 stoves. Over 200 potters and nearly 2000 stove installers were trained under the project, and officials of the government administrative structure were used in the promotion and extension activities.

Socio-Economic impact:
For the users, it reduces fuel use, improves combustion, reduces smoke in kitchen, and make cooking easier.
For the potters that make the stoves, it increases their income and wealth.

Environment impacts:
It reduces use of wood, which reduces deforestation and therefore reduces CO_2 emissions and gives other benefits. It also reduces local emissions of particles.

The stove, which was purchased at Rs 15 from the trained potters by the project officials, were given free of charge to the user. The user was expected to pay Rs 15 for the installation to the stove installer. The payment and installation were facilitated by the government extension officer. The main objective of this project was to reduce the use of firewood and thereby reduce the rate of deforestation. After the project was terminated, it was expected that the linkage among the user, potter and stove installer developed by the project would continue.

There was a considerable amount of awareness created due to the dissemination programme by the CEB, but it also raised several questions with regard to the future and sustainability of stove promotion and use.

Taking into consideration the large quantity of 400,000 stoves distributed during the dissemination phase covering 12 districts over a period of six years, the project was considered to be a rare achievement and a great success when stove programmes were failing elsewhere in the developing countries. But behind the success there were several questions hidden as to the sustainability of stove use and promotion thereafter. Once the subsidy was removed and involvement of the government officials in promotion activities was withdrawn, the linkages built connecting the producer (potter), stove installer and the user gradually disintegrated.

In the meantime, NGO ITDG (from UK, now called Practical Action), learning from the successful experience gained in commercialization of the "JIKO" stove in Kenya, came out with a proposal for a similar commercial approach for which funding was secured from Ministry of Power and Energy, CEB, and others. The project was implemented by the Ceylon Electricity Board in the Colombo City and the suburbs. The project duration was 18 months starting in June 1987. Thus began the commercialization process of stoves that is the main focus of this article. The total cost of the project was Sterling Pounds 101,404.

Accordingly the USP formulated by ITDG and CEB made provision to improve the previous (Sarvodaya) design (not a complete new design) to be made as a single piece two-pot design, thus making it portable item that could be marketable as an off-the-shelf product and used as it is without the need for installation by a skilled person. This modification facilitated the stoves to be sold commercially like any other pottery item and to adopt marketing strategies making use of existing channels to market similar products. The modified Sarvodaya Stove was named Anagi 2 because it has two pot holes. The programme also included a one-pot (CISIR) grate design in the promotion efforts and it was called the Anagi 1. These stoves were produced by the tile factories making use of trained potters and spare capacity in the tile-firing kilns. Thus, new techniques had to be developed and introduced in making and firing the stoves as compared to the Sarvodaya stove. They were marketed through private-sector dealers. Evaluations show that the urban stove project was more successful than the rural-sector project in terms of sustainability, due mainly to the suitability of the model, large-scale production by tile factories, and independent distribution by private-sector dealers at market prices that did not include a subsidy by the government. As the urban users discovered the benefits of the stove, and as stoves were available in the market, demand for them increased.

This, however, later resulted in the production of low-quality stoves to meet the demand. The urban project was also unable to reach out to the urban poor.

At the end of the USP project in 1989, the infrastructure for producing and marketing 50,000 stoves annually had been established. At the same time, the rural stoves programme too was phasing out and the need for a commercial strategy to replace the dissemination strategy in the rural areas was becoming increasingly evident. The Dutch – Sri Lanka bilateral Energy Programme that provided the major funding for the CEB rural stoves programme was ending. The CEB lost interest in continuing the stove programme, since it is not within the framework of their major business of Electricity Generation and Distribution, so a vacuum was created. Despite the concerns of the evaluators of the USP with regard to the macro objectives of the project vis-a-vis the lack of evidence for reduction of deforestation and reduction of consumption of firewood for domestic cooking at the national level, the establishment of infrastructure for commercial production and marketing of stoves was a success. The need to extend this experience to the rural areas to fill the gap created by phasing out the subsidy programme was recognised by those who were interested in continuing stove developments activities further. However, since CEB was not interested, there was no organization that had the willingness and capability to

continue the momentum created. In the meantime, the Project Manager of the National Stove Programme, with a few other development experts, created a NGO named Integrated Development Organisation (IDEA) to take over the responsibility to continue to extend the programme to the rural areas. The dream became a reality when the ITDG (UK) agreed to continue its support and commitment to IDEA by securing funding and technical assistance for a 4-year programme, which commenced in 1991 and was successfully completed in 1996. During this period, as in the USP, the infrastructure for commercial production and marketing was established to cover 12 districts of the country. This is, briefly, the history and background of the commercialization process in Sri Lanka.

Although, with the commercialization, a large number of stoves were widely available in many areas, it was observed that the commercial channels servicing the demand for stoves were restricted to urban and semi urban areas. Many rural poor do not have access to the distribution channels.

Accordingly, IDEA, with the support of Asia Region Cookstove Programme (ARECOP) and later supported by the UNDP/GEF, initiated a project to address these concerns, commencing in 2000. With this exercise it was able to spread the benefits of commercialization and of scale up the technology further to cover a wider group and area. This phase is identified as the diversification and reaching the poor.

Diversification and Reaching the Poor (1996- 2005)

After the commercialization process, the need for further interventions in the stove development activities was identified for several reasons.

To establish a network to decentralize stove development activities and empower stakeholders to carry out stove dissemination activities on their own, independent from IDEA.

To extend the stove activities to areas not covered by the previous projects and the commercial network.

To diversify stove activities to cover larger cooking needs and rural industries using firewood.

To integrate stoves with other development concerns and with user needs not necessarily confined to energy matters.

The need to decentralize the stove technology expertise and responsibility at district level so that IDEA could focus on other rural energy matters.

The need to diversify stove technology to cover other rural energy needs such as in brick making, bakeries, etc.

The ARECOP network had 15 members representing 15 districts. Although the main objective of these members is not stove dissemination, stoves and kitchen improvement were integrated into their programmes and stoves were an entry point for their work. These network members in turn encouraged other CBOs in their localities to introduce stoves into their activities. Many of these organisations, after the initiation and empowerment provided by IDEA, were able to secure funds from various organisations for stove activities.

It is now observed that stoves have become an important activity in the agenda of many projects seeking funds from donor agencies and many have been successful. The network members were trained by IDEA to prepare project proposals based on the Logical Framework Analysis. Artisans selected by the network members were also given one week

of training in the design and construction of large stoves and kitchen improvement to cater for commercial cooking such as preparing food and sweets for sale, making of pottery, etc.

Stove Production and Marketing Today

Lanka Shakthi Gasifier Stove

Despite the economic growth in the country, it is likely that biomass will remain the major source of energy for cooking.

In addition to the global concerns of climate-change impacts, the need for efficiency improvements in traditional wood use is therefore a necessary national concern to sustain the use of a local renewable resources.

There are several types of stoves used in Sri Lanka today. The thermal efficiencies or social acceptability of most of these stoves are not recorded, as no performance evaluations are known to have been carried out.

The most popular improved stove continues to be the two-pot clay "Anagi Stove" promoted by Ceylon Electricity Board, Practical Action, and Integrated Development Association (IDEA).

In addition, two wood-burning stoves available in the market:
- the "Lakro" single pot metal stoves produced and marketed by the private sector, and
- the Lanka Shakthi Gasifier stove designed by the NERD (National Engineering Research Development Centre), produced and marketed under a franchise arrangement.

However, these stoves are targeted specifically for the urban market and the demand seems not to be very significant.

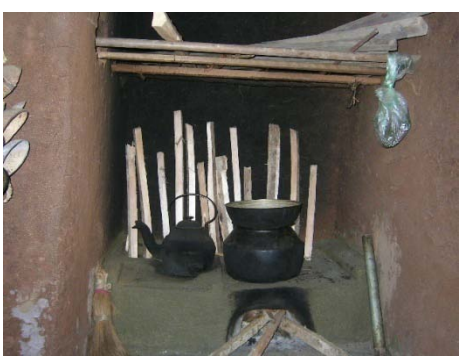
Lakro Stove

Unlike these stoves, Anagi stove can use a variety of biomass types and retains many benefits and conveniences of a three-stone fire, which is a specific requirement for rural users. This has contributed towards social acceptance and marketing success.

Anagi Stove

Since the inception of the Improved Cook Stove Program in Sri Lanka in the 1990s, it is estimated that about 4 million Anagi stoves have been marketed in all parts of the island.

Today, the "Anagi" stove is one of the common items in almost all the sales outlets that sell pottery items and in some village and urban grocery stores. It can be safely estimated that the total number of households in the country is 4 million and, of this, the rural sector may have about 3 million houses**.** If the Anagi stove is used without insulation the lifetime may be about 1-1½ years, and if insulated, 3 years or more. In several district surveys



Installed Anagi stove

carried out, it is revealed that about 23% use Anagi stoves, mostly insulated. With the present annual production rate of 300,000, it is unlikely that the penetration could be increased further.

Amidst the ethnic civil disturbances, which disrupted the political and economic development for over three decades, the stove development activities continued uninterrupted beginning in the early 70s to date. Currently, annual production appears to have stabilised at slightly over 300,000 stoves. New strategies and interventions are therefore required if higher levels of penetration of improved stoves are desired.

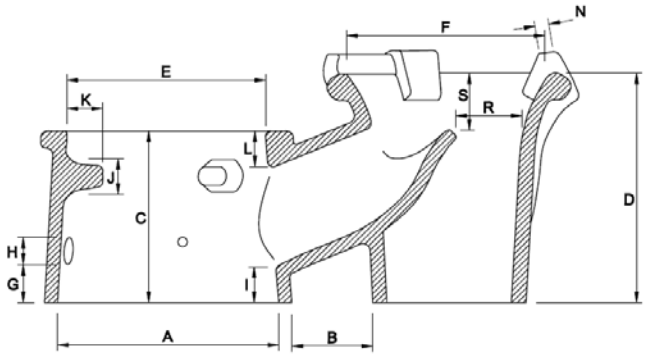
Anagi stoves are marketed through a commercial network of pottery dealers extending to 16 districts and covering nearly 70% of the country's population. The production, is spread over many parts of the country. Despite the efforts for decentralization of production, nearly 80% production is in 4 villages, namely Ambagaswewa, Nungamuwa, Kumbukgete, Bamunukotuwa and Katupotha, all situated in Kurunegala District. This district traditionally has the highest population of potters mostly living in clusters, producing a variety of pottery items and attracting pottery dealers to the area and giving rise to a strong commercial network. However the majority of the potters in these villages now produce stoves in large numbers. This can be compared to a semi centralized system and the whole village can be considered to be a single production unit, although each producer has a middleman distributor of their choice. This probably is the reason why production is high in these villages. This has further resulted in that more young people are getting motivated in stoves production. However, the overall production is limited to the present level, since the youngsters with average education are not interested in pottery due to the stigma associated with caste in low stove-production areas.

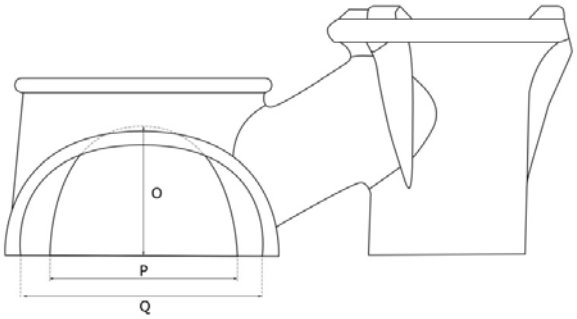
In other production areas, the commercial channels are not well established, which makes the production cost higher than in the Kurunegala district and makes stove production too competitive for small-scale and isolated producers. However, though the production level is not significant, it contributes positively to their subsistence and makes stoves available to isolated consumers. Central Environment Authority has already imposed legislation to limit clay mining in certain parts of the country for environmental reasons. Due to these reasons, it is unlikely that annual production will go beyond 400,000 units. However, since the Kurunegala potters enjoy a high income and social status, they will maintain the present level, which is some consolation for stove activists in Sri Lanka. At present, stove production has helped the informal pottery producers to earn a substantial income, raising their living standards and status in the society due to the economic status gained.

The present decentralized production system is employing a large number of active rural potter producers amounting to about 200 spread throughout the country with individual production levels ranging from 10 to 2,000 stoves a month. This decentralized system has some problems.

The major problem is the difficulty of maintaining a uniform product adhering to designed standards. After some experience in making stoves, the potters are smart enough to make stoves without the templates and moulds with a view to reducing production time, which results in sub-standard stoves. Tools were introduced at the time of training to maintain the dimensions and shape of the designed components, leading to consistency and expected efficiencies. This is unavoidable, as there is anyway a market for sub-standard stoves that look similar to the real "Anagi". The middleman distributors also influence the producer on the shape and size they want, which are way out of the standards specified and, which the producer cannot disregard, fearing loss of market. Many of the second generation of producers are not trained to make stoves but learned from their elders,

which also affects the quality. Fortunately, a random survey carried out shows that the majority of stoves in the market are acceptable quality-wise as shown by tests carried out by IDEA. Presently, wholesale prices of stoves produced by large-scale producers range between Rs 130 – 150, while small producers and selling around Rs 200 to 300 and retail prices are going up to around Rs 250- 450. (1US$= Rs 130).





Recently, Sri Lanka Standard Institution (SLSI), with the initiative of Practical Action and inputs from IDEA, introduced Sri Lanka Standards for Two pot Clay Cookstoves of two sizes small and medium: SLS 1475/2013 for Two Pot Clay Cook stoves (TPCCS). The standardized dimensions are given below.

Dimension (1)		
	Type A (2)	Type B (3)
A	195 – 210	167 – 175
B	73 – 80	58 – 62
C	155 – 165	155 – 165
D	205 – 220	205 – 220
E	175 – 190	145 – 155
F	175 – 190	145 – 155
G	32 – 37	32 – 37
H	22 – 28	22 – 28
I	32 – 35	32 – 35
J	32 – 35	32 – 35
K	32 – 35	32 – 35
L	32 – 35	32 – 35
M	12 –15	12 –15
N	12 –15	12 –15
O	110 – 120	110 – 120
P	155–165	147–155
Q	210–230	170–180
R	≤ 70	≤ 65
S	50 – 60	50 – 60

In addition to the stove dimensions, the thermal shock resistance and load capacities of all 10 components are specified in the standards. Sri Lanka Standard on two-pot clay cookstoves is anticipated to :

- Encourage quality control and adoption of proven methodologies for quality control by manufacturers.
- Promote healthy competition.
- Ensure improved performance and durability of final product.
- Ensure standardized product gets a better market.

However, the interests shown by the producers are lukewarm. Probably, the cost of taking the SLS license is high, which is not affordable to them, and stoves have a market anyway despite the quality.

Anagi Stove's Contribution towards Meeting the Millenium Development Goals

Anagi stove's ability to meet MDGs is proven by research carried out by various institutions nationally and internationally. It reduces energy use, cooking time, greenhouse-gases, and particulate matter. It promotes income generation.
Asian Regional Research Programme - Energy, Environment and Climate - AIT Program 66 report reveals:

Anagi two pot fuelwood stove:

- Rated Power Output 4-5 kWh
- Cost of Energy = 0.64 Rs/MJ
  (Three Stone = 1.27 Rs/MJ; Semi-Enclosed = 0.88 Rs/MJ)
- GHG Emissions = 214 g CO_2-e /MJ
  (Three Stone = 466 gCO_2-e/MJ; Semi-Enclosed = 292 gCO_2-e /MJ)
- Emission Reduction = 50 kt CO_2-e/y per 100,000 stoves (42%)
- GHG Abatement Cost = -21 US$/t CO_2-e

The Anagi-2 biomass cooking stove provides energy at a much lower cost than traditional cooking stoves. Replacing 100,000 traditional stoves with these units could reduce GHG emissions by about 50 kt of CO_2 equivalent per year.

It is estimated that considering 4 scenarios, the Anagi Stove has the potential to reduce CO_2 emissions within a range of of 111 kg/ CO_2/capita/year to 266CO_2/capita/year. (Sources: Initial Evaluation of CDM type projects in Developing Countries. Dr K.G.Begg et al. Centre for Environmental Strategy, University of Surrey).

Indoor Air Pollution

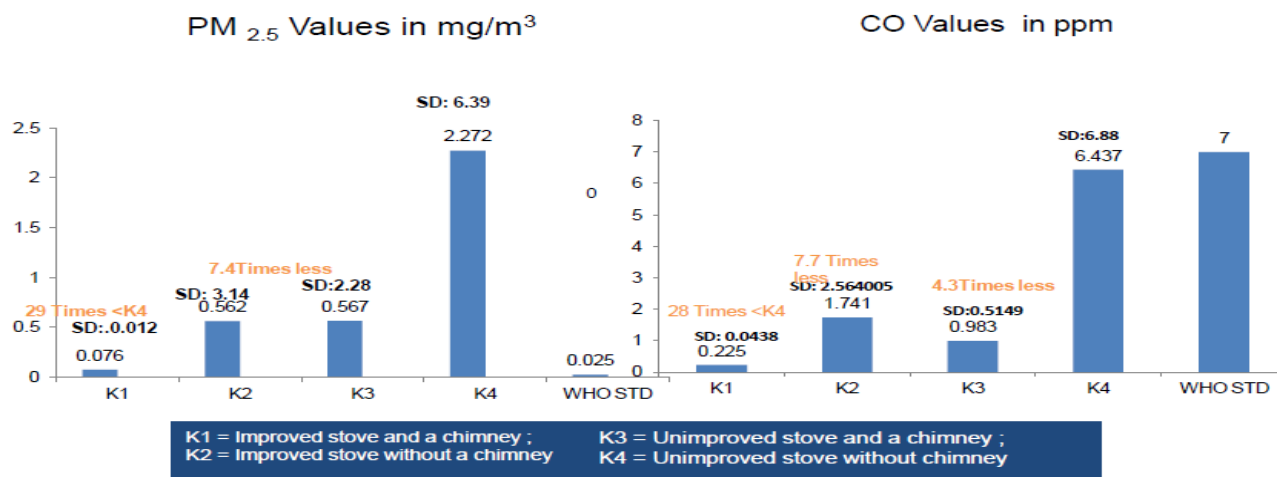
Research carried out in 50 households by Research Triangle Institute (RTI-USA) in collaboration with IDEA using the most modern equipment reports particulate matter emission values using traditional and Anagi Stoves with or without chimneys. While "Anagi" stoves reduce PM values moderately, it shows the importance of using a chimney hood irrespective of the stove type.

Indoor Air Pollution Monitoring

Graph: IDEA research results in 24 households

	Stove	Chimney	Avg Personal ($\mu g/m^3$)	Avg Indoor ($\mu g/m^3$)
1-50 AVG	Traditional	NO	197.4	320.1
1-50 AVG	Traditional	YES	79.6	107.0
1-50 AVG	Anagi	NO	140.8	244.1
1-50AVG	Anagi	YES	84.2	101.7

Graphical Illustration of Geometric Mean of $PM_{2.5}$ and CO values based on kitchen type



Conclusions & Recommendations

The "Anagi" stove production and marketing will continue at the present level, slightly over 300,000, without large increases. Therefore, the stove penetration rate is expected to drop as a percentage of households having such a stove.

In the future, it is unlikely that sufficient clay sources and pottery skills will be available to produce "anagi" stoves to meet the total demand in the country, due to shortages and restrictions enforced on clay mining and a trend of youths rejecting taking up to pottery as a career. This can lead to few large centralized production by few potters.

Although LPG use will increase in urban and suburban areas, firewood will remain the major source of cooking energy in the rural areas, which has to be promoted further to retain the high degree of energy security presently enjoyed by the rural poor. However, it also emphasizes the need for promoting new technologies for efficient use of firewood going beyond the "Anagi". The urban populace have to be provided with a better-performing biomass stove supported with an uninterrupted supply of biomass in a suitable package.

Since stove production has become a popular income-generating activity at present for older rural potters, promoting centralized production will affect poverty alleviation as an objective of stove production.

Due to cultural reasons, where traditions require cooking using biomass at auspicious times, use of biomass stoves may not get eliminated from the social systems for at least a few decades.

CASE STUDY - Nepal

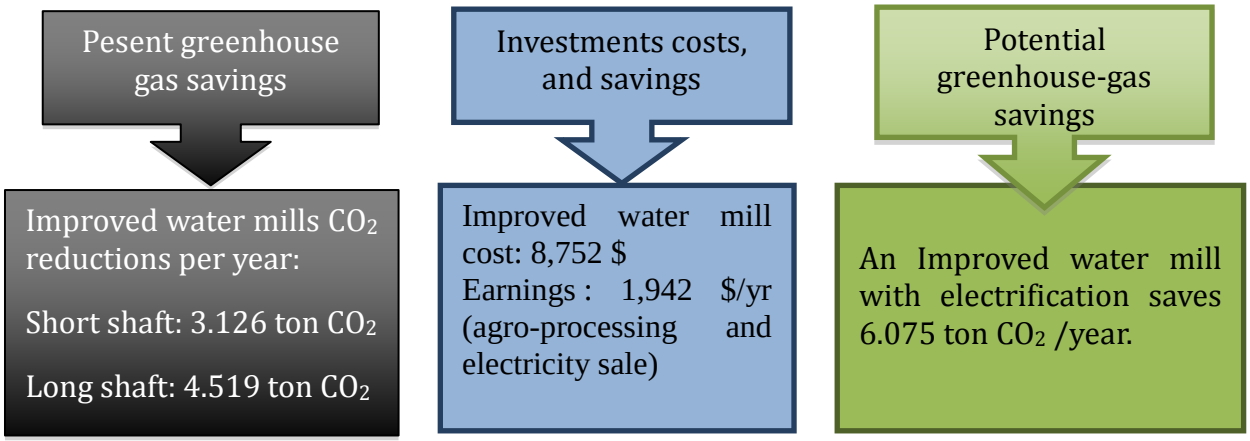
Improved Water Mills

By Ganesh Ram Shrestha, Subarna Prasad Kapali, and Ashma Pakhrin, Centre for Rural Technology, Nepal (CRT/N)

Summary

Improved Water Mills (IWMs) are one of the clean technologies being promoted by the Government of Nepal in cooperation with different stakeholders for about half a century. The installation and application of IWMs have helped the rural communities immensely in improving their livelihoods through user services like grinding, rice-hulling, husking, etc.; facilitating income- and employment-generating activities; and boosting the local economy as well as gender-mainstreaming and social inclusion.

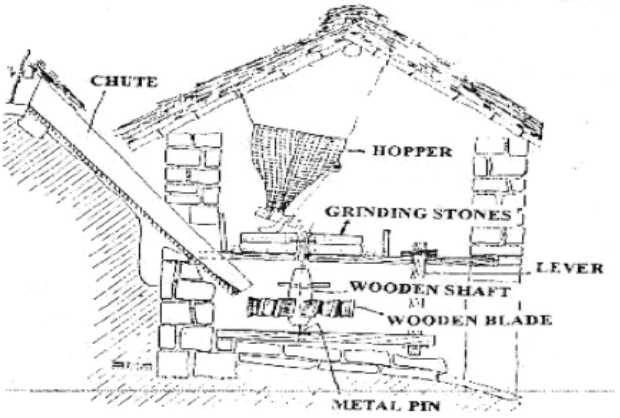
This case study summarizes the status of the Improved Water Mill (IWM) sub-sector, with its historical context of development and implementation as well as with its future potential development. Installation of improved water mills increases access to energy services, promoting socio-economic development of the rural communities in Nepal. It also contributes to a better climate, as it offsets fossil-fuel use. The case study was prepared by CRT/N, INFORSE's national focal point in Nepal.



Description, Development, and Background

Traditional Water Mill

Nepal, a landlocked mountainous country, has immense water resources. The power of falling water has been harnessed widely through the use of water mills, locally known as 'Ghatta', for centuries. They are used for grinding of cereals, mainly for maize and wheat.



Traditional Water Mill

The basic principle in operation of any water mill is the conversion of the kinetic energy of falling water into mechanical energy. After the diversion of stream water through a simple construction of stones or brushwood weirs, an earthen channel carrying about 40- 100 litres per second (lps) water is extended and led towards the water mill. In a traditional water mill, the water is then fed through a wooden chute made of a hollow tree trunk. A gate (a piece of flat stone) for safety overflow is opened when the mill is to be stopped. When the gate is opened, the water is diverted away from the water mill. A wedge is inserted at the end of the chute to direct the water to the runner. The centre-piece of the turbine runner is a massive boss in which a forged steel tip is driven into the lower cone.

The wooden blades of the turbine runner, with the peg on the other side, are driven tightly into the boss. The boss is coupled to its counterpart with a wooden wedge and then led to the shaft and key at the top. The whole runner rests on a steel plate with a conic depression. The shaft of the runner projects above the bottom of the grinding stone into which the key is inserted. The key exactly fits in the slot on the upper grinding stone and runs the mill. The grinding stone is made locally, and is grooved from time to time as per the requirement.

There are about 25,000 traditional water mills, comprising a major source of rural energy for agro-processing across the country. They have been used for centuries by the communities in the hills and mountain regions of Nepal.

Improved Water Mill

Improved Water Mill

The Improved Water Mill (IWM) is a modified version of the traditional water mill. It is an intermediate technology that increases the efficiency of the traditional water mill, resulting in increased energy output, thus helping both the millers and their customers. Replacement of wooden parts (rotor and shaft) with metallic parts is the main improvement made in the technology.

Two types of IWMs are in use: short-shaft, solely for grinding, and long-shaft, for grinding and other end uses such as paddy hulling and -husking, rice-polishing, sawmilling, oil-expelling, lokta (used for producing handmade paper)-beating, chiura (beaten rice)-making, and others. The technology can also generate electricity up to 3 kW, sufficient for lighting as well as for operating small electric and electronic home appliances.

Basic Functional Features of Traditional and Improved Water Mills

Comparison Parameters	Traditional Water Mill	Improved Water Mill
Operational Efficiency (%)	Below 25	30-50
Functions and Capacity	Grinding cereal grains only (maize, millet, wheat, rice, etc.), 10-20 kg/hr.	Grinding of cereals (maize, millet, wheat, rice, etc.) 20-50 kg/hr.
		De-husking/partial polishing of paddy (50- 70 kg/hr.)
		Expelling oil from oilseeds (10-15 kg/hr.)
		Generation of electricity (12V-DC, 220V-AC, 1-3 kW)
Repair/Maintenance	High	Low
Life Span	2 years	10 years

Source: Improved Water Mill Development in Nepal, A Status Review Book, CRT/N

History of Improved Water Mill

Pioneering Phase

The history of development of IWMs in Nepal dates back to the early 1980s, when the Research Centre for Applied Science and Technology (RECAST), a research and development wing of Tribhuvan University (TU), developed a prototype of an improved version of water mill. In the prototype, wooden paddles were replaced by hydraulically more efficient metallic blades, and a new bottom bearing was added. This prototype, with a closed chute and a covered chamber, was tested in a mill at Godavari, Lalitpur, Nepal. The technology was subsequently promoted among the farmers with involvement of a manufacturing company, the Kathmandu Metal Industries (KMI). The unit was called Multi-Purpose Power Unit (MPPU). A number of farmers adopted the technology; the experience of this effort was critical in improving the technology further and in promoting its social acceptance.

Market Development

The activities in the pioneering phase demonstrated that IWM could be a viable technology to address rural energy needs and, thus, rural poverty. In a bid to develop markets for IWM, the German Technical Cooperation (GTZ) came up with a programme to promote IWM in rural areas in 1984. The programme aimed at expanding markets for IWM through provision of financial incentives. Although there was some gap in the late 1980s, GTZ continued its support in the 1990s. Involvement of the Centre for Rural Technology, Nepal (CRT/N), as the implementer of the GTZ-supported programme marked the beginning of an institutional growth in IWM technology.

The market development for IWM continued even without donor support from 1993-96, when CRT/N continued to promote the technology on its own. Support from GTZ resumed in 1996, attracting a range of institutions, including development-oriented and financing agencies, towards IWM promotion. CRT/N was able to develop collaborative partnerships

with the Women's Development Division (WDD) of the Ministry of Local Development (MoLD), some national and international non-government organisations, banks, and local manufacturers.

Major Stakeholders and Partners

Over time, the IWM sub-sector has grown with the involvement of different players from public as well as private sectors. These institutions have been contributing at various scales and capacities to the promotion of IWM technology in Nepal. The emerging cooperation between these institutions exemplifies what one can call a best practice in public/private/civil-society partnership in community development. The public-sector institutions include the Alternative Energy Promotion Centre (AEPC) and the National Planning Commission (NPC). AEPC is the main executing agency of the IWM Programme, and is responsible for providing policy, coordination, and monitoring support to execute the programme. NPC, on the other hand, is more involved in policy development. Among the civil-society organisations, Centre for Rural Technology, Nepal (CRT/N) has been the major promoter of IWM.

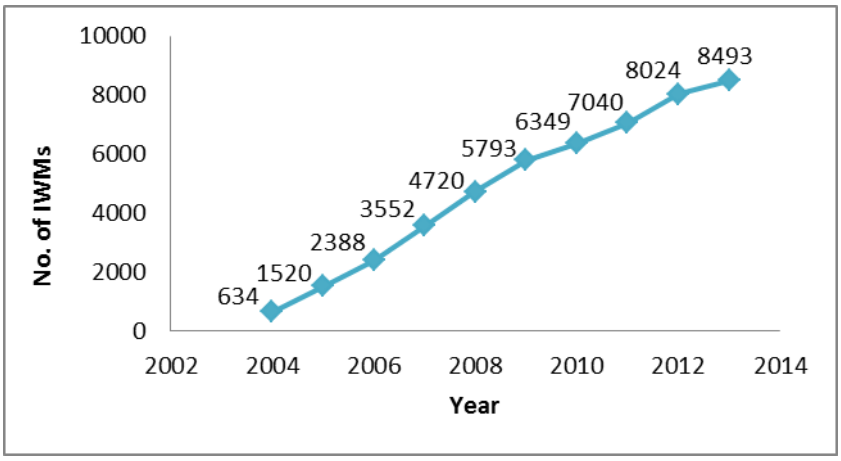
CRT/N has been promoting IWM since 1991. As a major implementer of the IWM Programme, it is responsible for overall management of the Programme. It coordinates with the programme partners, helps to ensure use of a quality-management system, monitors the programme activities, and facilitates the required flow of information. In the private sector, at least 4 different categories of institutions have emerged. CRT/N provides support for their capacity development. They include the kit-manufacturing companies, Service Centres, Ghatta Owner Associations (GOAs), and consulting firms.

Currently, 27 Service Centres, now called Local Partner Organisations (LPOs), procure standard IWM kits from the existing 14 manufacturing companies located in city centres in various parts of the country In some districts, GOAs have been recognised as LPOs, while in other districts, private companies and civil-society organisations have also been accorded that status. The range of services that they deliver includes feasibility studies, installation, and after-sales services. They also help to motivate IWM owners in the overall improvement of IWM management, facilitating subsidy applications for IWM owners and helping to arrange credit from micro-financing institutions. They also demonstrate the technology, and initiate end-use diversification. Micro-financing institutions in some of the programme districts actively promote IWM in coordination with LPOs and GOAs. In the city centres, a few private firms have taken interest in extending consulting services to AEPC and the IWM Programme. They have been involved in conducting studies and training sessions on IWM. The Community Electrification Sub-Component (CESC) of Alternative Energy Promotion Centre (AEPC) / National Rural and Renewable Energy Programme (NRREP) provides overall coordination and implementation support to the stakeholders. The AEPC/ Central Renewable Energy Fund (CREF) administers the subsidy for IWMs. The Regional Service Centres (RSCs) of NRREP, located in different parts of the country, coordinate local-level promotional activities, while the LPOs provide their services for supply and installation of IWMs. The National Capacity Builder extends technical support to the implementing partners in capacity-building in and knowledge management. Apart from the major stakeholders mentioned above, a number of support organisations, civil-society groups, financing interests, and academic institutions are contributing in their own respective ways to the development of IWM in Nepal. While some of them are directly involved in capacity-building or in financial or social-mobilisation support, others are involved in creating a supportive environment or in motivating the main stakeholders.

Potential Further Improvements / Installations

In 2012, there were 22,676 traditional water mills spread across 52 districts of the country. At the same time, there were 7,527 IWMs in the country (Source 1). It is estimated that there are still at least 25,000 traditional water mills located mainly in the mid-hill areas from east to west in the country (Source 1). A baseline study conducted in the 16 districts under the IWM Programme shows that about 90 percent of the existing traditional water mills can be improved. Considering this as the improvement potential factor, an estimated 20,400 traditional water mills (out of 22,676) could be improved.

The IWM Programme has reported that new installations of IWMs have also taken place in some of the districts, rather than just improvement of the traditional water mills. The annual growth trend of IWMs shown in the figure below reveals that 8,493 IWMs had been put into use across the country by 2013. Moreover, the key target of AEPC/NRREP has been to install 4,000 IWMs from July 2012 to July 2017.



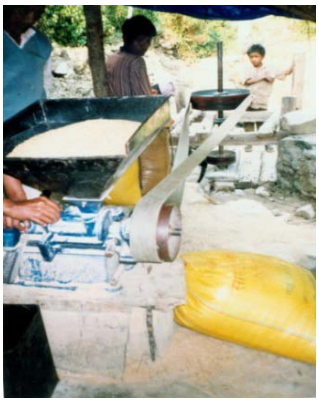
Cumulative Growth Trend of IWMs in Nepal

Source: Improved Water Mill

Effects on Poverty Reduction, Local Economy

User Services

An improved water mill serves, on average, 52 households at a time. Thus, altogether 441,636 households (8.1 percent out of 5,427,302 household in the country, *cf.* 2011 Census) are being served by the 8,493 IWMs installed so far. The services include use as theki-cutter, juice-extractor, choya-separator and tea-squeezer, besides grinding, rice-hulling, husking and polishing, sawmilling, and chiura-beating (Source 1). Likewise, around 871 household obtain lighting energy from 23 IWM electrification schemes, with total installed capacity of 62.6 kW.



Paddy Hulling from IWM

Employment

Promotion and installations of IWM have become good means for creation of economic, environmental, and employment activities in rural areas. According to the baseline survey conducted in 2012, around 7,572 people have been employed in IWM operation.

Technician Installing IWM

Rice Hulling from IWM

Income Level

The livelihood of the mill owners is based upon the income they make from the IWM that they operate. Income levels of mill owners can rise substantially with diversification of end-uses such as rice-husking, oil-expelling, sawmilling, generating electric power, etc. Reportedly, income level has risen even by 100 percent in the case of end-use diversification. It is also reflected in the improved living standard of the millers as indicated by various documented success cases. When the income from IWM operation is segregated, it is revealed that average annual income from the mill is only around NPR 39,000 ($411[2]) from short-shaft and NPR 85,000 ($895) from long-shaft, which are approximately 34 percent and 74 percent of total family annual income, respectively.

Boosting the Local Economy

The IWM has become an important hub in the value chain of various products in the rural economy, such as production of rice, flour, oil, furniture, etc. Moreover, the establishment of IWM has induced the institution of small cottage industries in rural areas. This has been possible due to the higher and more efficient output from the long-shaft IWMs. The time saved from using IWMs is also significant. With the time that is saved, the owners are able to devote their time to other income-generating activities like agriculture, cattle-farming, households, business, etc. The improved implements have also made it possible for the water mills to operate with lower flow rates, replacing the convention of closing the water mill during the winter seasons.

Gender-Mainstreaming and Social Inclusion

Women Operating Oil Expeller through IWM

Women's involvement in water-mill operation has been another distinctive feature of IWM. There are instances of women as mill owners and quite a few who help their husbands in the day-to-day activities of the water mill. According to the baseline survey conducted in 2012, 4.68 percent of IWMs are owned by women. This involvement has helped to improve the quality of women's lives and has given them some control over income. According to the impact study conducted in 2012, the IWMs, directly or indirectly, have changed in gender roles and relations to some extent. More and more women are being brought to public places as members of the workforce, service recipients, etc. The weakening of gender stereotypes in division of labour is noticeable within the workforce as well as on the assignment of the jobs of the service recipients, such as carrying and milling. Moreover, women do not face gender-specific problems in the mills.

The IWMs have reduced the drudgery facing women and children involved in agro-processing. Participation and leadership skills of women as well as socially excluded groups have improved. The IWM programme has played a role to reduce inequality between male and female by imparting technical skills as it provides economic and employment opportunities to rural people.

2 1 US Dollar = NPR 95, June 2014

Effects on Greenhouse-Gas Emissions (Fossil Fuels)

The IWM is powered by gravity-driven water, a renewable source of energy, which essentially does not produce air pollution or sound pollution. Therefore, the technology is environmentally sound and acceptable.

The technology has decreased dependence on traditional and conventional fuels. Operations of IWM have helped in replacing diesel-run mills in rural areas. A field survey shows that 8 diesel mills were displaced in Dolakha District alone (CRT/N 2011). Estimations show that each IWM could practically replace about half the capacity of a diesel mill. Therefore, each mill offsets about 900 litres of diesel per year, which eliminates 2.4 tonnes of CO_2 emissions.

It has been calculated that a short-shaft IWM reduces emissions by 3.126 ton CO_2/year; a long-shaft IWM cuts out 4.519 ton CO_2/year, and an IWM with electrification eliminates 6.075 ton CO_2/year. Studies show that operation of one IWM can reduce emissions by approximately 4.454 tons of carbon dioxide per year (Source: cdm.unfccc.int). Therefore, it can be estimated that the 8,493 IWMs installed by 2013 have eliminated 37,827.82 tonnes of CO_2 emissions per year.

The Designated National Authority (DNA) has already approved a Project Idea Note (PIN) submitted by Alternative Energy Promotion Centre (AEPC) for development of a CDM (Clean Development Mechanism) project on IWM. A Project Design Document (PDD) is in the process of validation (CRT/N 2011).

A Case Study: Improved Water Mill Enhances Rural Livelihoods

Mr. Chepang with his IWM

Mr. Dal Bahadur Chepang, a permanent resident of Jhatetar village, Kalikatar VDC of Makawanpur district, has 8 family members. Agriculture was the main occupation of his family, and he inherited a water mill from his father. Plenty of rice grew in the village, but lack of a rice-processing mill forced them to sell in the market at a low price and obligated them tp buy processed rice from the market at higher prices.

Mr. Chepang heard about Improved Water Mill (IWM) technology and its benefits during his visit to the Ghatta Owners Association, Makawanpur. Then he decided to improve his traditional water mill. A technician from a Service Centre surveyed his mill, then informed him of a government subsidy to improve it and of extensive services that could be available.

In 2009, his water mill was installed with long-shaft IWM, providing capacity for in grinding, rice-husking, and rice-polishing. He was happy about his increased income and about the new services that he provided to the villagers.

After two years, during a visit to the Service Centre, he came to know about IWM electrification. He then said, *"I looked back to my village, all the trouble we are having due to lack of electricity, the cost of kerosene used for lighting the house during night time and students suffering without light. It encouraged me to develop IWM as electrification project."* Later, he consulted with the technician of the Service Centre and gathered information about the provision of additional subsidy for electrification by the Government of Nepal (GoN) through Alternative Energy Promotion Centre (AEPC). But the subsidy

from AEPC was not sufficient to complete the entire project. So, he shared his idea with the villagers. The villagers agreed to operate the water mill for grinding and other extensive services in the daytime and electrification at night. They were ready to support him and were excited to know about electricity generation from IWM.

But, the available investment was not still enough to complete it. A series of dialogues and meetings was organized with local government agencies (District Development Committee, or DDC; Village Development Committee, or VDC), and the Poverty Alleviation Fund (PAF), and they shared their ideas of Public Private Partnership (PPP) for electrification. Finally, DDC Makawanpur, Kalikatar VDC and PAF provided NPR 300,000 ($31,581); 100,000 ($1,053) and 200,000 ($2,015), respectively, as financial support. He received NPR 240,000 ($2,526) as subsidy support from the AEPC and the remaining cost from the consumers. The users' committee was formed for timely completion of the project. Then the 'Kalikhola Ghatta Bidhyutikaran Aayojana' was completed, providing electricity to 80 households of Jhatetar. Electrification from IWM created new avenues in the village. Villagers of Jhatetar were also very happy as they do not have to live in darkness any more. They were able to finish their household chores easily and promptly; children were very happy that they could finish their school assignments in the evenings and no longer needed to wait for daylight. The generated electricity was also utilized by health-, post-, and police stations of Kalikatar VDC. Prior to electrification in the village, the villagers used kerosene lamps for lighting. The community was paying NPR 100 as tariff and the households with portable TV were paying NPR 150 as tariff for electricity per month, which the users were very happy to pay. So they were connected with the outer world and updated themselves with current news.

From IWM, Mr. Chepang was successful to earn NPR 112,500 ($ 1184) annually from agro-processing and NPR 72,000 ($ 758) from tariff for electrification. The income level of Mr. Chepang and his family is substantially increased with diversification of end-uses such as rice-husking, oil-expelling, sawmilling, generating electric power, etc., and he gave all the credit to IWM. Moreover, the IWM displaced a diesel mill in Jhatetar village.

Source: CRT/N Annual Report 2012

Conclusions

The impacts and benefits of improved water mill (IWM) technology have already been comprehended by the owners and the beneficiaries due to its diverse applications. Moreover, private-, civil-, and public-sector interests have grown to support the promotion and development of the IWM sub-sector, thus ending the energy poverty in the rural areas of Nepal. A more favourable policy environment is also taking shape, gradually. These and other factors sustain the uses of already established IWM and support dissemination of new IWMs in Nepal. Accordingly, this case study might be helpful and relevant to other developing countries as well to meet demands for energy and its end uses.

Currency: 1 US Dollar = NPR 95 (Nepalese Rupees), as of June, 2014.

Source 1: RETSC and CRT/N, 2012: Study made by Rural Energy and Technology Service Centre Pvt. Ltd. (RETSC) and Centre for Rural Technology, Nepal (CRT/N) with support from SNV Netherlands Development Organisation in 2012.

CASE STUDY – Bangladesh

Solar Home Systems with Micro Credits

By Mr. Abser Kamal, Dr. M Shahidul Islam, Mr. Mohammad Mahmodul Hasan, Grameen Shakti

Summary

Grameen Shakti is one of the leading social enterprises in the world. This organization has taken renewable energy solutions to the rural areas of Bangladesh. It has achieved a milestone by improving the rural livelihood through access to green energy. Grameen Shakti has developed successful market-based programs. It has social objectives for popularizing Solar Home Systems (SHSs), biogas plants, and Improved Cooking Stoves (ICSs) to benefit millions of rural people. Grameen Shakti works in all 64 districts of Bangladesh. Its three main programs are Solar Home System, Biogas Program, and Improved Cooking Stove.

More than 1.5 million Solar Home Systems (SHSs) have been installed through a micro-credit system provided by Grameen Shakti in Bangladesh. Around 10 million people are getting benefits from these systems, and over 350,000 tonnes of CO_2 are saved each year. Grameen Shakti also has significant achievements in Improved Cooking Stoves (ICSs) and in biogas production from organic-waste-based plants. However, this case study focuses on the Solar Home Systems (SHSs) installed by Grameen Shakti, a national focal point of INFORSE.

Present greenhouse gas savings	Investments costs and savings	Potential greenhouse gas savings in Bangladesh
One Solar Home System saves 0.232 ton of CO_2/year from avoided kerosene use.	Package Price from 104 USD (10 Wp system) to 590 USD (130 Wp system) Saving annually 108 litre of kerosene as well as dry batteries and cell-phone charging	1.5 million Solar Home Systems save around 350,000 tonnes of CO_2/year

Description, Development and Background Situation

Background Situation

Bangladesh, with 150 million people, and 147,570 km^2 territory, is one of the most densely populated countries in the world. The Gross National Income is 1010 USD per capita (2013), which is one of the lowest in the world.

Bangladesh is particularly vulnerable to flooding during monsoon periods, as two thirds of the territory is only 5 metres above sea level. Global warming raises sea levels and the frequency of cyclones, which makes the country even more vulnerable.

Over 60% of total households are located in rural areas, where many houses are still not connected to the electric grid. About 60% of the population is now connected to the grid, and Bangladesh is dependent on fossil fuels, especially natural gas, for its electricity generation. Still, 40% of the total population have no access to grid-connected electricity. Consequently, the Government of Bangladesh set a target for generating 5% of its electricity from renewable energy sources by 2015 as well as 10% by 2020.

Grameen Shakti was established as a not-for-profit organization in 1996 by Nobel Laureate Prof. Muhammad Yunus to bring renewable energy services to such households by providing them with renewable energy technologies (Solar Home Systems for electricity, Improved Cooking Stoves and biogas for cooking) at affordable costs on a rural level.

Rural Electrifications with Solar PV System

Rural electrification through solar PV technology is becoming more popular day by day in Bangladesh. Solar Home Systems (SHSs) are highly decentralized and are particularly suitable for remote, inaccessible areas. Under the "Rural Electrification Program" of the Government of Bangladesh, about 3 million Solar Home Systems have been installed in last 16 years. Of these 3 million, around 1.5 million were installed by Grameen Shakti since 1996. Grameen Shakti focuses on off-grid rural areas in this, one of its most successful programs. Currently, Grameen Shakti is one of the largest and fastest-growing rural-based renewable-energy companies in the world. Grameen Shakti is also promoting Small Solar Home System to reach low-income rural households.

Solar Home System can be used to light up homes, shops, fishing boats, etc. It can also be used to charge cellular phones as well as to run televisions, radios, and cassette players. Solar Home Systems have become increasingly popular among users because they present an attractive alternative to conventional electricity. Advantages include that there are no monthly bills, no fuel cost, very low repair and maintenance costs, easy of installation anywhere, etc.

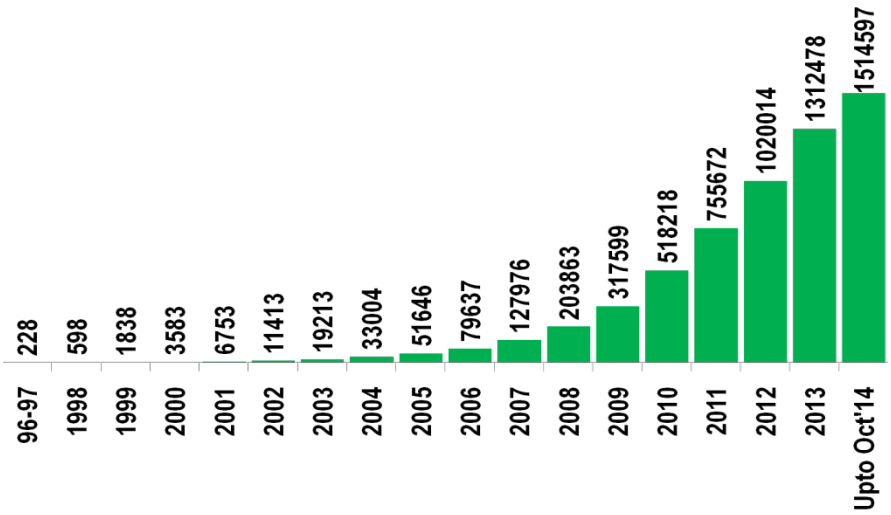
Solar Home Systems (SHSs) installed by Grameen Shakti have had a positive impact on the rural people. Grameen Shakti has introduced a micro-utility model in order to reach the poorer people who cannot afford a SHS individually. Making it possible to charge mobile phones with SHSs provides new access to more reliable telecommunication in off-grid areas.

Market Development

After starting its journey in 1996, Grameen Shakti focused on a door-to-door product campaign. Other significant components in market development and capacity-building were demonstrations held in village markets, school campaigns, and sharing information in village gatherings, especially among housewives in rural areas. Grameen Shakti continues these activities on a regular basis. Collection of monthly installments from customers' houses and free checkups during service periods build trust between Grameen Shakti and customers. Satisfied customers are promoters of Grameen Shakti's products to others.

Grameen Shakti now installs more than 25,000 Solar Home Systems (SHSs) each month. The milestone of 1 million SHSs installed was reached in November of 2012 and the next 1 million SHSs are expected to have been installed by 2015.

The following graph shows the number of Solar Home Systems (SHSs) installations (cumulative) since 1996.



Micro Credit Scheme

Grameen Shakti has structured its ownership-based financial mechanism in such a way that wide ranges of customers can afford a Solar Home System.

- A 6% discount is available on the price in case of cash purchase.
- On credit-based purchases of a Solar Home System, the user has to pay 15% of the total price as a down payment. The remaining 85% of the total cost is to be paid within 12/24/36 months with 12% (flat rate) service charges.

After Sale Services

- A free monthly checkup of the system during payment of installments.
- Post-warranty service through annual maintenance contract for Solar Home Systems, with an annual fee of USD 4.
- Inclusive warranty system for solar panel, charge controller, battery, and LED light.
- A buy-back system is available under which a buyer may return his/her solar system to Grameen Shakti when his/her area gets connected to the grid. However, the buy-back system is not applicable after 5 years.
- Regular training sessions for users so that they can take care of their systems.

Effects on Poverty Reduction, Employment, Obstacles, Dissemination

Grameen Shakti has a vast network of over 1,500 local branches that are easily accessible to customers throughout Bangladesh. Most of the staff of over 12,000 are competent in the Solar Home System technology. In addition, 150 women engineers work in 36 Grameen Technology Centres, where they perform electronic repairs and maintenance of Solar Home Systems. More than 3,000 women from disadvantaged groups have received training free of charge from Grameen Technology Centres; some of them have become independent entrepreneurs.

Effects on Greenhouse-Gas Emissions (Fossil Fuel)

Socio-Economic impact:
The Solar Home System costs 104 USD (10 Wp system) to 590 USD (130 Wp system) and the savings is 100 USD (only kerosene of 108 litres annually).
The pay-back time is around 2.5-3 years.

Environment impacts:
For the savings, each household saves around 108 litres of kerosene that produces 0.232 ton of CO_2 annually. Installing 1.5 million Solar Home Systems save 164 million litres kerosene and thus saving 350,000 tonnes CO_2.

Around 10 million people benefit from 1.5 million Solar Home Systems (SHSs).

The total number of SHSs installed by Grameen Shakti save 164 million litres kerosene and its costs, which is around 146 million USD.

As Bangladesh is dependent on imported kerosene fuel, this huge volume of saved kerosene contributes a lot in the country's economy. In addition, around an annual 350,000 tonnes of CO_2 emissions are prevented by use of these installed SHSs.

The Solar Home System Program of Grameen Shakti has been registered with the Clean Development Mechanism (CDM) program under UNFCCC in June 2012, and the latest monitoring report is available for 2013-14 period.

More information on the CDM registration can be obtained from the following web link:
http://cdm.unfccc.int/ProgrammeOfActivities/poa_db/ZSI6WP0ODGRQ8UYKXB3MHTL957JVAE/view

Potential for Scale-Up and Replication

It is very important to remember that, in Bangladesh, 40% of the people do not have access to grid electricity yet. In addition, the Government of Bangladesh has determined a target of 5% electricity generation by 2015 and 10% by 2020 from renewable energy sources. The micro-credit system is replicable in other countries, especially in South Asia, Africa, and South America. Several African countries are now focusing on ownership-based dissemination of Solar Home Systems. They frequently visit Bangladesh to learn about the rural electrification program in Bangladesh.

Investments costs	**104 USD (10 Wp system) to 590 USD (130 Wp system)**
Savings	-- Annually 108 litres of kerosene for each household as well as dry batteries and cell-phone charging, - 100 USD (only kerosene price for 108 litre with 0.90 USD/litre kerosene)
Resources needed for large-scale dissemination	- Expanded supply network of quality PV panel, charge controller, battery and LED lamps. - Expanded micro-loan facility. - Nation-wide repair and maintenance facilities. - Government certification to control import of good quality of product, and laboratory to control the quality. - Government can support private sector with innovated business model for more expansion.

Case: Solar-Powered Grocery Shop in Off-grid Singair Area of Manikganj District, Bangladesh

*Has anyone ever heard that a Solar Home System may be an **income generator** for a family?* Yes! The answer is that it can, as demonstrated by the surprising and inspiring experience shared by Mr. Md. Nurul Islam when he told his story in June, 2014.

Nurul Islam lives in an off-grid village area called North Bokchar at Singair of Manikganj District, Bangladesh. Like others in his village, Nurul leads a very simple life with his family. This 28-year-old resident has been running his grocery shop since 1998. His father died when Nurul was younger.

Nurul keeps the shop open until 10:30 PM every day. Apart from selling of grocery items, he also has an arrangement providing tea-stall facilities. Next to his grocery shop, he has started to run a poultry shed with 100-150 birds. Nurul formerly used kerosene to run a kupi and a lantern. He purchased 6 litres of kerosene every month to light his shop in the evenings and at night.

In 2010, Nurul installed a Solar Home System of 65 Wp for his shop. With this, he can run (in rotation) 5 LED lights, 1 television with DVD player, and a mobile charger. He owns the system, which was purchased on credit from Grameen Shakti. He paid the money in 36 monthly installments. From this solar home system, in addition to lighting his shop, Nurul also gets enough power to light the poultry shed for security purposes. In addition, sales in Nurul's grocery shop as well from his tea stall increase when he switches on a colored television to display daily drama serials, Bangla and Hindi films, jokes and musical programs. Village customers watch these programs in the shop and enjoy tea with cookies. Nurul's innovative idea keeping a color television running with solar power has also lifted up other grocery shops in the small village. Nurul feels happiness when he observes several installed solar panels on other shops' roofs.

Nurul also installed a 20-Wp Solar Home System for his house in 2012, purchased on credit from Grameen Shakti. With this system, Nurul can switch on 4 LED lights for all the rooms. His children can study until 10:00 PM, and other members of the family can perform their different types of tasks smoothly under solar-powered lights. It is very interesting to hear that Nurul has purchased a three-wheeled taxi with profit that he has generated from his solar-lighted shop and poultry shed.

With a happy smile, Nurul closes his story with *"Grameen Shakti Solar Home System is the 'Income Generator' of my family, you believe it or not"*. We believe it!.

Photos: Nurul Islam, owner of solar powered grocery shop.
- *Solar panel on roof of the shop*
- *Solar charger as part of the system*
- *Television run by solar*
- *Usage of solar light at poultry shed*

CONTACTS page 1/2

INFORSE, International Network for Sustainable Energy
URL: www.inforse.org
att. Gunnar Boye Olesen, Judit Szoleczky
Adress: Klosterport 4 E, 1st floor, DK-8000
Aarhus C, Denmark
T: +45 86227000, F: +45 86227096
E: ove@inforse.org, inforse@gmail.com

INFORSE- West Africa Coordinator

W: www.inforse.org/africa

ENDA Energy, Environment, Development
URL: www.endaenergie.org, www.endaenergy.org
att: Djimingue Nanasta, Secou Sarr
Adress: 54 rue Carnot, BP 3370, DAKAR, Senegal
T: +221 338 22 59 83 / 338 22 24 96, F: +221 33 821 75 95
E: enda.energy@endaenergie.org

MFC - Mali Folke Center Nyetta
URL: www.malifolkecenter.org
att. Ousmane Ouattara, Ibrahim Togola
T.: +223 2020 0617, +223 2020 6004, F.: +223 2020 0618
Mali BP E4211, Bamako, Republic of Mali

ATODES-Ed Association Togolaise pour le Developpement de l'Energie Solaire / Environnement Developpement
URL: www.atodes.org
att. Romuald Sambiani, Joseph Y. L. Kogbe
Adress: BP: 65 Agbodrafo - Togo.T: +228 23 35 18 60
E: atodes_solaire@yahoo.fr, romuald@atodes.org, josephkogbe@yahoo.fr

INFORSE-South Asia Coordinator

W: www.inforse.org/asia

INSEDA - Integrated Sustainable Energy and Ecological Development Association
URL: www.inseda.org
att. Raymond Myles
Adress: WZ A-5, First Floor, Asalatpur, Janak Puri, New Delhi-110058, India.
T: +91 11 25504533 and +91 11 25644038, E: info@inseda.org
inseda@inforse.org, ray.myles06@gmail.com

CONTACTS page 2/2

WAFD - Women's Action For Development
URL: www.wafdindia.org
att. Zareen Myles
Adress: WZ-34/5, Asalatpur, A-2, Janak Puri, New Delhi 110058, India.
T: +91 11 2561 0344 (New Delhi office) or +91 5644.228.772 (Bharatpur Office)
E: wafd@wafdindia.org, zareen_myles17@yahoo.co.in

INFORSE National Focal Point - India

AIWC - All India Women's Conference
URL: www.aiwc.org.in
Att Lalita Balakrishnan, Madhu Bajpai, Usha Nair
Sarojini House, 6 Bhagwan Dass Road, New Delhi-110001, India.
T: 91-11- 23389680/1165, E: info@aiwc.org.in
E: president@aiwc.org.in, lalitabalakrishnan@gmail.com

,

INFORSE National Focal Point - Sri Lanka

IDEA - Integrated Development Association
URL: www.ideasrilanka.org
att. R. M. Amerasekera
Adress: Galmaduwawatta Road, Kundasale, Sri Lanka.
T: +94 81-2423396, F: +94 81 4470649, E Mail: idea@sltnet.lk

INFORSE National Focal Point -Nepal

CRT Nepal, Centre for Rural Technology, Nepal
URL: www.crtnepal.org
att. Ganesh Ram Shrestha, Subarna Prasad Kapali, Ashma Pakhrin
Adress: Bhanimandal, Lalitpur, G.P.O. Box 3628, Kathmandu, Nepal.
T: +977-1-5530071, -5544758, -5547627
E: info@crtnepal.org, ganesh@crtnepal.org

INFORSE National Focal Point - Bangladesh

Grameen Shakti
URL: www.gshakti.org
att Abser Kamal, M Shahidul Islam, Mohammad Mahmodul Hasan
Adress: Grameen Bank Bhaban, 19th fl, Mirpur-2, Dhaka-1216, Bangladesh.
T: +880-2-9004314, -8035347, F: +880-2-8035345
E: g_shakti@grameen.net, g_shakti@grameen.com