CASE STUDIES OF SUCCESSFUL DECENTRALISED RENEWABLE ENERGY PROJECTS THAT HAVE NOT ONLY ENSURE ENERGY ACCESS BUT ALSO IMPROVED LIVELIHOODS OF PEOPLE

1. Kasai village, Madhya Pradesh (biomass for electricity)

Kasai is a remote, forest-fringe *adivasi* (tribal) village with 55 households and a population of 392. It is not connected to the grid. The village is endowed with abundant biomass resources in the form of wood (from forests and farmland), crop residues, cattle dung and oil seeds.

Since 2005, the Government has been supporting a project in the village to generate electricity from a small, 10 KW biomass plant. (MNRE is funding eleven such projects in Madhya Pradesh.) Although the government funded 100% of the capital costs, the project is being managed by the local community, with some technical support from the local Forest Department. For instance, villagers are responsible for gathering biomass for the plant and collecting Rs.120 a month from each household (£1.55p) to meet the plant's operating and maintenance costs.

In addition to the maintenance fee, there is a user charge, based on the amount of electricity and energy consumed. A village committee comprising 11 members, five of whom are women, has been constituted to oversee the operation.

The plant generates all the lighting for households, school and streets, has enabled music systems and television to be installed in the village for entertainment, and supplies electricity for a flour mill, water pumping and a milk-chilling unit.

The project has helped stem migration from the area and has enabled a trebling of agricultural production due to the availability of water for irrigation. Milk is not spoilt due to the extreme heat, so it has become marketable. This could possibly help in bringing in a village dairy system, which could mean further livelihood enhancement for the villagers.

The setting-up of a flour mill will mean that people can process wheat and rice and sell the flour at a higher price in the market. Last but not the least, this project has also led to a household water piping system.

At this point, traditional biomass (dung, wood and charcoal) continues to be used for cooking and heating purposes. The existing system could be possibly modified to ensure that gas is supplied for cooking purposes too. This would help avoid the respiratory illnesses caused by burning traditional biomass indoors.

2. Gosaba island, West Bengal (biomass for electricity):

Gosaba Island is one of the 54 inhabited islands (out of a total of 104 islands) in the Sundarbans, a large mangrove forest region situated on the Ganges Delta. Farming here depends almost completely on the monsoon and the area is low-lying.

After independence, the overall progress of the people remained severely hindered due to absence of electric power in the region. The conventional electric power line had not reached the region due to its geographical location, and also because most of these places are separated from the mainland by wide rivers or creeks.

Electricity was available to only a few houses situated near specific shops or market places. This was generated and supplied for 3-4 hours by means of small diesel generators. Customers paid Rs.4 per day *per point* (typically a 40W bulb or tube light), which was a very high rate (the present rate is Rs.18 per kWh). Kerosene lamps were the only source of light for students studying at night.

Then, a biomass gassifier power plant was commissioned on 20th June 1997 as a joint collaboration of the state and central government. It uses two fuels to generate electricity via gasification. The main fuel is biomass in the form of tree branches, twigs and bark (70%). The support fuel is diesel (30%). (Diesel is used here because when this plant was built; up till then the technology for generating power using only biomass was still not available). Local people called it the "wood electricity" plant.

One of the reasons for the project's success was that locals were involved in decision-making from the very start. Door-to-door visits were made and briefings on different aspects of the project were given to the village *panchayat* representatives, who in turn discussed it with the local people. A series of public meetings was held to raise awareness of the technology, its limitations, advantages, and the need for an energy plantation.

Concerned by the threat to their incomes, the local diesel operators initially opposed the setting up of the power plant. But other members of the community undertook a vigorous campaign to sell the benefits of the new approach (which included the health benefit of cutting the toxic fumes from the diesel generators). This dissipated the opposition to a large extent and some of the diesel operators were later employed in the plant.

The plant is locally owned and managed through the 'Gosaba Rural Energy Cooperative'. This body was set up by the West Bengal Renewable Energy Development Agency (WBREDA) in 1996. Members of the village *panchayats* are on the board, which is one of the ways of ensuring a good level of community ownership. The Cooperative sets the tariff, advises WBREDA on where the power line should go, and is responsible for collecting electricity bills from each household. It is a matter of pride that there have been no instances of electricity 'theft' or of defaulting on bills.

For the energy plantation, trees were planted on 71 hectares of low-lying riverbank silt beds (*char* lands). After three years, the plantation was fully established and was providing a steady supply of wood to the plant. Additional biomass is supplied by local farmers.

This is a relatively large biofuel plant of 500 KW, benefiting 3,027 households and a total population of 18,220.

The availability of electricity has allowed students to study at night and achieve better exam results. Small-scale factories have been established which are using electric machinery to carry out boat repairs, welding, knife- and tool-sharpening and spice-grinding. An operating theatre is now functioning at the government health centre on the island. With the availability of refrigerators, it has become possible for the first time to store life-saving vaccines and medicines.

Electric pumps are now being used for irrigation; people are able to watch sports and other programmes on cable television, which was not thought possible earlier; films are being screened in newly-established video parlours; a computer training centre has also been opened; and electric sewing machines are being used to make fishing nets.

3. Gram Vikas projects in Orissa (solar, biodiesel, gravity flow for a piped water supply; lessons from previous biogas schemes):

Gram Vikas is an NGO and Christian Aid is their international partner working on rural development in the eastern, coastal state of Orissa. The NGO operates in 21 of the 30 districts in the state, in a total of 732 villages.

One of their principal interventions is the provision of a piped water supply and lighting for a*divasi* villages. Being remote, these villages are generally not connected to the grid. Gram Vikas's solution to the water supply problem is to install stand-alone, renewable pumping systems, driven by solar power, gravity flow and biodiesel - In the case of solar and biodiesel, by pumping water from wells in the village; in the case of gravity flow, from wells or springs at a higher altitude connected to a water tower in the village.

Under the scheme, each household is provided with a toilet and washroom; water is piped to these units as well as to taps installed in the kitchen and yard. If the project involves solar, then lighting can also be supplied.

Measured purely in cost terms, gravity flow is the best option, followed by biodiesel and then solar. The installation cost for each in three villages of a similar size was: Rs.195,000 (£2,530) for gravity flow in Kerandi; Rs.325,000. (£4,220) for biodiesel (Kichiling); and Rs.500,000 (£6,490) for solar (Chanabogodo). So far Gram Vikas has installed 80 gravity flow systems – and the state government has been supporting this work.

Labour time is one factor that needs to be taken into account here. The small-scale biodiesel projects do require considerable labour inputs by villagers to succeed: for example, the time spent planting trees, harvesting the seeds or nuts, and then preparing the fuel (oil is extracted from the seeds or nuts and mixed with ethanol).

Gram Vikas previously supported biogas projects, which saw villagers using cattle dung to produce gas for cooking and lighting. This has made them aware of some of the maintenance challenges posed by this technology. Many of the biogas plants built in Orissa during the 1980s and 90s fell out of use because people were not trained in how to maintain them, the upkeep was time-consuming and families did not keep enough cattle to produce sufficient dung for the plants.

One advantage of Gram Vikas' current projects is that a 'maintenance fund' is set up after the infrastructure is built. Every household makes a small contribution to the fund to cover the cost of future maintenance and repairs. One person in the village is nominated to operate the system. Gram Vikas's insistence on 100% community participation increases the chances that the project will last beyond the intervention period (usually three to five years).

Scaling up all these schemes, so that they cover whole districts, will of course require considerably more investment by government and donors. For example, in the case of solar, the Orissa state government is subsidising some village lighting and water supply projects. However, this support is not yet extensive enough to either pay for all the capital costs or transform the energy supply situation across whole districts. UNFCCC finance could be one trigger for a wider expansion of these projects.

4. A case study of Rural Electrification: Coming together of Private Sector, Government and People-Chhattisgarh Solar Rural Electrification Project:

Chhattisgarh is India's most backward state. The state has suffered under decades of negligence from government authorities and continues to do so. The geography of the place is covered by dense forests and mountainous landscape making it an extremely difficult terrain for development activities. So much so, the government has notified that many villages would not get electrified since it is difficult to provide grid connectivity under such harsh geographical conditions.

A joint project of the Chhattisgarh Renewable Energy Development Authority and TATA BP Solar, aimed at electrifying 113 villages using solar power plant covering over 2000 households has been initiated here.

While this is a case of private sector and government participation, there has been little or no involvement of the local communities either in the project design, sizing up of systems (in terms of determining the quantum of generation) nor in its routine management and maintenance.

While the solar power packs ranging from 2.5 kWh Peak to 6 kWh peak are still functioning, the downside to projects are related to its long term sustainability. The key questions which will arise in the near future are:

a) Who will pay for the regular maintenance of batteries?
b) Who will pay for the replacement of batteries?
c) Who will pay for any repair or rectification of inverters etc.?

In this case, as far as the people of the villages are concerned, it is a government property and they have no stake in it, but does the government or the 'utility' realize that it is their asset and they need to maintain it, only time will tell.

5. A case study on Indira Nagar (Solar Energy)

Location details: Indira Nagar, a small hamlet of Panchayat Soda in District Tonk, Rajasthan, consists of 13 houses with a population of 190 mainly farmers. Most of them have their own lands that they use to cultivate a single rain fed crop of pulses and groundnut every year; whereas others are laborers.

Agencies and Supporters: Minda NexGenTech Ltd along with the support of local sarpanch Ms Chhavi Rajawat started with setting up of a 240 W solar power-based micro grid, investment being made by Minda NexGenTech Ltd.

Objectives: It was to provide basic lighting in the village. The outcomes of such plant later turned into its objectives as:
• Providing basic lighting and charging of mobile phones
• Better standard of living by providing opportunity for generating income
• Kerosene free lighting
• Improvement in health, safer environment and education opportunities

Pre Implementation: Prior to installation of the solar plant, kerosene lamps used for lighting emitted harmful fumes with a characteristic smell. It was not possible to carry out household activities such as cooking, washing utensils, stitching, and fertilizer mixing after sunset.

Post Implementation: Basic lighting achieved to all houses in Indira Nagar. This also developed entrepreneurial spirit among women. Activities such as grinding pulses and stitching to supplement family incomes have now become part of their activity during evening hours where they make use of energy efficient LED bulbs. Children are benefitted as they have more hours to study, inspired women's education initiatives.

Terms of the project: The solar power plant works on BOM (built, operate, and maintain) model where each household pays monthly charge of Rs. 150 for usage.

Outcomes: In addition to each household lighted up, with the initiatives and support from villagers, provision of extra icome generation was started as for eg grinding of pulses at Rs5/kg which has resulted in a monthly additional income of about Rs 547 per household. Other activities initiated are sewing centre, education centres etc. In all the efforts have been to come up with sustainable development for the villagers.

6. **BERI (Biomass Energy for Rural India), Villages of Karnataka:**

Location Details: The project started in 2001 and has been implemented in five village clusters consisting of 28 villages in Tumkur district of Karnataka.

Agencies and Supporters: The project supporters include GoK (Government of Karnataka); Gram Panchayat people's representatives, private investors, UNDP (United Nations Development Programme) funded by the GEF (Global Environment Facility); and co-financed

by the ICEF (India-Canada Environment Facility); MNRE (Ministry of New and Renewable Energy), GoI (Government of India); and people residing in the targeted project villages along with all beneficiaries.

Objectives: The project objectives used bioenergy technologies including bioelectricity produced from biomass gasification, community biogas plants, along with efficient cook stoves. Biomass as fuel coming from energy plantations rose for this purpose.

Pre Implementation: As the estimated biomass to run the plant was not enough in the area, tree plantations were raised in 2930 ha (1983 ha of forest land and 947 ha of tree based farming) to support the fuel requirements of the power plants. This has supported the livelihoods of over 240 women in 81 SHGs (self-help groups) who raised about one million seedlings. Thirty households were required to get employed for tree-based farming.

Post Implementation: Gasifier-based plants were established in three clusters. A 500-kW capacity system was installed in Kabbigere (including two gasifier systems of 100 kW each and one of 200 kW using 100% producer gas and another with 100 kW dual fuel). These plants together have generated 1,520,000 kWh of electricity as of June 2012. In addition, two 250-kW more gasifier-based power plants have been installed in Seebanayanapalya and Borigunte.

Terms of the project: The BERI Society and Tovinakere Grama Panchayat have signed a PPA (power purchase agreement) with BESCOM to sell the power produced to the state power utility at a tariff set at Rs 2.85/kWh. Generation and distribution are synchronized to the grid through a dedicated 11-kV transmission line.

Operational Management: Biomass is raised through the plantation which is managed by the VFCs (village forest committees). Decisions regarding biomass procurement and gasifier plant management are taken by the VBEMC (Village Biomass Energy Management Committee) and panchayat together. Four NGOs namely BIRD-K, Mother, IYD, and Srijan work with the communities to create awareness on energy issues and promote the project. The activities basically included provision of borewells, laying of drip irrigation systems, and construction of community biogas plants and improved cookstoves for village households.

Outcomes: In this project 56 borewells were dug serving 127 households. Each bore well water shared among three to four neighbours. These borewells have the advantage that they are connected with drip irrigation systems that save water and reduced the energy required for pumping it from a depth of over 300 feet. Apart from this other initiatives have leaded to construction of 51 small community biogas plants which are estimated to have generated more than 95,000 m^3 of biogas. At household level reduction in fuel consumption and indoor air pollution has been achieved by the provision of improved cook-stoves.

Co-Benefits:

- Creation of WUAs (water users associations) – As the project area is primarily rainfed sa long-term strategy was facilitated by the establishment of community irrigation systems. The main objective was to amplify existing livelihoods, generate more income, improve

the socio-economic condition of poor farmers, and cultivate the habit of paying fee for service.

- A 1-MW biomass gasifier power plant has been installed in three villages in Koratagere taluka. These systems have resulted in generation of approximately 1.5 million units of electricity by 30 June 2012 thereby reducing almost 1200 tCO_2. This power production at small scale has resulted in significant intangible benefits such as green cover, increase in rural economy, and creating employment opportunities.

7. Clean Energy for Ladakh (Micro Hydro & SPV):

Location Details: Due to the snow and cold for almost three to four months in Ladakh region most of the remote villages remain inaccessible. Udmaroo is one of them situated on the bank of River Shayok in Nubra valley of Leh District and is located at about 150 km from Leh. The village has 90 households with a total population of about 540.

Agencies and Supporters: LEDeG – in collaboration with the EU (European Union), BORDA (Bremen Overseas Research and Development Association), GERES (Groupe Energies Renouveable, Environment et Solidarites), and SD Tata Trusts (for end-use machine).

Objectives: The project has a decentralized approach of energy production so as to make the region self-reliant making use of renewable resources mainly sun and water, both of which are available in abundance in the region.

Pre-implementation: Ladakh due to its remoteness, topography, and location has been an energy-deficient region and so a centralized electricity distribution model is not feasible for the region. During prolonged winter season, the extreme weather conditions and scarcity of natural resources makes life difficult. Neither clean energy sources such as electricity nor natural gas by the state agencies has reached the remote and far-flung villages. So the major dependence is on fossil fuels which has polluted the atmosphere of Ladakh and has been a major factor for endangering the fragile ecosystem of this region.

Post implementation: Micro Hydro installed with a capacity of 32 kVA which presently generates 20–25 kVA electricity.

Terms of the project: User cash of approximately Rs 1000 per Household contributed towards capital cost whereas user in-kind contributed unpaid labor for installation.

Operational Management: The unit is looked after and managed by the village electricity committee.

Outcomes: The villagers in addition have taken initiatives to install carpentry and saw machine, a flour machine, and an oil expeller machine. These have resulted in added income to the community and provided livelihood to many families along with reduction in drudgery.

Co-Benefits:

- LEDeG along with SCATEC Solar (India) have installed four small SPV (solar photovoltaic) power plants during 2011 in four remote villages of Ladakh (Maan and Shayok villages in Leh District and Juldo and Tashistongday in Kargil District). Here again concerned village electricity committees are managing the plants successfully and villages are enjoying the benefits.

8. **Renewable Energy of Community Promoted Electrification through Biogas for the Thalingi Tribal Area:**

Location Details: The area is a tribal settlement named Thalingi in the Amaravathy Forest Division of Coimbatore district, Tamil Nadu, comprises of cluster of villages, which for years were devoid of electricity just because they were six kilometers off the main road which made it difficult to manage the grid supply.

Agencies and Supporters: NERD (Non-conventional Energy and Rural Development)

Objectives: To prevent the cutting of trees and create a healthy atmosphere by providing cleaner energy source for electrification. It will release the pressure on conventional thermal power generation and the burning of firewood in inefficient conventional chulhas thereby reducing GHG emissions and switch towards adopting RE Technology.

Pre-implementation: Villagers made use of kerosene to meet their lighting needs and as explained electricity access was not realized due to the lack of roads in these areas.

Post-implementation: The power generating capacity of the generator is 12 kW. On an average generator daily runs for five hours and generates is 5 x 12 = 60 kWh power equivalent to approximately 18 tonnes of CO_2 emission annually that can generate 18 CERs per year.

Terms of the project: Communities through the SHGs pay fixed monthly charges for the use of biogas and to suit the maintenance and up-keeping costs of the biogas plants installed.

Operational Management: For the project operations seven women and youth SHGs were formed at the project site which they converted into a federation of SHGs in the area. These SHGs have saved almost Rs 4 lakh, which have about 120 women members. The members have been trained by the funding done by NERD in managing their loans and repayments and to carry out effective account keeping. A federation is also formed by the communities to manage resources like the power tiller, oil engine, tractor, and trailer that were given to the federation of SHGs. This federation includes all the SHGs as its members. Maintenance of the system is carried out as each member expected to pay about Rs 20 per month. For the maintenance of biogas-based electricity generating system another federation account has been formed in the State Bank of India, Jallipatti branch, located at Kurichikottai, exclusively.

Outcomes: The project has resulted in gaining access to many facilities to the people of the hamlet. The biogas-based power is useful for the operation of television sets which they have received from the Government of Tamil Nadu as free.

9. Ramakrishna Mission's economic PV development initiative:

Location Details: Villages of Sunderbans, West Bengal in districts of South 24 Parganas, Midnapur, Bankura, and Gosaba lie in the vast swamy delta areas and the only mode of transportation into the area and between its countless villages is by boat.

Agencies and Supporters: Ramakrishna Mission (RKM) with the support from MNRE and UNDP.

Objectives: To identify the beneficiaries of the PV (photovoltaic) systems, providing trained personnel to install and maintain the systems, collecting the loan repayments, and working with other funding organizations to expand the programme.

Pre-implementation: Home lighting provided by candles, kerosene lights, dry-cell batteries, and rechargeable car batteries.

Post-implementation: Villages provided with 300 home lighting systems that furnished 50 W DC for two 9W CFL and one electrical outlet of about 30 W for a TV set or other appliances. 15 street lights were installed for a clinic, a training center, youth clubs, and two battery charging stations of 4 kW each.

Terms of the project: The RKM has provided the following information for charging a 60 Ah battery three times per month. The battery, with an expected lifetime of two years, costs about Rs 3500, that is, about Rs 150 per month. A battery charge is estimated at Rs 30, that is, Rs 90 per month. The cost of transporting the battery by boat to the charging station is Rs 20 to Rs 60 per month. This brings the total to Rs 300 per month.

Operational Management: A senior PV technician is responsible for each district. Under him are four or more village-level technicians who work on solar energy systems, taking care of installation, maintenance, and inspections.

Outcomes: Use of solar energy allows for the provision of an additional four hours of light.

Co-Benefits: Allows the young students to study at night. It also allows for additional productivity as seen at the weaving center, and provides health care at the local clinic.

10. Innovative Solar Power Model, Uttar Pradesh:

Location Details: Rampura- a small village in the Bundelkhand region which is a semi-arid region of district Jhansi, in Uttar Pradesh.

Agencies and Supporters: Development Alternatives and Scatec Solar.

Objectives: The main objective was to come up with a Community Solar Power Plant (CSPP) and gain a first-hand experience about the design, construction and operation of stand-alone solar power plants and to establish a community managed revenue mode.

Pre-implementation: There was no grid electricity supply to this village till 2008. Kerosene was used as the prime source of energy for household lighting which resulted in almost 2400 liters of kerosene consumption annually.

Post-implementation: 8.7 kW Community Solar Power Plant was introduced on 'Build-Own-Operate-Transfer' (BOOT) approach where the ownership of constructing and operating the solar power plants lie within village community jurisdiction itself. 44 out of the 69 households in the village got connected to the solar power plant mini-grid supply.

Terms of the project: To ensure financial sustainability of the plant 'Pay for Energy' concept was introduced to the villagers. The tariff structure is divided into three slabs and under two categories- domestic and enterprises. Under Slab 1 (0-5 kW), domestic fixed cost is Rs. 20 and variable cost of Rs. 4.5 per kWh. Under Slab 2 (5-10 kW), domestic fixed cost is Rs. 90 and variable cost of Rs. 5.5 per kWh. Under Slab 3 (15-20 kW), domestic fixed cost is Rs. 160 and variable cost of Rs. 6.5 per kWh whereas under all the slabs enterprises have fixed cost of Rs. 200 and variable cost of Rs. 6.5 per kWh.

Operational Management: To make any community-based project sustainable, it is essential that ownership of the project should be in the hands of the community. To realize this, local people were involved in activities such as plant construction right from the beginning. After continuous training in accounting and management for 8 months, Village Energy Committee was formed and became the owner of the solar power plant who is responsible to take care of the plant. With the experience of running the pilot solar plant for a long time now, Village Energy Committee in Rampura has now taken prudent decisions to meet every day challenges of load management.

Outcomes: Plant generates average energy of 950 kWh per month whereas the average energy consumption of the village is 840 units. Thus, the solar power plant is running at 90 per cent of its full utilization capacity.

Co-Benefits: In addition to providing assured energy supply, this effort has also made its impact in social, economic and environmental domains. Specific development areas are- education and skill development i.e. using computer, watching TV, flexible studying hours, etc, a positive change in the lifestyle of women they have indulged themselves in income generating activities

like sewing, stitching, rope-making and sweater-weaving. Renewable energy based enterprises provides employment generation and enterprise development in the village. A flour mill of 3 HP operates on electricity generated from the solar power plant. Improved health and sanitation, reduction in usage of kerosene oil has reduced emissions. The concept of mobile irrigation introduced in the village.