CATALYST

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Newsletter of Cyriac Elias Voluntary Association (CEVA), Kochi

renewable energy for sustainable development

From the Chief Editor

The rising crude oil prices and the concern over climate change have generated a lot of interest all over the world for renewable sources of energy. Renewable energy has an important role to play in reducing carbon dioxide (CO_2) emissions. It is also expected to be economically competitive with conventional energy sources in the medium and long term. Many nations promote renewables to improve the security of energy supply by reducing the dependence on imported energy sources.

The importance given to renewable energy in India is exemplified by the fact that there is a full-fledged national ministry to deal with renewables. On 30th June 2008, the Prime Minister of India, Dr. Manmohan Singh unveiled India's Climate Action Plan, which gives priority to solar power and other renewable energy sources. Even though India is not yet required to cut emissions under the Kyoto Protocol, there is rising apprehension all over about the emission of CO_2.

At present, 70% of India's energy requirement is met by imported oil. For a country with over 50% of its population having no access to electricity and 90% of its rural population dependent on biomass to meet cooking requirements and over 70% of its required infrastructure yet to come in place, it is difficult to find the right balance between economic growth and concerns of climate change. "Our people want higher standards of living", said Dr. Singh while releasing the nation plan on climate, "but they also want clean water to drink, fresh air to breathe and a green earth to walk on." His words echoes the need for giving more importance to renewables at affordable prices. The renewable energy sources in a sub-tropical country like India provide enormous potential in this direction. In this issue, we try to highlight some of the pioneering efforts of NGOs in developing small-scale renewable energy projects that have made a real difference to the lives of rural poor in India.

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Renewable Energy–Facts Unveiled

Anoop Jacob*

There is no universally accepted definition of renewable energy, but it is generally agreed that it includes energy derived from natural processes that do not involve the consumption of exhaustible resources such as fossil fuels and uranium.

Hydro power, wave and wind power, solar and geothermal energy and combustible renewables and renewable waste (landfill gas, waste incineration, solid biomass and liquid biofuels) are the constituents of renewable energy. A large share of renewable energy is non-commercial in the sense that its production and consumption do not involve a market transaction. Energy that is not commercially traded typically consists of combustible renewables and renewable waste, including firewood, charcoal, crop residues and animal waste. This source of energy is especially important in emerging economies and accounts for the vast majority of the world's renewable energy use.

Advantages of Renewable Energy

- It is perennial
- Available locally and does not need elaborate arrangements for transport
- Usually modular in nature, i.e., small-scale units and systems can be almost as economical as large-scale ones
- Environment friendly
- Well suited for decentralized applications and use in remote areas

Large-scale hydro power generation and non-commercial combustible renewables and renewable waste are sometimes excluded from this definition, leaving small-scale hydro, wind, and wave power; solar and geothermal energy and modern biomass energy, including ethanol, in the more narrow definition. The definition of primary energy in the Statistical Review confines itself to traded fuels (commercial renewables). Among fuels such as combustible renewables and renewable waste, only ethnol is included in the Statistical Review, because other sources of bio energy are not reliably documented. Geothermal, wind and solar forms of renewable energy are better documented. These are mostly used in the production of electricity and process heat.

Status of Renewable Energy Consumption

Despite high growth rates, renewable energy still represents only a small part of today's global energy picture. The IEA (International Energy Agency) estimates that renewable energy, excluding combustible renewables and renewable waste, accounted for less than 3% of total primary energy in 2004. In 2006, about 18% of global final energy consumption came from renewables, with 13% coming from traditional biomass, like wood-burning. Hydropower was the next largest renewable source providing 3%, followed by hot water/heating which contributed 1.3%. Modern technologies, such as geothermal, wind, solar and ocean energy together provided some 0.8% of final energy consumption.[1]

In some countries, renewables play an increasingly important role in electricity generation. For example, wind power generation has a significant share in total electricity generation in Denmark (14%), Spain (9%) and Germany (5%); geothermal sources account for approximately one quarter of total energy generated in EI Salvador and one fifth of all electricity in the Philippines, Kenya and in Iceland.[2] Developed countries like Britain also are having plans to depend on renewable sources for their energy needs.[3]

While there are many large-scale renewable energy projects and production, renewable technologies are also suited for small off-grid applications, sometimes in rural and remote areas, where energy is often crucial in human development. Kenya has the world's highest household solar ownership rate with roughly 30,000 small (20-100 Watt) solar power systems sold per year.[4]

Energy consumption status in 2006 signifies affinity of the world towards unconventional energy sources. Still large hydropower remains the major energy provider with approximately 770 GW production/year. The renewable energy sources like biogas heating (235 GWth) and solar collectors for hot water heating (105 GWth) make significant contribution to the energy supply.

Renewable Energy Use in Developed Countries

Climate change concerns coupled with high oil prices and increasing government support are driving increasing

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**Anoop Jacob is the Project Officer of CEVA, Kochi, Kerala.*

Renewable Energy for Environment and Development in a Globalised World

Rev. Dr. George Peter Pittappillil*

As we all know, renewable energy is the energy of the future, because sustenance of environment and development of the society is not possible without the use of non-polluting and unending renewable energy sources. Non-renewable energy sources such as fossil fuels are finite and regionally distributed. This clearly means that at some point in future mankind should turn to non-limited globally available renewable energy sources. Pollution of environment caused by fossil fuels, hike in prices of fossil energy as the limited sources get depleted, the chances for terrorist attacks on fossil energy resources and the need to preserve condensed energy for the future generation for unique applications that require fossil fuels and their byproducts are added reasons to convince any person that the spread of renewable energy use should be much faster in the future than it is today. This is all the more true in the globalisation scenario we are in by choice or compulsion. Countries in the tropical and subtropical regions have an edge in the use of renewable energy. However, tangible results could be achieved only through hard work involving all sections of the society. This requires awareness building, training of professionals for the application and encouraging the use of green energy through necessary legislation by governments and relevant support.

Renewable Energy Centre, Mithradham, Kerala

Renewable Energy Centre, Mithradham, the first fully solar educational institution in India dedicated to the promotion of environment and renewable energy, operating from a village named Chunangamveli in Ernakulam District, is probably the first institutional structure in this direction in the state of Kerala, India. Under the Sacred Heart Monastery, Thevara, the centre started functioning in the year 2000. It is specifically involved in awareness building, education and training in the area of environment and renewable energy with the technical support of internationally renowned institutions working worldwide. For the last five years, the centre has been offering training programmes in topics like organic farming, solar assisted drying, energy from biomass and production of solar electricity.

Training in Solar Drying and Organic Farming

Having understood that what we lack is scientific and professional skills for improving the efficiency of cultivation, harvesting and processing of organic agricultural products, Mithradham together with a German NGO, called the Society for the Promotion of Development Oriented Projects (VEV) installed a solar tunnel dryer in India in 1996. The dryer was developed in the University of Hohenheim, Germany. The first solar tunnel dryer used in India was installed in Mithradham Campus at Chunangamvlei in 2001 when a separate drying section started functioning at Mithradham. Together with this, a training programme in organic farming and solar assisted drying was also started with the technical support of Innotech Company in Germany. The dryer is now used for imparting training and drying organic agricultural products harvested from the three hectare land attached to renewable energy centre.

Training for Energy from Biomass

Another area of training and education for the country is energy from biomass. Although biogas plants using animal dung are common in India, the use of all sorts of biological mass for the production of heat and electricity is not very much known to the public and the decision makers. In this area Mithradham is offering training programme in Rotaller Model for production of energy from biomass. The inventor of this unique model, Mr. Walter Danner has been offering the training programme for the last three years. This programme is attended by various organizations including officials from the United Nations Industrial Development Organisation (UNIDO) and representatives of rice producers. The programme has also paved the way for application-oriented initiatives in the use of biomass for energy production. UNIDO along with Mr. Danner has met various civic bodies and the rice producers' representatives for concretizing some projects that are expected to be landmarks in the history of biomass use in Kerala, especially, with the use of bio-waste from corporate bodies and industries like rice mills.

The projects if realized would convert the environmentally harmful bio-waste into productive renewable energy resources, reducing the quantity of carbon dioxide and other harmful gas emissions; they would be replicable models for energy production from municipal and industrial wastes. Bio-fuels also offer an interesting area for Kerala where a variety of oil producing non-edible agricultural products are discarded as waste.

**Rev. Dr. George Peter Pittapillil is the Director of Mithradham, Aluva, Kerala.*

Training of Solar Technicians

The third topic in which practical training is imparted in Mithradham is production of solar electricity. The solar power station for Mithradham was installed in 1999. From the day of installation onwards, the 5.1 kW solar energy system is supplying electricity required for a modern conference centre capable of accommodating 30 people where all modern equipments needed are functioning. For water pumping, there is a separate system that pumps water from 15 m deep well during sunshine hours. The solar system is augmented by a wind mill of nearly 1 kW capacity and a bio-diesel generator that could be run with plant oil. The stand-alone power system is used for demonstration and training from 2000 onwards. The training programmes are directed by international experts who have wide experience in developing countries in training and installation of stand-alone systems. Mithradham has also installed 10 home lighting systems for poor families who do not have grid connection. Nearly 20 technicians and decision makers have been given training in each of the 7 training programmes conducted so far. Some of the trainees have started their own business or small-scale industries in solar energy.

The programmes undertaken with the cooperation of technologically advanced countries like Germany are very well attended, and bring follow up activities with participants who are mostly NGOs and German experts. Mithradham, which is committed to promote the protection of environment and renewable energy, is a member of World Council of Renewable Energy (WCRE) and also the institutional partner of the Society for the Promotion of Environment and Renewable Energy (ISPERE), an international society consisting of people who are reputed in the area of renewable energy. It is not surprising to know that the European Solar Energy Association, EUROSOLAR has awarded the German Solar Prize 2005 for third-world cooperation to Mrs. Rosemarie Zaiser, the President of the German NGO, VEV, for her 'Mithradham Initiative'. She had volunteered to coordinate all the activities of Mithradham from its very beginning. She was also awarded the One World Prize of the state of Baden Wuerttemberg this year, which is given to great social activists working for international cooperation.

Mithradham is a model for the future generation showing them the way to sustainable development in a technologically advanced world.

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renewable energy legislation, incentives and commercialization. European Union leaders reached an agreement in principle in March 2007 that 20% of their nations' energy should be produced from renewable fuels by 2020, as part of its drive to cut emissions of carbon dioxide, blamed in part for global warming. Investment capital flowing into renewable energy climbed from $80 billion in 2005 to a record $100 billion in 2006. This level of investment combined with continuing double digit percentage increases each year has moved what once was considered alternative energy to mainstream. Wind was the first to provide 1% of electricity, but solar is not far behind. Some very large corporations such as BP, General Electricals, Sharp and Royal Dutch Shell are investing in the renewable energy sector.

Wind power, growing at the rate of 30% p.a. has a worldwide installed capacity of over 100 GW [4] and is widely used in several European countries and the USA. The manufacturing output of the photo voltaics industry reached more than 2,000 MW per year in 2006, and PV power plants are particularly popular in Germany. Solar thermal power stations operate in the USA and Spain, and the largest of these is the 354 MW SEGS power plant in the Mojave Desert. The world's largest geothermal power installation is The Geysers in California, with a rated capacity of 750 MW. Brazil has one of the largest renewable energy programmes in the world, involving production of ethanol fuel from sugar cane, and ethanol now provides 18 percent of the country's automotive fuel. Ethanol fuel is also widely available in the USA.

Renewable Energy Use in India

The Ministry of New and Renewable Energy (MNRE) is the nodal ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country [5]

India is implementing one of the world's largest programmes in renewable energy. The country ranks second in the world in biogas utilization and fifth in wind power and photovoltaic production. Renewable sources already contribute to about 5% of the total power generating capacity in the country.

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Remote Village Electrification through Biofuel Route: The WII Experience

Prodyut Mukherjee*

Biofuels as an Option for Rural Energisation

Among the different kinds of renewable energy sources/ technologies, the role of biofuels in meeting the future energy needs of India has a lot of prominence. India has the advantage of being a sub-tropical country, where several species capable of giving oil-bearing seeds grow. *Jatropha curcas* (*Ratanjot*, Wild Castor, *Jangli Erandi*) and *Pongamia pinnata* (*Karanj, Honge*) are two such trees, which can thrive on any type of soil, need minimum input and management, and have low moisture demand. Their propagation is very easy and *Jatropha curcas* starts giving reasonable yields of seeds after the third year of plantation. Oils extracted from seeds of these trees have been traditionally used as a source of energy for lighting and heating. Both these seeds have high oil content (25-40%), and the yield is adequate to justify its use for biodiesel production. It is estimated that even if 10% of the total wasteland of 60 million hectares is brought under cultivation of these species, India can produce about 4-5 Mt of biodiesel per annum, which is about 10% of our current diesel demand.

A comparison between different renewable energy technologies show that biofuels are mostly at par with or superior than many other options available. There could be many variants of this resource, and ideally, it could be used to meet both the electricity as well as cooking needs of the rural population in the most cost effective manner.

Promotion of biofuel based rural village electrification can serve four broad purposes: (a) with proper selection of low nutrition demanding oil-bearing species, large tracks of wastelands can be brought under plantation; (b) such activity will lead to rejuvenation of the wasteland by upgrading the soil quality; (c) contribute positively to national and local energy security; and (d) stimulate local economy. Further, since biofuels can be used in compression ignition engines with little or no modifications, it is a relatively simpler form of distributed generation that could be managed by the local community, and do not require additional servicing/repair infrastructure, which has been one of the major bottlenecks in mainstreaming renewables.

The Project

With this understanding, Winrock International India (WII) has taken up electrification of three villages through the biofuel route in the state of Chhattisgarh. The objective of this initiative is to demonstrate the technical and financial viability of running diesel generation sets using vegetable oil as fuel in place of conventional diesel to provide electricity in remote villages. The initiative aims to build upon an existing initiative of WII/MNRE (Ministry of New and Renewable Energy) in one of the lesser-developed states in India by designing and implementing a replicable model of remote village electrification through the bio-fuel route. WII initially prepared a detailed project report for a pilot project to electrify remote villages in the state of Chhattisgarh using non-edible oil derived from tree borne oil seeds. The initiative is complimentary to the actions already initiated by WII along with the Chhattisgarh Renewable Energy Development Agency (CREDA) and MNRE in exploring the use of Jatropha oil for electrification of remote villages in the state.

Project Area

The project village called Ranidehra comes under the Bairakh panchayat of Bodla block in Kabirdham district. Ranidehra is located deep inside a valley surrounded by forested hills on three sides. The village is not electrified and the grid is about 15 km from the village. The area is highly underdeveloped. Physical infrastructure is near absent. The reasons for the high underdevelopment in the area are

High percentage of tribals: The percentage of tribals is highest in Bodla block. Not surprisingly, in terms of overall development or poverty, Bodla is the least developed block in the district.

Primitive agriculture: In Ranidhara, the low reliance on agriculture (primary sector) is not due to reaching a saturation point but due to the low productivity and risks associated with practicing agriculture.

Activities Undertaken

Several activities have been undertaken under the project by using a bottom-up participatory approach with a strong emphasis on ownership of the initiative. Various stakeholders have been engaged for designing intervention, which has ensured ownership of the initiative by the local community and sustenance of efforts beyond the period of project intervention. Given below are the details of the activities undertaken:

**Prodyut Mukherjee is working with Winrock International India, New Delhi.*

System design: Initially, a Detailed Project Report (DPR) was prepared taking into account all the logistics and system requirements. The DPR also outlined various capacity building needs and initiatives to be undertaken.

Community mobilisation and capacity building: Extensive community mobilization, which is a very crucial aspect in ensuring long term sustainability of the project, has been carried out for management of facilities, including tariff setting, bill collection etc. A number of training programmes for the Village Energy Committee (VEC) and operators of the power plant have been carried out. The operators were also trained at the Field Marshal factory in Rajkot for the maintenance of engines and alternators.

Plantation of Jatropa saplings: In this village, after a long drawn process, more than 25,000 Jatropha saplings were planted. WII only contributed the cost of saplings and the villagers undertook pit digging and plantation through voluntary labour contribution. In order to avoid issues regarding food security in the future, plantation has been carried out on farm boundaries and roadsides and not on farm lands. There are a few waste lands in the village and after discussions with the villagers, some plantation was also carried out in these lands.

Installation and commissioning: After the construction of the power plant building, the equipment including gensets, oil expeller, filter press and boiler were installed. Adequate space has been created for storing seeds and oil. The power plant was commissioned on 9th April 2007, and has been in continuous operation since then.

Formation of VEC: A VEC (Village Energy Committee) consisting of members from the village community has been constituted to govern the operation and management of this facility. Apart from this, the responsibility of the VEC is to collect user charges every month. The formation of the VEC has been undertaken as per the guidelines of MNRE.

Additional interventions: Recognising the linkages between access to energy and demand for water for irrigation, WII has implemented a complementary project focused on augmenting the water resources in the area and promoting decentralised irrigation infrastructure based on Jatropha oil. Simultaneously, the capacity of the farmers has been built up to adopt improved agricultural practices. This project is being supported by Sir Dorabji Tata Trust, Mumbai.

Sustainability of the Project

Sustainability of any project rests on four pillars: (a) technical sustainability; (b) social sustainability; (c) financial sustainability and (d) institutional sustainability. The project is well on its course in attaining all the above.

Technical sustainability: The technical sustainability of the project can be gauged from the fact that till date the operation of the power plant has been totally reliable – there has not been even one day of downtime in the last 10 months of running. The power plant is being managed by three operators, who are trained – both onsite, as well as in the factory of the DG set manufacturer. The operators are confident of handling the day-to-day operation of the power plant, including small repair/maintenance work. However, it would still take some time for them to independently handle dismantling or cleaning or reassembly of the engines. Efforts are currently underway in building up their capacity regarding the same.

Social sustainability: The level of interest and the feeling of ownership have been increasing steadily not only among the VEC members, but also among the community. The power plant is presently run for 3.5 hours in the evening (till 9:30 pm). The battery back-up ensures that the street lights are on till midnight. Although the project has been set up and is running well for the last seven and a half months, there is a strongly expressed need from the community to provide them with hand holding support (and technical backstopping), till such time that they are capable and confident of managing the facilities entirely on their own.

Financial sustainability: From May 2007 onwards, the villagers are paying for the electricity services. The agreed tariff is Rs. 20 per light point/month. The number of light points per household varies from one to three. In addition to the light points, around 65 households were also provided with sockets. The tariff for the socket has now been agreed upon, and from December onwards, the households using the sockets (mainly for entertainment) will also pay at the rate of Rs. 30 per socket per month.

The money collected from villagers is being deposited in the VEC bank account. The collection provides enough money to meet the expenses towards paying the salary of power plant operators, small miscellaneous maintenance expenses and is also generating some surplus for any possible major maintenance work that may be needed in future. The project is also working parallel on making briquette of the

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Powering Dignity: Mantra and Micro Hydro

Dipti Vaghela*

Gram Vikas is a rural development organization, working with poor and marginalised communities of Orissa since 1979. It was founded by a group of student volunteers from Chennai who came to Orissa under the umbrella of the Young Students Movement for Development (YSMD). The organisation currently serves a population of over 189,000 across 559 villages in 17 districts of Orissa. Gram Vikas' mission is to promote processes which are sustainable, socially inclusive and gender equitable, to enable critical masses of poor and marginalised rural people or communities to achieve a dignified life.

To initiate Mantra, an entry point activity, which transforms hierarchical stratification into equitable inclusion in order to induce democratic self-governance, is required. Once the community has self-shattered its hierarchy via the entry point activity, Gram Vikas facilitates the united communities to undertake further development activities. These are based on a combination of the Mantra elements – self-governing people's institutions, health, education, livelihoods and food security, and enabling infrastructure – to improve the quality of rural habitations and to demonstrate a socially inclusive, gender equitable, people friendly, and financially viable model of sustainable and holistic development.

Powering Dignity: Mantra and Micro Hydro

Access to electricity has widely been proven to bridge the gap between urban and rural areas and the poor and the enabled. However, in order for electrification to be sustainable in poor rural areas, it must be sustained by the community. Being labour intensive and requiring centralized hardware, micro hydro solutions for decentralized rural electrification can be sustained only if they are community driven. Micro hydro implementation that is community driven will be characterized by the Mantra values – all having a stake and sharing the costs, regardless of gender or social stratification.

Challenges and Solutions

Gram Vikas has implemented two community-based micro hydro projects in remote areas of Kalahandi District, ranging from power output of 5 kW-25 kW with additional projects planned for the near future. Gram Vikas' agreement with the benefiting community involves formation of a micro hydro committee, labour contribution from each family, Rs. 1000/household contribution to the community corpus, and Rs. 30/month tariff from each household to pay the operators salary.

Although the first micro hydro project in the villages of Amthaguda and Kuang was designed to follow Mantra, various project aspects faltered as a result of applying some of the Mantra values narrowly. Learning from its first project by assessing how well the project followed Mantra, Gram Vikas has been able to prevent significant challenges in the second project located in the village of Karlapat. However, similar and new challenges were experienced in the second project also. Additionally, the inherent differences between the communities of the two projects did not allow the challenges learned in the first project to be directly transferred to the second project.

Amthaguda-Kuang Micro Hydro Project

The level of success of the Amthaguda-Kuang project has been achieved via a process of identifying a series of community development challenges and applying appropriate solutions. Because the project was technically sound, it could have been perceived as a flawless project after the commissioning. The system was built with the community, electricity was being generated, and the community was using it. However, Gram Vikas wanted to ensure that the project was promoting its mission of creating a socially equitable process that improved the lives of rural populations. Hence, Gram Vikas began to measure the results of the project to the core values of Mantra and was able to clearly identify the development gaps

Inclusion: The Amthaguda project had 100% inclusion because all the households had decided to commit to building and managing the system. All the households have contributed and benefited equally.

Social Equity: Social equity was also fulfilled because the villages' social stratification did not affect project implementation. Each village is equally represented in the micro hydro committee. Each voiced its concerns during project development. The system operators come from both villages: Amthaguda selected 2 youths to be village operators; while Kuang, being the smaller community, selected one youth.

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**Dipti Vaghela is the Energy Programme Coordinator, Gram Vikas, Orissa.*

NEWS FROM CEVA

New Patron for CEVA

The Prior General of CMI congregation is the patron of CEVA. Very Rev. Fr. Jose Panthaplamthottiyil CMI who was elected as the Prior General of CMI congregation is the new patron of CEVA. We extend a hearty welcome to him and extend all support for his new endeavours. We gratefully acknowledge the contributions made by the previous patron Rev. Dr. Antony Kariyil for the growth of CEVA.

Visit of KKS Representatives

Mr. Arno Eul visited CEVA Cochin office on the 4th and 5th of March 2008. He held discussions with project partners from Trivandrum Social Service Society and Samagra Vikas, Mannanam. During the visit, CEVA Cochin arranged a farewell function for Mr. Arno Eul. He left KKS in May 2008. We wish Mr. Eul all success in his new endeavours.

Mr. Ralf Tepel and Mrs. Daniela Kobelt Neuhaus, Executive Directors of KKS, Germany, visited CEVA on 13th March 2008 and held an informal discussion with the executive committee members and staff of CEVA.

Visit of European Commission Staff from Delhi

Mrs. Sirkku Siltamies & Mr. Shylendra Mathur from the finance department of the European Commission visited CEVA Kochi office on 14th January 2008. There was a meeting of CEVA, EU and Peace Trust team at the CEVA office. Fr. Varghese Kokkadan, the Secretary of CEVA, presented the activities of CEVA to the visitors during the meeting. On 15th and 16th they were involved in the spot checking of financial documents of the watershed project implemented by Peace Trust.

Change of Guard in CEVA

The month of May (2008) witnessed major changes in the administrative stratum of CEVA. Rev. Fr. Varghese Kokkadan CMI who served CEVA as Secretary for a period of three years became the Moderator preceding Rev. Fr. Austin Kalappurackal CMI. CEVA also got new Secretaries –Rev. Fr. Joy Vattoly CMI in the South, Rev. Fr. Dominic Kunnumpurath CMI in the North, and Rev. Fr. Joseph Puthenpurackal CMI in the East. It was the time for CEVA to affectionately remember the previous Moderator Rev. Fr. Austin Kalappurackal CMI and Secretaries Rev. Fr. Varghese Kokkadan CMI, Rev. Fr. Thomas Medackal CMI and Rev. Fr. Reji Muttathu CMI.

Mr. Anoop Jacob joined CEVA as Project Officer in March 2008 in place of Mr. Suhas B. We gratefully acknowledge the contributions made by Mr. Suhas for CEVA and wish him all success for future.

Annual Meeting 2008

Annual meeting of KKS, KKF, KKID and CEVA was held at KKID from 6th to 8th March 2008. The Executive Directors of KKS, Mr. Ralf Tepel and Mrs. Daniela Kobelt Neuhaus along with Mr. Arno Eul from KKS attended this 12th Annual Meeting of the family. From CEVA, Fr. Varghese Kokkadan CMI (the Secretary), Fr. Austin Kalappurackal CMI (the Moderator), Fr. Thomas Medackal CMI (Regional Secretary of NRO) and Fr. Reji Muttath CMI (the Regional Secretary of ERO) along with all the coordination staff attended the meeting. Decisions on key issues related to the KKS project coordination were taken during the meeting.

"Darkness to Light": Renewable Energy Programme at Thondai Tribal Village

Thondai is a small tribal settlement situated at the foot of the Nilgiri Hills in the Western Ghats situated in Kemmarampalayam village of Karamadai block, Coimbatore district. Fifteen families of Irulas, one of the primitive tribal communities, live here. They were jungle food gathers in the ancient days, but nowadays depend on casual agricultural earnings. Thondai is surrounded by Lantonara bushes and dense forest where interference by wild animals such as elephants, wild boar, bear, bison and leopard is very common. Basic amenities such as electricity, transportation, hospital and school are lacking for years.

Good Shepherd Health Education Centre (GSHEC) intervened to develop this village with the support of the Karl Kubel Stiftung (KKS) & BMZ, Germany. Rs. 10 lakhs was sanctioned as grant-in-aid for implementing the renewable energy programme during the year 2005-2006 at Thondai village. Solar home lights, lanterns and street lights were provided through this project. Solar fencing was erected around the village.

Simultaneously, GSHEC trained the community in maintaining the solar system. The project staff promoted Self Help Groups (SHG) through which they put their efforts in developing the socio-economic condition. People's participation at all levels enabled the community to enjoy the resources available. The protection of their land through solar fencing resulted in raising mountain crops, millets, pulses, vegetables, greens, fruits and bee keeping on their land holding (totally 12 acres). Bio gas plants were also established in the village for cooking purposes.

The impact of the interventions with the support of KKS led to empowering the tribals in Thondai, through several developmental activities. Through various capacity building training, the community gained leadership qualities. The people are now willing to go to banks and government departments and press for their demands. The children are able to study during night, and the school dropouts have considerably decreased.

Gender issues like women empowerment, violence against women, sexual exploitation, single mother issues, etc. have been taken up. The energy of youth and men are utilized constructively for the development of the village. The families now have access to more income resulting in the upliftment of their standard of living. It can be said that the availability of solar energy has raised the community from darkness to light in every sense.

Sr. Anila Mathew, Director, GSHEC, Coimbatore.

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Gender Equity: Although Gram Vikas made sure that there were women representatives on the committee, they did not attend meetings. This was mostly due to lack of time and interest. As a solution, meetings are scheduled earlier and the times are confirmed with the women leaders. To generate interest amongst the women, Gram Vikas is reaching out to women's self help groups (SHGs) to practically teach them about load management and brainstorm on how they can make productive use of electricity. The result has been that an increasing number of women have started attending the micro hydro meetings, but without voicing their opinions. To create a space that is free of intimidation for the women, the SHG leaders will be holding separate, women's only meetings regarding the micro hydro system. The women's representative on the micro hydro committee will be coached to voice the group's ideas.

Cost Sharing: The Amthaguda-Kuang community and Gram Vikas had agreed that the community would create a community corpus to ensure sustainability of the system, while Gram Vikas would pay for the civil works and hydro electric hardware, partially through available government funds. The costs of sustainability were to be shared by each household by contributing Rs. 1000 to the corpus. The community was to manage by itself the identification of families who could not afford Rs. 1000 and finding some way to help them meet their corpus commitment. After commissioning the system, each household was to share the cost of paying the operators. Each household agreed to pay an electricity tariff of Rs. 30 in order to collectivly pay the salaries of three village operators.

Unfortunately, no corpus was formed, and no tariff was collected. The technology-driven approach at the outset of the project reflected to the villagers that Gram Vikas was going to implement the micro hydro system regardless of its involvement. The villagers held this assumption to be true when Gram Vikas gave more attention to complete the construction than to mobilisation of the community to form the corpus. Further, even when the system was running, the community was not paying the tariff and or raising the corpus.

Due to these challenges, cost sharing within the Mantra framework did not happen. The ultimate result was that the community as a whole did not feel it had a stake in the project, and hence did not care that there were no funds to address technical maintenance and repairs.

Gram Vikas' solution to these challenges manifested when a small part of the system needed repairing. Gram Vikas was then able to show the community in real time why funds were needed to keep the system running. The community immediately collected enough funds to fix the part. Having presented the repercussions of no cost sharing to the community, Gram Vikas had to offer tangible solutions for raising a corpus and collecting a monthly tariff.

To help form the corpus, the community has been mobilized to set small and frequent goals to raise a full corpus. Community participation in income generating via government programmes, e.g., NREGA, has been encouraged. The community realised the need to have a corpus and is confident that they can raise one-third of it by January 2007.

Sustainability: There are three aspects to Mantra's definition of sustainability – technical sustainability, financial sustainability and environmental sustainability.

Technical sustainability: The system was not technically sustainable because the operators' salary was not being paid due to the committee not being able to collect the tariff. With the pressure of ensuring technical sustainability of the system by the community, Gram Vikas had no choice but to direct the village operators to keep the system off until tariff was collected and the operators were paid. The system was shut down for two weeks before the community started questioning.

Financial sustainability: Although the Amthaguda-Kuang project involves financial sustainability for maintenance and small repairs, financial security for large repairs still needs to be thought through. Gram Vikas feels that, as much as possible, the corpus should be left untouched. It is in fact the formation of the corpus that unites the community. Also, for some repair cases, the corpus amount would not suffice. The options being considered are insuring the expensive components of the system and building a separate fund from income-generating activities that could be established using the electricity.

Environmental sustainability: As it does in its other programmes, Gram Vikas aimed to link the Amthaguda-Kuang micro hydro project to environmental sustainability. In the most basic sense, this would mean educating the community on the connection between trees, watershed and micro hydro. In the case of Amthaguda-Kuang, the path leading to the area of the civil structure was clear of stone and trees; it did not need to have rocks blasted or trees cut.

Energy Security: Ushabali and Keshkeri Show the Way

Achyut Das & Ashis Das*

Most of the tribals in India live in poverty and hunger and face all kinds of insecurities – food, water, livelihood and energy. Various surveys show that the quality of life is still very low for them even after 60 years of India's independence. Their low literacy rate and poverty always makes them vulnerable to exploitation. Food insecurity, inaccessibility to various anti-poverty and welfare schemes offered by the government, and poor health and sanitation conditions have been matters of great concern. The loss of land, restriction on access to forest produce and lack of livelihood options for survival have caused immense hardships for tribal people. Although there are several constitutional rights and privileges guaranteed to the tribals, such privilages have very little impact in changing their status.

Kashipur block of Rayagada district in Orissa is a typical tribal area where more than 70% of the population consists of Kondh and Paraja tribes. A big hydro electricity project at Indravati, which is located a few kilometers away, produces enough electricity for the state, but most of the villages in Kashipur remain in darkness. It is apprehended that electricity will not be available for these villages for the next 20 years. Socio-economic infrastructures have been nearly absent. Market is a big problem and so is enterprise. Despite having a range of agricultural and minor forest produce, there is no processing industry. All these have led to perpetual livelihood insecurities in the area.

The tribal population has visited nearby towns and cities and has seen how electricity has made a difference. Compared to light by fire-wood or kerosene lamps with limited kerosene oil supply, electricity offers far more options – better lighting, ability to do livelihood and household work in the night, schools in the night for the entire village population etc.

Advocating a pollution-free environment and emphasising on the integrated development of tribals, Agragamee a grassroots level NGO along with KKS (Karl Kubel Stiftung) has implemented two renewable energy projects in Keshkeri and Ushabal village of Kashipur block. A 15 kW small micro hydel is installed in Keshkeri and a 1 kW solar photo voltaic power plant is installed in Usabali village. Both are tribal dominated villages. The objectives of the programme are follows:

- To generate renewable energy/power for lighting, cooking, lifting of water and processing industry.
- To be less dependent on electric grid and fossil fuels, which are very costly and beyond the reach of the tribal population.
- To enhance livelihood, increase agro-horticulture production, to reduce distress migration.
- To reduce pollution and ensure a good environment.
- To ensure community mobilisation and show examples of best practices in managing renewable energy sources. This will also address the issues of equity and sustainability.

1 kW SPV Power Plant in Ushabli Village

Ushabali village is located on the top of a hill. The village has sufficient shadow-free open space and receives adequate solar light for about 300 days a year. The average sunshine hours available per day is 6 to 7 hours. After situational analysis, it was decided to install a solar power plant in the village that could provide point lights to each household and can cater for street lights and for some community programmes. A Village Energy Committee (VEC) has also been promoted to look after the utility and maintenance of electricity. Emphasis has been given to make the process of coordination more transparent and accountable. Accordingly, a capacity building programme for community members have been organised.

A separate bank account has been opened in the name of the VEC, where they are depositing the maintenance money. This is at the rate of Rs. 100 per household. Up to December 2007, people of Ushabali village have raised Rs. 30100 as maintenance fund. People of the village contributed in the form of land, labour and material to the whole process. The installation was completed in June 2007, and afterwards electricity is being supplied to the village from 7 street light points in the village. The plant is illuminating the village from 6 pm to 9 pm. A night school was initiated where 41 children are getting education. In order to avoid dependency and to cut down managing and maintenance costs, two local youths were trained. Both are right now managing the distribution system and the power plant. A total of 615 man-days were created in the installation of the solar power plant.

"It's the time for people of the village to cheer," said Dania Majhi, president of the Ushabali VEC. "Due to the electricity our children are getting education in the evening. Women

**Achyut Das & Ashis Das is working with Agragamee, Orissa.*

are getting some more hours for the household work. We are also planning to provide leaf-stitching machines to community members for better livelihood options."

15 kW Micro Hydel at Keshkeri Village

Located at the foothills near a perennial stream, people of Keshkeri village were fully dependent on agriculture. The slope, the landscape and the water flow of the area showed the potential for hydro electric production at Keshkeri. After consulting the villagers and experts, Agragamee decided to construct a micro hydel in Kosher Village. But the main obstacle was the construction of a check dam on the stream as a snap flood caused by heavy rain in 2006 had washed the old one away. Agragamee approached Deutsche Wetthungerhilfe (German Agro Action), a German based NGO for the same, who later provided the support for construction of the check dam on the stream. A total of Rs. 5,97,376 was spent in construction of the check dam along with a generation of 3150 man-days of employment.

The construction and installation work of the micro hydel is complete, and the commissioning will start from 5th April 2008 onwards. Every household in the village will get three light points and a plug point for other household consumptions with 15 street lights throughout the village. Till now, a total of Rs. 18,04,529 have already been spent in the implementation, and 4486 man-days of employment was generated.

In another initiative, Agragamee along with the people of Keshkeri tried to construct a concrete feed channel through the NREGS (National Rural Employment Guarantee Scheme), and respecting the people's approach, the district administration also added the construction of the feed channel in their action plan. A Village Energy Committee (VEC) consisting of 10 members, out of whom three are women, was formed to monitor and supervise the work of the micro hydel project. A separate bank account was opened in the name of the VEC, where they are depositing the monthly maintenance fund money. Money receipts duly signed by the president and the secretary of the VEC are issued to the contributors.

Equitability and Sustainability of the Initiative

To address issues like structural relationship within the village, the VEC played an important role in equitable distribution of electricity by a participatory management process. Two light points and one plug point are provided to each household in both the villages, along with 7 street light points in Ushabali village and 15 light points in Keshkeri village. After installation, the renewable energy units will work with a minimum maintenance. To make the system sustainable, the VEC collects the maintenance fund fee. This will be used later for repairing the plant and the distribution line. Two local youths were trained to operate the systems at Ushabali and Keshkeri.

Lessons Learnt So Far

Availability of land for installation of the plant, labour force, equitable distribution of energy and ensuring of people's participation are the key components for the success of this project. In this connection, lots of efforts have been facilitated through the project team to make it really a people's initiative. The lessons learnt in implementing the processes are

- Community can participate in the process of energy security.
- Micro hydel technology in remote villages like Keshkeri can have multiple impacts.
- Demonstration and Dissemination: The success of the project has generated multiple demands in other tribal villages.
- To strengthen the process of development, processing and marketing activities have to be integrated into renewable energy projects.
- Ushabali needs another 2 kW for the installation of a leaf-stitching machine, and Keshkeri needs investment for setting up a rice mill and an oil mill.
- For the success of the project, the collaboration with government departments, panchayat, NGO and the community is necessary.

Taking Forward

The experience in implementing the projects suggests there is vast scope for replicating the process in surrounding areas. People of the nearby villages are already demanding renewable energy devices. The Government Department for Development of Renewable Energy in Orissa, OREDA, and the Ministry of New and Renewable Energy, Government of India are being approached for strategic support. The experience shows that renewable energy is the best way for ensuring the energy security of tribal people. Taking the issue forward, Agragamee is planning to construct two micro hydels at Pipalpadar and Minakhunti villages in the same block.

Captive Plantation for Renewable Energy in Sundarbans, West Bengal

A.K. Ghosh*

Sundarbans is the largest inter-tidal area in the world with an area of approximately 26000 km^2 formed at the meeting place of two great river systems – Ganga and Brahmaputra – with the Bay of Bengal along the cost of India and Bangladesh. The Indian part of Sundarbans covers an area of 9630 km^2. The human society in the island groups still remains outside the mainstream due to lack of transportation and telecommunications facilities. Furthermore, a vast area of Sundarbans still remains without electric power. Lack of educational facilities, health care, safe drinking water and sanitation continue to be hurdles to human development.

Of the total 1060 villages in the region, at least 156 villages are likely to remain deprived of power from the main grid in the foreseeable future. They can only depend on alternative energy sources like solar energy, tidal energy, wind energy and biomass energy. To provide power at the most affordable cost, the West Bengal Renewable Energy Development Agency (WBREDA) has initiated a wood-based gasifier power project of 500 kW capacity in the Choto Mollakhali Island for five villages with an estimated total population of 30,000. The present paper is based on the experience of collaborating with WBREDA for providing an assured supply of biomass from captive plantation for gasification.

Project Activities

Different activities associated with the project were community level meetings for creating awareness; raising a nursery for 5 ha captive plantation; planting of seedlings with mulching, de-weeding and fertilization; protection work for the plantation until it reached above browsable height; in-filling the damaged plantation site and periodic supervision by forestry experts and other experts from ENDEV team.

Selection of Land

The area was surveyed by a team of experts from the Society for Environment and Development (ENDEV), Calcutta, in the year 2000 to identify community land under the governance of Panchayat. A village map prepared with the help of Global Positioning System (GPS) showed the available land (50 ha) suitable for energy plantation. After soil testing, five species of plants were selected for plantation to meet the demand of the gasification unit.

Selection of Species and Rotation Cycle

To run the 500 kW capacity unit for 2 hours, the daily requirement of fuel wood was estimated to be 5000 kg. To meet the demand of wood for the power plant, fast growing plants were selected, namely, Eucalyptus *(Eucalyptus sp.)*, Akshmoni *(Acacia sp.)*, Siris *(Albejia lebeck)*, Rain tree *(Siamea saman)*, Sissoo *(Dalbergis sissoo)* and Jaml *(Lagerstroemia speciosa)*. Additionally, seeds of Babla *(Acacia arabic)* and Subabul *(Laucaena leucocephala)* were broadcast because of their known potential values as energy plants. Saplings were used for five selected species for plantation, but seeds were also used for sowing in the periphery of the plantation area.

Community Level Meetings

Three community level meetings were organized before plantation every year by the ENDEV team in which local people and WBREDA representative were present. In the meeting, the WBREDA representative explained the future programme regarding the supply of electricity in the area and also made the local people aware as to why the plantation was raised in the panchayat land. The ENDEV team and panchayat member also made the people aware about other benefits from energy plantation (other than fuel wood), such as collection of leaf biomass and the role of plantation in resisting or minimizing the impact of cyclones.

Raising Nursery and Plantation

Due to lack of time in the first year, plantation seedlings were procured from the forest nursery and planted in the plantation sites. But in the second year, a nursery was raised in Gosaba (land given by the WBREDA Project Authority). In the third year, a local citizen of the village of Hetalbari provided a 0.2 ha land for the nursery rent free.

Employment Generation and Cost of Production

A total of 6600 man-days of employment were generated through the captive energy plantation project in three years for the protection work only, i.e., average of 2200 man-days per year. The labour requirement during nursery bed preparation, transplanting, sowing of seeds, mulching, weeding and fertilizing, appeared highly variable but in

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**A. K. Ghosh is working with Centre for Environment & Development, Kolkata.*

Use of Biomass to Meet the Energy Demand of the Remote Villages of India

S.K. Bose*

India has a large potential for renewable energy, an estimated aggregate of over 100,000 MW. In addition, the scope for generating power and thermal applications using solar energy is huge. However, only a fraction of the aggregate potential in renewable energy has been utilized so far. Biomass as a source of renewable energy is most important in view of its sustained availability as well as economic viability with respect to its use for electrical and thermal applications both for industrial uses and for providing energy security to the vast rural population of India.

Biomass Power: Gasification and Biomethanation

The advantage of biomass is that it can be used to generate electricity with the same equipments that are used in power plants that are now burning fossil fuels, with some modification. It is an important source of energy and the most important fuel worldwide after coal, oil and natural gas. Biomass energy is an alternative energy source as it is renewable and free from net CO_2 (carbon dioxide) emissions, and is abundantly available on earth in the form of agricultural/forestry residue, city garbage, cattle dung, firewood, etc.

Biomass Gasification Technology

Biomass gasification process can be used for both thermal and electrical applications. Generally dry biomass, such as, firewood, rice husk, cashew shell, coconut shell, mastered / maize stalk etc., are being used in gasifiers for generation of producer gas. In India, there is a wide range of gasifiers available with capacities varying from 10 kW to 1000 kW for electrical and thermal applications. Thermal gasifiers finds applications in industries like bakeries, steel re-rolling, engineering industries, tiles manufacturing, brick kilns, chemical industries etc. However, for rural electrification, usually 10 to 30 kW capacity biomass gasifier based power plant is being used. Cost of installation of such power plants is in the range of Rs. 8 to 11 lakhs, and there is further additional capital cost involved in respect of installation, power distribution to the rural households, etc.

Biogas Technology (Biomethanation)

At present, biogas technology provides an alternative source of energy in rural India for cooking mostly by small biogas plants, popularly known as 'Gobargas Plant', which are run by cattle dung only. It is particularly useful for village households that have their own cattle. Through a simple process, cattle dung is used to produce methane-based gas, which serves as a fuel for cooking, and the residue is used as manure. The gas essentially comprises of methane (CH_4) and carbon dioxide (CO_2), approximately in the ratio of 60:40. It is methane that has the fuel value.

Use of Biomethanation Technology for Rural Electrification in India

Whenever question comes for rural electrification, major focus is being reflected to Biomass Gasifier based Power Plant (BGPP) run on 100% producer gas engine mode, as in this case cost of installation is much lesser compared to solar power. But due to various constraints, such as the lack of availability of dependable 100% producer gas engine, increasing of cost of dry biomass, lack of training for operating BGPP, short duration operation (only 4-5 hours in evening) etc., progress could not be made as per plan. Considering the huge potential and due to operational advantages, equal importance needs to be given for installing biogas plants (biomethanation process) to generate biogas for power generation either exclusively or parallel with BGPP, for rural electrification. In certain areas, there may be abundance of wet biomass, which is suitable and more economical to use for generating biogas.

Rural Electrification Versus Rural Energy Security

To generate electrical power for rural electrification, there is a need for gas based generator in respect of both the above referred technologies. Small capacity generators/ engines for remote rural electrification are not readily available in the market. Modifications of existing fossil fuel based engines are done, but many of these proved to be less efficient. Even if such engines are arranged, after sale service/repair of such engines is a real problem.Because of this problem and also the fact that in most of the remote rural villages there is hardly any industrial activity, which may demand electrical power, direct use of gas for thermal applications is not getting importance. This basic need of fuel for lighting and cooking are presently being met partially by costly kerosene oil, inefficient burning of wood, burning cattle dung cake, etc., which is causing health hazards, emission of CO_2, and continual deforestation.

**S.K.Bose is the Director of Trans Bio Energy Technology Services Pvt. Ltd, Kolkata.*

Direct Use of Gas for Cooking and Lighting

In villages, the primary domestic uses of energy are cooking and lighting. Best solution to the problem is direct use of either producer gas or biogas or both, as the case may be, with the direct burning of gas through burners for cooking and illumination through gas lamps for lighting. Reported gas consumption for cooking and lighting is 0.34 to 0.37 m^3 per capita/day and 0.15 m^3 per hour respectively. Thus, a typical family of five members will require 2.60 to 3 m^3 biogas per day.

To generate 3 m^3 biogas, only 24 kg of vegetable/organic waste or 75 kg of cow dung will be required per day. Providing this facility to a family will not only improve the standard of living of the family but also will save large quantity of wood/coal/cow dung (used for dung cake) and thereby lesser emissions of CO_2, which are direct benefits. The indirect benefits are immense – people will learn to derive benefit out of waste, children of the targeted families will be able to study in the evening, the organic compost produced through biogas plant will help in improving soil fertility etc.

Direct Thermal Application

In certain areas where there is availability of both dry and wet biomass, the demand for electricity for small/cottage industrial activities can be met with generation of producer gas and/or biogas. In remote rural places, there may be one or two small bakery units for making low-cost bread and biscuits, where heat energy is obtained mostly by burning firewood, which can be replaced by direct firing of gas. Similarly in some areas, there may be one or two wheat grinder/ husking mills, which are being operated by diesel engines, which can easily be converted to gas operating system, by either of the aforementioned gases. Adoption of such a system will not only have a reduction of capital cost but also will be an effective step towards energy security in a sustainable manner for the target group.

Conclusion

This article suggests the direct use of gas both for the cooking and lighting. The work of providing energy security to the rural community will be easier and faster, in view of the fact that India's energy requirements are enormous and the demand is growing, but our resources are limited both in physical and financial terms.The direct use of both producer gas and biogas will be much more reliable and safe as compared to conversion of gas to electricity in remote rural areas, where getting a mechanic for repairing of generating sets is not only difficult but also time taking.

Moreover, the actual need in remote areas is consuming energy for cooking and lighting, and many of them cannot afford electricity other than for lighting. As regard to availability of efficient and eco friendly technology, one should agree that operating a biogas plant is easier than operating a biomass gasifier plant. Besides, the use of effluents from biogas improves fertility of fields, while the effluent from gasifier plant is a pollutant. Availability of biogas digester (even for batch feeding) is not difficult, and if a digester is properly installed, it can serve the purpose for 20 years with proper maintenance, while a small gasifier plant may live at best for 10 years.

However, the purpose of expressing the merits of biogas is not for substituting the gasifier, but to provide equal importance to the use of biogas with producer gas (gasifier) for clean energy and providing energy security to remote rural areas.

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jatropha press cake and its possible sale to the eateries in nearby towns, which would open up another revenue stream for the VEC, and may help to drive down the electricity tariff further. Efforts are also underway to establish small business plans for the VEC and local SHGs that have been set up in the village.

Institutional sustainability: The VEC is becoming more and more active in every aspect of the power plant operation, including motivating the villagers. Every month, they collect electricity charges from the community and follow up diligently on the late payers. The committee is also actively considering other income generating activities (as mentioned earlier) to improve their financial situation.

Conclusion

The transport sector is increasingly receiving attention as an option for the use of biofuels in the country. Although this is important keeping in mind the energy security of the country as a whole, it is the rural areas where the use of biofuels, especially Jatropha, can improve the access to a clean and affordable source of energy. The promotion of biofuels for rural electrification can also stimulate the local economies and alleviate the negative impacts of the use of fossil fuels at the village level. The project can serve as a model to be replicated in other remote parts of the country hitherto untouched by the mainstream development processes.

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general, 150 man-days for this part of work was required. The average cost of a man-day was Rs. 60. Therefore the total expenditure incurred for growing 30,000 energy plants (labour component only) was Rs. 405,000 with a direct benefit of generating employment for nearly 2300 man-days per year.

At the end of the third year, the total project cost for creating captive plantation was Rs. 800,000. Considering the total projected produce of 720 Mt of dry wood, the price would be Rs. 1,111 per Mt. Considering the replacement cost of diesel (80%) by wood biomass, a net saving of Rs. 515,000 per year could be noted in addition to the benefit of reduction of carbon emission.

The total hardware cost for 500 kW gasifier plant was Rs. 1 crore. The fuel cost corresponding to 80% of the energy input from wood and 20% from diesel is estimated to be Rs. 2.90 kWh. Normally WBREDA supplies electricity at Rs. 4.50 per unit. When compared with the current rate per unit of solar power at Rs. 8.00 (even with 50% subsidy), the sale price of electricity from wood-based gasifier power plant would be much cheaper. The total man power (3 persons) employed for running the gasifier power plant is also very low. Considering all alternatives for supplying renewable energy in the absence of grid power, the production cost and sale price of energy appears to be the cheapest through the use of wood-based gasifier power plants.

Problems Encountered

The problems encountered during the project implementation are summarized as follows:

- Lack of stakeholders' commitment to save plantation on common property resources
- Adverse impact on government-sponsored projects as a result of rivalry between ruling and opposition political parties
- Lack of grazing land for local livestock, leading to frequent problems of grazing and browsing in the young plantation sites

Lessons Learned

The present project shows the feasibility of supplying power to all the 156 remote island villages of Sundarbans through stand-alone, off-grid, wood-based biomass gasifier-based power plants. Considering the success of Choto Mollakhali Project, the Ministry of New and Renewable Energy has assured West Bengal a subsidy of 90% for similar projects to be undertaken in the future. The role of NGOs in such ventures appears to be vital. NGOs can act as facilitators between the government departments, panchayat and the local community. Before any project is launched, the use of Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA) and other social tools will be most relevant to find out the people's priority for local development.

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CEVA
CEVA Bhavan, Monastry Road
Karikkamuri, Cochin, Kerala
Pin - 682 011, India
Phone: 0484-4070225-228
Fax: 0484-4070225
E-mail: cevakoci@airtelmail.in

Regional Offices:
CEVA - Northern Regional Office
Mariam Nagar, Meerut Road
Ghaziabad, U.P.-201 003
Phone: 0120-3242777
Fax: 0120-2870902
E-mail: cevanro@del3.vsnl.net.in

CEVA - Eastern Regional Office
C/o CMI Dharma Niketan
1/1 Bonamali Ghoshal Lane
Behala, Kolkata, W. Bengal-700 034
Phone: 033-32582163
E-mail: ceva.ero@reliancemail.net

Visit us at www.cevaindia.org