Decentralized Energy Options in the Tribal Belt of the Eastern Ghats Region in India

A Hand Book Based on a Feasiblity Study

INDIAN NETWORK ON ETHICS AND CLIMATE CHANGE (INECC)

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This document was produced on the basis of a feasibility study of Decentralized Energy Options Study in four states, Jharkhand, Chhattisgarh, Andhra Pradesh and Orissa, undertaken by the DEO Action Group, INECC and financially aided by Kerk-In-Actie.

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FOREWORD

This handbook is a synopsis of the processes and insights gained from a feasibility study undertaken on Decentralized Energy Options (DEO) across the tribal belt of four states of the Eastern Ghats region of India , which was initiated in January 2007 and ended in March 2008.

The source of inspiration to undertake this study emerged from the lack of basic information and access to renewable energy resources in the remote tribal areas of the region. Energy policies are controlled by the State and local communities have hardly any role in decision making relating to energy access. Hence the bottom up approach in this study was prompted by the imminent need to play a proactive role in influencing India's energy policies based on grassroots' realities.

The study has been meaningful because we have been able to generate data for 36 typical DEO intervention sites linking them to sustainable development for neglected tribal regions. The insights from the study will help decision makers at all levels to take requisite measures to ensure improved livelihood and living conditions through improved energy access for the tribal communities. The study holds more relevance in today's context of Climate Change when the world is looking for feasible options beyond conventional sources of energy, especially for regions which cannot be connected by grid lines or if connected, experience frequent power cuts.

Our sincere gratitude to all those who have made the study possible: our NGO partners, resource agencies, colleagues and tribal community representatives.

The main idea of this handbook is to share information and experience gained during the course of the study. Based on the outcome of the study the implementation phase has been initiated since May 2008.

Dr. Nafisa Goga D'Souza, November 2, 2008

Convener, INECC

INTRODUCTION

The Energy Perspective: Macro Scenario

The increasing use of conventional energy is clearly becoming counterproductive in the global context due to the growing threat from Climate Change. According to current science, drastic reductions in Green House Gas (GHG) emissions by a massive 85% by 2050 are needed if the atmosphere is to be stabilized with relatively low risk levels by the end of the 21st century.

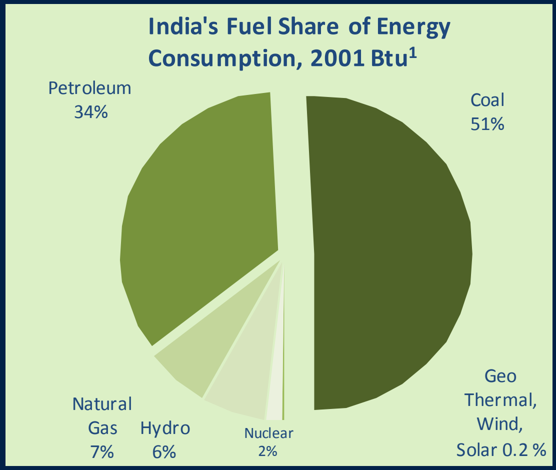
While the current contribution of India to GHGs is well below countries like the USA and China, and its per capita consumption, one of the lowest in the world, there is an urgent need to minimize India's GHG emissions keeping the post Kyoto Protocol scenario in mind.

Current trends reveal that the increasing energy consumption in the industrial, transportation and domestic sectors continues to drive India's energy usage upwards at a rate faster than even China in the period 1980-2001. However, India's per capita energy consumption is low as 70% of India's population still lives at rural sustenance levels.

Non-Conventional Energy in the Indian Context

The share of non-conventional energy in the overall energy consumption is extremely low.

Renewable energy constitutes only about 8.2% of total energy consumption. Most of it constitutes conventional renewables. Similarly hydropower forms 6.3 % of the energy consumption, but most of this consists of large-scale hydro projects, most often leading to rampant displacement off tribal communities. The policy of the government is to increase the share of hydro power through large-scale hydro projects to meet its future energy needs. The share of decentralized energy is hardly visible. The distortions in pricing of conventional energy, which do not take into account the environmental and social costs, continue till date.



Scope of Renewables in the Rural Context

Energy can play a crucial role in underpinning efforts in improving the lives of poor people across the world. It can contribute to all three pillars of sustainable development - economic, social and environmental. However, today one of the major challenges of the energy sector is to secure future energy supplies and provide for accessibility, availability and affordability of energy services in a way that does not lead to the proliferation of GHG emissions in the atmosphere, and at the same time ensures sustainable development, particularly to those populations, which are marginalized and out of the mainstream.

Renewable energy sources such as solar, wind, micro hydro, and biomass are indigenous, non-depleting and environment friendly and can play an important role in securing future energy requirements. This technology holds more relevance in the energy-deprived areas that are distantly located and have little and irregular access to the supply line.

GRID INTERACTIVE RENEWABLE POWER[2]

SOURCE/SYSTEMS	ESTIMATED POTENTIAL (MW)	CUMULATIVE INSTALLED CAPACITY (AS ON 31.03.05) (MW)	POTENTIAL UTILISED (%)
Wind Power	45000	3595	7.98
Biomass Power	16000	302.53	1.89
Bagasse Co-generation	3500	447	12.8
Small Hydro (up to 25 Mw)	15000	1705.63	11.37
WASTE TO ENERGY			
Municipal Solid Waste	1700	17	1
Industrial Waste	1000	29.5	2.95
Solar Photovoltaic	20 MW /sq km.	2.8	negligible
	TOTAL	6099.46	

Renewable Energy in the Indigenous (Tribal) Community Context

Tribal areas have always been remote and hence have been historically excluded from development opportunities despite the establishment of tribal development agencies. While there are special provisions for the administration of tribal areas they continue to be excluded from development opportunities, having little access to overall infrastructure facilities. A large part of tribal areas are outside the reach of the electricity supply grid. Even if they are within the grid, they are not assured of electricity on a regular basis as the systems breakdown frequently.

ALL INDIA ELECTRIFICATION STATUS (2001-2002)[3]

STATISTICS	ALL INDIA FIGURE
Habitated villages	5,87,556
Villages electrified	4, 74,982 (81%)
Rural households	1,38,271,559
Electrified households	60,180,685 (44%)
Unelectrified households	78,090,874 (56%)

Some of the basic issues of energy in tribal areas relate to the continued lack of access to domestic lighting, decreasing availability and drudgery involved in dependence on fuel wood as the chief source of energy for cooking, the pressure on environment and ill health of women arising out of fuel wood use on the one hand and the increasing demand for energy for lighting on the other hand. The use of kerosene adds to the cost of living. This has drastically affected their socio-economic development.

In a nut-shell, conventional energy has not yet reached those marginalized communities to whom energy is critical for their livelihood. Hence, there is a need to foster energy options, especially decentralized renewable energy options, to enable their socio economic development.

Current Status of Rural Electrification and Government Policy

The government has an Energy Policy in place, which states that "a village is deemed electrified when 10% of the total number of households in the village is electrified"[4]. This means that households in the 'electrified villages' do not necessarily have access to electricity. Moreover, in the villages, which are deemed to be 'electrified', the service is inadequate, unreliable and of poor quality.

According to the National Action Plan on Climate Change 2008[5], 44% of the population is still without access to electricity.

It is the government's opinion that extension of the conventional grid to distant villages is uneconomical and would involve heavy capital investment and significant losses in transmission of power over long distances.

India's approach to renewable technology dissemination and popularization has had limited success due to various barriers in planning, implementation, capacity building, social engineering, publicity, allocation of and access to financial resources and technology adaptation to local needs. The policy of the government is to increase the share of renewables through large-scale projects to meet its future energy needs. The share of decentralized energy (energy which is locally managed and controlled) through 'nano' projects serving the need of small remote habitations, especially tribal communities, is hardly visible.

It was in this context that a feasibility study on decentralized energy options was undertaken.

RATIONALE OF THE STUDY

A Bengali Fisherfolk Village on the banks of the Balimela Reservoir, Malkangiri District, Orissa

The study was inspired by a necessity for having comprehensive data and information on renewable energy resources and potential in the energy starved tribal belt of the Eastern Ghats region of India. This was prompted by an aspiration to play a proactive role in influencing India's Energy Policy options and practices based on ground level reality.

DECENTRALIZED ENERGY OPTIONS (DEO) IS THE ALTERNATIVE MEANS BY WHICH ENERGY CAN BE LOCALY PRODUCED CONSUMED AND MANAGED. IT INCLUDES...

- Renewable technology
- Small scale in nature
- Proximity for access
- Community owned
- Community managed and controlled

Why Decentralised Energy Options (DEO)

From a macro perspective there are clear advantages in the use of renewables as an energy source. Firstly, the problematic emission of GHGs is primarily from the extensive use of fossil fuels. However, while renewable energy does reduce emission levels, not any kind of non-renewable energy is acceptable from our perspective. For example, we do not advocate large hydro-electric projects, not only because of the implication of large-scale displacement, but also because of other ill-effects like water-logging and increasing soil salinity; nor do we advocate nuclear energy for mainly ethical reasons: environment polluting processes and inter-generational safety.

Secondly, decentralized energy options, while rooted in renewables as a source of energy, also have the key dimension of local management of the energy generated, wherein there is no alienation between the producer and consumer of energy.

These options are not likely to attract large business and trade or even the State in the current conditions of development thinking and practice. Nor are these entities capable of addressing the social and cultural contexts so essential in developing these options. DEO provides non-governmental organizations the opportunity to demonstrate an alternative approach for sustainable development in the micro context for emulation by the government and other stake holders.

Renewable energy could be made cost effective for local communities in the long run if treated on par with conventional energy.

Why Tribal Communities?

Since a large number of tribal communities (approximately 8 million people) in India are geographically scattered, consuming very small quantities of electricity, extending the grid may not be a viable solution, as compared with energy generation using local, renewable resources. Interventions that could harness renewable sources such as the sun, water, biomass and wind could lead to energy access to off grid areas or complement the main grid for energy generation addressing livelihood concerns and reducing environmental stress.

A distinctive reason ,why tribal areas became important for the first selection for undertaking the study and demonstrative initiatives, is that remote tribal societies comprise homogeneous communities, which possess the quality of cohesiveness, which few communities in today's context tend to manifest. This community cohesiveness is an important quality to recognize in ensuring the management of the decentralized energy options for the projects to be a viable option.

What we envisage is therefore that DEOs identified in these areas will fulfill three basic concerns:

1. *Ensure improved livelihood of tribal communities*
2. *Provide clean and efficient technology*
3. *Safeguard social cohesiveness in the management of technology*

Objective

The objective was to develop sound feasibility studies for renewable energy technology demonstration in the tribal areas of the four states in the Eastern Ghats region. The long term outcome was to ensure tribal 'energy self sufficiency', maintain environmental quality, generate employment and contribute to economic development of these marginalized groups.

Methodology of Study

The methodology of the study comprised surveys and intensive field visits followed by participatory discussions. Specifically this included the following:

- *Identification of partners in the four states;*
- *Baseline information collection by surveys on the basis of prefeasibility formats outlining village energy profiles;*
- *Visit by social and technical teams for assessing socio technical feasibility;*
- *Formal and informal interactions with different stakeholders from the community: men, women, youth , etc;*
- *Preparation of prefeasibility reports followed by additional visits by technical consultants for carrying out feasibility studies;*

- *Building linkages with rural technology developers;*
- *Studying responses and getting feedback on the feasibility of the decentralized energy options;*

Detailed feasibility studies were undertaken in 36 DEO sites, 12 each of the micro hydro, biomass and solar-based energy systems.

POSSIBLE GAINS TO COMMUNITY

- Information and Knowledge
- Skill & Technology
- Equipment & Facilities
- Financial

Expected Outcome

The insights from the study will facilitate interventions to undertake demonstrative initiatives that focus on the micro-energy needs of the tribal communities in the Eastern Ghats region to sustain their livelihoods.

The outcome that we envisage would be at different levels:

- *At the micro-community level, the outcome would be linked to enhanced livelihood opportunities and social benefits: this should lead to community ownership and control.*
- *At the technological level, the expectation is that we emerge with demonstrative examples of appropriate technologies that take into consideration the need and the conditions of tribal societies;*
- *At the regional level , this enterprise should provide us insights into workable options related to livelihood needs, the technological benefits and the perception of the community. The focus will be on popularizing the use of decentralized options at the grassroots level;*
- *At the macro level, the intended outcome is to create conditions for dialogue with policy makers so that decentralized energy options find a place in operationalizing the policy of the government on energy management in the country.*

Geographical Coverage

TARGET AREA FOR DEOs

These villages are characterized by small to moderate number of households in scattered locations.

The villages are remote and have little access to mainstream government schemes and facilities. Hence the development of these areas is exceedingly slow.

THE SELECTION OF THE TARGET AREA WAS BASED ON THE FOLLOWING CONSIDERATIONS

- Remoteness - The villages are extremely remote and are currently outside the grid system
- Community - primarily PTG - The communities are deemed to belong to notified primitive tribal groups (PTG)
- Off grid - The villages are the ones which the government finds difficult to access due to them being situated in 'hilly and forest areas'
- Neglected - being remote these areas receive scant attention from the government

Tribal Profile and Status of Energy

Indian tribes comprise 573 communities that constitute roughly 8 percent of the nation's total population of more than 1 billion. In eastern India the tribals are concentrated in the hilly areas of the Eastern Ghats' forests (Chhattisgarh, Orissa, Jharkhand and Andhra Pradesh). The major occupation of these tribes is primarily agriculture and collection of non-timber forest produce (NTFP). Their rich culture is well depicted in their folk songs, dances, art and craft , and music according to regional differences.

Tribal regions consume very little energy. Most tribal areas rely mainly on traditionally extracted fuel wood for cooking and heating, on kerosene (replacing traditional oil) for lighting, on manual and animal power for agricultural operations, and solar heat for some functions like drying, etc. More recently some households have begun to use diesel for irrigation and for transport.

Andhra Pradesh

The total population of Andhra Pradesh, as per the 2001 Census, is 76,210,007 of which, 5,024,104 (6.6 per cent) are Scheduled Tribes. Of the 33 different tribal groups[7] the Bodo Gadaba, Gutob Gadaba, Bondo Poraja, Khond,Poroja, Parangiperja, Chenchu, Dongaria Khonds, Kuttiya Kondhs, Kolam, Kondareddis, Konda Savaras, and Thoti have been recognized as Primitive Tribal Groups (PTGs). As per 1991 census, there are 26586 inhabited villages of which all have been electrified (100% village electrification). The percentage of electrified rural households stands at 59.65%. This clearly is indicative of the huge gap between village electrification and household electrification. It can also be said that most of the non-electrified households are the ones situated in remote, mostly tribal areas.

STATUS OF RURAL ELECTRIFICATION IN A.P[6]

STATISTICS	A.P.
Total No. of inhabited villages (1991 Census)	26,586
No. of villages reported as electrified	26565*
% of Village electrification	100%
Villages electrified under REC programmes	14907 (56%)
Total no. of rural households	126,76, 218
Households electrified	75,61, 733
%a of electrified rural households	59.65%

*Balance not feasible for electrification

Orissa

The tribal communities of Orissa constitute about 23% of its total population. About 62 tribes exist in Orissa of which the key ones among them include the Kondhs, Koyas, Bondas, Gadabas, Santals, Juangs,Paraja, Oraon and Malis.

Orissa is a power rich State. There are some 18 mega power projects out of which four are major hydro projects. These projects have displaced more than 2,50,000 people. The power generated is diverted mostly to the plains and has hence deprived the indigenous community. The State represents electricity coverage of only 56.5% of the total rural households.

STATUS OF RURAL ELECTRIFICATION IN ORISSA[7]

STATISTICS	ORISSA FIGURES
Total No. of Villages	5,87,258
Villages electrified	5,08,515 (86.5)
Villages to be electrified	78,743
Total No. of households	13,82,71,559
Electrified households	6, 01,80,685 (43.5%)
Un-electrified households	7,80,90,874 (56.5%)

Chhattisgarh

Chhattisgarh has always been synonymous with tribes and tribal culture. Scheduled tribes constitute 31.8% of the State's population as per the 2001 census. There are a total of 42 tribes in Chhattisgarh, most important among them being the Gond, Baiga, Korba, Abhuj Maria, Bison, Horn Maria, Muria, Halbaa, Bhatra and Dhurvaa tribes.

The State has achieved 90% electrification (in the plains); the remaining 10% villages are not electrified because these are forest areas - very remote and hilly presenting a difficult case for grid extension. It is noteworthy that the State's total forest cover is 44% and 32% population in these forest areas are tribals.

STATUS OF RURAL ELECTRIFICATION IN CHATTISGARH[8]

PARTICULARS	AS ON 30.11.2000	AS ON 31.08.2007
No. of inhabited Villages (as per 2001 Census)	19720	19744
No. of Electrified Villages	18075	18878
Percentage of Village Electrification	91.66 %	95.61 %
Un electrified Villages (as per 2001 Census)	1645	866
Majra-Tola Electrification	9768	18734

Jharkhand

Undulating terrain, high forest cover and abundant mineral resources characterize Jharkhand, which was carved out of Bihar in 2000. The Scheduled Tribe (ST) population of Jharkhand State as

STATUS OF RURAL ELECTRIFICATION IN JHARKHAND[9]

PARTICULARS	FIGURES
Total no. of registered villages	30,225
Total no. of villages electrified	5,108 (16.8%)
Total No. of rural households	38,02,412
Households electrified	3,79,987
% age of electrified rural households	10.0%

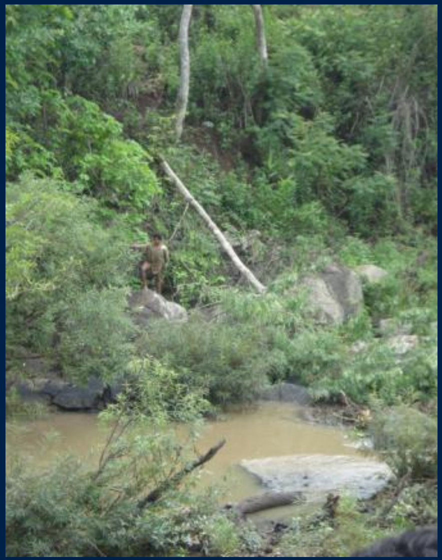
per 2001 census is 7,087,068 constituting 26.3 per cent of the total population (26,945,829) of the State. The Scheduled Tribes are primarily rural as 91.7 per cent of them reside in villages. There are a total of 30 Scheduled Tribes, of which the Mundas, Santhals, Paharias and Oraons are the important ones.

The extent of rural electrification in Jharkhand is very low. Out of the 30,225 registered villages only 5,108 villages or 16.8 percent of the villages are electrified. The reason for the very slow progress in tribal region electrification has been attributed to the delay in granting forest clearances for rural electrification projects by government agencies.

The Jharkhand Renewable Energy Development Authority (JREDA) is promoting solar and wind as the two primary sources for electrifying the villages of Jharkhand. It is also providing 50 % subsidy to the villagers as far as solar photovoltaic systems for household electrification is concerned. However, there is allegedly a lot of corruption in the distribution of lanterns.

JSEB (Jharkhand State Electricity Board), NTPC (National Thermal Power Corporation) and DVC (Damodar Valley Corporation) have been entrusted to undertake the rural electrification programme under the Rajiv Gandhi Grameen Vidyutikaran Yojna (RGGVY). Through this national programme the government aims to cover 1, 25,000 villages across the country over the next five years (till 2012) with a budget of Rs.16,000 crores.





MICRO HYDRO

A 'Nano' Hydro (less than 1 KW) at work, Burdhamamidi, Peddakodapalli Panchayat, Peddabayulu Mandal, Visakhapatnam District, Andhra Pradesh

What is a Micro Hydro?

A micro hydro system very simply takes the energy available from a falling stream of water and converts it into usable electricity. It only takes a small amount of flow (as little as five litres per second) or a drop as low as 1.5 meters to generate electricity with micro hydro. It produces a continuous supply of electricity in comparison to other small-scale renewable technologies. Electricity can be delivered as far as 2 km away to the location where it is being used. A micro hydro is considered to function as a 'run of the river' system, meaning the water passing through the turbine is directed back to the stream with very little impact on the surrounding ecology. It is one of the most cost effective solutions for rural areas. Maintenance cost is very minimal in comparison to other technologies.

Selection of Micro Hydro Sites

For identification of suitable sites preference was given to hilly areas that had a perennial source of water. The first step towards identifying a suitable location for a micro hydro involved a prefeasibility study based on the certain parameters such as village profile, village energy demand, current energy use per household, location details, basic hydrology studies (quantity of water available and flow), civil design with broad budget estimation and broad cost benefit analysis of the scheme. These details were further worked out for the feasibility study, which also touched upon the basic tenets of social engineering such as supportive attitude of the community, initiative by the community/ panchayat/sarpanch, income generation schemes to be supported by the micro hydro and strategies for proper maintenance of funds attributed for success.

Profile of Micro Hydro Sites

Sl No	Name of the site	Village	Mandal/Block	District	State
1	Jontri	Jontri	K.Guma	Malkangiri	Orissa
2	Rabha	Rabha	K.Guma	Malkangiri	Orissa
3	Kodaikundh	Kodaikundh	Mathili	Malkangiri	Orissa
4	Bondhruputh	Bondhruputh	Paderu	Visakhapatnam	Andhra Pradesh
5	Bongadari	Bongadari	Paderu	Visakhapatnam	Andhra Pradesh
6	Bordhamamidi	Bordhamamidi	Paderu	Visakhapatnam	Andhra Pradesh
7	Vendurupally	Vendurupally	Paderu	Visakhapatnam	Andhra Pradesh
8	Maridhatu/ Baridhaput	Maridhatu/ Baridhaput	Paderu	Visakhapatnam	AndhraPradesh
9	Batchleru	Batchleru	Y.Ramavaram	E.Godavari	Andhra Pradesh
10	Pathakota	Pathakota	Y.Ramavaram	E. Godavari	Andhra Pradesh
11	Lankapakkalu	Lankapakkalu	Y.Ramavaram	E. Godavari	Andhra Pradesh
12	Sargod	Sargod	Tatidar	Bilaspur	Chhattisgarh

Micro Hydro Sites

The study covers 12 diverse geographical locations with different contextual situation across the three states viz.: Orissa, Andhra Pradesh and Chhattisgarh. The state of Jharkhand was left out based on considerations like the lack of enthusiastic partners willing to undertake micro hydro initiative due to failure of several such initiatives; state policies and politics; low potential for sustaining a micro hydro, etc.

Regional Profile of Micro Hydro Sites in Orissa

The study and identification of micro hydro sites in Orissa state has been confined to potential tribal habitations along the huge Balimela reservoir in Malkangiri district. In 1963 the government of Orissa planned to set up the hydro project in collaboration with the government of Andhra Pradesh to supply electricity to industries and urban plains in both these states. The construction of the dam has isolated some 156 villages across 6 Gram Panchayats of Kudumulugumma Block of Malkangiri District. Even today, these areas remain cut-off from the rest of the State. The tribals of this region have been victims of double displacement due to the construction of the twin reservoirs - Machhakund and Balimela.

Socio-economic Profile of Communities in the Reservoir

More than 80% of the population of Kudumulugumma block belong to the Scheduled Tribes and Scheduled Castes. Three tribal groups inhabit these villages namely the Paraja, Kandha and Didoi, of which the Didoi tribe is believed to be the most primitive. They inhabit the hilly areas of the block. The Paraja tribe is concentrated in a patch of Kudumulugumma block of the district and has migrated from Koraput, which is the neighbouring district of Malkangiri. The Kandha live in the forest area of the entire block.

The main occupation is agriculture and NTFP collection. A large chunk of the cultivable and productive land along with dense forest, which was the mainstay of the tribals of Kudumulugumma block since ages, has been submerged by the Balimela dam project. Thousands of tribals became homeless and jobless over night. There has been no authentic record of the households or persons affected by the development project, their settlement, etc. as there was no proper rehabilitation and resettlement policy of the government at the time.

Agriculture in the region has become undependable due to drought, large-scale deforestation, erratic rain and soil erosion. Very few households own more than 2.5 acres and a large number of families face food and income scarcities for 4 to 6 months a year. Forest resource, which was once the primary source of sustenance for the poor, has declined from more than 65% of the geographical area to less than 20% at present. The non-tribal business communities act as moneylenders and the poor tribals get trapped in the vicious cycle of money lending, bondage, and exploitation.

Government Initiative on Electrification

The 156 villages have not been electrified till today. There is no immediate or short term plan either by the electricity department or OREDA(Orissa Renewable Energy Development Agency) for electrification citing them as very remote and hugely expensive venture (as per the report of the Electricity Department, Malkangiri).

Regional Profile of Micro Hydro Sites in Andhra Pradesh

The sites in the study are located across two districts, Vishakhapatnam and East Godavari .

Visakhapatnam district is one of the north eastern coastal districts of Andhra Pradesh. The district presents two distinct geographical regions. The strip of land along the coast and the interior called the plains and hilly area of the Eastern Ghats. The Scheduled Areas comprise the hilly regions with an altitude of about 900 metres dotted by several peaks. Administratively the district is divided into 3 Revenue Divisions and 43 Mandals.

East Godavari District is situated on the North East of Andhra Pradesh. This district can be broadly classified into three natural zones: the delta, upland and agency tracts. The general elevation of the district varies from few feet near the sea to 1500 to the hills of the scheduled areas.

Socio-economic Profile of the Region

The population of Visakhapatnam district is 3.8 million as per the 2001 census. The scheduled tribes account for 14.55% of the population while the scheduled castes constitute 7.82%.

East Godavari is one of the most populous and densely populated districts in the State with a population of 4.9 million. Out of the total population 23.5% lives in urban areas and remaining 76.5% lives in rural areas. As per 2001 census the population of schedule caste and schedule tribe is 18% and 4% respectively of the total population of the district.

Agriculture is the mainstay of nearly 70% of the households. Though Visakhapatnam city is industrially developing, the rural areas continue to have little access to development services. Rice is the staple food of the people and paddy is therefore the principal food crop of the district followed by ragi, bajra, jowar and cash crops such as sugarcane, groundnut, niger and chillies.

In East Godavari also, as much as 75 percent of the population depend on agriculture for their livelihood[10].

Regional profile of micro hydro sites in Chhattisgarh

The micro hydro site in Chhattisgarh is located in Bilaspur district which is situated in the eastern part of Chhattisgarh.

Bilaspur district has a major contribution for the Chhattisgarh region being called *Dhan Ka Katora* or Rice bowl. The total population of Bilaspur district is 16,948,83 of which 79% lives in the villages. According to the 1991 census the Scheduled Castes and Scheduled Tribes constitute about 40% of the total population.

Learning from Micro Hydro

Micro hydro is a cheaper technology in the long run than other renewable energy options on the basis of the cost incurred on generating one unit of electricity. Also being a robust technology the recurring cost on maintenance is relatively low. However, it is to be mentioned that in case of major repairs like replacing the turbine/penstock would involve a capital investment, which the community on its own would not be able to pay. Hence it is proposed to work out a system where the community contributes regularly to take care of major repairs, if any in future.

Micro hydro projects can be implemented at places that have a perennial source of water making it a critical resource. The degradation of this resource will affect the long-term viability of the project itself. This is because the same stream is the source of irrigation for the villages. Therefore it is essential to keep this in the background for all the planning and execution of the micro-hydro project. It is recommended to take adequate care to protect the catchment area covered with sporadic forests.

The ideal way towards first hand identification of micro hydro sites is through contour mapping, which shows the source of water. However, it is to be borne in mind that the source of water might not necessarily be perennial in nature. Hence this would require validation by on site visits. The irrigation department can also be approached to get a list of check dams built by them. The sites having check dams are usually economically potential sites for harnessing water through a micro hydro as there would already exist some civil construction in place that can either be upgraded or used in its present form.

While taking hydrology details like the flow measurements it is important to take into consideration the seasonal variation. It has been experienced that water flows in various seasons could vary drastically and having just one set of flow data will not suffice. Hence to get a realistic figure of water flow it is recommended to have at least three sets of data. The average of the flow data would present water availability data all round the year. The objective behind this process is to assess if there is sufficient water to operate the micro hydro even during the lean season.

In the rural context the households are widely scattered. These households have limited energy requirements that are confined to meeting basic lighting, heating and entertainment. The power generated from a 'nano' micro hydro (say 5KW) could leave additional power over and above that required for domestic use. In such a context the micro hydro should be linked to its end uses. Like power from the micro-hydro being used for paddy de-husking, oil milling, flour milling, food processing, operating community television, computer center, etc. The sustainability is ensured for such a power scheme, as post harvest processing is a very important value addition for the communities.

Ensuring people's participation at all levels is very important as it is the people's participation that will contribute to the successful implementation and utilization of a micro hydro. While planning for the micro hydro with the community it is quintessential to address community members' specific needs (e.g., gender concerns). It has to be ensured that needs and ideas of all the community members (elders, young members, and women) are respected and taken into account in the feasibility study. The fact that a micro hydro has potential for employment creation or income enhancement for the village has to be clearly discussed with the community to instill confidence of the people in the project.

In general the community's stake is the highest for micro-hydro if the community contributes labour towards construction of micro-hydro structures. e.g., building of forebay, check dam, laying pipes, etc. This process ensures ownership from the very beginning.

It is true that India has to review its energy policy. Although it boasts of having made enormous progress, there is a wide gap between its potential and installed capacity of non-renewable energy. Moreover, there is visible lack of participation from NGOs/activists in relation to energy needs of remote tribal areas. This is because NGOs lack the technical understanding towards initiating micro hydro programmes. Although there have been isolated attempts at promoting micro hydro projects, this has not yet led towards influencing policy decisions. Hence, it is imperative to have a comprehensive response to energy needs of this region by developing a critical volume of engagement from the perspective of understanding outcomes and impact. This can be done by demonstrating a multiple of such projects interlinking technology with overall sustainable development initiatives from a long term perspective in the area.

The implementation of micro hydro involves technical designing of the project requiring engineering skills. Hence, the need for a micro-hydro engineer. However it is not sufficient to have just an engineer with superior engineering skills but also with a social perspective. Combination of both these aspects is rare. Hence there is a lot of dependence on such individuals who have to make a couple of visits to every site to work out the technical feasibility. This constraint can be partly overcome by capacity building of middle order NGO workers who could undertake first level site identification. This saves time, energy and dependence on engineers for basic level site validation.

It is also important to have a full time on site engineer and a community mobiliser during project implementation. This helps in smooth progress and also addresses group conflicts and other community dynamics if any.

One concern is the sustainability of micro hydro once the village gets connected by conventional grid lines. It is argued by some that the micro hydro system would become defunct and useless under such circumstances. However, given the quality and erratic supply of electricity in tribal areas, the micro hydro system has the potential to function as a full time backup support system apart from it being an asset for income generation activities.

Solar photovoltaic systems refer to a wide variety of solar electricity systems that use solar panels made of silicon to convert sunlight into electricity. Solar intervention assumes particular significance among 'off grid areas' but is also useful to regions that are connected to the grid but still experience very frequent load shedding.

The focus during the feasibility study was primarily to identify potential tribal areas that lack basic lighting and assess ways and means by which their basic lighting demand could be met.

Site Selection:

Solar systems are more expensive per unit of power generated to that of a micro hydro power. The selection of villages took into account the location of the village to meet at least its basic lighting requirement and also reduce drudgery associated with regular household chores in the evening.

To ensure a sustainable process of model building initiatives sites/villages/clusters were selected that have already had some exposure to the technology in any form such as solar street lighting system. During the field visits we learnt that the government had undertaken a solar street lighting drive for rural areas in the late 1980s. However, almost all the systems lie defunct. Nevertheless, in some villages, some enterprising youth were using the solar panels for charging radio and tape recorder batteries.

Learning from Solar Initiatives

This technology was found to be particularly relevant in very remote 'off grid' areas for meeting basic lighting demand. This would do away/reduce the use of kerosene, candles and dry cell torches which otherwise result in considerable cost to community's budget, danger to their homes and health with a poor lighting result.

The study facilitated the understanding of the lighting requirements of the communities and this helped to identify and understand various models and samples that could meet community specific requirements.

Light emitting diode (LED) seems to be the green technology for the future. There is high level of acceptance of this model. This was primarily because the luminosity was higher in LEDs. Also charging was found to be simpler and more effective for this model.

It was evident during the study that almost all through the tribal belt, the communities related electricity availability with entertainment in the form of music systems and movies. It was observed in certain pockets that the batteries in the solar lanterns were being used for operating radio and tape recorders instead of being used for illumination. A system that has an inbuilt tape recorder with a lighting element would prove quite useful under such requirements.

The central charging station approach where a relatively large solar panel is used for charging 8-10 lanterns could prove very economical and useful for closely situated households. This would save the cost towards individual panels and also provide scope for income generation for village youth. However, for distantly located households individual panels work best.

It is important to build capacities of local youth who could undertake repair and maintenance work in the village and vicinity at cost. Lack of manpower for local repairs compels the community to dump the system in cases of even minor problems.

Profile of Solar sites

Sl No	Site	Panchayat	Mandal	District	State
1	Jodambo	Jodambo	Kudulguma	Malkangiri	Orissa
2	Kodigandhi	Andirapalli	Kudulguma	Malkangiri	Orissa
3	Pulusukumamidi	Pathakota	Y. Ramavaram	E. Godavari	Andhra Pradesh
4	Senagunurru	Pathakota	Y.Ramavaram	E. Godavari	Andhra Pradesh
5	Gaukhuri	Tatidar	Kota	Bilaspur	Chhattisgarh
6	Baghdhara	Tatidar	Kota	Bilaspur	Chhattisgarh
7	Tumaragandi	Guttulputtu	Paderu	Visakhapatnam	Andhra Pradesh
8	Peddabayalu	Guttulputtu	Paderu	Visakhapatnam	Andhra Pradesh
9	Chapadanga	Isakpur	Pakur	Pakur	Jharkhand
10	Durgapur	Kalajora	Pakur	Pakur	Jharkhand
11	Saharcol	Saharcol	Pakur	Pakur	Jharkhand
12	Dhanjoripoddiya	Taljhari	Littipara	Pakur	Jharkhand

There is huge demand for solar systems in the rural areas. However, the community has little information on the means to avail the system. The community in most of the cases is also ready to make a monetary contribution. It is important to ensure that people pay for the system. It was observed that when people value improved lighting and living conditions they are ready to pay for it. Considering the fact that the tribal communities do vary in financial capacities and preferences, it is important to provide them with a range of products to suit their requirements and their potential to pay for the product.

It is also important to encourage and support local solar developers and technicians. This is because most of the models available in the market do not cater to rural requirements in terms of their accessibility, availability and affordability. Technology appropriation is required from standard models to derive outcomes most relevant to the local community context.

The concern with solar technology is the disposal of batteries. Most of the batteries have a life not more than 5 years. Disposing them off in our immediate environment has toxic effects on air, soil and water. Hence arrangements have to be made for proper disposal/recycling of these batteries.

The shelf life of the LED based solar lanterns is said to be around 50,000 hours i.e. approximately 30 years. However, there are concerns regarding the quality of LEDs available in the market. Meanwhile, if the village gets connected to the grid system there will be a tendency to neglect the maintenance of the solar lanterns. However, these lanterns could continue to serve as excellent back up systems if maintained properly.

Community perception of solar Technology

- Sufficient light for reading
- Portable and handy (to be carried around the homestead land, cattle shed at night)
- Has a 360 degree spread of light
- High battery back up (where one charge could last for 2-3 days)
- Affordable (where community could contribute up to Rs 500)

The rural population in India still depends largely on biomass in general and fuelwood in particular for meeting domestic energy needs. Energy for cooking forms a major share of the domestic energy requirements in rural areas. These areas use non-commercial energy sources such as firewood, biomass and cow dung in inefficient devices to meet their daily energy demands for cooking and water heating.

This is one of the contributing factors for Indian Indoor Air Pollution (IAP) being the highest in the world. Nearly 28% of the world IAP accounting for 2.5% of the global ill health burden can be attributed to inferior or poorly designed wood burning stoves[11]. The stoves or 'chulahs' that are used by the women in the village are not only low in efficiency but also emit a lot of smoke causing immense damage to the health of the women and children who bear the brunt of this smoke in rural households.

BIOMASS REFERS TO RENEWABLE ORGANIC MATERIALS THAT CAN BE USED AS FUEL OR ENERGY SOURCE. BIOMASS CAN BE BURNED DIRECTLY OR PROCESSED INTO BIOFUELS SUCH AS ETHANOL AND METHANE. COMMON SOURCES OF BIOMASS ARE:

- agricultural waste such as corn stalks, straw, seed hulls, sugarcane leavings, bagasse, nutshells and manure from cattle, poultry etc.
- wood materials, such as wood or bark, sawdust, timber and mill scrap;
- municipal waste, such as waste paper, and
- energy crops, such as Jatropha, Sweet Sorghum and Sugarbeet.

Government Initiatives

The National Programme on Improved Chulahs (NPIC) of the Ministry of Non-renewable Energy was the first serious attempt aimed at installation of improved chulahs in rural households during 1986-87. The programme was terminated in 2003 and till then this technology had reached less than a third of the potential users, indicating a huge requirement for efficient chulahs. Inability to identify key socio-cultural issues led to the failure of the programme. The government through the NPIC programme had provided one pan stoves to some tribal communities in the last decade, which lie unused even today. This was because the tribal communities found cooking on one pan time consuming and culturally repelling, as they were used to cooking on a two/three pan stoves.

The Government of Andhra Pradesh disseminated subsidized LPG stoves through DWCRA (Development of Women and Children in Rural Areas), but with the increase with LPG prices, most of these connections were withdrawn as the fuel cost was not affordable by the beneficiaries of the programme.

Study on Cooking Stoves

The reason for undertaking the study of cooking stoves was because stoves have not been a priority for energy researchers and planners. The conventional cooking stove being used today is not only the cheapest but also the least efficient of local energy devices. The objective was to study and identify all possible models that fulfilled the following criteria:

- *Clean and fuel efficient stoves;*
- *Reduce drudgery in fuel collection, smoke, cooking time and fuel usage;*
- *Affordable - a model that can be purchased with those with low ability to pay;*
- *Involves participation of women in decision making in identifying the most appropriate cooking system;*
- *Enables decentralized dissemination;*
- *Generates employment opportunities for women groups in chulah construction;*
- *Environment friendly- releases the pressure on local environment by reducing CO_2 emissions.*

Profile of Bio-Mass sites

Sl No	Site	Panchayat	Block	District	State
1	Muchkirasi	Kothapalli	Mathili	Malkangiri	Orissa
2	Eguvabadama/Diguvabadama	Aradikota	Pedabauyalu	Visakhapatnam	Andhra Pradesh
3	Adguluputtu	Adguluputtu	Peddabayalu	Visakhapatnam	Andhra Pradesh
4	Jankramputtu	Olda	Hukumpeta	Visakhapatnam	Andhra Pradesh
5	Rangapalli	Muttujoru	Hukumpeta	Visakhapatnam	Andhra Pradesh
6	Gullarai	Aradikota	Pedabayalu	Visakhapatnam	Andhra Pradesh
7	Nimmagunta	Aradikota	Pedabayalu	Visakhapatnam	Andhra Pradesh
8	Bongadari	Aradikota	Pedabayalu	Visakhapatnam	Andhra Pradesh
9	Bansjori	Nawadih	Littipara	Pakur	Jharkhand
10	Dhanjoripoddiya	Taljhari	Littipara	Pakur	Jharkhand
11	Durio	Karmatand	Littipara	Pakur	Jharkhand
12	Banjharili	Baru	Littipara	Pakur	Jharkhand

We have also studied cooking practices in the following locations:

- *Tribal households*
- *Tribal hostels*
- *Hotels*
- *Anganwadi centres*
- *Primary schools providing mid-day meals*

The following stoves were studied and researched to understand the efficacy and usefulness in the tribal context: Sarala (smokeless stoves for household and schools) and Aneela (gasifier stoves for anganwadis)

As women needed to be convinced about the efficiency of the stove before they buy it, it was recommended that about three stoves be built as demonstration units. We assumed that remote regions that are inaccessible and had very poor connectivity on-site construction is always preferable. However prefabricated ones are better in regions close to urban areas.

The overwhelming response indicated that it is very important to demonstrate smokeless stoves all along the tribal belt where cooking is done primarily on highly inefficient wood stoves. The tribal women are able to relate to the mud brick construction and happy with the idea of having a smoke and a soot free cooking environment. Moreover, they could also be capacitated to pick up the stove building skill and build them at cost.

It was also seen that almost all of these sites are off grid with thin forest cover. Such areas also needed intervention on solar and value light equally. However it is affordable for them to have a cooking stove than solar lanterns. Efforts should be made at our end to make such technologies accessible to these areas, which are completely neglected to improve their living standard and also protect the environment.

Learning from Biomass Initiatives

There is a large unfulfilled demand for fuel-efficient stoves in tribal areas. It should be ensured that this technology reaches all the households in the tribal areas. However failing to identify key socio-cultural issues could defeat the very purpose of an alternative stove programme. Hence an understanding of the community's cultural cooking practices is important before introducing this technology.

In the process of the study, we were able to link biomass with gender. The drudgery involved in wood collection and indoor air pollution caused by inefficient cooking devices has implications on health and general well being, especially of the womenfolk. Tribal women value clean, efficient and faster cooking technology, as they are hard pressed for time and cannot afford to stay in the kitchen for long. Hence, it is important to introduce energy efficient models in such areas.

The 'Sarala' stove is good as an entry point technology in the tribal belt. This is because this technology is not alien being very similar to the mud and brick stove that the tribals use in their houses. Demonstration of this technology in certain tribal pockets had a positive response from the community. The other reason for high acceptability of this model was because of the affordability factor. As this model is quite cheap and efficient, the community is ready to buy it. It is recommended to have this technology all across the tribal belt. Once the community familiarizes itself with it, advanced technology like gasifiers can be introduced subsequently, which could be linked to other livelihood initiatives.

It is the women who build stoves in the tribal areas and hence have practical knowledge on stove building. The potential of generating employment by stove construction created a lot of enthusiasm. With the huge demand existing in these areas this activity can prove quite remunerative for trained tribal women. Hence, it is necessary to empower them as stove builders and start a stove building enterprise.

The existing pattern of roofing in most of the tribal houses provides limited scope for setting the chimney of a smokeless stove, as the roofs would have to be demolished. However, houses made under the government's rural housing scheme (Indira Awas Yojna) have a separate kitchen with an aperture for the chimney to pass through. It is recommended to identify such hamlets for demonstrating this technology.

The Aneela stove (gasifier stove) has been found to be quite useful in the 'anganwadis' which provides meals to pregnant, lactating mothers and young children. It is recommended that ITDAs (Integrated Tribal Development Agencies) procure such technologies and make it available to all the 'anganwadis' which otherwise are dependent on irregular supply of LPG, coal or wood.

Under the government's 'Sarv Shiksha Abhiyaan' programme, mid-day meals are provided in primary schools. Most of the cooking is done on the conventional three brick stove or on mud stoves in poorly ventilated conditions. This affects the quality of food served to young children. It is important that the government spells out actions on 'energy efficiency and fuel saving' in its agenda which is otherwise not addressed.

With the heavy fuel wood consumption for cooking in tribal hostels and hotels, it is important to look for a technology that is relevant in such places.

Fuel saving was observed to be of concern in the tribal context not only in terms of emissions but also from the point of fuel wood collection. The visible depletion of forest cover from their immediate environment compels tribal women to trek long distances with considerable cost to their time and energy. A technology that could lead to fuel wood saving was highly acceptable.

Varahalamma, Anganwadi worker (Day care center) lighting up an Aneela Stove

It is important to develop linkages with rural technology developers who are in the process of developing innovative technologies. Field experiences from varied geographical locations and a variety of end users would enable the development of a wide range of models that would be relevant in the culturally varied tribal locations.

Energy cultivation like 'jatropha' and 'pongamia' is already being practiced in tribal areas in the form of live fencing. Jatropha cultivation can also be undertaken to reclaim degraded 'podu' (shifting cultivation) lands. However this needs validation through field experimentation. The cultivation of these bio-fuel generating species should be promoted in 'wastelands' from the perspective of local consumption like replacing diesel in generators, mills etc for supporting village economy rather than promoting large scale cultivation from the point of view of income generation. However the efficacy of locally extracted Jatropha oil needs to be explored. The danger lies in the commercialization of these species such that farmers convert their food security crops in favour of cash crops due to short-term incentives.

Key Process Insights

The study validated our assumption of tribal areas being abundantly rich in natural resources.

When we started with the study, we were looking at micro hydro, solar and biomass technology as independent energy options that had the potential for rural electrification. However, we were able to establish the link between energy options and sustainable development as the study progressed. This gave us a holistic picture of how energy could trigger, support and sustain other livelihood activities.

We were able to relate to the importance of very small demonstrative initiatives ('nano' levels) in the tribal context. This was based on our findings that the tribal communities use very little energy to meet their daily requirements and this limited amount of energy is very crucial for their sustenance. Hence, 'nano' demonstrations which could address energy needs in the micro context would be of more relevance under such conditions.

We were also able to understand practically the relationship between gender and energy and learn how positively energy access affects the general well being of womenfolk. Moreover, the important role women play in operating maintaining and dissipating the technology options cannot be undermined (especially solar and fuel efficient stoves).

One of the most important but very basic requirements in undertaking decentralized energy initiatives with the support and involvement of the community is the social acceptability. For the purpose of undertaking DEO initiatives it is the people's participation that translates into a project success. This is primarily because the community is responsible for operation, maintenance and management of the power generation system once the system is in place. This aspect has to be ensured at all levels from site selection to implementation.

It is very important to ensure people's stake in the process of identifying suitable sites for a successful DEO implementation. It is evident that the community will value the system only when they can develop ownership. Ownership can be developed by contributing labour for civil works for micro hydro; or cash towards owning a solar or an efficient biomass conversion device and taking responsibility for operation and management of the system.

Implications of the Study

The feasibility studies on decentralized energy options in the tribal belt across the Eastern Ghats' region has generated data for 36 typical DEO intervention sites which can serve as a baseline for improved energy access for this region. This is the first step towards linking DEO to development for these neglected tribal areas.

The demonstrative initiatives based on the study are intended to be a model building one that will present the link between energy and sustainable development in the tribal context. The proposed models will also have a catalytic effect in putting pressure on the government for emulation of similar models based on renewables in other prospective tribal areas. A multiple of such models will demonstrate that renewables have the potential of meeting energy needs, expand livelihood options and improve living conditions. With further analysis and technical assessments these models could address the larger context of green house gas emissions, which would have otherwise existed, had the grid passed through the village.

Cluster Approach: Possible Model for Renewable Energy Hub Creation

An important approach that emerged in the process of the study was the 'cluster approach' towards a comprehensive development of widely scattered tribal pockets. It was observed that while one village had a huge potential for micro hydro the adjacent village was potentially a solar village. This variation was primarily because of the undulating tribal topography and location of the hamlets. Hence this approach will be significant in undertaking energy related initiates where a group of villages/hamlets can be treated as a cluster where all the villages within the cluster can benefit from the energy initiatives.

By 'cluster' we mean a group of hamlets/villages located in close proximity powered by renewable technologies. We are looking at a cluster approach from two dimensions:

Geographically – we identify one geographical area and work around this area on relevant technology options e.g. support micro hydro, solar, bio-mass based initiatives and then link them to other livelihood options for promoting sustainable development;

Technologically – establishing and standardizing a technology and trying out the same in different areas.

As a follow up of this study we envisage creation of demonstrative models or 'renewable energy hubs' on a cluster approach basis. Such models would demonstrate that access to energy based on renewables is possible even in the most distant areas which have a potential to expand livelihood options and improve living conditions. The focus of our work will not remain confined to renewable energy development and its associated environmental benefits but also to economic development that renewable energy can stimulate and support in the tribal context. It is expected that the greater benefits flowing to the tribal areas as a result of renewable energy hubs would increase the rural communities' interest in and support and demand for renewable energy.

Potential Impacts Envisaged

Improved lighting and environmental gains

Access to lighting in remote tribal villages will result in tangible gains. Solar home systems (SHS) and village hydro projects are likely to replace kerosene and other fuels that are currently used for lighting resulting in corresponding reductions in indoor air pollution. The replacement of fossil fuel based power generation plants will reduce emissions of SOx, NOx, CO_2, and particulates. This would result in improved air quality. Biomass energy systems have the added advantage of contributing to the reduction of the agricultural waste disposal problem. By providing a wider range of electrification options, the implementation of such projects could also create alternatives in the long run to monopolistic, State-led electricity provisions and would contribute to sector efficiency and reform goals.

Benefits to women and children

Availability of light and improvement in air quality is particularly beneficial for women and children. If work hours can be extended by four hours on an average, the pressure of daily chores could be eased. Also, extra time is likely to be available for other productive works. This should improve the quality of life of the tribal communities.

Entrepreneurship development

Going beyond employment generation, the models could be successful in inspiring entrepreneurs. Local capacity may be built or strengthened.

Vibrant rural renewable energy market:

Well-implemented projects could contribute to a vibrant rural renewable energy market with emphasis on community solutions, enabling increased energy access of electricity. This is consistent with strategies to invigorate the rural economy, empower and build assets for the poor and promote rural economic development and well-being.

Reduction in greenhouse gas emissions:

Renewable energy projects could result in a host of environmental benefits, most notably the absence of green house emissions and reduced particulate matter that contributes to air pollution. Introduction of proposed 'nano' projects can be argued to have little impact on emission mitigation. However, the emissions reduction would be significant for multiple projects when calculated over a period of years.

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INDIAN NETWORK ON ETHICS AND CLIMATE CHANGE

Indian Network on Ethics and Climate Change (INECC) is a network of individuals and organization representatives, who are concerned with the Climate Change issues, particularly with reference to the Indian context. It was instituted in June 1996 although it has been in operation since 1993. INECC believes that Climate Change is a part of a larger environmental crisis and addresses the basic issue of ecologically destructive development processes that have been globally pursued. Moreover for INECC, the issue of Climate Change raises basic questions of social justice which has a direct bearing on development alternatives for the future.

Laya

Laya is a resource center for Adivasis and also the secretariat of INECC. Laya began working with tribal communities in the East Godavari district since 1984. Currently Laya operates in the tribal belt of the north Andhra region. Laya works with a mission to empower these marginalised communities for assertion of their rights and to promote relevant sustainable alternatives at the grassroots level. It envisages a socially just and humanized society where the marginalised communities find a space for survival with dignity.

kerkinactie
believing-helping-building

Kerk in Actie (Church in Action) is the development agency of Protestant Churches in the Netherlands comprising 10 smaller churches and ecumenical organisations. Kerk in Actie aims to be in solidarity with people who suffer from injustice, poverty and violence. They support, among other areas, health-care work, poverty reduction efforts, agricultural projects and human rights programmes. Kerk in Actie tries to provide direct support to people in need, to contribute to the empowerment of people and civil society actors and to promote an enabling environment to change situations of injustice.