A Feasibility Study of

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

An Executive Summary

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1. Introduction

The increasing use of conventional energy is clearly becoming counterproductive in the global context due to the growing threat from climate change. While the current contribution of India to Green House Gases (GHGs) is well below countries like the US and China, and its per capita consumption one of the lowest in the world, 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. Hence, there is an urgent need to minimize India's emissions .

The main challenge which confronts us today is to provide energy access to the vast rural populations in a way that does not lead to the proliferation of 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. Decentralized energy options also has the key dimension of local management and there is no alienation between the producer and consumer of energy.

This study has tried to investigate into the feasibility of producing power from renewable energy sources available in the resource rich tribal areas which lack access to basic energy supplies to meet livelihood requirements.

2. Rationale for Study

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 ghat 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.

Why DEOs?

- Conventional energy has not yet reached those marginalised communities to whom energy is critical for livelihood;
- DEO offers an opportunity for control and management of energy at the doorstep
- Renewable energy could be made cost effective for local communities in the long run if treated on par with conventional energy;
- DEO provides us an opportunity to adopt an alternative approach to development in the micro context;
- Use of renewables addresses the issue of reduction of carbon emission in the Indian context.

Why tribal communities?

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

Since a large number of tribal communities 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.

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

- Ensure improved livelihood of tribal communities;
- Provide clean and efficient technology; and
- Safeguard social cohesiveness in the management of the technology.

2. Objectives

Ensuring tribal 'energy self-sufficiency', maintaining environmental quality, generating employment and subsequently contributing to the livelihood enhancement and thereby economic development of these marginalized groups have all been the important goals of the feasibility study. **The objective has been to develop sound feasibility studies to guide renewable energy technology demonstration in the tribal lands under study.**

3. Methodology of Study

The study has been conducted across the four states of the Eastern Ghat region viz: Andhra Pradesh, Chattisgarh, Orissa and Jharkhand. The reason for selecting these four states is because they comprise scheduled areas which are dominated by tribal communities which have little access to mainstream energy options. The selection of villages/ sites for DEOs has been done based primarily on considerations like remoteness, type of tribal community with focus on access to 'primitive' tribal groups, areas being off grid and receiving scant attention by the government. The profile and status of electrification in the target areas in the states was studied.

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 states under study

- Baseline information collection by surveys on the basis of prefeasibility formats outlining village energy profile
- Visit by social and technical teams for assessing socio technical feasibility– discussion with community members. Formal and informal interactions were held with different stakeholders (men ,women, youth etc)
- Preparation of prefeasibility reports followed by additional visits by technical consultants for working out feasibility
- Building linkages with rural technology developers
- Studying responses and getting feedback on the feasibility of the systems

Detailed feasibility studies were undertaken on twelve sites each of the micro hydro, biomass and solar based energy systems.

4. Summary of Conclusions

4.1 Key Process Insights

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

DEO Site Locations

STATE	HYDRO	SOLAR	BIO-MASS
ANDHRA PRADESH	8	3	7
ORISSA	3	3	1
CHHATTISGARH	1	2	-
JHARKHAND	-	4	4
TOTAL	12	12	12

When we started with the study, we were looking at micro-hydro, solar and biomass technology as independent energy options which 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 from our finding 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 to 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 i.e 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 has been learnt that community shall value the system only when they can develop ownership. Ownership can be developed by contributing as labour for civil works for micro hydro; contribution in cash towards owning a solar or an efficient biomass conversion device and taking responsibility for operation and management of the system.

4.2 Learning from Micro-hydro Initiatives

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 which 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 would be through contour map which shows 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 would be economically potential site for harnessing water through a micro hydro as there would already exist some civil construction in place which can either be upgraded or used in its present form.

While taking details of hydrology like the flow measurements it is important to take into consideration the seasonal variation. It has been studied that flow might 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 would be 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 which are confined to meeting basic lighting, heating and enter-

tainment. 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 dehusking, 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 process for the communities.

Ensuring people's participation at all levels is very important as it's 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.

It has been observed that community's stake is the highest for micro-hydro. The reason is that the community contributes labour towards construction of micro-hydro structures. e.g. building of forebay, check dam, laying pipes etc. This process would ensure 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 by some of them but this is not the solution towards influencing policy decisions. **The need is 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 initiative of the area from a long term perspective.

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 would save 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 would help in smooth progress and also address group

conflicts and other community dynamics if any.

One concern that remains a matter of debate is the sustainability of micro-hydros 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.

4.3 Learning from Solar Initiatives

This technology has been studied to be 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.

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, because 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 which 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 man power for local repairs compels the community to dump the system for the want of even minor problems.

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 paying potential.

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 its accessibility, availability and affordability. Technology appropriation is required from standard models to derive models most relevant in the local community context.

The concern with solar technology is the disposal of batteries. Most of the batteries have a life not more than five years. Disposing them off in our immediate environment has toxic effect 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.

4.4 Learning from Biomass Initiatives

There is a large unfulfilled demand for fuel efficient stoves in tribal areas. It is to be ensured that this technology reaches to 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.

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 tribal practically 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 also 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. Information that the stove construction could generate employment potential creates 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 up a stove building enterprise.

The existing pattern of roofing in most of the tribal houses provides limited scope for setting the chimney of 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.

Aneela stove (gasifier stove) has been studied to be quite useful in the 'anganwadis' which provides one meal to pregnant, lactating 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/wood.**

Under the government's "Sarv Shiksha Abhiyaan" programme mid day meals is 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 which is relevant in such places.

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

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 variety of end users would enable development of wide range of models which would be relevant in the culturally different 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. The cultivation of these biofuel 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 it from the point of view of income generation. **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.**

4.5 Implications of the Study

The feasibility studies on decentralized energy options in the tribal belt across the eastern ghat region has generated data for 36 typical DEO intervention sites which can serve as a baseline for improved energy access for this region. This shall be 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 which 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 renewable in other prospective tribal areas. A multiple of such models will demonstrate that renewable 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.

4.6 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 (to be developed). 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 – i.e we identify one geographical area and work around this area on relevant technology options (for eg we identify one geographical area which could support a micro hydro and then link it to other livelihood options/other energy initiatives for promoting sustainable development).
- Technologically – i.e establishing/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 has a potential to expand livelihood options and improve living conditions The focus of our work shall not remain confined to renewable energy development and its associated environmental benefits but also on 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/demand for renewable energy.

4.7 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, CO2, 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 should 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. Work hours can be extended by four hours on an average- the pressure of daily chores will 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.