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STUDY ON THE ALTERNATIVE ENERGY TECHNOLOGIES IMPLEMENTATION FOR PROMOTING THE SUSTAINABILITY OF TECHNOLOGIES IN SIKKIM

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ABSTRACT

Aiming towards achieving of sustainable development at the rural and urban (especially the rural) levels, the importance of Alternative Energy Technologies (AET's) (like biogas plants and stoves, wind-solar hybrid system, solar systems, micro hydro power project etc.) has increased. Apart from being eco-friendly and helping in reduction of load on the environment, AET's also provide immense socio-economic opportunities which help in improving the livelihood and creating independence among the population. It also reduces the work load and drudgery of women, (who are viewed as the central pillar of development at the most basic levels i.e. the household) which in-turn leaves them with spare time for personal development. The aim of this paper is to analyze the policy planning and implementation of AET's by the central and state government and the policies being formed, along with their inherent challenges that pose retardation to policy implementation, be aimed at effective rural energy planning and the sustainable development of the locals of Sikkim and instill them with independence for their energy needs.

Keywords: Sustainable Development, Alternative Energy Technology, Sikkim, Rural Development

1. INTRODUCTION

Sikkim, having joined in 1975, in the union of India is located in the Eastern Himalayas; the terrain of the state is mainly characterized by steep mountains and deep valleys [1]. The Altitude range of the state ranges from a lowly 300 m to 8598 m, which results in diverse climate which ranges from the tropical to the tundra [2]. The rural population of Sikkim is located in the 4 districts and 165 gram panchayats (villages). The average number of households per gram panchayat is 550, with a population of 2750. According to the Census of India (2011), the total population of the state is 0.61 million, of which, the rural population accounts for 0.46 million and the urban population accounts for 0.15 million. Increase in population of the state since 2010 has been reported as 12.36% [3].

The demands of fuel have also gone up in the state, not to mention the need for commercial and household electricity across the state have seen an increase. This, in way has also affected the beauty of the environment and ecological warming. In the rural parts of Sikkim, biomass (firewood, agricultural resources and animal dung) is an important source of fuel, but, improved use of this fuel source is also an important issue to reduce the environmental implications that it might have and also in saving human energy in managing energy resources, and improving health conditions by reducing the domestic air pollution, which is a severe problem in case of direct burning of firewood or animal dung.

Larger quantities and better quality of energy are equally necessary to raise the living standards of the rural population. In the face of rising population, increasing energy demands need to be met and also provide energy for socio-economic development [4]. With sudden drought of resources and fuel in the country, the government has actively started looking into new and improved clean and renewable energy prospects, which can provide an Alternate for Non-renewable sources of energy and in turn also replace primitive technology with improved and efficient technology and energy conversion mechanism which are cost effective, simple to install, operate and maintain and are reasonable on environment, than submergence of large areas for large scale hydro power plants and are a core component for sustainable development. Yes, AET's have had issues regarding their efficiency in the past (Biogas cooking stoves and traditional solar cookers have been good for small meals only), but, with the advent of technology has led to the development of various new clean energy conversion mechanisms and improved the efficiency of the traditional AET's.

A total of 68 potential sites for creation of Small Hydro Power Plants have been identified across Sikkim with a combined generation capacity of about 202.75MW [5]. Out of these 68 sites 13 have been installed with a generation of 39MW and 4 other projects were underway when the news of scraping the projects came due to insufficient funds.

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The government of India provides for a special 18 crores subsidy on such projects [6]. Therefore, the need arises to study the reasons, challenges and implications of such projects and their vital running in order to benefit the growing population, with growing needs, but, in a sustainable way.

Sikkim, having a large capacity for development of Renewable Energy, [7], initiation of projects in the region would help develop independence of the locals, develop the region, its landscape, provide social boost for rural population, economic growth and recreational growth, not to mention the reduction of the drudgery of women, as they would be spending less energy and time on collection of firewood and other biomass resources, and use that time in personal development and personal economic growth. And all these small scale developments together inhibit Sustainable Development of the State.

2. AET IMPLEMENTATIONS IN THE STATE: SUCCESS & CHALLENGES

The Commission for Additional Sources of Energy was constituted in 1981, to assist the Atomic Energy Commission and bear the responsibility of developing renewable energy technology in potential (especially at the rural level). Over time, the commission matured into a department in the government, and then further, into a full-fledged ministry [8,5].

A lot of programmes, focused toward AET development have been established and many new programmes are up and coming, in the state. Hybrid AETs, like the Hybrid Wind and Solar System (Capacity: 620W), have also been installed in the areas of Namchi (Sports Authority of India Complex), South Sikkim and Assangthang Model Village, South Sikkim. More that 720 solar lanterns distributed among the rural parts, where electricity is a problem. 10,215 solar home lights and 152 solar street lights have been installed and are running successfully in the region [6].

Under the National Biogas and Manure Management Programme, setting up of small size and family size biogas plant will take place and a support of Rs. 11,700/each will be given by the government, along with special training at IIT Guwahati, for use and maintenance of the plants shall be provided free of cost. A Detailed Project Report for 400kW mini hydro plant in Sikkim has been jointly prepared by Swiss-Nepalese and Indian engineers. Policy level engagement at state, national and international level is being shaped.

More than 150 growers of large cardamom in Sikkim, India, have been benefiting from biomass gasifier technology in a variety of ways. Sikkim is the largest producer of large cardamom in the world, consuming some 20,000 tons of fuel wood annually. To dry the harvested produce, grower's burn wet logs in traditional stone and brick ovens and pass the smoke through a thick bed of cardamom. Most large cardamom producers are small farmers who cannot afford higher-cost technologies.

And basic problems like difficulty of transportation in hilly areas and un-electrified villages make it harder for them. The updraft gasifier system, designed and developed by TERI, has the advantage of operating without electricity and is easily transported to hilly areas. The technology provides a healthy working atmosphere with its higher combustion efficiencies and smoke reduction, which in turn saves 50–60 percent of fuel wood. With the rich natural reddish colour of the fruit, 35 percent more oil content, and absolutely no burnt smell (which was common in the traditional product), the cardamom is fetching 10-20 percent more in local trading centres. Further, the gasifier systems have the ability to dry large quantities of harvested produce in one, shorter cycle. The low-cost gasifier system has potential for application in other rural industries. In north-eastern India, current activities include lime, tea, areca nut, cashew nut processing, pottery making, and fruit processing, turmeric boiling, ginger drying, and yarn dyeing [8].

All India Coordinated Research Project on Renewable Energy Sources (AICRP-RES) along with the help of Coordinated Agricultural Engineering and Post-Harvest Technology (CAEPHT) centre of the AICRP on RES have helped install projects at many villages around Ranipool, Sikkim and are now planning to setup more projects in the interiors of the state, where energy still hinders development. These installations have helped farmers full fill their requirements through improved low cost renewable energy gadgets i.e. smokeless single and double pot stove; rice husk fired improved sigri, inverted down draft biomass gasifier, solar LED light, water heater and others. Another village, where one cubic meter fixed dome "Deenbandhu" Biogas plant is in operation collaboration with the RES Centre, for cooking and water boiling of 6 member family. The centre has provided a biogas stove with every necessary accessory for cooking. The biogas is also used in poultry house to save electricity charges by using biogas lamp for lighting as well as heating to provide thermal comfort to chickens. Demonstration regarding the benefit of using loose biomass mixed with cow dung and ashes with charcoal left after using stove to prepare valuable fuel "Briquettes" made by hand using wood frame and Bamboo halves, were carried out as part of training of the farmers. These locally made briquettes saves fuel wood and the residual ash provides for a quality cleaning agent of cooking utensils to safeguard for contamination of land with toxic detergents. The advantage of using renewable gadgets viz. smokeless stove and biomass gasifier with 30% thermal efficiency compared to the traditional stove that consumes valuable fuel wood in bulk reduces the consumption by 35%. It was discussed that the use of biogas for cooking and lighting saves LPG consumption. The RES centre, have promoted Renewable energy sources and technology to support the energy demand of Sikkim in rural parts, have done a commendable service.

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Now the programme is quite spread out and providing its services to the locals of the state [9].

The world's highest solar energy plant has been set up in Sikkim's, Chaurikhang area which can light up an area of two sq km. the 2.2 kilowatt plant. The plant was designed and conceived by West Bengal Renewable Energy Development Agency (WBREDA) and has been set up at an altitude of 14,000 feet by the exide industry at a camp of Himalayan Mountaineering Institute (HMI) in the area. The Union Renewable Energy Department financed the plant. The solar panels have a capacity of lighting up the two sq km area of the base camp and enable about 250 HMI camp employees to run electronic appliances. The plant is run on a daily basis and senior WBREDA engineers run a three month maintenance work schedule, regularly [10].The Renewable Energy programmes have been running, maintained and inspected, regularly by Sikkim Renewable Energy Development Agency (S.R.E.D.A.). Under their watch, Biogas, Improved Stove, Village Electrification, Energy Parks, Aditya Solar Shops have been started and running well and benefiting villagers of all genders. Besides these above programmes, adequate provisions have also to be earmarked under the scheme for payment of salaries, expenditures as Office Expenses, Travel Expenses etc.

Even after impressive, "on paper" policy making, many instances have been found where effective implementation does not occur on ground, because of which, a lot of projects have also been scrapped in the recent past. These shortcomings have been attributed to certain factors predominant in the social structure they are:-

- Lack of Professional Manpower Base, HRD and Capacity Building.
- Improper Project/Programme formulation.
- Weak Delivery Mechanism.
- Weak Operation and Maintenance Mechanism.
- Problem of State Share of funds.
- No Private Sector Investments.

[6].

Efforts to strengthen access to AETs need to be accompanied by the right kind of incentives, policy alignment, political and institutional support [11]. Even when AETs are available, affordability can always retard their deployment as they usually compete with traditional energy supplies and practices that involve no financial transaction and seem to have been imbibed in the local's everyday routine [12].

Hence, the need of the hour is to focus attention on the functioning of projects and programmes on ground. Attract Private sector investors through attractive tax saving schemes and redeeming investments with carbon credits. Manpower should be generated within the area of the project installation, rendering the locals of the area to build, maintain and operate the AET's for their own benefit, hence, generating rural employment and a chance for them to sustain their own development.

For example, technicians and project managers can be sent to sites, generate manpower in terms of the local population, explaining them the benefits of sustainable development and the importance of their involvement in the project. After completion of the project few locals can maintain and operate the system under the gram panchayat. Although the problems of landslides and earthquake in the region do tend to dig deep into the funds of the state, hence, sacrificing developments of such sustainable projects, due to deficiency of funds due to extra spending on restoration work, incurred by natural calamities.

3. IMPLICATIONS OF AET DEVELOPMENT ON THE SOCIETY

AETs have diverse socio-economic effects on both the sex. AETs, though, have been able to significantly reduce women's workloads and save their time and energy. And Exposure to new technologies has been a positive implication of AET's raising the interest and keenness of both the sexes. Women have also been benefited from these socio-economic developments.

Research suggests that the analysis of the Integrated Energy Policy (IEP) against the macro-economic implications it might have, proved, that changing technological choice results in gross domestic product gains, and reduction in energy demand and CO_2 emission. The results show that the policies considered can have adverse welfare impacts. That is if the policy implementation is conducted fairly [13]

Access to energy for domestic use and electricity produced from AETs can have a significant impact on livelihoods in rural areas. Efficient use of traditional fuel resources can significantly improve health conditions by reducing acute respiratory infection and conjunctivitis, mainly caused in homes with domestic air pollution. The health benefits are immense, like, cooking with more efficient technologies can make for better dietary choice and boiling of water more affordable. Women and children in particular will have more time for educational and leisure activities and self development.

Electric water pumps can provide clean water, reducing the effort needed for manual collection. Electricity can make possible the refrigeration of vaccines and availability of essential medical procedures at rural hospitals, which always remain, otherwise, at the receiving end. Access to radio and television can improve educational opportunities, and provide entertainment. Electric lighting provides higher quality illumination than kerosene lanterns, improving opportunities for work at night hours and sustains study time as well as better security, comfort and reduces the domestic air pollution. Access to electricity can significantly reduce the time required to devote to household activities. [14].

Improved health and education, combined with more time to undertake economic and social activities, are important goals in themselves, towards sustenance of development.

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Demand for services associated with AETs can help generate local economic activity based on these technologies, in addition to the means to power local cottage and small scale industry. Applications of AETs for productive activities vary from mechanical wind-powered water pumping to motorized milling machines for grinding grain. Radio services can provide farmers with weather forecasts and television services can provide growers with information on crop prices [14]. These applications can lead to job creation and improved livelihoods, both of which can contribute to significant increases in productivity in rural areas [11].

On the case of Micro Hydro Power Plant, there implications have been immensely positive for all people, especially in the case of women. The plants have helped in reducing the labor and time spent by them in activities of procurement of resources for lighting the house in the evening and then processing them and storing. Women now have more time for recreation and leisure with access to micro-hydro mills. Since women do not need to fill up kerosene lanterns and light them in each room, their time and labor is saved. However, it was also observed that women's work has increased in the morning and nights with the availability of electric light. Access has been provided for indulgence in some income-generating like incense-making and social interaction activities like adult literacy and ladies club, with the help of lighting. For instance, adult literacy classes are usually conducted with electric lights at the night or evening when work load is less. Similarly, there was a positive change in women's and men's attitude to women's mobility and participation in socio-economic development activities with the awareness program supported by the Integrated Rural Development Program (I.R.D.P.). Such awareness activities also provided to increase their confidence in and outside of their household and venture into traditionally restricted territories and also helped in reduction of evil ailments which are prevalent in the men like drinking and gambling.

Lighting made it easier for men to interact and conduct social gatherings and chat with their friends in the evenings. Men also recognized the possibility of earning more income through establishing sawmills and poultry farms using hydro-power. There was a positive implication for men's knowledge through getting information from radio and television. With electric lights, men were motivated to increase participation in social gatherings and enjoy entertainment such as listening to the radio and watching television (which is now equipped with Direct to Satellite feature). However, the youth seemed to be idle with radios and televisions and reluctant to go to work. This was seen by older people as having a negative impact on their culture and their lives.

Similarly, biogas plants have positive-negative implications for men and women.

Though there was a reduction in women's work in collecting firewood and cleaning up the house afterwards, which, saved time when performing these tasks. However, field research suggested that some women also found more work with the biogas plant, since they had to carry more water to mix with dung and to use in the toilet. In addition, some of them felt it took a longer time to cook their meal with biogas stoves than with the traditional stoves, since they live in a big joint family and biogas stoves are only good for cooking light meals. Women also faced more problems when the biogas stoves turned off frequently because of inadequate gas production during the winter. However, there was a possibility of women being involved in income-generating and social activities, with the possibility of time saved in cooking and cleaning with the use of biogas stoves. Women have managed to save on labor and time from cleaning activities, which was a positive implication of the Improved Cooking Stoves (ICS). With the changed attitude of local people to using the ICS, the households have benefited in terms of freedom from smoke which was a vital problem in the traditional stoves. Solar lighting has had positive implications for women, reducing the work required for cleaning the house and clothes because it provides an alternative to kerosene, which leaves a black film when it burns and needs to be cleaned regularly before lighting. Similarly, less time was needed to perform the same tasks. In addition, with an awareness program supported by the I.R.D.P., the local people were more aware of gender and environmental issues.

With the advent of technology, most of the villages now have become cyber equipped (taking examples from model villages, developed in Rajasthan and Andhra Pradesh) with computer technologies available powered by MHP's. Information Technology has also been placed in the lap of rural development giving boost to their self-confidence and ease of procurement of knowledge and equipment. Although, the IT revolution is still a long road ahead before it gets integrated with the rural development. But, it would be the next important step towards rural development, and with improved electricity through AET's we can hope for a sustainable IT development in the state, a first of its kind.

These AET's have benefited the people in a way that conventional modes couldn't. AET's have given them a chance to mainly sustain themselves and be independent. In other rural parts of the country where conventional sources of energy are present, like, being connected to the main power grid, results in having long power cuts and helplessness in terms of enduring their plight. But, here a sustenance and independence of energy control have given them a chance to enhance their knowledge, social circle and economic ties, presenting both genders with equal opportunities.

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4. CONCLUSIONS AND DISCUSSIONS

1. Details covering the implementation of AET projects have been tabulated in Table 1 (Tables & Figures). From the numbers we get a rough idea about the development potentials of different AET's in Sikkim based on the geography and weather of the area. Figure 1 & 2 (Tables & Figures) give us an insight on the fuel wise breakup in the state and upcoming project capacity break up.
2. As discussed earlier, the advent of AET's have definitely given a new dimension to the scene of rural development in Sikkim leading to sustainable development, involved in further nurturing of development, giving it a holistic approach. Bypassing of traditional energy systems with AET's in rural energy are in great demand not only for saving on the use of conventional fuel, but also for saving women's energy that could be used for other socio-economic activities, leading to their productivity increase, which, by fact and figures. The priorities of the policies have been to fulfill modern energy requirements of rural households, without paying attention to socio-cultural issues including gender based priorities. This has provided very little opportunity to integrate gender concerns into rural energy planning and policies and to incorporate women's voices in AET development
3. The policies issued by the government have to be worked out with the Human Resource Development department, New and Renewable Energy department and Power and Energy department of the government, in order to include the existing structure of the Small and Micro Hydro Power Projects into power grids so as to liberalize energy and inter-district sharing in order to build support structures as back up during calamities. Distribution of energy in villages, with respect to time, in order to encompass, the economic development of the village, for example during day time solar energy can be used to fulfill household needs, while the MHP electricity can be diverted for economic activities being performed by the locals.
4. A lot of development has yet to come in the field of Alternative or Renewable Energy Technology, and this has to be checked upon and researched into further with in depth field work and survey on the consent of the local population. Conversion of lifestyle from the traditional to the sustainable has the primary challenges of psychology of the people, which could change with the knowledge of the problems that are faced regarding the AET's among people and will have to be analyzed on the basis of gender, age group and location. Also, local R&D stations would be required to setup in order to develop the technology and check its adaptability with the environment, so as to gain the maximum efficiency from it. Such R&D stations will have to aim towards hybridization and inter-dependence of two separate AET mechanisms. These ideas though ambitious, would require huge capital investment; hence, policies need to be worked out with the private sector so as to fund such projects and utilize the local human resource, so as to cater for independent running of these projects.

5. TABLES & FIGURES

Table 1 [6, 15]: Project Status Report

1.	**Small Hydro Power Programme - Potential & Implementation Status**					
	Potential	**Installed**			**Under construction**	
	No.	MW	No.	MW	No.	MW
	68	203	13	37	4	16
2.	**Solar Photovoltaic Programme – Achievement**					
	Solar Lanterns	**Solar Home Lights**	**Solar Street Lights**	**Solar Pumps**		
	2730	335	152	-		
3.	**National Biogas and Manure Management Programme**					
	Family Type Plants Installed		**Estimated Installation of Family Type Plants**			
	98		-			

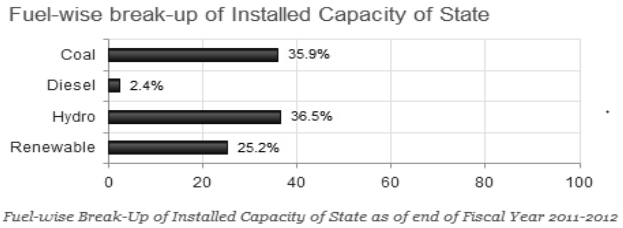

Fig. 1 [16]: Fuel Wise Break-up of Installed Capacity of Sikkim

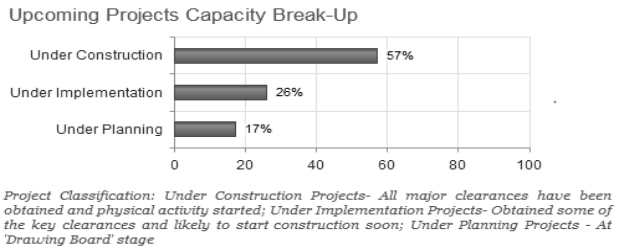

Fig. 2 [16]: Project Status Graph

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