Article

Decentralised Renewable Energy and Rural Development: Lessons from Odisha's First Solar Village

Journal of Land and Rural Studies
9(1) 178–192, 2021

DOI: 10.1177/2321024920967842
journals.sagepub.com/home/lrs
SAGE

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Abstract

Energy plays an indispensable role in providing basic services for our daily lives. The perils of climate change and its impact on our environment have made accessibility of energy difficult. The burden of energy poverty falls particularly on the poor households in rural areas. Decentralised renewable energy options can be used to meet the energy requirement especially for the rural and tribal communities, which are scatteredly located. The study aims to find out the effectiveness of a renewable energy project at village level by studying the experiences of the *Ho* tribal community residing in Barapita village of Odisha, India. Barapita village is the first 100 per cent solar powered village of Odisha. Participatory rural appraisal method comprising tools such as transect walking, interview schedule, focus group discussion and key informant interviews has been used to find out the energy use pattern and challenges faced by the community. Although the solar project was initially a success, later on technical issues and maintenance problems led to the decline of solar energy use. This article suggests how the Gandhian model coupled with Nai Talim approach can be deployed to train the villagers as solar engineers, which will enable them to resolve issues related to the use of renewable energy.

Keywords

Decentralised renewable energy, rural development, solar village, Ho tribe, Nai Talim

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Introduction

Energy is required for our daily lives and for the socio-economic development of our country. International institutions such as European Union, World Bank and United Nations believe in the indispensable role of energy in providing and improving a wide range of basic services such as lighting, cooking, drinking water facilities, treating patients at health centres and facilitating communication. Despite efforts to provide these basic services, over 1.3 billion people still lack access to electricity and nearly 2.6 billion people are left without clean cooking appliances and technologies (Van der Hoeven, 2013). There are still many households in developing countries especially in the rural areas who do not have access to modern energy services. Lack of clean and affordable energy affects household and community well-being in various ways (Modi et al., 2005). India is facing both developmental and environmental crises. Glaring poverty, inequality and rapid environmental degradation are putting pressure on each other. Decentralised renewable energy options (DREOs) can be used to meet the energy requirement especially for the rural communities and tribal communities which are scatteredly located (ECC, 2008). Along with energy policies, other resource constraints such as finance, infrastructure and income have led to limited energy access (Barnes & Floor , 1996; IEA, 2006; Pandey, 2002). There is an impetus for the decentralised energy service delivery in developing countries because of its commercial viability and environmental sustainability; however, decentralised energy is in its nascent stage. Reliability, affordability and environmental sustainability are the hallmarks of decentralised energy planning that makes it a viable option to meet the needs of rural people and small-scale energy needs (Ravindranath & Hall, 1995; Reddy & Subramanian, 1980).

Decentralised Renewable Energy

Decentralised refers to any system that uses renewable energy to generate, store, and distribute power in a localized way. This includes small stand-alone devices (solar lanterns or advanced biomass cooking stoves), integrated solar home systems (SHS) that power multiple devices or appliances for a single household, and smaller generation and storage resources that feed isolated or localized distribution networks (mini-grids or micro-grids) (Srinivas, 2018).

There have been many efforts to popularise modern energy services to the rural poor. Rural energy programmes in Bangladesh, Nepal and Mali revealed that the decentralisation process related to energy has hassled the engagement of local actors at various stages starting from planning to implementation (Havet et al., 2009). In comparison to the centralised technologies decentralised renewables also have a low upfront cost. It also can help in avoiding high costs which are generally related to the transmission and distribution of grids (Alazraque-Cherni, 2008). As they operate on a small scale, they are close to the users. Moreover, it can be beneficial for the tribal communities who are scattered geographically. They have been deprived of energy services which are also essential for their day to day

activities and livelihood (ECC, 2008). DRE technologies can be adopted to reach rural communities where government programmes fail to reach (Alazraque-Cherni, 2008; Goldemberg, 2000). So the focus should be shifted from large to small scale renewable energy technologies which can be locally implemented by communities and small-scale producers. Meanwhile, it has the potential to contribute significantly to the national energy supply (Hiremath et al., 2009). Nearly 10–15 per cent of India's energy requirement can be met by decentralised renewable energy. It can increase the accessibility of energy to the disadvantaged people and contribute to reducing poverty by initiating rural growth (Srinivas, 2018).

International and National Initiatives

Renewable energy (RE) use can facilitate and accelerate rural development. Although significant efforts are made in this direction to mobilise resources much more is needed to be done to realise the potential (Bhattacharyya, 2006; Boyle et al., 2006). The Millennium development goal (MDG) for 2015 was set to achieve eight goals and targets. Reducing poverty through rural development was one of the key requirements in achieving MDGs. Also, energy poverty can be reduced by facilitating access to modern energy services which ensure environmental sustainability, fulfilling another MDG goal. International commitment for converging clean energy and rural development can be found from the Johannesburg Plan adopted at World Summit on Sustainable Development, 2002. In 2015, Sustainable Development Goals (SDGs) were adopted by the UN General Assembly and the SDG 7 aims to provide affordable, reliable, sustainable and modern energy services for all. Working towards this goal is important for India to fulfil the increasing energy demand of its growing population. More than 304 million people are lacking access to grid-based electricity and over 500 million people in India still depend on conventional energy sources for cooking.

India has initiated programmes like Soubhagya Yojana for providing electricity to all households by December 2018. Ujjwala Yojana has also been implemented to universal coverage of cooking gas in the country. India, being the initiator of International solar alliance and also as a part of its intended nationally determined contribution (INDC) for the Paris Agreement on Climate Change, aims to achieve an ambitious 175 gigawatts of RE installed capacity by 2022. Out of it, 100 gigawatts share is to be achieved through solar energy itself. Although over the years changes have been made at the policy level which has positively impacted the growth of RE but the sustainable growth of the sector has been impeded by the bottlenecks (Gopal, 2018).

Need for Access to Energy and Barriers to Decentralised Renewable Energy

Greater access to energy has a significant impact on livelihood in rural areas. Achieving higher and stable productivity in rural livelihood requires access to a

reliable energy supply (Mordt et al., 2013). The use of cleaner fuels have health benefits for users and households. It helps in reducing respiratory diseases, body aches and eye irritation which often affect women and children as they spend much of their time indoors. Modern energy services can reduce the time required for household activities and the burden of collecting fuel particularly for women (Barnes & Sen, 2004). This will leave women with more time for learning, leisure and economic activities (Murphy, 2001). Similarly, collecting water is also a very tedious job which can be reduced with the help of electric water pumps to provide clean water. Access to radio and television increases the opportunities for awareness, education and leisure time spending. As compared to kerosene lanterns, higher quality of lighting through electric lights helps in improving working conditions, study time and comfort (World Bank, 2001).

Renewable energy technology can help in generating local economic activities. Job creation and improved livelihood facilities can significantly improve the productivity of rural areas (Steger, 2005; UNDP, 2011). Decentralisation helps in institutional development and it increases space for community actors (Oteman et al., 2014). The DRE services strengthened local governance and reduced indoor air pollution along with supporting energy requirements (UNDP, 2011). Varieties of decentralised energy services like solar power, improved cookstoves, biogas and micro hydropower have helped in combating climate change through the reduction of carbon emission (Sapkota et al., 2014).

Regardless of the benefits of decentralised energy and its services there are certain barriers that prevent penetration of the facilities to the rural areas. A study from Liberia showed that the electricity generated from diesel and solar photovoltaics was beyond their purchasing power and willingness. However, the households were optimistic to afford biomass and small hydropower (Guta et al., 2017). Lack of credit and financial issues are some of the limitations of the long-term sustainability of renewable energy projects. It includes the cost of production and management of the project (USAID/ARE, 2011). Apart from this, there has been absence of proper information, lack of coordination and communication among different people of the rural community which has eventually reduced their scope of making informed choices. A case study of the role of decentralised energy for rural electrification in Maharashtra revealed that community perception towards renewable energy, government policies favouring DRE and participation of local government are some of the determinants for the successful run of renewable energy programmes. Framing a robust business model, maintenance, economic feasibility and sustainability of raw materials are some of the challenges (Deshmukh, 2009).

For any project to be successful, it needs the participation of people. Community participation is acknowledged to boost the viability of decentralised energy projects (Holland et al., 2001). Community involvement throughout the process of the biomass cook stove programme in India helped to develop a suitable and sustainable project for the village Chibau Khera near Lucknow (Rouse, 2002). Similarly, in Nepal, it was found that the community-based participatory approach has improved sustainability for a longer period because

of local ownership and advanced scaling up of decentralised energy programmes (UNDP, 2011). Community-based approach can empower people through inclusive participation of local people and implementation of projects. This would help local stakeholders to directly monitor and manage resources and thereby influence investment decisions (Haider, 2009).

Objectives

1. To find out the energy access and experience of the *Ho* community of Barapita village.
2. To assess the effectiveness of the solar energy initiative undertaken in the village.
3. To explore methods of improving sustainable energy access through the Gandhian model.

Study Area

Barapita village of Mendhasala gram panchayat is situated in Chandaka Tehsil of Khordha district in the state of Odisha in India. It is situated adjacent to Chandaka forest and is 15 km away from the district headquarter of Khordha. The state capital Bhubaneswar is the nearest town to Barapita. The total geographical extent of the village is 380 hectares. Barapita village has a total population of 298 people living in 65 households. The hamlet is inhabited by Ho tribes. Ho is a Kolarian tribe inhabiting in the interiors of Mayurbhanj and Keonjhar districts of Odisha. *Ho* is one of the major tribes of Odisha belonging to the proto-Australoid group (Ota et al., 2013). The members of the Ho community of Barapita village and their predecessors migrated from the Mayurbhanj district and have settled in this village.

Methodology

The study used the Participatory rural appraisal (PRA) method for capturing the energy experiences of the villagers. PRA is aa family of approaches and methods to enable rural people to share, enhance and analyse their knowledge of life and conditions, to plan and to act' (Chambers, 1994). PRA is helpful in recognising the needs, expectations and problems of rural indigenous people (Binns et al., 1997). It encourages the community members to communicate their opinions and ideas relating to their experiences and problems encountered by them (Abdullah et al., 2012). The primary data was collected from Barapita village over a span of one month during November 2018. Transect walking, semi-structured interview, focus group discussion (FGD) and interview with key informants are the PRA tools that were used for data collection. Transect walk along with key informants helped in mapping the condition of community renewable energy assets, water sources and school infrastructure. Both probability and non-probability samplings

were used for the study. For the quantitative part, an interview schedule was prepared and random sampling was used to collect data from 35 households selected as samples from the village. For the qualitative part, in-depth interviews, key informants interview and FGDs were conducted. For the qualitative part, the researcher used purposive sampling and voluntary sampling. Voluntary sampling was used to choose participants for the two FGDs from the villages. However, care was taken to ensure that each group was representative of the village including men and women, and both the youth and the elderly.

Energy and Water Experiences of the Community

Electricity

Globally, 1.06 billion people lack access to electricity (World Bank, 2017). That means one in every five people, most of them living in rural Sub-Saharan Africa and South Asia, rely on kerosene, candles and battery torches for essential lighting (Mordt et al., 2013). All the households of the village did not have access to electricity before 2015. During the interview, the respondents shared how their lives were before electricity reached their village. 'In 2015 solar lights were installed in our village. Before that, there were only very few households that used consumer electricity. We were living in darkness earlier, so when lights came to our village it was helpful in the evening and at night time.'

In September 2017, the Government of India had initiated the Saubhagya scheme which had targeted universal household electrification by the end of 2018. The respondents were also asked how the recent 'Soubhagya' scheme of the government has helped them to access electricity to which a key informant (ward member) replied 'From 2008 there was electricity in our village but only 4 households were the consumers. In 2015, solar lights came to our village. Recently, all the households have got electricity under the Soubhagya scheme'. Figure 1 shows the distribution of electricity access of the households. Out of 35 households, 22.8 per cent of the households accessed electricity as consumers and 77.14 per cent of the households got electricity through the scheme.

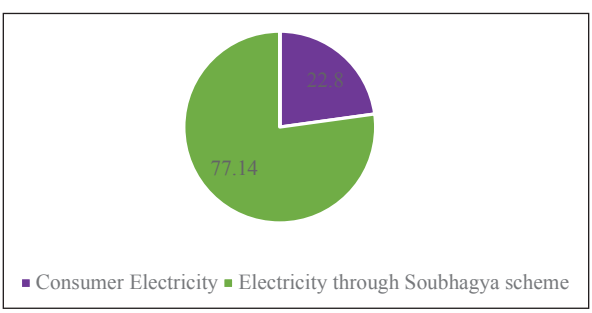

Figure 1. Access to Electricity
Source: Primary data.

Cooking Fuel Access: A Gendered Aspect

Almost 3 billion people use wood, charcoal and animal waste for cooking purposes. Energy access is a challenge (Mordt et al., 2013). Despite the initiatives taken by the government to connect villages and households to grids women in villages continue to use firewood to cook and boil water (Wright, 2007). Energy has gender-differentiated aspects which are evident from earlier studies. Women and girls are primarily responsible for the collection of water and fuel in the family which has an adverse impact on them (Agarwal, 2010; Habtezion, 2012). Women who use biofuel have a burdensome life. The collection of firewood and water consumes the maximum portion of the time of women and girls (Blackden & Wodon, 2006). Moreover, rural residents suffer from higher health risks from the energy they use than urban residents (Chung Sheng et al., 2012).

To know the consumption pattern of the residents of Barapita village, the respondents were asked about the fuels that they used. Alike any other village of India, common fuels used by the community is firewood, LPG, kerosene and cow dung. Firewood was the most commonly used fuel by all the sample households, while 57.1 per cent used LPG, 34.2 per cent kerosene, 22.8 per cent used cow dung. There were households that used 2 to 3 fuels but some were used frequently and some rarely. Firewood was used frequently by 88.5 per cent of the households. While 66.6 per cent of the households and 62.5 per cent of the households rarely used kerosene and cow dung respectively. The frequency of the energy sources used is shown in Figure 2. Women had the responsibility of collecting firewood from the nearby forest. One of the female respondents said,

We go to the nearby forest to collect firewood. The firewood that we collect generally lasts for 3–4 days. Some women carry a lot at a time so that it can even last for a week. As I have back pain I carry as much as I can.

The common health issues reported by the female members of household are aches, eye irritation and cough.

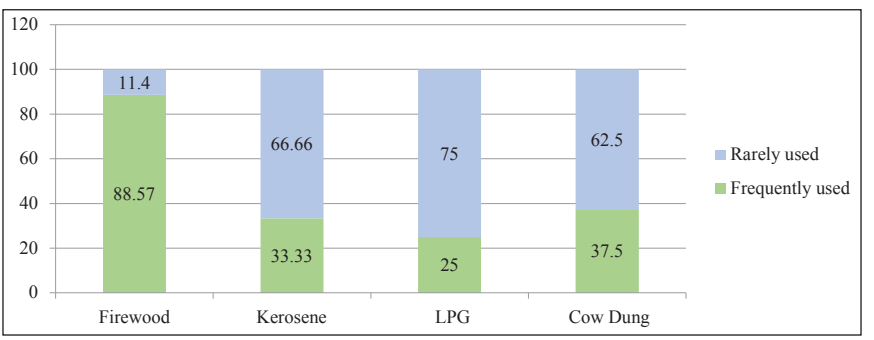

Figure 2. Frequency of Energy Usage

Source: Primary data.

Note: Firewood N = 35, Cow dung N = 8, Kerosene N = 12, LPG N = 20; N represents the total number of users.

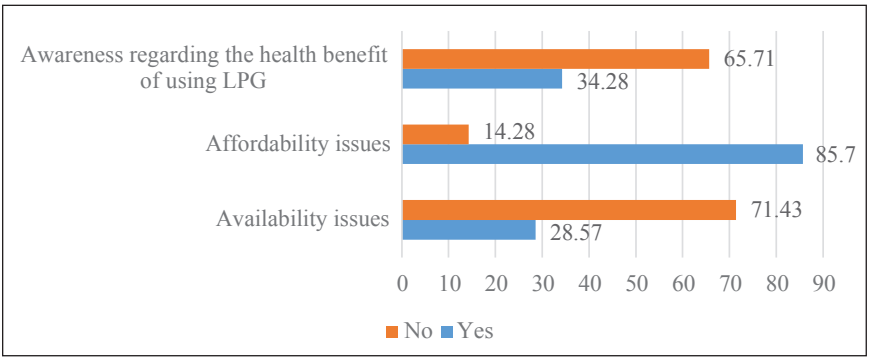

Figure 3. LPG Usage
Source: Primary data.

Ujjwala scheme initiated by the government enables families below the poverty line (BPL) to get free LPG connection. Many households of the village have received LPG connection under the scheme. The issues regarding the usage of LPG and awareness of benefits of using LPG of the respondents is represented in Figure 3.

The availability of LPG was not an issue for nearly three-fourth households as the villagers buy LPG from Mendhasala which is nearer to the village. Out of the 35 households surveyed, 85.7 per cent of the households regarded affordability issues as a barrier for using LPG. During the interview one of the respondents said,

We have got LPG connection from government but I am not using it. From where will we get 1000 rupees to get a gas cylinder? We are getting firewood free from the nearby forest and our family manages with that. I had used it but I am not using it now.

Refilling their LPG cylinders was not economically feasible for all the households. So, they had to limit the use of LPG and resort to traditional cooking fuels. Nearly 66 per cent of the respondents were not aware of the health benefits of using LGP and the harmful impact of traditional biomass on health. There is also a potential area where renewable energy options as alternative fuels can be introduced to the village.

Water

Energy and water are linked with one another. Energy is an important component of improved water supply and water quality. Water pumping requires electricity to circulate water to more convenient points for collecting water. Energy-related constraints on improved water supply, therefore, need to be addressed (Thom, 1995). During the FGD, it was found that there were only two tube wells in working condition for fulfilling the requirements of 65 families. Out of which only from one tube well they got clean water. A respondent said,

Out of two tube wells, from one tube well the water that comes has a different taste. Although a filter has been put it is not working properly. If we use that water for cooking the rice becomes red in colour and gets broken. So water from that tube well is not used for cooking. Sixty-five families have to manage from one tube well.

From observation, it was found that children in the village school were using water from a side by stream to wash their plates after their mid-day meals. Three-fourth of the households did not boil the water before using it for drinking purpose as it consumed a large amount of energy. This can also have a severe health impact, especially on children. Interview with key informant revealed that the panchayat is planning to bring water connection to the village.

First Solar Village of Odisha: A Success or Failure?

Barapita is the first village of Odisha to be 100 per cent solar-powered. The initiative was started by an IPS officer and the project which was of 0.7 million budget which was jointly funded by ECCO Electronics and Jackson Group. While ECCO electronics is a solar products manufacturer, Jackson Group is a diversified power solution provider. The 61 households, in 2015, were given individual solar units and 2 multipurpose LED lamps, a central 1 kilowatt unit that powers eight street lamps, an LED TV set and setup box for the village community centre. The positive aspects of the project was that it was a decentralised project. Generally, rural solar projects have central units for power supply to each household which has the scope of sharing issues. Second, the projects were low priced, required less maintenance and were owned by community members.

The present study reveals some of the aspects of the solar project undertaken in the village and its effectiveness. After the grid electricity connection to the households, the dependence on solar power has decreased. The electricity consumption and solar power usage is shown in the chart in Figure 4.

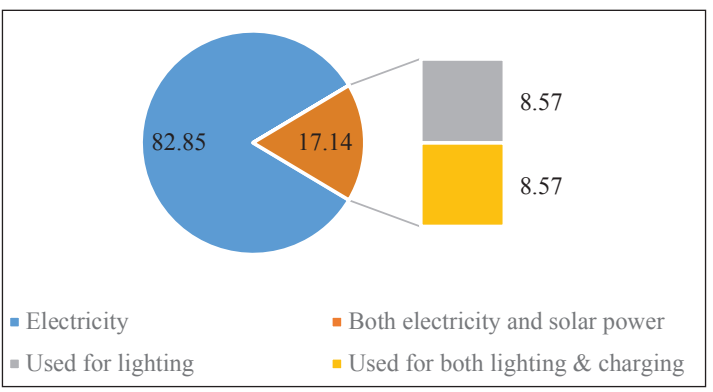

Figure 4. Grid Electricity and Solar Power Usage

Source: Primary data.

Out of 35 households now only 17 per cent of the households are using solar power along with grid electricity whereas nearly 83 per cent of the households are using only grid electricity. Solar power is being used for only lighting purpose for 8.5 per cent of households and the other 8.5 per cent of the households use it for both lighting and charging mobile.

When any projects are initiated into a community its impact on the community is expected to be felt. During the interview with a key informant regarding the impact of the solar project on the school children and their education, she said,

> When the village got solar power, I had asked them to provide light and fan to schools. But till today there is no light or fan in the classroom…. As we have classes in the morning hours we manage without lights. Before 2015, children faced problems reading in the evening and during tuition time. But the solar lights helped them in studying.

Electricity has reached poor households through the Soubhagya scheme but schools have been left out. So looking beyond households into the community services, health care and education should also be the priority of improving energy access for the rural communities.

The main issue related to the decline in solar power was related to the maintenance of the solar lights. Most of the multipurpose LED lights of the community are not functioning now. During the FGD, when the members were asked that how solar light is maintained by the community, the FGD revealed that when initially there was a problem in the solar panel the villagers had called the company. The workers from the company came and repaired the panels. The villagers had to bear their travel expenses. But when they were called second time to repair, they did not respond. So, the villagers have decided that they are going to collect money from each household and repair the inverter. They said that the panels are functioning but the inverter needs to get repaired. Although the households have got household electricity connection the solar light was used for street lighting. The central solar panel which is responsible for lighting eight street lights is currently not functioning because of which villagers are facing difficulties after dusk.

Energy projects that aim for rural areas need to be informed with an in-depth understanding of conditions in rural areas. The complex and fragile nature of rural people's lives and their efforts to secure their livelihood and how these are related to energy use need to be understood. It requires to be drawn on the practical experiences of implementing energy-related initiatives that have had the desired impact (Thom, 1995). The solar project initiative in the Barapita village could have been a model village showcasing the success of DRE for rural communities. Although the project started with lightening the lives of the members of the community, now it is one on the verge of failure. Sustainability of renewable energy projects should be monitored before, during and after the initiation of the project. The attitude of the community towards accepting renewable energy is quite positive, unlike other communities that are apprehensive about modern energy services. It would be myopic to view the project as a success or a complete failure as there is enough scope for improving the project and introducing new renewable energy options to the village.

The study finds that in the case of LPG usage, affordability was the main issue that the community faces. Although the government has introduced accessibility of LPG to the rural poor, they are still beyond the purchasing power for many households. These fuels cannot be highly subsidised forever. So, renewable energy services that can be cost-effective should be introduced to the rural community. However, the maintenance of solar equipment was the major issue faced by the Ho community of Barapita village. This problem can be addressed by robust planning and model which involves the community members to be the solutions to their own problem in order to ensure the sustainability of renewable projects.

Improving Decentralised Renewable Energy Services Through Gandhian Model

Business models used for the electrification of villages have shown their own limitations. Either they last for a temporary period or they create energy divide in rural areas itself. The problem of repair and maintenance loans from banks, and recurring costs hunt rural people and they find using traditional energy sources safer and more comfortable. The service providers and entrepreneurs mostly reside in urban areas, after installing the system customers become strangers for them. Gandhian partnership model involves the participation of the whole community in the renewable energy project. The core idea of the Gandhian model of DRE is based on the Gandhian philosophy of 'Nai Talim'.

Nai Talim: A Gandhian Blueprint for Sustainable Rural Development

The Gandhian strategy of rural reconstruction was based on village Swaraj. Some of the principles of village Swaraj as outlined by Gandhiji include trusteeship, decentralisation, self-sufficiency, equality and Nai Talim among many others. Gandhiji introduced the concept of Nai Talim in 1937. 'Nai' refers to new and 'Talim' refers to education. There were two purposes of this new education namely gram Vikas (village development) and rural development, that is, Gramin Vikas. According to Ramesh Panse, the four basic principles of Nai Talim include learning in vernacular language along with handicraft work, work should be applicable for fulfilling the employment needs of local people, learning ought to be linked with vocational work and work should be socially relevant and productive that is required for a living (Takwale et al., 2010).

The use of accessible technology for work-centric education was the basic approach of Nai Talim (Takwale et al., n.d.). Sykes (1988) in *The Story of Nai Talim: Fifty Years of Education at Sewagram, India (1937–1987)* said for Gandhiji, 'Nai Talim was the expression of the principle of non-violence in the educational sphere. It was the preparation for, and practice of, the peaceful organization of a co-operative human community.' This approach engages mass education and engages people for working in the sectors which are socially relevant. Although

Nai Talim as the alternative education system did not work well as a full-fledged educational system, the approach can be used widely today. However, it should be understood that Nai Talim is not a fixed system, method or curriculum. It is a philosophy of learning and living and not just pedagogy. It is not restricted to any vocation (Jain, n.d.). It is a flexible approach, which can be moulded as per the local requirements.

The Nai Talim envisaged by Gandhi can be seen through a broader perspective in the present time. It still holds relevance today for sustainable rural development. In case of improving energy access through solar power, rural illiterate masses can be imparted the skills of making and maintaining the solar equipment. This would not only help the rural people meeting their energy needs but can also generate employment and livelihood. It would also boost the 'Make in India' initiative along with achieving the renewable energy target and help India in its commitments to turn into a low carbon economy.

The Gandhian model believes technology should be selected for the villages in such a manner that it has immediate and tangible impacts on the members. The use of technology should in the meantime be used to generate work for people (Roy, 2015a). Pressing urban solutions to rural problems can be detrimental for rural people (Thom, 1995). For instance, The Barefoot College initiative of training women as social engineers is one of such examples where rural people can be adequately trained to build, repair and manage solar lights and systems. Tribal women from Jharkhand, Andhra Pradesh and Bihar have also been part of their practical training method 'Learning by Doing' which is central to Nai Talim.

The Gandhian model is based on a partnership that promotes the inclusion and development of people with dignity where everyone is treated and benefited equally (Roy, 2015b). The ability of the rural illiterate masses as agencies should be believed. Through training, they can achieve the skills that are required for maintaining the solar equipment and the system. In this way, the long-term sustainability of renewable energy projects can be achieved. It will eventually encourage the villages to adopt other DRE options that can cater to their energy requirements as alternative sources of energy.

Conclusion

Although the government is taking initiatives to provide energy access to rural poor, for sustainable development it is essential that people should be introduced to renewable energy services. Because in the long run when the globe will face energy crunch, renewable technology is going to play a crucial role in meeting energy demands. Introducing and popularising the use of DRE will eventually help the people to have a smooth energy transition. Adequate training in areas such as installation, operation and maintenance of renewable energy options, along with learning and awareness activities are key for effective and sustainable renewable energy technology use. Capacity building of the local masses should be focused so that renewable energy projects can be cost-effective and sustainable. The Gandhian model for implementing DRE in rural areas involves community

participation. Here, the potentials of the rural masses can be tapped to channelise it for community development which could be a valuable step towards sustainable rural development.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The author received no financial support for the research, authorship and/or publication of this article.

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