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Techno-Economic Analysis of Decentralised Small Hydro Power Projects for Rural Electrification: A Case Study of Meenvallom Project in Kerala with the Use of RET Screen Expert Advanced Software

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Abstract

Rural electrification is a fundamental factor of poverty mitigation and rural growth of a nation. In India, electricity has not played an active role in the socio-economic progress of the village. Gross Domestic Product (GDP) is growing by 8%, whereas the involvement of agriculture division is 1.9%. The government of India has encouraged the goal of providing electricity to all villages in various phases. Therefore, the aim of this research was to define the techno-economic analysis of decentralized Small Hydro Power projects in Kerala with the help of RET Screen expert software. The objectives are to explore the potential hydropower to be harvested by Small Hydro Power for rural electrification, to assess financial saving and cost analysis and to investigate the environmental impact of the Small Hydro Power in Kerala. The RET Screen expert is used to assess the economic feasibility of a Small Hydro Power system and to recommend the possibility of installing the technology in the Meenvallom SHP in Kerala. The RET Screen expert is a Clean Energy Management Software developed by the Government of Canada, which is a free-of-charge decision support software for pre-feasibility or feasibility analysis and also ongoing energy efficiency performance analysis (Netscreen Canada). An attempt has been made in this study is to evaluate the features of rural electrification in Kerala and the viability of Small Hydro Power (SHP).

Keywords: Techno-economic, Energy, Small hydropower, Renewable, RET Screen expert software

Introduction

Energy is the pillar for the progression of a nation. India's demand for electrical energy is increasing speedily, while its electrical energy structure is aggressive with severe scarcity to supply the same. Renewable energy technologies have performed a vital role in reducing the shortage of power crises. To discriminate the country's power generation mix, the Government of India has issued several nation-wide policies to stimulate their additional development. Among the renewable energy source, small hydropower contributes 13% of the total grid-connected power generation, thereby establishing the second-largest grid-connected system after wind power, as per the report by MNRE. India is brilliant with a vast and viable hydro potential for cleaner power generation. Due to its plenteous availability, it can be utilized competently to reduce the gap between energy demand and supply (Farrell). Such kind of power plants is quite possible wherever water resources are presented and where power is to be provided to remote areas away from the grid, especially rural villages. Kerala State has huge unexploited potential for Small Hydro Power (SHP) installation. Small, Mini and Micro Hydro Power plants play a vital role in electrifying the rural parts (Haberkorr).

Objectives of the Study

The objective of this study is to examine the techno-economic analysis of Small Hydropower (using the RET Screen expert software), which can be used to analyze the Meenvallom SHP in Kerala. The objectives of this study are as follows:

- To evaluate the credibility of SHP as a competitive alternative source of power generation for rural electrification.
- To examine the financial saving and cost analysis of Small Hydro Power for rural electrification.
- To analyze the techno-economic viability of Small Hydro Power of Meenavallom SHP in Kerala.

Methodology of the Study

The assessment of Small hydropower projects lengthens the time and cost required to achieve the projects which have concerned the engineers. Over the past twenty years, the engineers have developed various computer-based valuation tools designed to assess the project's economical -viability before spending large amounts of money and valuable time (Canada Launches Clean Energy Software).

The range of Computer-Based Assessment tools is from simple to advanced software packages. The majority of these computer-based assessment tools aim to predict the output of power in a given Small hydropower scheme (https://www.reeep.org). Also, some of these tools can perform financial analysis or cost estimation.

The Government of Canada established a Clean Energy Management Software known as the RETScreen expert software, which is a free-of-charge decision support software for pre-feasibility or feasibility analysis and also on-going energy efficiency performance analysis (http://www.retscreen.net).

If renewable energy projects are to be considered as good alternatives, certain criteria have to be qualified. They are technical , financial and greenhouse gas emission analysis, adaptability, durability, reliability and viability. The RE projects are different and large. This study used RET Screen expert software for analyzing the small hydropower project, namely Meenvallon SHP in Kerala. Besides, to give a scientific insight as this software can estimating the generation of power and saving, the accurate estimation of the cost within a short time, financial viabilities and Green House Emission (GHE) reductions of this research. Also, the present study will have a significant impact on contribution in renewable energy (RE), especially in Kerala. It can be beneficial for the rural people who have the same as climate.

Small Hydro Power in Rural Development

Large hydro projects are criticized as pro-urban and pro-rich, having a bias towards the affluent farmers, elite urban population and heavy industries. Small hydro projects are regarded as pro-rural as they can provide an answer to the quest for the development of the rural, isolated population. Keeping the village as the focal point of development of electric power system is a basic step to its development. Existing power grids concentrate more on urban areas, while rural and isolated areas are not satisfactorily covered (Paschotta). Rural electrification programs face several impediments due to the scattered nature of villages: the need for long transmission and distribution lines, involving heavy capital investments, difficult terrains in hilly areas etc., an extension of existing lines to faraway areas is considered very uneconomical about the prohibitive cost and resulting transmission losses. Diesel or thermal generation is also uneconomic given escalating fuel prices and high transportation costs. Solar power is expensive. Wind and bio-gas power is costly and location-specific. A small, mini, micro-hydropower scheme involving simple and economical civil engineering structure with shown distribution lines is the only potential option.

The basic premise for the significance of small hydro is the need for every additional unit of energy that can be generated and supplied to promote the social and economic wellbeing of the society. SHP development has definite social benefits as it improves education, health care, rural distribution and general welfare of the rural population. The versatile claim of SHP can regenerate the economy (Surendra, A.). SHP is ideal for developing not electricity but also irrigation,and agriculture, water supply and flood control, inland fisheries, industries, tourism environment protection, and a whole host

of other integrated rural development activities resulting in a far better quality of life in villages

Important Factors Manipulating Prospects of SHP

In Kerala, the SHP potential that has at least 331.03 MW. If this potential is extracted on a time-basis, the shortages in supply in the power system can be lessened to a great extent.

Table 1: Potentiality of Small Hydro in Kerala

Name of District	Number of Sites	Estimated Power Potential (MW)
Trivandrum	49	7.43
Kollam	31	8.45
Patrhanamthitta	39	0.66
Kottayam	32	6.19
Idukki	262	275.95
Ernakulam	23	2.8
Trichur	42	3.34
Palakkad	48	3.36
Malapuram	59	2.67
Kozhikode	53	9.99
Wayanad	48	3.68
Kannur	88	5.51
Kasargod	93	1
Total	**867**	**331.03**

Source: ANERT Report of Small Hydro Power Potentiality in Kerala

As small hydro projects cost less initially, they will not be a financial burden to the state. But there are some important points that have a significant bearing on the prospects, acceptability and popularity of small hydropower projects.

SHPs are Installations of Small Magnitudes

They are easy to be installed at a low initial capital cost and in a short period. These positive points of SHP should not get spoiled, as happened in the case of many short term projects. The shameful time and cost escalations have resulted in the unpopularity of hydropower stations of the state. This history should not repeat in the case of small hydropower projects. But this requires a complete restructuring, attractive policies and a proper framework.

Quantum of Each Element of Work Involved with SHP Schemes is Less

So competent, resourceful contractors may shy away from taking up the project or maybe willing only at a higher bid. A possible unfortunate outcome may be that small, local contractors with no expertise, experience and means, may get the contracts, resulting in low quality work or failures. A possible solution is to give the contract of complete works of an SHP to a single contractor or allot contract of groups of SHPs to a contractor. This can ensure good competent contractors executing SHPs. A Turn-key system is adopted in installation. Companies like SILK, which is well experienced, can be entrusted with jobs of SHP.

Local people, local materials, local equipment, local expertise and local technology must be encouraged to involve in and execute SHPs. Local-level participation can be utilized in the planning and construction stage (Ramachandra, T.V). As SHPs are location specific, local people may be best accustomed to the circumstances and specifications of the site. In identification, surveying, planning, construction and operation of SHPs. Popular participation must be assured. This can make SHPs more popular and decentralized. Development schemes that can succeed to come near the hearts of people can chew success. As SHPs are small scale and simple, local materials, local technology, local equipment, local expertise and local finance can be available. The projects can ensure employment to local people, better transport and communication facilities, positive spillover effects of infrastructure projects, and better voltage to nearby projects.

Thereby they can contribute to rural development in line with the Gandhian concept of development, which advocates that the soul of India sleeps in its villages. The multipurpose application of SHP like power generation, irrigation, agriculture, water supply, flood control, inland fisheries, and tourism can rejuvenate the village economy (Schiller, J). The development of villages and rural regions, which are possible abodes of SHP, can guide in overall progress of the state. Unlike mega projects which are anti-people by threatening the lives of people in the nearby areas by way of large-scale displacement, submergence and seismicity threats, the small hydro

projects are environment-friendly and pro-poor and pro-people.

SHP Development on a Decentralised Basis

Scope for a system of SHP development on a decentralized basis must be explored. It requires a new outlook, policies and dimensions different from that of the existing system of generation, transmission and distribution. The background for decentralized development is available in Kerala. SHP potential of the state is distributed in almost all districts; a system of administration is three-tier and decentralization perception is well established, well-practiced in the state. Transmission and distribution networks are well connected all over the state. The pattern of a distribution network and the availability of substations also are appropriate to adopt a decentralized SHP network. Panchayats are the key center of decentralized development. They must be entrusted with the accountability to develop their SHP potential through local loans, local funds, local materials and maximum local people's participation. Maximum aids/grants/subsidies/ soft and easy loans must be ensured. KSEB or agencies like EMC, IRTC, etc., can supervise and guide the installation of these projects (ARRERC). The quality of completed works and apparatus must be properly ensured by a supervisory expert committee. A people's committee comprising local people can be entrusted to ensure timely completion of works and avoid time and cost overruns. Indigenous technology and expertise must be utilized maximum. Localized transmission and distribution networks can be installed which must be connected with the state grid. The excess or shortage in generation can be adjusted with the state grid. Operation, maintenance and tariff collection must be the accountability of owner panchayats. KSEB can be the controlling agency, supervising constructions, operations, transmission and distribution and retaining the centralized power distribution and utilization of other power resource potential. The decentralized schemes can be plowed back to the development, operations and maintenance of the scheme and the excess can be used for the development of panchayat. An appropriately planned, coordinated, managed and installed network of decentralized SHP schemes are a potential option before the state.

Panchayat Owned SHP Schemes

The socio-political institution framework of Kerala entitles panchayats a significant role as the basic unit of direction. The role of panchayat reached unparalleled heights under the Peoples Plan, the decentralized planning system implemented in Kerala, making panchayats the key center of power, providing them the power to decide about themselves. Panchayat is the smallest administrative unit in Kerala. People's plan played a vital role in spreading the call of mini and micro HP projects. Panchayati Raj Legislation has approved panchayats' right to pursue SHP projects. The 'vipassana Rekha' (development outline) of peoples plan has specifically asked the panchayats to identify potential small, mini, micro-hydropower sites in the locality concerned; many panchayats have come forward to take up mini, micro-hydropower projects in the area; some enthusiastic panchayats have conducted surveys and prepared Thorough Project Reports (DPR) from their development funds (Central Electricity Authority).

At present, five schemes are allowed to panchayats and are under various stages of implementation. Meenvallom project is initiated by Karimba panchayath of Palakkad district. It has a 3MW installed capacity. The project owners have registered as a company in the name Palakkad Small Hydro Company. The panchayats are the major shareholders of this company. Kalanki mini hydroelectric scheme with 0.8 MW installed capacity is allowed to Kannur Zilla panchayat. Arippara SHP is a 3MW capacity SHP scheme allowed to Kozhikode Zilla panchayat. Adiyanpara is 0.8MW capacity scheme in Malappuram. 30% of the project cost is borne by panchayats as their contribution. The panchayat schemes have much potential in the state with a strong and vibrant panchayat network. Electric Energy Policy statement of Kerala govt (Balachander). Directs district panchayats to develop mini micro HPs or SHP. Energy Management Centre, Kerala, is assisting many panchayats in formulating project proposals. Based on a feasibility study done by EMC, govt. Will approve the project and transfer these projects to those local self-govt. Institutions interested; technical advice will be provided by the govt. Le/ US lake some examples from Ranni Panchayat: Ranni, in Pathanamthitta district, is a

panchayat much dedicated to utilizing its large SHP potential (Anni Ninnan).

Decentralised Isolated SHP Schemes

The popularity of the concept of small hydropower as a source suitable and adequate to meet the demands of rural people has enlightened the spirit of people striving for electricity and lighting in the remotest parts of the state where grid supply was a mere dream. People in those parts have to depend on firewood and kerosene for even lighting purposes. Many areas were occupied by the settler population. Many non-governmental agencies are behind the implementation and success of these ventures. People's School of Energy (Kannur), (Maithri@alakkad), Malanad Development Society (Kanjirappal1y) are some organizations that successfully implemented/initiated many of the mini HP schemes in different parts of the state. The Asankavala project near Karuvanchal in the Kannur district is regarded as a milestone, as the popularisation of the idea of mini HP schemes on an individual or community basis has started from the success of this project. The project was mooted by People's School of Energy in 1997-over a stream in Asankavala. The initial plan was to set up a station supplying power to 10 local households, but nine out of them backed out, and the project was scaled down to 1 kW generation (1200w exact) at an investment of Rs 240001. Panchayath SHP schemes practiced in the state are similar to these schemes in concept. Still, the difference is that unlike panchayath schemes, people are directly benefiting from these decentralized SHP projects they installed for which they have dedicated their labor and money. These projects are glaring examples of a Gandhian model of development and self-reliance.

Meenvallam Project

The Meenvallam project purposes of developing the potential power Meenvallam of tributary in Bharathapuzha basin. The project is a run of the river type. The project proposes limited storage to increase the power potential of the scheme. IRTC is behind the idea, opening and application of this scheme. The achievement of the scheme will inspire other projects introduced by IRTC under WGSHP. The involvement of scientific research organizations like IRTC makes the studies about the project more authentic and realistic. In 1999 January, Palakkad small hydropower company, got registered with Grama Panchayat. District Panchayats are shareholders for the funding of the project. The stockholders have advanced Rs.3 crore (30%share of the project). IRTC is appointed as the technical expert of the project.It is actually behind the setting up of this project (ANERT).

Features of the Meenvallam Project

- **Location:** Palakkad
- **Taluk:** Mannarkkad
- **Panchayat:** Karimba
- **Type:** Run Of River Scheme
- **Road Access:** 3 Km From Highway
- **River:** Meenvallam

Features of Hydrology

- **Catchment Area:** 6.2 Sq.Km
- **Average Annual Yield:** 286.594 Mm2
- **Average Annual Rain Fall:** 4289.4 Mm
- **Design Flood Discharge At The Weir Site:** 305 cumecs
- **Weir Type:** Gravity Dam
- **Penstock Number:** 1(Steel Penstock Spirally Weided)
- **Length:** 60m
- **Design Discharges:** 17.93cumecs
- **Max. Velocity:** 5.71m/Sec
- **Type And Number of Turbines:** 2 Nos.
- **Annual Power Generation:** 8.028 MU
- **Installed Capacity:** 2*1500 kW
- **Cost:** 912.4 Lakhs
- **Total Project Area:** 1.15 Hectares
- **Cost/ Kw:** 30,400
- **Idc on Loans:** Rs. 60.36 Lakhs
- **Return on Equity:** Rs. 37.96 Lakhs
- **Average Annual Generation:** 8.5 MU

Case Study Analysis of the Results with the help of RET Screen Software

Location and Climate data

Location

	Unit	Climate data location	Facility Location
Name		India-TamilNadu-Coimbatore / Peelamedu	India-Kerala-Palakkad
Latitude	˚N	11.0	10.8
Longitude	˚E	77.1	76.7
Climate Zone		1A - Very hot - Humid	1A - Very hot - Humid
Elevation	m	399	98

Financial Viability

Inflation rate	%	4.9%
Discount rate	%	9%
Project life	Yr	30
Incentives and grants	INR	1,000,000
Debt ratio	%	69.6%
Debt	INR	634,847,920
Equity	INR	277,552,080
Debt interest rate	%	10%
Debt term	Yr	15
Debt payments	INR/yr	83,465,854

Annual Revenue

Electricity export revenue		
Electricity exported to grid	MWh	61,802
Electricity export rate	INR/kWh	2.50
Electricity export revenue	INR	154,505,003
Electricity export escalation rate	%	2%

Costs | Savings | Revenue

Initial Costs			
Initial cost	100%	INR	912,400,000
Total initial costs	**100%**	**INR**	**912,400,000**
Incentives and grants		INR	1,000,000
Annual Costs and Debt Payments			
O&M costs (savings)		INR	200,000
Debt payments-15 yrs		INR	83,465,854
Total annual costs		**INR**	**83,665,854**

Annual Savings and Revenue			
Electricity export revenue		INR	154,505,003
Total Annual Savings and Revenue		**INR**	**154,505,003**

Financial Viability

Pre-tax IRR - equity	%	31.1%
Pre-tax IRR - assets	%	12%
Simple payback	Yr	5.9
Equity payback	Yr	3.5
Net Present Value (NPV)	INR	991,160,233
Annual life cycle savings	INR/yr	96,475,921
Benefit-Cost (B-C) ratio		4.6
Debt service coverage		1.9
Energy production cost	INR/kWh	1.501

Lessons Learned from the Project

From the above financial analysis it is understood that the project period is 30 years. The inflation rate and discount rates are respectively 4.9% and 9 % annually. It produced 2*1500kw. The export rate of each unit is Rs. 7. From each unit export to the grid the project gets the revenue of Rs. 154,505,003 annually. This project cost is Rs. 912.4 lakhs. The total annual maintenance cost is Rs. 7,877,708. The total annual savings and revenue is Rs. 154,505,003. The simple payback period is 5.9. It means that the investment payment is recovered within 5.9 years. The NPV is Rs. 991,160,233. This project is gainful because NPV is greater than original costs. The cost –benefit ratio is 4.6 and the IRR is 12%. The cost-benefit ratio is greater than one that means it is economically viable. So based on all indices of profitability, the scheme is economically viable and profitable. NPV is positive, B-C ratio is greater than unity, IRR is greater than the cost of capital and payback period is less than the critical minimum period. So the Meenvallam SHP project is economically feasible and viable. Profit from the project is very high.

Conclusion

The small hydropower projects are environment friendly, easy finance, easy clearance, easy installation are other advantages of SHP projects over major hydropower projects. Economically

and environmentally, they are beneficial related to thermal projects, as SHPs have zero fuel cost and is free from fuel cost increases .they have low operation and maintenance cost compared to thermal projects. The potential for a decentralization system of generation, transmission and distribution of power with SHP playing the key role must be explored.

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