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Rural Electrification – A step towards Sustainable Development

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ABSTRACT

The diverse landscapes, climates and social structures across India's numerous regions, encompassing approximately 0.586 million villages present a spectrum of economic prospects rooted in leveraging local resources carefully. Sustainable development relies on the prudent utilization of these resources. Among various resources energy stands out as a very crucial for the sustainable development of rural areas. Rural electrification plays a pivotal role in fostering sustainable development in India by facilitating economic growth and social progress. Despite efforts, only 44% of rural households have access to electricity. The Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), a national renewable energy scheme, aims to address this gap outlined in the National Common Minimum Programme (NCMP). While significant investments have been made in physical infrastructure, the focus has been on development rather than effective management. Ensuring reliable 24/7 power supply to essential facilities is crucial. The success of initiative like RGGVY hinges on empowering State Electricity Boards (SEBs) to enforce regulations and ensure reliable service delivery, especially during peak demand hours in rural areas. This paper delves into the significance and challenges of rural electrification, exploring technical solutions and viable strategies to empower policymakers in utilizing electrical energy effectively.

Key words: *Rural, Sustainable, Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), National Common Minimum Programme (NCMP)*

Introduction

Rural electrification stands as a pivotal step towards sustainable development, encompassing the transformation of remote areas through the provision of electricity. It not only illuminates homes but also facilitates the mechanization of agricultural tasks, enhancing productivity in farming operations. Moreover, electrification plays a vital role in alleviating poverty by addressing key factors like healthcare, sanitation, and education. Recent discourse underscores the significance of integrating electrification efforts with productive energy usage to effectively combat poverty. In the context of India, it is imperative that rural electrification is underscored by the nation's pursuit of food security, prompted by the lessons learned from past droughts. Despite recognition of its importance, progress in electrifying remote rural areas remains sluggish, necessitating concerted efforts to accelerate the pace of development in this regard.

Methodology

The research relied on secondary sources of data, which encompassed published sources, books, aca-

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demic papers and online resources. For conducting this research secondary data are used. Various reference books, Journals, Magazines, various Government reports and online articles to gather pre-existing data and information are used for this research paper.

Farmers in the Darkness

Rural electrification stands will lead to strong hope for sustainable development, particularly for farmers who have long labored in the darkness of unlit rural areas. In today's world, electricity is often taken for granted, with the simple flick of a switch transforming darkness into light. However, the absence of electricity in rural areas brings significant challenges, especially for those in the agricultural sector. Before the advent of electricity, farmers toiled tirelessly, carrying out tasks by hand or by the dim glow of lanterns at night. From milking cows to hauling water from deep wells, every aspect of farm work was arduous and time-consuming. Working in the shadows, farmers rose before dawn to milk cows by kerosene lantern light, struggling to see amidst the flickering shadows. With the limited daylight hours dedicated to fieldwork, the absence of electricity constrained productivity and perpetuated the cycle of laborious manual labor. Rural electrification has the power to transform the farmers' life, offering them the opportunity to work efficiently and effectively, ushering in a new era of prosperity and sustainable development in rural communities.

Benefits of Rural Electrification

Rural electrification serves as a keyelement for sustainable development, ushering in a multitude of benefits across various facets of rural life:

1. Enhanced Socio-Political Awareness: Access to electricity fosters greater awareness and engagement in socio-political issues within rural communities.

2. Economic Growth: Rural electrification stimulates economic growth by boosting community GNP and catalyzing industrial revolution, particularly through the emergence of small-scale and agro-allied industries.

3. Mechanized Farming and Irrigation: Electricity enables mechanized farming and irrigation pilot schemes, revolutionizing agricultural practices and enhancing productivity.

4. Mitigation of Rural-Urban Drift: Access to electricity reduces rural-urban drift by providing employment opportunities and improving living conditions in rural areas.

5. Technological Advancements: Electricity facilitates the introduction of information technology, improves educational standards, and enhances health sector control and management.

6. Infrastructure Development: Rural electrification drives infrastructural development, addressing issues such as improved lighting, access to communications, and public safety.

7. Environmental Conservation: Electrification reduces deforestation problems by mitigating desert encroachment and promoting sustainable land use practices.

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Moreover, reliable electricity services lead to increased productivity in agriculture and labor, better delivery of health and education services, improved communication, and enhanced public safety. Access to electricity also fuels economic growth, as demonstrated by the significant acceleration from 3% to 7% through the adoption of electric pumps for groundwater-based irrigation in rain-fed agriculture sectors. Thus, rural electrification not only meets the aspirations of rural populations but also serves as a cornerstone for sustainable development and prosperity in rural areas.

Sources of Renewable Energy

Rural electrification stands as a crucial step towards sustainable development, and leveraging renewable energy sources can play a vital role in this endeavor. Private sector investment holds promise for rural electrification programs, with renewable energy options emerging as particularly advantageous for two key reasons. Firstly, with the arrival of peak oil, the sustainability of oil-based electricity production is increasingly uncertain. Diversifying energy sources is essential to mitigate the risk of fossil fuel scarcity and price volatility. Secondly, renewable energy sources are becoming increasingly competitive as advancements in technology drive down costs and enhance commercial viability.

In India, the Ministry of New and Renewable Energy (MNRE) provides a strategic advantage for

promoting renewable energy initiatives. Deregulating this sector and relaxing licensing requirements for setting up off-grid plants are essential steps to unleash its full potential. By embracing renewable energy sources, rural electrification efforts can become more sustainable, robust and conducive to long-term development goals.

Rural electrification represents a central step towards sustainable development, and various technological models have been employed to achieve this goal. One such model is the Rajiv Gandhi Gramin Vidyutikaran Yojna (RGGVY) in 2005, spearheaded by the Ministry of Power, which builds upon earlier initiatives like the Kutir Jyoti Programme and the Rural Electricity Technology Mission.

The Kutir Jyoti Scheme, launched in 1989, successfully connected nearly 6 million households over 15 years, at an average rate of approximately 400,000 households per year. However, the RGGVY faces a more ambitious target, aiming to electrify approximately 6 million households annually for the next four years, surpassing the electrification rate achieved under Kutir Jyoti by over 15 times.

Source of Energy	How is it converted to electricity?	Risks and pitfalls
Bio Mass	Biomass electricity is produced by using plant products directly or indirectly. This can be implemented on a small scale or large scale. There are vast tracts of waste lands in India that can be utilized to grow high energy crops. Ethanol from corn and sugarcane has been runaway success in the need for alternative energy.	This would need construction of large scale refineries. Also, the decision on investment has to be only based on supplying to the main grid.
Solar PV	Solar energy itself comprises of thermal component as well as the light energy part. Solar Photo-voltaic use the light part of the energy to store DC electricity.	Current level of energy conversion efficiencies is poor. Research over the years have started yielding better efficiencies, but still are much costlier than other sources like wind.
Solar Thermal	This uses the heat component of the sun's energy. Solar thermal cookers are already quite prevalent in many parts of India and Africa. These can go a long way in reducing greenhouse gases especially in rural households where firewood cut from trees in the primary source of energy. Solar thermal ponds are also being experimented on to generate electricity.	While solar thermal power for cooking is a runway success, it's not efficient enough for generation of electricity.
Municipal Waste	Burning municipal solid waste can generate heat energy which can then be used to produce electricity. In the process 90% of waste also gets consumed.	Ash disposal and the air polluting emissions from plant combustion operations are the primary environmental impact control issues.
Bio Diesel	Crops such as Jatropha can be grown on arid and unirrigated lands. Large scale or small scale power plants producing electricity from biodiesel can be easily setup.	Same issue as in the bio mass case.
Wind Power	Wind is the most promising of the alternative sources of energy so far. It has really huge potential. Off grid wind mills can be set up easily. Potential applications include direct generation of electricity as well conversion to recharge batteries. As the penetration of hybrid cars and battery operated cars increases all over the world, small rural communities could benefit by co-locating small wind mills in petrol stations where hybrid cars and other battery operated scooters could get re-charged.	Capital investments are heavy. Also there's a discrepancy between supply and demand.

The objectives of RGGVY include achieving 100% electrification of all villages and habitations, providing electricity access to all households, and offering free-of-cost electricity connections to Below Poverty Line (BPL) households. To realize these objectives, RGGVY envisions the creation of a Rural Electricity Distribution Backbone (REDB) with substations in each block, Village Electrification Infrastructure (VEI) with distribution transformers in each village/ habitation, and Decentralized Distributed Generation (DDG) systems where grid extension is not feasible.

While the primary focus of rural electrification in India remains on grid extension, distributed generation is recognized as a crucial component, especially to address the demand-supply gap. Therefore, a two-pronged approach is envisaged, with grid extension prioritized alongside distributed generation to ensure comprehensive electrification coverage and meet the energy needs of rural populations effectively.

Rural electrification through grid extension, distributed generation and mini-grids is indeed crucial for sustainable development.

Grid extension requires careful consideration of transmission models and cost-effective infrastructure to ensure reliable supply. Meanwhile, distributed generation, exemplified by micro-hydel plants like the Janaki Chatti Micro-Hydel Committee, plays a vital role in electrifying remote villages. However, challenges like parts shortage and maintenance issues need to be addressed.

The current installed capacity of distributed generation, primarily diesel-based, highlights the need for transitioning towards renewable energy sources. Mini-grids offering 220 volts 50 Hz three-phase AC electricity, caters to various household, commercial and community needs leveraging renewable and distributed generation. These mini-grids, categorized based on their energy sources, are important for providing sustainable electricity access to rural areas.

Models for Electricity Transmission

Rural electrification in India is essentially a three-phase system either from the grid or from distributed generation units.

Capital Cost for Rural Electrification

Rural electrification is vital for sustainable development, entails significant capital costs primarily attributed to material expenses. These include conductors, poles, pole-top assembly accessories and transformers. To minimize material costs efficient utilization of existing design elements such as poles, conductors and line hardware is essential. Additionally, optimizing the design and construction processes can further reduce expenses which ensuring effective implementation of electrification projects.

Rural Electrification and Panchayats

Rural electrification plays a paramount role in fostering sustainable development, and the involvement of Panchayats is crucial in ensuring effective implementation. The Constitution of India, through the 11thschedule, empowers Panchayati Raj Institutions (PRIs) to oversee rural electrification activities, including distribution of electricity. Gram Panchayats have the potential to gradually take on responsibilities such as billing and collection of electricity dues from consumers within their jurisdiction. Some State Electricity Boards (SEBs) or Electricity Supply Companies (ESCOMs) have successfully outsourced billing and collection to private entrepreneurs, providing training and commission incentives as part of the arrangement.

Tariffs for Rural Electricity

However, the challenge of setting tariffs for rural electricity remains significant. The rural population is often thinly dispersed, leading to low energy density and high costs of energy supply. Additionally, the electricity needs for irrigation and rural industries are widespread, further complicating the cost dynamics. Despite the necessity for subsidies due to the low income levels of rural populations, sustained subsidization poses challenges. Even with assistance from various donors, no state can afford to provide subsidies to the entire rural population indefinitely. Balancing the need for affordable electricity with financial sustainability remains a key consideration in rural electrification efforts.

Importance of Cost Recovery

Rural electrification stands as a cornerstone for sustainable development and the importance of cost recovery cannot be overstated in ensuring the long-term effectiveness of electrification programs. Similar to other rural services like water, successful electrification programs prioritize cost recovery as a fundamental element. When cost recovery is prioritized, other program components tend to align more

effectively.

Successful electrification programs often secure a significant portion of capital at concessional rates or through grants. However, long-term sustainability hinges on recovering operating costs through revenues. Without cost recovery, the financial health of service providers deteriorates over time, rendering the system unsustainable.

Charging the Right Price for Electricity

Despite common beliefs that electricity tariffs for rural areas should be extremely low, evidence suggests otherwise. In reality, realistic tariffs do not deter rural populations from accessing electricity. Moreover, they enable significant savings compared to alternative energy sources like kerosene, LPG, or battery-powered solutions. Charging the right price allows electricity companies to provide reliable and sustainable power supply to rural consumers, leading to improved services and increased consumer satisfaction.

Current Status of Electricity Access in India

Rural electrification stands as a crucial step towards sustainable development in India, Approximately 90 percent of villages in India were estimated to be electrified in 2019. The 2017, government launched a project Saubhagya Scheme or Pradhan Mantri Sahaj Bijli Har Ghar Yojana aimed to provide electricity to all households in the country each household was provided with one LED light and a DC power plug including repair and maintenance of meter for five years.

Moreover, India's per-capita power consumption of 1,327 KWH is merely 25.77% of the world average.

Conclusion

In conclusion, the implementation of the Electricity Act 2003 is vital for fostering sustained planning at the district and state levels, with a focus on monitoring and decentralized accountability. Encouraging private sector participation in the power sector, particularly in rural electrification, is crucial. The Rajiv Gandhi Gramin Vidyutikaran Yojna (RGGVY) aims to achieve universal access to power in villages, while State Electricity Boards (SEBs) need to redefine their roles to effectively manage contracts with various providers and ensure legal compliance regarding service and tariffs.

Rural electrification is crucial in unlocking the vast economic potential of rural India. Therefore, it is imperative to plan, manage, and implement electrification programs effectively by drawing lessons from international experiences and adapting solutions to the unique realities of rural India. With the robust framework provided by the Electricity Act 2003, this ambitious program can be successfully implemented and meet its demanding targets, ultimately contributing to the sustainable development of rural areas in India.

Conflict of Interest: There are no conflicts of interest in the study undertaken.

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