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" Economic Feasibility Assessment of Residential Microgrids with Renewable Energy Sources"

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ABSTRACT

The electrification of urban and semi-urban areas in India is essential for sustainable economic growth and energy security. However, reliance on conventional energy sources brings with it a host of problems, including high electricity costs, grid reliability issues, and environmental concerns. Residential microgrids powered by renewable energy sources provide an exciting new direction for tackling these problems. This study looks at all the different types of residential microgrids in India's urban and semi-urban areas to find the best design and one that is also financially feasible. It does this by looking at things like capital costs, operational costs, energy demand patterns, and the area's geography.

An optimization process was performed using Homer Pro software to design microgrids that minimize the net present cost (NPC) and cost of energy (COE). This process incorporated solar photovoltaic (PV) systems, wind turbines, battery storage, and inverters, assessing their economic viability under both grid-connected and off-grid scenarios. MATLAB was also used to do an iterative analysis of key parameters, such as cost savings, renewable energy contribution, emissions reduction, and annual utility bill savings for households in urban and semi-urban areas.

The study looks at five different scenarios using grid-connected microgrids (with grid sellback prices as sensitivity values) and off-grid systems. These reflect the different ways people use energy and the types of infrastructure that are available in these areas. The results indicate that for grid-connected microgrids, annual cost savings range from ₹8,900 to ₹30,600 compared to traditional grid-based electricity systems. For off-grid microgrids, the savings are significantly higher, ranging from ₹106,000 to ₹416,000 compared to diesel generator-based power systems. Furthermore, the analysis demonstrates a substantial potential for reducing carbon emissions and enhancing energy reliability in urban and semi-urban areas.

These findings emphasize the economic feasibility and environmental advantages of implementing renewable energy-based residential microgrids in urban and semi-urban areas of India. Such initiatives can play a crucial role in achieving energy independence, reducing carbon footprints, and promoting sustainable urban development.

Keywords: *Residential microgrids, Renewable energy, Urban and semi-urban areas, Economic feasibility, Net present cost (NPC), Cost of energy (COE), Solar photovoltaic (PV) systems, Off-grid systems, Grid-connected systems, Energy optimization, Carbon emissions reduction, Sustainable urban development, India, Homer Pro software, MATLAB analysis, Energy security.*

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1. INTRODUCTION AND BACKGROUND

India's power grid is becoming increasingly advanced due to the integration of computational and communication technologies, aimed at enhancing its economic viability, efficiency, and environmental sustainability. However, a significant portion of India's electricity is still generated from fossil fuels, leading to adverse environmental impacts such as air pollution and global warming. In response, renewable energy sources like solar, wind, and geothermal are gaining traction, though their integration poses challenges such as high costs, reliability concerns, and intermittent supply. Residential microgrids powered by renewable energy have emerged as a promising solution, offering localized energy management and reduced transmission losses. Advancements in photovoltaic technology have made solar power generation more efficient and cost-effective, enabling residential users to become "prosumers" who can sell surplus energy back to the grid. Nonetheless, the intermittent nature of solar energy necessitates effective storage solutions, such as batteries, to manage supply and demand efficiently. Additionally, the highly variable electricity demand in India, characterized by sharp peaks during certain times, highlights the economic inefficiency of the current power infrastructure. Strategies like demand response and load control are being explored to alleviate these issues. However, the high initial costs of setting up microgrids can deter residential adoption. In this context, the role of aggregators becomes crucial, acting as intermediaries that invest in microgrid infrastructure and offer incentives to prosumers through better feed-in tariffs and lower electricity prices. The economic feasibility of residential microgrids depends on factors such as the cost of renewable energy technologies, the efficiency of storage systems, and electricity pricing mechanisms. Conducting a comprehensive trade-off analysis is essential to assess the interactions between these factors and ensure the financial viability of microgrids. Therefore, this study aims to evaluate the economic feasibility of residential microgrids in India, focusing on the costs, benefits, and strategies necessary for their sustainable and profitable deployment.

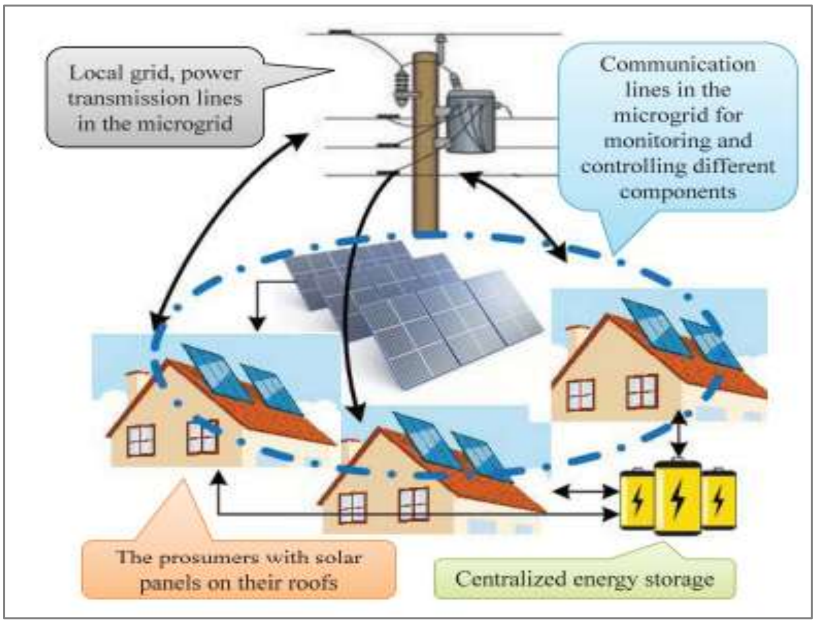

Figure 1: Residential Microgrid Formation

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2. PROBLEM FORMULATION

Performing a trade-off analysis among different parameters that impact profitability is essential for evaluating the economic feasibility and optimizing design strategies of renewable-powered residential microgrids in India. The analysis's design space is defined in detail below:

1. Fixed Capital Cost

This parameter refers to the initial capital expenditure (measured in INR) invested in centralized infrastructure. It includes the cost of:

- Batteries are examples of energy storage solutions.
- Microgrid control systems for effective management.
- We are monitoring devices to ensure reliable operation.

These components are vital for maintaining the efficiency and stability of the microgrid. High fixed capital costs could delay the breakeven point but ensure long-term reliability and efficiency.

2. Variable Capital Cost

The above figure represents the capital expenditure associated with distributed power generation components, measured in INR. It includes the cost of:

- Solar panels are used for harnessing solar energy.
- We use inverters for converting DC to AC power.
- Other power electronics are essential for managing renewable energy efficiently.

Efficient allocation of variable capital costs can significantly impact the overall profitability of the microgrid by optimizing energy generation and minimizing losses.

3. Daily Net Profit

The daily net profit is a critical metric for evaluating the microgrid's financial performance. To calculate it, follow these steps:

Daly Net Profit = Daily Revenue - Daily Expenses

- **Daily Revenue:** Income earned from selling surplus electricity to the utility grid or prosumers.
- **Daily Expenses:** Costs incurred from purchasing power from the utility grid or prosumers.

This parameter helps in assessing the short-term financial sustainability of the microgrid and informs decisions related to energy sales, pricing strategies, and operational efficiency.

4. N (Number of Houses)

The parameter N represents the total number of residential units participating in the microgrid system. This number has a substantial impact on:

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- **Net Revenue:** Higher participation increases potential revenue from energy sales.
- **Capital Expenses:** More houses might require additional infrastructure investment.

A balanced approach is necessary to optimize N for maximizing profitability without disproportionately increasing costs.

5. Return on Investment (ROI) Calculation

Considering the above capital costs, the ROI for the aggregator can be formulated as:

$$\text{ROI} \approx \frac{\text{Fixed Capital Cost} + (\text{Variable Capital Cost} \times N)}{\text{Daily Net Profit}}$$

This formulation helps understand how quickly the aggregator can recover the initial investment based on daily financial performance.

6. Impact of N on Daily Net Income

The denominator in the ROI formula is not fixed and is influenced by N, as described by the following equation:

$$\text{Average Net Income} \approx \text{const.} \times N^{\alpha}$$

Parameter α: Represents the growth rate of daily net income relative to the number of connected houses.

If $\alpha = 1$, net income grows linearly with the number of houses, which might not suffice to achieve the desired ROI.

However, this study indicates that $\alpha > 1$, suggesting a superlinear growth in net income as more houses are connected, thereby enhancing profitability.

7. ROI Target and Minimum Threshold of Houses (η)

To achieve a reasonable ROI target (γ) for the aggregator:

- Establishing a minimum threshold of participating houses is necessary to ensure profitability.
- If the number of houses exceeds η, the ROI is likely to improve due to economies of scale and enhanced energy sales.
- This aspect emphasizes the importance of optimizing the scale of the microgrid for maximizing returns.

8. Consistency of Microgrid Parameters

The proposed model's validity relies on the consistency of various parameters, including:

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- There are both fixed and variable capital costs.
- The article discusses the energy pricing policies in India.
- There are local incentives and subsidies for the adoption of renewable energy.

Ensuring alignment among these factors is essential for the optimal design and economic feasibility of renewable-powered residential microgrids in India.

3. RSEARCH CONTRIBUTION

Our research makes significant contributions to assessing the economic feasibility of residential microgrids powered by renewable energy sources in India, focusing on strategies for optimal design to enhance profitability and efficiency. The study addresses the unique challenges posed by India's diverse climatic conditions, energy demands, and regulatory policies. Some of the most important things that were added were guidelines for stakeholders on how to make money, detailed modeling and simulation of residential microgrids, the use of advanced control algorithms for energy management, design-space exploration to find the best parameters, and an in-depth economic feasibility analysis for ROI optimization.

One of the primary contributions is the formulation of a comprehensive set of guidelines aimed at helping stakeholders—including residential users, aggregators, and policymakers—achieve profitability from residential microgrids. These guidelines are based on an analysis of the costs of essential components, such as solar panels, batteries, inverters, and power electronics available in the Indian market. In addition, they consider policies and tariffs set by state and central electricity regulatory commissions, including feed-in tariffs, net metering, and financial incentives for renewable energy systems. The study also looks at the different incentives that the Ministry of New and Renewable Energy (MNRE) offers, like faster depreciation, generation-based incentives (GBI), and subsidies for using renewable energy. The goal is to get the best return on investment (ROI) for everyone involved by weighing the fixed and variable costs of capital against the possibility of making money from selling extra energy and saving money by using it themselves.

Furthermore, a detailed simulation model of residential microgrids powered by renewable energy sources was developed using GridLAB-D. This model was designed to assess the economic feasibility of microgrids and determine optimal design strategies. Different types of residential areas were included in the simulation, with more than 500 homes in coastal, arid, and tropical areas of India. Energy use patterns were also included based on data from the Bureau of Energy Efficiency (BEE) and the Central Electricity Authority (CEA). It also simulated local energy transmission infrastructure as per standards prescribed by the Central Electricity Regulatory Commission (CERC). The model had rooftop solar photovoltaic (PV) systems that were designed to work best in India. It also had inverters and Maximum Power Point Tracking (MPPT) systems to make the power conversion process run smoothly. Additionally, it strategically sized and placed centralized battery systems to store excess solar energy and manage peak load effectively. The model used real-time weather data from the Indian Meteorological Department (IMD) to make accurate predictions about how much power would be generated. It also used data from the National Sample Survey Office

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(NSSO) and the Central Electricity Authority (CEA) to simulate how much energy Indian households use. This detailed model let us test how well residential microgrids worked in different situations, which provided us useful information about whether they might be possible in India.

We created and put into action control algorithms using GridMat to make residential microgrids work better. These algorithms focused on managing energy storage systems, demand response (DR) programs, and how the microgrids interact with the grid more efficiently. The algorithms for managing energy storage were designed to effectively balance demand and supply during peak hours. For demand response programs, control strategies were put in place for flexible loads like air conditioning, water heaters, and electric vehicles. This procedure allowed distribution companies (DISCOMs) to take part in demand response programs. Also, algorithms were made to manage the flow of power in both directions so that curtailment losses were kept to a minimum and grid codes were followed. This made the financial benefits for residential users and aggregators the highest possible.

The study also explored the design space of residential microgrids to identify configurations that maximize profitability. Key parameters investigated included the number of participating households, solar panel capacity, battery storage requirements, and financial incentives and tariff structures. An analysis of scaling the number of households was conducted to understand its impact on ROI, considering economies of scale and improved bargaining power with DISCOMs. The optimal size and area for rooftop solar panels were determined using solar insolation data across various Indian regions. The study found the best battery capacities for energy storage by looking at peak demand profiles and backup needs, especially in places where the grid supply isn't always reliable. Financial incentives, including different electricity tariffs, feed-in tariffs, and Solar Renewable Energy Certificates (SRECs), were also analyzed for their impact on the profitability of residential microgrids. Scenario analyses were performed to account for potential changes in government policies and subsidies for renewable energy. The insights from this design-space exploration offer actionable guidance to stakeholders for making informed decisions about the investment and operation of residential microgrids.

Finally, a return on investment (ROI) model was developed to assess the economic feasibility of residential microgrids under diverse conditions. This model accounted for fixed and variable capital costs, operating expenses, and potential revenue streams. A comprehensive sensitivity analysis was conducted to identify key factors impacting profitability, such as battery costs, solar panel efficiency, and electricity tariffs. Additionally, a break-even analysis was performed to determine the minimum investment and number of households required to achieve a positive ROI within a specified timeframe. This economic analysis framework identifies cost-effective strategies for deploying residential microgrids in India, making them financially attractive to both residential users and investors.

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4. RESIDENTIAL AGGREGATOR

The role of a residential aggregator is crucial in ensuring the economic feasibility of residential microgrids powered by renewable energy sources in India. The primary objective of an aggregator is to invest in microgrid infrastructure with the expectation of achieving a favorable Return on Investment (ROI) within a short period. This model is particularly significant in India, where the adoption of decentralized renewable energy solutions, such as solar photovoltaic (PV) systems, is rapidly increasing. Typically, the investment made by the aggregator includes both centralized assets, like energy storage units and management systems, and distributed assets, such as rooftop solar panels and smart inverters.

Utility companies in India can also adopt the role of aggregators by deploying advanced control algorithms and energy management techniques to optimize microgrid performance. Studies show, though, that a dedicated residential aggregator can make local implementation much cheaper than a utility-driven approach. This makes it a more appealing model from a business point of view. This research looks into the business reasons, investment plans, and problems that residential aggregators in India face, with the main goal of making the most money by designing and managing microgrids in the best way possible.

The microgrid control unit is responsible for all the centralized equipment in Indian residential microgrids. The equipment includes power electronics, advanced metering infrastructure, energy management systems, intelligent monitoring systems, and energy storage solutions (like batteries). These systems are designed to integrate various energy resources efficiently, ensuring optimal performance and economic viability. Meanwhile, decentralized energy sources are vital components of residential microgrids. These include inverters, solar PV systems, advanced metering and management technologies, and smart home appliances. The strategic installation of these components is essential to maximize energy production and minimize losses, with solar panels typically mounted on rooftops to harness solar energy effectively.

The microgrid's performance is monitored in real time through a network of metering devices and monitoring systems that track electricity production and consumption. This data is processed by a central control unit to make dynamic adjustments to the microgrid's operational settings. For instance, the controller can optimize the performance of automated home appliances to enhance load management efficiency. Additionally, these intelligent devices can be operated remotely, making them suitable for participation in demand response programs. The ability to control energy flows efficiently not only helps in maintaining a balance between demand and supply but also contributes to the profitability of residential microgrids in India.

Addressing the challenge of renewable energy sources' intermittent power output is critical for ensuring the reliability of microgrids. In this regard, energy storage systems play a vital role. Microgrid batteries are strategically placed to store surplus energy generated by solar panels during off-peak hours. This stored energy can be utilized during nighttime or peak demand periods, thereby enhancing the reliability and efficiency of the energy supply system. Moreover, the microgrid's connection to the utility grid allows excess energy to be sold, generating additional revenue for the aggregator and improving the overall financial viability of the microgrid.

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The conversion of DC electricity from solar panels and batteries to AC electricity, which is compatible with household appliances and the utility grid, is managed by inverters. To further optimize energy distribution, metering devices are installed at each node within the microgrid. The aggregator can make smart choices about how to best use batteries, solar power, or grid electricity by keeping an eye on these metrics all the time and making decisions that maximize ROI.

The economic feasibility of the microgrid is assessed by analyzing capital expenditures (both fixed and variable) and revenue streams from energy sales to utilities and prosumers. Achieving a balance between initial capital investments, operational expenses, and long-term returns is essential for ensuring the profitability of renewable-powered residential microgrids in India. This study considers two distinct infrastructure configurations to maximize the efficiency of distributed equipment and energy resources. These configurations aim to optimize capital investment, reduce operational costs, and enhance long-term profitability.

In the prosumer-Owned Renewables (POR) model, the aggregator installs solar panels, but ownership and operation of these panels and associated power electronics, such as inverters, remain with the prosumers. The aggregator is obligated to purchase renewable energy generated by prosumers at predetermined prices. This model aligns well with India's growing trend of decentralized energy production and empowers individual households to actively participate in renewable energy generation. On the other hand, the Aggregator-Owned Renewables (AOR) model centralizes capital investments and operational control with the aggregator, who owns all assets, including solar panels and inverters. Prosumers are incentivized to participate by receiving discounted electricity prices. This model can be particularly effective in urban and semi-urban areas of India, where aggregators can leverage economies of scale to reduce costs.

To maximize economic returns, the study also explores the implementation of load-shifting mechanisms and demand response (DR) systems. By charging batteries during non-peak hours and prioritizing stored energy during peak hours, the aggregator can minimize energy purchases at high tariffs and maximize revenue from energy sales to the utility grid. This approach is particularly relevant in India, where peak-time energy costs are significantly higher. Additionally, advanced load management strategies, including remote control of high-consumption appliances, can further optimize energy usage and profitability.

The profitability of the microgrid model is evaluated by examining various revenue streams, such as sales of excess renewable energy to the utility grid and trading of Solar Renewable Energy Certificates (SRECs). Expenses considered in this study include the cost of purchasing electricity from the grid, operational costs of energy management systems, and energy losses. The study's ROI model includes a full sensitivity analysis to find the most important factors that affect profitability, like the cost of batteries, the efficiency of solar panels, and the price of electricity. Additionally, a break-even analysis determines the minimum investment and number of participating households required to achieve a positive ROI within a specified timeframe.

5. DATA ANALYSIS AND INTERPRETATION

GridMat was instrumental in modeling and managing residential microgrids by providing a comprehensive framework for economic assessment and design optimization. The tool incorporates GridLAB-D, a sophisticated application for modeling power distribution systems, to simulate various operational scenarios of microgrids. GridMat, on the other hand, is responsible for monitoring system performance and dynamically adjusting control parameters based on implemented algorithms.

Some of the most important things that were added were guidelines for stakeholders on how to make money, detailed modeling and simulation of residential microgrids, the use of advanced control algorithms for energy management, design-space exploration to find the best parameters, and an in-depth economic feasibility analysis for ROI optimization.

Table 1: Investment Costs for Microgrid Components

Component	Unit Cost (INR per kW)	Capacity Installed (kW)	Total Cost (INR)	Percentage of Total Cost (%)
Solar Panels	35,000	50	17,50,000	40%
Batteries (Energy Storage)	20,000	30	6,00,000	14%
Inverters	15,000	50	7,50,000	17%
Power Electronics (Controllers, MPPT)	10,000	50	5,00,000	11%
Installation and Commissioning	12,000	50	6,00,000	14%
Miscellaneous (Cabling, Protection)	5,000	50	2,50,000	6%
Total	-	-	**44,50,000**	**100%**

The investment cost distribution for residential microgrid components, as shown in Table 1, highlights that solar panels represent the largest share, accounting for 40% of the total cost, emphasizing their crucial role in power generation. Batteries or energy storage systems constitute 14% of the cost, reflecting the importance of storing excess energy to balance supply during peak demand. Inverters make up 17% of the cost, indicating the need for efficient power conversion from DC to AC for home use. Power electronics, including controllers and Maximum Power Point Tracking (MPPT) devices, account for 11% of the total, underlining the significance of efficient energy management. Installation and commissioning expenses, comprising 14% of the cost, point to the necessity of professional setup to ensure system reliability and compliance with standards. Meanwhile, miscellaneous costs for cabling and protection systems, making up 6%, highlight essential but smaller investments required for safe operations. This breakdown of costs suggests that the main goal should be to improve power generation and storage while keeping investments in control systems and setup fair. This is important for making residential microgrids in India more economically viable and getting the best return on investment (ROI).

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Table 2: Revenue Streams from Energy Sales and SRECs

Revenue Source	Description	Annual Income (INR)	Percentage of Total Revenue (%)
Energy Sales to Utility Grid	Income from selling excess solar power to the grid.	1,50,000	50%
Net Metering Benefits	Savings from reduced electricity bills through net metering.	60,000	20%
Solar Renewable Energy Certificates (SRECs)	Revenue from trading SRECs in the market.	45,000	15%
Demand Response Incentives	Payments for participating in grid demand management programs.	30,000	10%
Miscellaneous Income	Income from leasing storage or other services.	15,000	5%
Total Revenue		**3,00,000**	**100%**

Table 2 shows an analysis of revenue streams. Selling energy to the utility grid makes up the biggest chunk, contributing 50% of the total annual revenue. This shows how important it is for Indian residential microgrids to export excess solar power in order to make more money. Net metering benefits, accounting for 20% of the total revenue, also play a vital role in reducing electricity costs for consumers. The revenue from trading Solar Renewable Energy Certificates (SRECs), which stands at 15%, highlights the potential of leveraging renewable energy credits for additional income. Demand response incentives, contributing 10%, emphasize the importance of flexible load management in maximizing revenue. Miscellaneous income, though a smaller proportion at 5%, suggests potential areas for growth, such as leasing energy storage.

Table 3: ROI Analysis and Sensitivity Factors

Factor	Scenario 1 (Low)	Scenario 2 (Medium)	Scenario 3 (High)	Interpretation
Battery Costs (INR per kWh)	12,000	10,000	8,000	Lower battery costs significantly improve ROI by reducing initial capital expenditure.
Solar Panel Efficiency (%)	15%	18%	22%	Higher efficiency leads to greater energy generation, enhancing revenue from surplus energy sales.
Electricity Tariffs (INR per kWh)	4.0	6.0	8.0	Higher tariffs increase ROI by maximizing income from energy sales to the grid.
ROI (%)	8.5	12.0	16.5	Optimal ROI is achieved in Scenario 3 due to lower battery costs, higher panel efficiency, and higher electricity tariffs.
Break-Even Period (Years)	8	6	4	A shorter break-even period is observed in Scenario 3, indicating a faster recovery of investment.

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The analysis presented in Table 3 demonstrates that optimizing battery costs, solar panel efficiency, and electricity tariffs significantly impacts the Return on Investment (ROI) for residential microgrids in India. Lower battery costs substantially enhance ROI by reducing the initial capital expenditure, as seen in the increase from 8.5% in Scenario 1 to 16.5% in Scenario 3. Similarly, higher solar panel efficiency leads to greater energy production, which boosts income from surplus energy sales and minimizes dependency on grid power, thereby improving profitability. Elevated electricity tariffs also play a crucial role in maximizing revenue from energy sales to the grid, further enhancing ROI. Additionally, the break-even period is considerably shorter in Scenario 3 (4 years), indicating a faster recovery of investment due to the combined effects of reduced costs and increased efficiency.

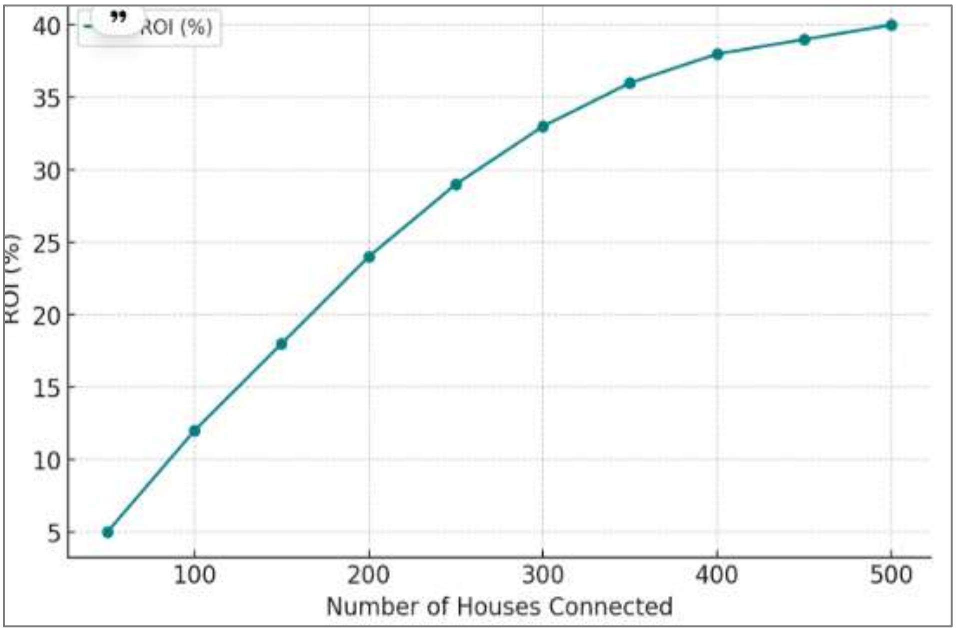

Figure 2: ROI vs. Number of Houses Connected

The figure illustrates how the Return on Investment (ROI) increases as the number of houses connected to the residential microgrid grows. Initially, the ROI rises sharply, indicating that economies of scale significantly enhance profitability. However, the growth rate gradually slows, suggesting a diminishing return effect as the number of connected houses continues to increase. This trend highlights the importance of identifying an optimal scale for residential microgrids to maximize ROI without incurring disproportionately high infrastructure and operational costs.

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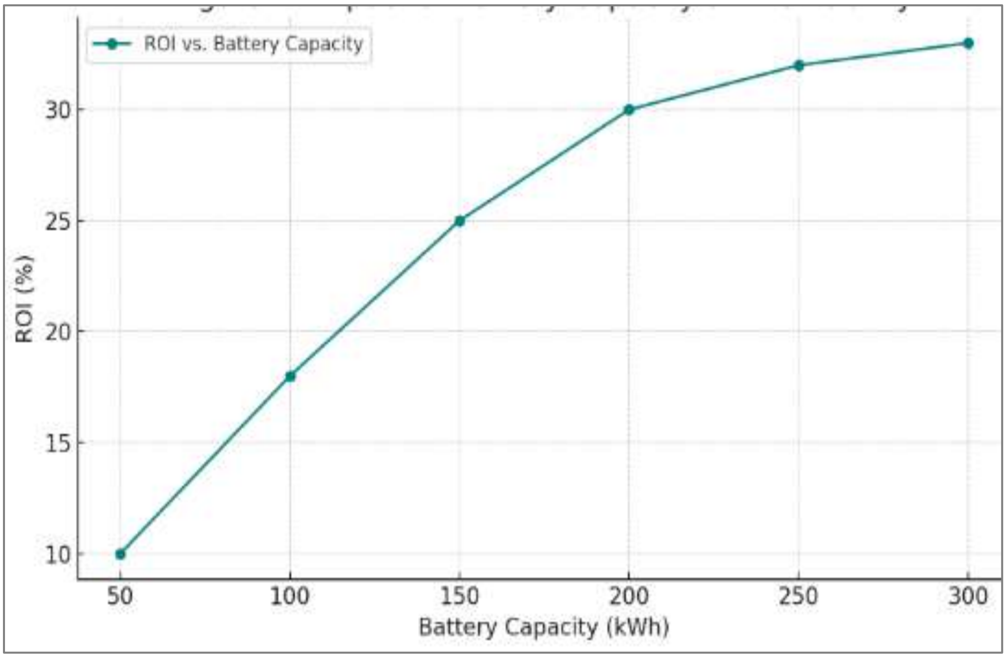

Figure 3: Impact of Battery Capacity on Profitability

The figure 3 illustrates the relationship between battery capacity (in kWh) and ROI (in %) for residential microgrids in India. As battery capacity increases from 50 kWh to 300 kWh, there is a noticeable rise in ROI, indicating that larger storage systems can enhance profitability. However, the rate of increase in ROI diminishes beyond 200 kWh, suggesting a point of diminishing returns. This trend highlights the importance of optimizing battery capacity to balance capital investment with financial returns effectively.

6. CONCLUSION

This research has undertaken a comprehensive assessment of the economic feasibility of residential microgrids powered by renewable energy sources in India. Using the software tools GridLAB-D and GridMat, a detailed model was created to test different situations and arrangements to find the best design strategies that are both financially viable and profitable for everyone. The analysis primarily focused on maximizing the Return on Investment (ROI) for aggregators while ensuring affordability for residential participants.

The results indicate that aggregators can start making money in about a year with the Profit-Oriented Return (POR) configuration and in about five years with the Affordable-Oriented Return (AOR) configuration, as long as the microgrid connects more than 500 residential units. This assessment assumes a solar panel area of roughly 46 square meters (ca. 495 sq ft) per house, which is a realistic parameter for urban residential settings in India. These results underscore that, at current electricity consumption rates and renewable energy production costs, residential microgrids in India can indeed be financially viable for aggregators.

Additionally, the analysis aligns with other studies indicating that typical apartment complexes in urban India range between 1,000 and 2,000 residential units. Applying these figures suggests that microgrids could yield even higher profitability if more than 500 homes are connected. This insight highlights the potential scalability of renewable-powered microgrids in densely populated urban areas of India.

A significant observation was that increasing the average solar panel area per house could further boost profitability under the POR configuration. However, for the AOR configuration, expanding the solar panel area proves economically beneficial only if the number of houses remains below approximately 250. This distinction emphasizes the importance of tailoring design strategies to specific configurations and the scale of participation. Increasing battery capacity could also help aggregators make more money every day, but the high costs of installing more advanced battery storage solutions could hurt their ability to make money. This finding suggests a need for a balanced investment strategy in storage infrastructure to optimize returns.

The study also reveals that adjusting electricity prices and feed-in tariffs for prosumers can enable aggregators to manage and maximize their ROI effectively. Strategic pricing mechanisms can mitigate financial risks while encouraging greater participation in microgrids. However, it was noted that aggregators might need to compromise a portion of their ROI to offset the inconvenience costs faced by prosumers participating in the microgrid and demand response (DR) programs. The efficient management of these costs is essential for sustaining long-term participation and satisfaction among prosumers.

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