Electricity Access, Gender Disparity, and Renewable Energy Adoption Dynamics: The Case of Mountain Areas of Bangladesh

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The United Nations underlines that "achieving gender equality and empowering all women and girls" is vital for an economy to attain its full potential, making gender equality a "critical element" in the development goal. However, it has been argued that there is still a considerable discrepancy in gender engagement due to a lack of policy implementations. In order to promote gender equality, certain initiatives have been focusing on women's economic engagement, i.e. empowerment. These include financial inclusion, political participation, and property rights among others.

Energy and gender equality are linked as recent literature points to the positive impact of electricity access on women's empowerment, especially in the case of developing countries. Energy access has disproportionately favoured women in developing economies because women spend more time in operating the household than men. Therefore, gaining access to electricity is expected to empower women through an increase in labour supply in non-household activities as well as overall economic autonomy and economic decision-making abilities.

Women and girls in the Indian sub-continent facing inequality due to existing social norms has been long observed. The results of gender discrimination prove to be multifaceted such as from being less educated than men and boys and having less access to information, skills, training, and labour markets, to facing greater risks of violence and harmful practices. These factors, overall, constrain women's chances of empowerment both at household and non-household activities, which is linked with regional economic development. Thus, women empowerment is intuitively perceived as a major driver of economic development in these regions. Moreover, in mountain regions such as the Chittagong Hill Tracts (CHT) of Bangladesh, women have experienced more disadvantages than those in flatlands due to inadequate access to energy and infrastructures.

The government and private entities have taken initiatives to generate renewable electricity from devices such as Solar Home System (SHS) in the CHT to electrify the vast off-grid areas as grid connectivity is challenging due to the combinations of steep hills and narrow valleys. These projects improve access to services and increase the quality of essential social services for women and children. Some unique ways in which women have been empowered are through income-generating activities at night. Household income also increased as a result while such initiatives have also improved the living standards of marginalised women by uplifting their social and economic conditions. Nevertheless, issues of high price, lack of appropriate finance, and maintenance costs seem to restrict the multiplier effect of such initiatives in the CHT districts, contributing to the persistence in gender disparity. Therefore, we aim to explore the relationship between electricity access, gender disparity, and renewable energy adoption in the mountain areas of Bangladesh.

We develop a theory-driven empirical framework for the paper's analysis. The empirical analysis uses a novel set of micro-level data obtained from a holistic survey conducted in the CHT districts in 2022. The empirical analysis is divided into three distinct phases, where robust non-experimental and quasi-experimental econometric methods are applied.

In the first phase of the empirical analysis, we reveal that access to electricity has a strong positive impact on women empowerment indices, such as economic freedom, economic decision, household decisions, and mobility and agency in total and split samples (i.e., urban and rural sub-samples). Keeping

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the aforementioned findings in mind, in the second phase of the empirical analysis, we confirm that the average effect of access to electricity on the women empowerment indices does not significantly differ for grid-electricity-connected households and households outside the grid coverage. This finding leads us to the third phase of the empirical analysis. In the third phase, we find that the earlier insignificance arises because off-grid households are utilising renewable energy devices (i.e. SHS) for ensuring reliable access to electricity. We further show that the likelihood of renewable energy device adoption declines due to a surge in different non-food expenditures in the CHT households, where the poorer households suffer the most. Moreover, it was observed that issues of instalments issues and high cost of maintenance tend to act as barriers for facilitating smooth outreach of renewable energy devices in the CHT districts.

The success of off-grid electrification initiatives could be strengthened by collaborating with renewable energy actors in a public-private partnership to acquire green funds to establish a mechanism for providing after-installation services of the distributed SHS in the CHT remote households to reduce upward pressure on income-expenditure. Moreover, we argue in favour of innovative financial schemes to facilitate renewable energy device adoption in the off-grid areas of CHT districts. Policies should increase the reach of microfinance in the CHT areas similar to the districts in the flat lands. Besides, a policy push by the government to facilitate a customised green mobile banking scheme in collaboration with microfinance institutions should be introduced to overcome the geographical barrier. We also advocate in favour of purposeful surveys in rural Bangladesh. Implementing such surveys on large scale or integrating our survey materials in the existing national surveys can contribute to better policy design for remote and less-connected areas to improve the energy landscape.

The methodology of the study can be used to research other aspects of ESG in the future. Another avenue of extension could be to design Randomised Control Trial (RCT) studies to understand the heterogeneity dynamics of women empowerment in different parts of Bangladesh.