



Women in Renewable Energy: A conceptual framework

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Abstract

The importance of gender has drawn the attention of scholars of energy research from time to time, creating awareness of intersections of energy access and gender equity. Differences between women and men in their access to and use of energy services constitute the theme of gender-energy nexus. Women's underrepresentation in the renewable energy sector is not confined to a single country or region, but reflects a global pattern that cuts across geographies. Gender equality and sustainable development are intrinsically linked. The aim of this paper is to explore within a certain framework the gender dimension in different aspects of renewable energy. It explores the historical and theoretical understanding of gender as well as presenting gender from the standpoint of energy and vice-versa. The paper elucidates the forms of gender inequality that occur in the renewable energy sector and the factors contributing to the low participation of women, despite their high interest and concern for environmental and energy issues.

Keywords: Renewable Energy, Gender equality, Women participation, sustainable Development

1. Introduction

"Women make up half of the world's population, yet their perspectives remain underrepresented in shaping the future of energy transitions. It's time to turn blind spots into bright spots." WEC2025

One of the fundamental principles of the 2030 Agenda of sustainable development goals is to "leave no one behind", which means that development must benefit everyone. Thus, achieving sustainable development requires recognizing the contributions of women, who form half of the world's population, ensuring their meaningful participation in decisions that affect their lives and their communities, and equitable benefits to both men and women. Women's underrepresentation in the renewable energy sector is not confined to a single country or region, but reflects a global pattern that cuts across geographies. Gender equality and sustainable development are intrinsically linked. The United Nations' 2030 Agenda for Sustainable Development identifies gender equality as both a stand-alone goal (SDG 5) and a cross-cutting theme essential to achieving all other goals.

Gender equality, in this context, means equal rights, responsibilities, and opportunities for individuals regardless of gender (Adhuze and Ogunbona, 2025).

Women are not a special interest group in renewable energy, they are the mainstream users and often producers of energy. Without their involvement, renewable energy projects risk being inappropriate, and failing. Women are the main users of household energy in developing and industrial countries; they influence or make many family purchases related to energy; they are experienced entrepreneurs in energy-related enterprises; and women's organizations are effective promoters of new technologies and active lobbyists for environmentally benign energy sources (Celcelski, 2000). Clancy defined gender as "the roles, privileges, attributes and relationships between women and men that are socially constructed and not biologically determined" which basically emphasize gender as social construct (Feenstra et.al, 2021).

Hence, the gender dimensions of energy access and use vary across social, cultural, economic and political contexts. The objective of gender and energy policy research is an engendering energy policy that enables a fair energy distribution between women and men, recognizes gendered energy needs, and contributes to equal participation of women and men in the energy sector. Concerns about climate change and fossil fuel insecurity have convinced many countries to transition to low-carbon energy supplies derived from renewable such as solar, bioenergy and wind. Since producing and distributing renewable is more labor-intensive than producing and distributing fossil fuels, this shift is creating new employment opportunities. Applying a gender lens to the enthusiasm for renewable, however, reveals a major blind spot (Baruah, 2016).

1. Objectives

The main objectives of the paper are:

- a. It attempts to explore the gender dimension of energy use and usage pattern.
- b. It investigates the role of women in the dissemination and utilization of renewable energy, with due emphasis on the importance of gender inclusivity.

2. Methodology

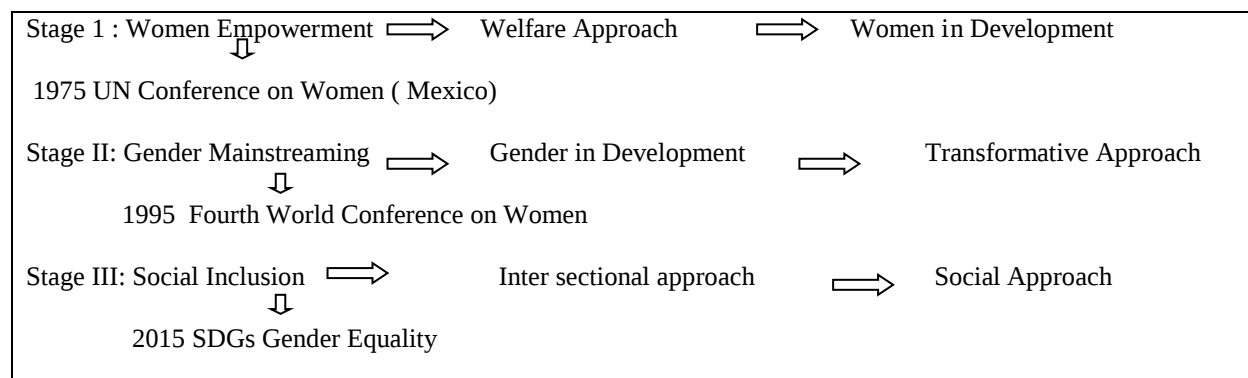
The present study is a descriptive research, where the main focus has been given to conduct an in-depth analysis of the role of women in the renewable energy sector. An extensive literature survey is done through referring various reputed online and offline journals. Subsequently collected data from secondary sources were analyzed to assess the status of gender equality and women empowerment in the energy sector.

3. Analysis and Findings

3.1 Historical Background

Literature indicates that historically women has been excluded from formal development process, and the mainstream economic models during 1950s and 1960s. Meanwhile like WID (Women in Development) in 1970s and approaches like Gender and Development (GAD) in 1980s, emphasized the importance of power relations and analyses both women's and men's role in development and advocated for the

transformation towards gender equality. It is the millennium development goals (MDG's) in 2000 that brought significant changes towards gender equality. And the transition towards SDGs in 2015 focused on gender consideration through multiple goals (Antasya and Kerssana, 2023).



Source: Feenstra and Ozerol,2021

Feenstra and Ozerol (2021) revealed in their work how the gender and energy literature has evolved since 1970s, making an epistemological shift from gender neutral to a more inclusive concept in energy research. They prepared a diagrammatic presentation showing the historical development of gender approaches. The approaches can be clustered into gender mainstreaming and social inclusion.

The transition to the Sustainable Development Goals (SDGs) in 2015 amended gender considerations across multiple goals, such as those related to poverty (SDG 1), education (SDG 4), and climate action (SDG 13). Recent global trends show progress in some areas, such as increased access to education for girls and improved maternal health. According to UNESCO (2021), the global gender gap in primary and secondary education has narrowed significantly over the past two decades.

3.2 Theoretical background

Certain theories from time to time have offered valuable framework to analyse the perspective of gender in environmental context. Theories reveals that women and men interact differently with natural resources due to their distinct social roles, responsibilities, and access to power (Rocheleau et. al 1996).

Sen's (1999) capability approach and Nussbaum's (2000) elaboration on human development provide a robust framework to evaluate how gender inequality limits individuals' freedoms and capabilities. Adequate provision of the range of choices and opportunities available to all genders in society can boost the opportunities for all-around development. The emphasis on capabilities—such as education, health, political participation, and security—aligns with a broader understanding of human well-being beyond economic growth. Crenshaw's Intersectionality theory also projected the importance of considering how gender intersects with social categories like race, class in shaping developmental outcomes (Aduze and Ogunbona, 2025).

Incorporating a feminist perspective in climate discussions brings up an alliance between gender studies and natural system studies through different gender perspectives related to environmental knowledge and practices. Feminist climate justice employs a gender perspective by demonstrating how the causes of climate and environmental damage are also the structural causes of gender inequality (Nikiema, 2017). It recognizes the disparities in climate change that puts impact on the most vulnerable groups as well as

prioritises adaptation. Feminism is both an analytical method and a progressive action to transform institutions, laws, policies, and practices towards better gender equality (Antasya and Kerssana, 2023).

3.3 Role of Women

4.3a Position of Women as Consumers

Globally women spend 2.8 more hours than men on unpaid care and domestic work. On the current trajectory, the gap between the time spent by women and men on unpaid care will narrow slightly, but by 2050, women globally will still be spending 9.5% more time or 2.3 more hours per day on unpaid care work than men (*UN data, 2023*).

Moreover, As per the 79th round of the National Sample Survey (2022–2023) (National Sample Survey Office, 2024), 37% of Indian households still rely primarily on solid polluting fuels to meet their cooking energy needs. This is highlighted in the fact that, while the number of domestic LPG connections in India doubled between 2015/16 and 2023/24, annual domestic LPG consumption grew by only 48%, from 17.2 MMT to 25.5 MMT (PPAC, 2024).

Cecelski (1995) pointed out that decentralized renewable energy systems have a good potential for contributing to labour saving and income generation in rural areas but that, if women were to benefit equally with men, two constraints that were a greater barrier to women than to men had to be addressed: lack of credit, and lack of technical information and knowledge.

Women's distinct roles also provide them with skills and knowledge, which make them valuable agents of environmental safeguard and a key resource for positive adaptation and mitigation of environmental damage. Thus, the empowerment of women is not only a human right but also vital to the achievement of other development goals, such as the reduction of poverty and environmental sustainability, and is therefore an important part of the inclusive and sustainable industrial development agenda. Realizing this, the United Nations Industrial Development Organization (UNIDO) has recognized that the empowerment of women and the promotion of sustainable energy are mutually reinforcing goals. Increased access to affordable, reliable and sustainable forms of energy can reduce the burden of household chores typically assigned to women, thus allowing them to engage in productive activities leading not only to their empowerment but also to creating equality among genders. Since understanding female energy usage facilitates more comprehensive and long-term energy solutions for inclusive growth and development (UNIDO, 2016).

According to WHO data, household air pollution caused an estimated 3.2 million deaths in 2020. This included over 237,000 deaths of children under five. Combined with ambient air pollution, this contributes to 6.7 million premature deaths annually. It also leads to non-communicable diseases like strokes, heart disease, chronic obstructive pulmonary disease and lung cancer.(WHO,2025). Since women are the primary users and often producers of energy, interventions that do not reach women or meet their needs adequately risk ignoring a key section of the population—in turn, reducing the odds of the technologies being adopted and used (Cecelski, 2000, GACC 2014, ENERGIA, 2011).

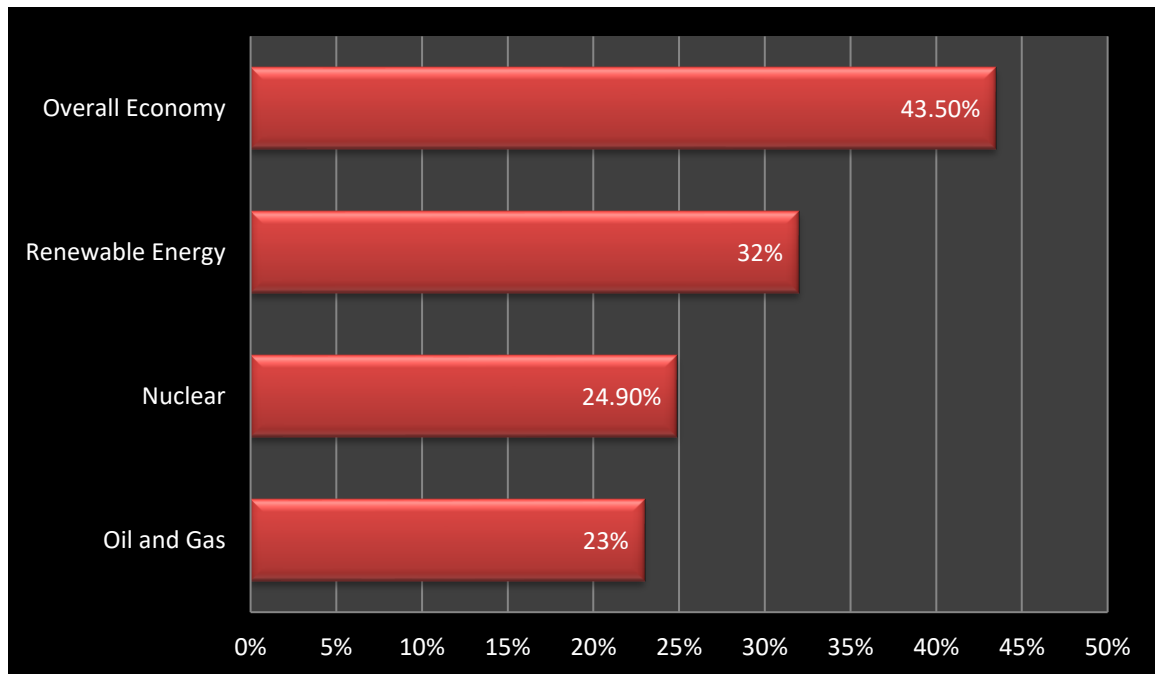
Twumasi et al. (2020) reported that, together with other household characteristics, access to credit, opportunities for employment, and non-farm income are positively correlated with the consumption of cleaner energy fuel (Quoted in Timilsina et.al, 2023). Female-headed households with access to economic opportunities tend to have a higher probability of choosing clean energy sources compared to a male-headed household with similar conditions. Thus, the role of female household members is vital for the household's decisions regarding the use of energy sources. Female household members, as principal decision-making agents, place a higher priority on the use of clean energy sources, which provides better health for their families and more leisure time for themselves. Their inclusion in policy development and empowerment by making them principal decision-making agents is crucial toward energy transition (Timilsina et.al, 2023). In rural India, the importance of women, being the primary users of household energy for cooking and heating, in the context of energy have been widely recognized by prominent and effective renewable energy-based institutions like The Energy and Resources Institute (TERI), AIW C (All India Women's Association), SEWA (Self Employed Women's Association), TIDE (Technology Informatics Design Endeavour), & SELCO (Solar Electric light company of India) and many others. All India Women's Conference (AIWC) in India started providing women with solar lanterns and solar charging stations in urban and peri-urban regions of the country. These women - in urban and rural areas - would charge their lanterns during the daytime, and then later in the evening, they would rent out the solar lanterns to street vendors (selling vegetables, flowers, fruits, and other perishable commodities) and also to households that do not have electricity or face long hours of a power cut. The AIWC has also successfully implemented initiatives in solar-powered water purifier systems where women would sell purified potable water to the locality at very nominal rates (AIWC, 2009, quoted in Mukhopadhaya, 2020)

Ignoring the active involvement of women in renewable energy development plans or projects will result in a discrepancy between the principles and practices of sustainable energy management, and even risk failure. The active participation of women in the energy transition aims to recognize the various differences in needs, obstacles, and challenges faced by women and men at all levels of society (Cecelski, 2000).

4.3b. Position of women in the workforce

A study conducted by the International Energy Agency across 29 countries in 2019, found that on average, there are 76% fewer women than men working in the energy sector. In India women represent a mere 11% of the workforce renewable energy sector, significantly lower than the global average of 32%. (TERI, 2025)

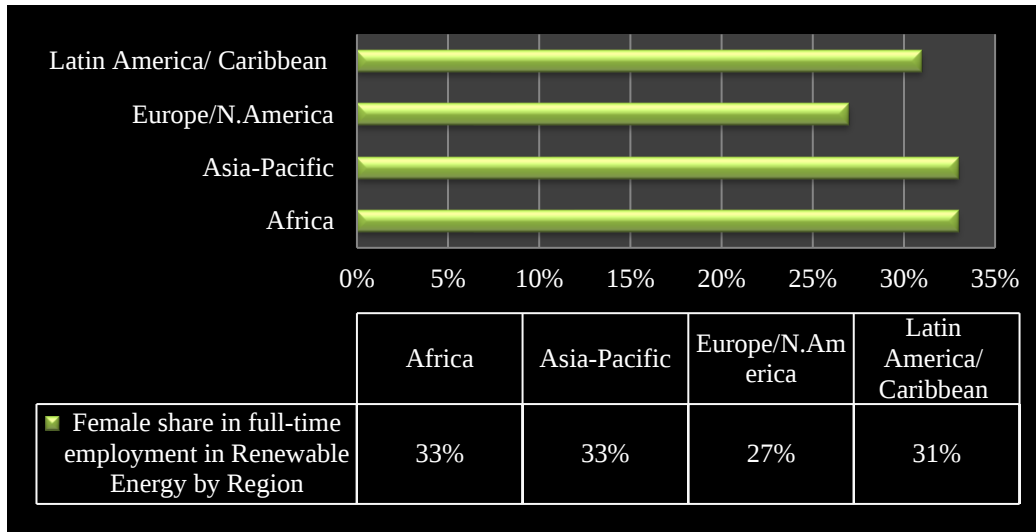
Women's participation in the Renewable Energy (RE) sector plays a significant role in India achieving Sustainable Development Goals (SDGs), particularly SDG 7 (affordable and clean energy), SDG 13 (climate action) and SDG 5 (gender equality). India is at a crucial juncture in its RE journey and has risen to the demand for energy transition, with strong policy and regulatory frameworks, and initiatives such as the PM Surya Ghar: Muft Bijli Yojana, PM KUSUM, and the National Green Hydrogen Mission. The transition has the potential to be equitable, when India works towards unlocking the full potential of women's engagement in the RE sector (TERI, 2025). Roychowdhury (2022) stated that countries with fewer chances for women and greater imbalance in gender prejudice have shown a low economic development at the World Economic forum 's Global Gender Gap Index for 2021 (Sengupta, 2025).



Source: IRENA Global Survey 2025

Fig.-1: Female share of employment across the energy sector and overall economy

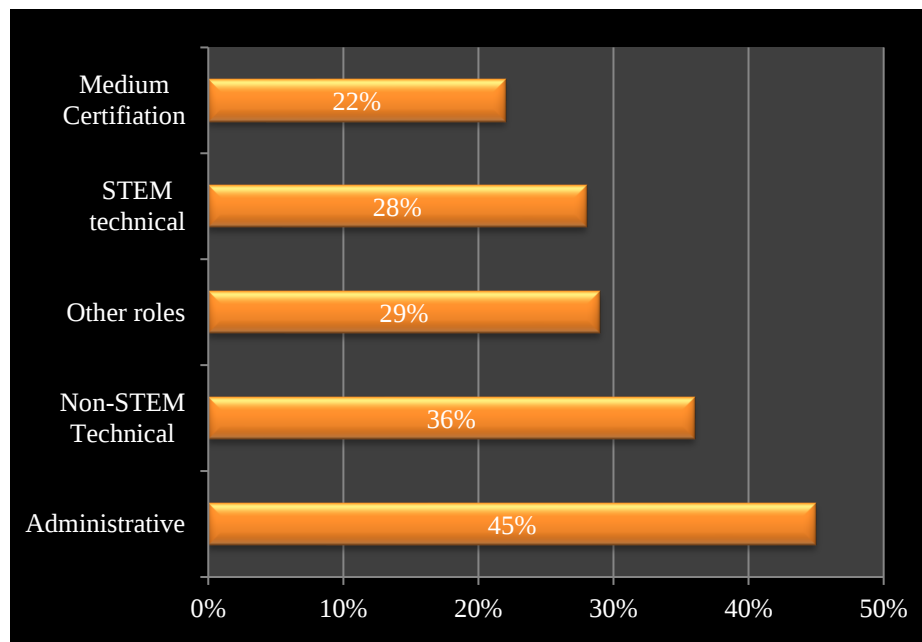
The energy sector is perceived as gender-biased due to the majority of its jobs involving physical labour and technical calculations. The percentage of women studying in higher education in the fields of Science, Technology, Engineering, and Mathematics (STEM) is only 30%, with the number of men significantly higher at 70%. This disparity in women's participation in STEM automatically affects the number of women professionally involved in the energy sector. The lack of interest and attraction of women in STEM fields is influenced by spending more time at home. In such a culture, women are positioned as housekeepers with all household affairs burdened on them. It becomes taboo in such a culture when women leave the house frequently for work. Another factor causing low participation and interest in STEM is the double burden felt by women due to productive and reproductive work. Discrimination against women's nature also often occurs, such as menstrual sick leave or maternity leave, which is considered detrimental to the company. Factors like these are often overlooked in company policy targets (Ekawati, 2021).



Source: IRENA Global survey, 2025

Fig 2: Female share in Full-time employment in Renewable Energy by region

Cases can be found across rural societies of south Asia where microfinance organisations would offer small credit to women entrepreneurs to start renewable-based enterprises in their community e.g., *Gramin Bank*. Empirical studies exhibit that these women are found to be marketing Photo-Voltaic (PV, hereafter) systems, co-farming with their household heads using solar irrigation pumps and solar crop dryers, and also operating/running solar mobile charging systems (Mukhopadhyaya, 2017).



Source: IRENA Global report 2025

Fig.-3: Female share of full-time employment in Renewable Energy by role

Above figure shows the average share of female employment in each of the different positions or roles included in the survey. The highest share of female employment is in administrative roles, with 45% of those positions held by females in organizations that employ people in those roles. The next highest share is for employment in non-STEM technical roles (36%). The female share of employment in “other” roles is 29%, followed by STEM technical roles (28%). The lowest shares of female employment are for medium-skilled roles (22%). This uneven distribution indicates that women are disproportionately represented in support functions and are underrepresented in technical and decision-making roles, a clear sign of gender stratification in the workforce.

5. Conclusion

Globally, a gradual shift of energy systems towards more clean and sustainable way can be witnessed, which is paving a new pathway for overall development, that impacts every sphere of a society be it social, economic or cultural. To it run in a successful manner and bring a sustained change to the world, it is imperative to call upon an inclusive workforce, diverse talent pool and employ diversity of ideas and perspectives to bring upon great innovation. It is evident that gender inclusive within the energy sector is not upto the mark. Moreover, scarcity of data related to women engagement is poor. The evidence gathered through literature and interviews highlights the huge effort that is needed to increase inclusion for women. The role of women in sustainable development is multidimensional, and their voices need to be included at the forefront. Being the first responders to their families, their ideas and perspectives, can drive change at various levels. Empowering women, who are about 50% of the world’s population. Through education, resource access, and leadership roles unlocks transformative potential for equitable, resilient societies.

Conflict of Interest: The author declares no conflict of interest.

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