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Power, Gender, and the Ground Beneath: Rethinking Geothermal with People in Mind

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INTRODUCTION

The energy transition, defined as the shift from fossil fuels to renewable energy sources combined with reduced overall energy consumption, is a key component to enhance climate resilience (Sovacool, 2016), and frequently framed as a predominantly technological and economic challenge. Yet, this transformation also entails profound social and political dimensions that shape how different groups experience and participate in the process (Ahlborg, 2017). Not all individuals and communities have equal opportunities to contribute to, or benefit from, the transition.

Furthermore, gender differences in carbon footprints, with women emitting significantly less in key sectors, reveal how consumption patterns, preferences, and social norms intersect with environmental impacts (Berland and Leroutier, 2025). Leveraging these insights can inform more equitable and effective climate and energy policies. An inclusive and socially just energy transition requires recognising and addressing these gender-based inequalities. Integrating a gender perspective is therefore not only a matter of equity but also a key factor for ensuring the effectiveness, legitimacy, and sustainability of the energy transition.

Based on an intersectional approach, this study aims to evaluate the extent and forms of women's involvement in knowledge sharing and the historical development of the renewable energy sector. Recognizing that women should be empowered to participate fully, not only as consumers but also as producers and energy citizens engaged in governance, decision-making, and local initiatives. This research seeks to shed light on their actual contributions and roles within this transition.

To achieve this, we adopted a mixed methodological approach. First, a bibliometrics analysis was conducted to examine global research trends. Second, this was complemented by a series of concrete case studies from different regions of the world, providing empirical insights into how women contribute to energy innovation, policy advocacy, and community-led initiatives. This combined approach allows us to capture both the global knowledge landscape and the grounded realities of women's engagement, highlighting their potential to shape an inclusive and resilient energy future.

1. KNOWLEDGE PRODUCERS

A bibliometric analysis was performed using the OpenAlex database which includes not only research articles but also datasets, books, and dissertations. Scientific productions related to geothermal energy published from 2000 to 2025 were selected. Then, top 100 most prolific authors was extracted and a gender-querier function from Python library was applied to infer the gender of the authors' first names.

Taking into account the 25 years of the analysis, the proportion of women as authors increased from less than 10% at the beginning of the 21st century to more than 20% from 2014 onwards (Figure 1). While we can rejoice in this increase, only one woman appears in the top ten most prolific authors for the 21st century. This finding follows the trend highlighted by Christopherson et al. (2021), who showed that women's participation and visibility at the World Geothermal Congress increased from 10% to 22% over the 21st century, based on analyses of authorship.

Based on Bagdi et al. (2023), scientific productions about renewable energy since 2015 include as key themes: a) gender inequalities in access to energy; b) the role of women in community-based renewable energy projects; and c) inclusive energy policies, and energy justice. Therefore, these themes were included as additional search criteria, together with geothermal terms. In contrast with the previous analysis, women represent 52% in this gender and society oriented subset, compared with 48% men, and six women appear in the top 10 authors.

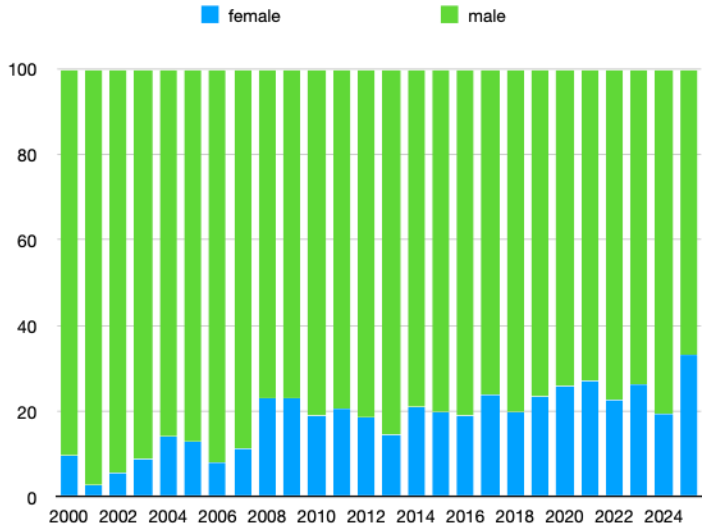


Figure 1. Proportion of female vs male authors in geothermal thematics after the bibliometrics analysis of the 21st century.

2. GENDER INEQUITIES IN ENERGY

Women are disproportionately affected by energy poverty compared to men, primarily due to structural socio-economic inequalities. On average, they earn lower wages and are more likely to face economic vulnerability linked to single parenthood, longer retirement periods, and part-time or precarious employment. Consequently, women spend a higher proportion of their income on energy and are more likely to live in older or less energy-efficient housing. This heightened exposure has significant health and social implications, including increased vulnerability to cold and heat stress, psychological strain, and social isolation. At the same time, because they experience these impacts more directly, women tend to be more aware of and concerned about energy poverty. This is reflected in their strong engagement in the field: they contribute to more than 50% of the studies and data production on the topic. This dual position as both those most affected and key knowledge producers, underscores the critical role of women not only as vulnerable groups but also as active agents shaping discourse and driving solutions. Addressing energy poverty therefore requires targeted and gender-responsive policies that actively reduce structural inequalities and ensure a just and inclusive energy transition for all.

According to Kar and Harichandan (2022), incorporating gender considerations into promoting renewable energy contributes to societal transformation by fostering gender equality and ensuring universal access to sustainable energy. This process should not be perceived as a women's issue alone; men must also feel concerned and actively engaged, as their involvement is essential to achieving structural change and advancing a truly inclusive energy transition.

Understanding social behaviour and gender roles in decision-making can facilitate the effective implementation of renewable energy programmes and policies. There is increasing literature and research on the intersection of gender and energy. Numerous international organisations, including the United Nations Development Programme (UNDP) and ENERGIA, research institutions, non-governmental organisations, and governmental agencies, have put their effort into policies and objectives concerning energy and women (Clancy et al., 2019; Morris et al., 2019; Pearl-Martinez, 2020).

3. ENERGY CITIZEN

Across the globe, women have demonstrated their capacity to be powerful agents of change in geothermal and water resource management. In New Zealand, Māori women have played a central role in geothermal tourism and resource stewardship since the mid-nineteenth century, laying the foundation for sustained female leadership in energy development, exemplified by Aroha Campbell's leadership in reinvesting geothermal revenues into community welfare (Rei and Rangiheuea, 1993). In El Salvador, the state-owned company LaGeo has integrated gender inclusion into its operations, enabling women from rural communities to create income-generating activities through the productive use of geothermal by-products, while also promoting their participation in environmental protection and company governance (Escobar, 2021). In the Andes, Indigenous women, often described as guardians of Pachamama", have been at the forefront of defending territorial sovereignty and advocating for climate-just adaptations, emphasizing the inextricable link between cultural knowledge, water, and energy systems (Moulton, 2024). Similarly, in Indonesia, women have actively engaged in environmental monitoring and community advocacy around the Baturraden geothermal project, voicing

concerns about ecological impacts and playing a key role in shaping community responses (Kusuma et al., 2023). In Tibet, women's active participation in renewable energy initiatives, grounded in their indigenous knowledge, has improved energy quality, reduced disease incidence in rural areas, and fostered a broader shift toward modern and clean energy technologies (Ding et al., 2019).

These experiences collectively highlight that women's participation is not merely a matter of equity but a strategic driver of effective, socially embedded, and environmentally sustainable energy transitions. Their leadership strengthens community trust, fosters inclusive decision-making, and ensures that renewable energy projects address both environmental and social needs. Understanding gender dynamics is also critical for managing community perceptions of geothermal development. Studies show that women and minorities tend to express heightened concern over environmental and health risks, reflecting their social roles and responsibilities. This underscores the importance of inclusive consultation processes that engage both men and women, ensuring that diverse perspectives inform project design and risk management. Taken together, these examples demonstrate that gender inclusion is not peripheral but central to equitable and resilient geothermal development. By recognizing women as economic actors, community leaders, and environmental stewards, energy projects can achieve not only technical and economic goals but also advance social justice, cultural sustainability, and community resilience.

CONCLUSION

A growing body of research highlights the persistent gender inequalities that shape both energy poverty and the broader energy transition. Women are overrepresented among vulnerable energy consumers yet remain underrepresented in energy production, decision-making, and leadership positions within the energy sector. Energy policies are still too often conceived as gender-neutral," overlooking structural differences between women and men. This lack of gender-sensitive approaches is compounded by limited sex-disaggregated data, which hinders the measurement and understanding of inequalities.

Within this landscape, geothermal energy presents a particularly meaningful opportunity to advance gender equity in the energy transition. Unlike other renewable technologies, geothermal systems are intimately connected to the land and its thermal expressions, including hot springs, geysers, and fumaroles. For many Indigenous communities, these manifestations have long carried cultural, medicinal, and spiritual significance. Women have often been the primary knowledge holders, caretakers, and interpreters of these geothermal environments and their healing or symbolic properties (Ramos Chocobar & Tironi, 2022). This deep relational and ontological association between geothermal landscapes and women stands in stark contrast with their limited representation in contemporary geothermal research, development, and governance. Acknowledging this gap not only exposes an inequality within the sector but also points to a missed opportunity to build a more inclusive, culturally grounded, and socially responsive geothermal future.

At the same time, women have emerged as key knowledge producers and advocates in the field of gender inequalities and energy poverty, shaping energy policy debates. Acting as agents of change, women drive research, advocacy, and policy innovation, and they are becoming increasingly visible as leading researchers, experts, policy analysts, and critical voices in the energy transition. It should also be noted that concrete data on gender equality within the geothermal community in geothermal-producing countries, such as Iceland, New Zealand, Kenya, and Indonesia, have been collected, processed, and compiled by WING members (Yogandari et al., 2020; Calibugan et al., 2021; Ómarsdóttir et al., 2021; Vidal et al., 2025). This strong motivation to engage reflects their commitment to building a more just and inclusive energy future.

Addressing these gaps requires coordinated and multi-level strategies. Strengthening women's integration into the energy transition can accelerate innovation, enhance social justice, and build a more democratic and equitable energy system. This entails targeted policy interventions to remove barriers to participation, improved data collection on energy poverty and gender disparities, and measures that position women not only as consumers but also as producers, decision-makers, and agents of change in the energy landscape.

Finally, numerous successful initiatives already exist at various levels (national, local, and community) that can serve as models for scaling inclusive practices. Drawing on these experiences, and reinforcing legal, financial, and political support at the local level, is essential to ensure that no one is left behind and that women can fully and meaningfully participate in shaping a just and sustainable energy future.

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