Women and Green Skills in the Renewable Energy Sector

*The **Global Forum on Sustainable Energy (GFSE)** is a neutral multi-stakeholder platform that facilitates international dialogue on energy for sustainable development by taking into account the special interests and challenges of developing countries. GFSE aims to establish a sustainable world energy system from a social, economic, and environmental perspective.*

GFSE contributes to both international discourse and information dissemination on sustainable energy. The multi-stakeholder platform plays a crucial role in facilitating sustainable energy projects by bringing together donors, investors, and project developers. Their interaction creates new opportunities and enhances existing initiatives in sustainable energy.

Abstract

This Policy Brief looks at data from various studies on the gender gap in the energy sector and offers some best practice examples on mitigating it. In the analysis of access and consumption, special attention is paid to the effects of limited or no access to electricity and its impact on women's health. Concerning the occupational gender gap, the energy sector lags behind compared to the global workforce average in occupation types, hierarchical positioning, and entrepreneurship. Global goals related to empowering women in renewable energy can be found in several SDG's, and an example is given for the effect policy can have on job accessibility for women. Further best practice examples are described by sector, giving insight into programs supporting women in wind energy, photovoltaics, and geothermal energy.

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1. Introduction

Access to energy is a defining factor in how we live from a societal perspective. It has a significant influence on the level of productivity and industry's growth rate and is key to the individual to not be left in the dark. The possibility that comes with sufficient clean energy access is by no means distributed equally in our world. Inequality between the global north and the global south is large enough to be seen on satellite pictures. However, not only the difference between countries but also that within the labor force is worth pointing out: There is still a significant gender gap in who possesses knowledge and tools to actively build and sustain energy supply. Women's participation in the energy sector is below the broader economy and varies widely across energy sub-sectors.

In households, women are often the primary energy managers. However, sustainable modern energy infrastructures and technologies usually reach women and girls last, even though they are crucial for relieving their disproportionate share of unpaid care and domestic work and improving their economic opportunities.[1]

Renewable energy and energy efficiency are key to a just and equitable energy transition that can meet the energy needs of men and women. The wide range of skills needed in renewable energy and energy efficiency requires access to a wide talent pool. Thus, we need to ensure that the workforce is diversified. This means that gender equity must be improved and minorities and marginalized groups included. In addition, more training and jobs for young people are urgently needed.[2] Targeted education and training will play a key role in addressing disparities and promoting inclusion. Women need to be integrated into the value chains of renewable energy and energy efficiency. Education and training are key to achieving women integration.

Initiatives to develop business and technical skills and create jobs for women should be pursued more vigorously. Increased collaboration between the private sector and educational institutions to improve the quality and accessibility of training would be beneficial. In addition, more support programmes to women are necessary, including mentorship, networking, experience exchange and childcare. Moreover, initiatives to change organisational practices and culture in the energy sector to eliminate discrimination against mothers during pregnancy, when on parental leave, or when they return to work are essential.

[1] Sheila Oparaocha Executive Director at ENERGIA, Opening Speech at the at the SDG7 Conference https://sdgs.un.org/sites/default/files/statements/26741Sheila_Oparaocha.pdf

[2] IRENA, 2021: Renewable Energy and Jobs. Annual Review 2021. Renewable Energy and Jobs - Annual Review 2021 (irena.org).

2. Data on the Gender-Gap

The Gender-Gap in renewable energy is multilayered, as women are underrepresented in the workforce and are often most dependent on reliable energy sources in their daily work.

Access & Consumption

The European Institute for Gender Equality found that women are more sustainable consumers than men, rating eco-labeled products and green procurement higher. They were also more likely to change their energy-related behavior favoring sustainable options.[3]

But not all women have the luxury of choosing eco-labeled products. More than 1 billion people do not have access to electricity, and nearly 3 billion do not have access to clean cooking.[4] Women spend more time doing unpaid energy-intensive household chores like cooking and laundry. In many developing countries, women spend an average of 1.4 hours a day collecting firewood and 4 hours a day cooking, making them disproportionately affected by energy poverty.

Access to electricity and electrical appliances reduces the time spent on household chores, allowing for paid work, while access to the internet and mobile phones provides business opportunities and greater access to information. Electricity also brings light into homes and additional hours for learning, while street lighting improves women's safety.[5]

Women in the clean cooking value chain

The lack of clean cooking and heating options has substantial health impacts. Indoor air pollution causes an estimated four million deaths worldwide each year. Up to 70% of the approximately 1.3 billion people living in poverty are women, many of whom live in female-headed households in rural areas. Most are exposed to high levels of smoke for prolonged periods while preparing food. This leads to the overall mortality rate for women being about 50 % higher than for men.[6]

Indoor air pollution also aggravates health problems due to climate change. In many Asian and African countries, household cooking can account for as much as 60%-80% of black carbon

[3] https://www.iea.org/articles/tracking-gender-and-the-clean-energy-transition

[4] ENERGIA, World Bank, ESMAP, UN Women (2018) Policy Brief 12, Global Progress of SDG 7 – Energy and Gender https://sustainabledevelopment.un.org/content/documents/17489PB12.pdf

[5] IEA (2018) Tracking gender and the clean energy transition https://www.iea.org/articles/tracking-gender-and-the-clean-energy-transition

[6] WHO (2018). Household air pollution and health. https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health.

emissions.[7]Particularly in Sub-Saharan Africa, biofuels are used as for cooking fuel in ways that have direct impacts not only on people, but also on forests, flora, fauna.[8]

Heatwaves and severe cold spells are associated with a decline in overall population well-being and increased mortality and morbidity, particularly among vulnerable populations. Women living in poor quality or unsafe housing are more likely to report poor health and suffer from various health problems. One of the rootcauses is being exposed to extreme temperatures and the problem is compounded by air pollution.[9]

In response to the demand for clean cookstoves, sophisticated mass production capabilities are built through large-scale production facilities in China, India, and Kenya, among other countries. Women are not traditionally employed in the construction and metal industries, so involving women directly in these production processes can be challenging.

However, women have many opportunities to generate income in local production, assembly, and installation of clean cookstoves. Innovative hybrid approaches such as building local factories and

[7] Clean Cooking Alliance, (accessed April 2022) Clean Cooking. Protects the Climate and Environment https://cleancooking.org/the-issues/climate-environment/

[8] UN Enviornment, African Union (2019). Review of Woodfuel Biomass Production and Utilization in Africa. https://wedocs.unep.org/bitstream/handle/20.500.11822/28515/WoodfuelRpt.pdf

[9] UN Department of Economic and Social Affairs (2022) Sustainable Development https://sdgs.un.org/goals

importing packages that can be assembled on-site are now being used to produce clean cookstoves and women can be involved as part of the workforce.

In many societies, women are traditionally involved in pottery and pottery making. They can use their skills to make clay cookers, cooker linings, or fire pits inserted into metal cookers. Local-level production processes, such as the production of simple clay stoves, have also evolved into processes with better quality control measures, including the integration of simple mechanized processes in the past years.

The production of clean fuels such as biomass briquettes and green charcoal offers livelihood opportunities that are particularly suitable for women, as they often have extensive networks in the community and earn regular income from sales.[10]

The Global Alliance for clean cookstoves found that women outnumbered men selling cookstoves by almost 3:1. When women sold to other women, those consumers were more likely to report consistent and correct cookstove use and were more likely to convey the benefits of cookstoves to others compared to the customers of male cookstove sellers. [11]

How can these multi-beneficial occupation opportunities be fostered? Training is key: Women are continually adopting nontraditional work roles in the energy sector as access to education, training, and technology increases. Agency-based training, which helps building skills while simultaneously considering the psychosocial factors of undertaking a new endeavour, can be effective. Agency-based training is adapted to the local socio-cultural context and it focuses on exercises that target the improvement of individual capabilities while emphasizing self-empowerment, hope and resilience. In Kenya's cookstove value chain, for example, empowerment training led to a more than doubling business capacity for both genders. Those entrepreneurs that received the agency-based empowerment training were nearly three times more likely to be high sellers of cookstoves. While offering trainings, the Global Alliance for Clean Cookstoves recommends best practices to ensure successful implementation:

- Conduct an analysis gender roles and dynamics in the community and develop a strategy for engaging men
- Adapt the time and location of meetings/activities to women's availability and remain "flexible".
- Identify and build strong local partnerships with trusted individuals and organizations; strongly consider working with women's groups.

[10] Global Alliance for Clean Cookstoves (2013), Scaling Adoption of Clean Cooking Solutions through Women's Empowerment, https://cleancooking.org/wp-content/uploads/2021/07/223-1-6.pdf.

[11] Global Alliance for Clean Cookstoves (2015), Understanding Impacts of Women's Engagement in the Improved Cookstove Value Chain in Kenya, https://cleancooking.org/wp-content/uploads/2021/07/356-1.pdf

- Conduct gender-specific training on relevant topics and mentoring opportunities.

Training women as biogas masons in Vietnam

Biogas can provide a valuable renewable energy source and improve sanitation. Biogas burns cleanly and produces fewer pollutants during cooking than traditional wood. Anaerobic digestion also contributes to a circular economy because besides producing biogas for cooking, heating, and lighting, it also generates digestate, which can fertilize future crops. A best practice example for a transition towards clean cooking can be found in a training program for biogas supply chains in Vietnam.[12]

Together with local partners Dong Hoi Women's Union (DHWU) and Urban Environment Company (URENCO), SNV, a not-for-profit international development organization, is carrying out a pilot project on the inclusion of women in biogas training and, in particular, training women in masonry for biogas plants in the city of Dong Hoi in Vietnam. The project is implemented in cooperation with the National Biogas Programme (BP). Women are very rarely allowed to participate in biogas-related training.[13]

The pilot project in Dong Hoi focuses on engaging women in the biogas supply chain. In cooperation with the BP has successfully trained women as biogas masons who have been certified by the National Biogas Programme (BP).[14] Masons are then entitled to run the biogas digestor supply business. The main elements of the program include:

- The inclusive and sensitized selection process focussing on women who already work as mason assistants. Women who were selected were able to attend the training with their husband, a family member, or a friend
- Provide technical and soft skills to women that wish to operate a Biogas Mason Enterprise (BME)
- Provide additional introductory training for women to improve their basic masonry skills and develop self-confidence
- Gender-sensitive training materials and programs were developed and used for training.
- Sensitization sessions were provided to trainers, and their training methodologies were reviewed/revised to reduce gender bias.

[12] Lefebvre, S., 2016: Biogas fever is rising in developing countries. https://www.biogasworld.com/news/biogas-fever-is-on-the-rise-in-developing-countries/

[13] SNV and IGES, 2019: New skills, new opportunities. Empowering women as agents of change. Vietnam: New roles for women in the biogas supply chain. harnessing-climate-change-initiatives-to-benefit-women-adb-reta7914.pdf (snv.org)

[14] "The Vietnam Biogas Programme was founded in 2003 by SNV with funding from the Netherlands Ministry of Foreign Affairs (DGIS), aiming to effectively exploit biogas technologies and develop a commercially viable biogas sector in Vietnam. SNV provides technical assistance to the implementer of Vietnam Biogas Programme, the Department of Livestock Production under Vietnam's Ministry of Agricultural and Rural Development (MARD)." https://snv.org/project/vietnam-biogas-programme

Women also receive financial and management training to empower them to run their own Biogas Mason Enterprise. In addition, financial support is given to them to start their business. Coaching and mentoring to build women's skills and increase their confidence to work independently are also provided.

Biogas mason training typically includes:15

- Sizing and siting considerations
- Construction materials required
- Interpreting design building plans
- Excavation & setting out
- Building the biogas dome shape
- Initial feeding & gas build-up

Given that the payment is typically done per biogas digester built, women receive a lower salary than men. This is because women work slightly more slowly than men. However, they produce better quality biogas digesters, given their attention to detail. Women who operate and use the digester products also receive so-called end-user training. This helps these women optimize the use of biogas and bio-slurry to generate income and reduce the use of fossil fuels and fertilizers. Biogas can also be used for cooking, and when doing so, it helps women reduce the time required to collect firewood.

In the workforce

[15] UMRI Institute, 2022: Biogas Masonry Building Course. http://umri.org.zw/courses/biogas-masonry-building-course

Examining the example of clean cooking as a need and an opportunity for women opens thoughts on a further pressing matter: The general distribution of women in the renewable energy workforce and their challenges.

Despite making up 48% of the global labor force, women only account for 22% of the labor force in the conventional energy sector. In taking on the challenge of building a more sustainable world, there are also efforts to raise gender equality. Still, with a significant gap but smaller than in non-renewables, women make up 32% of the workforce in renewables[16].

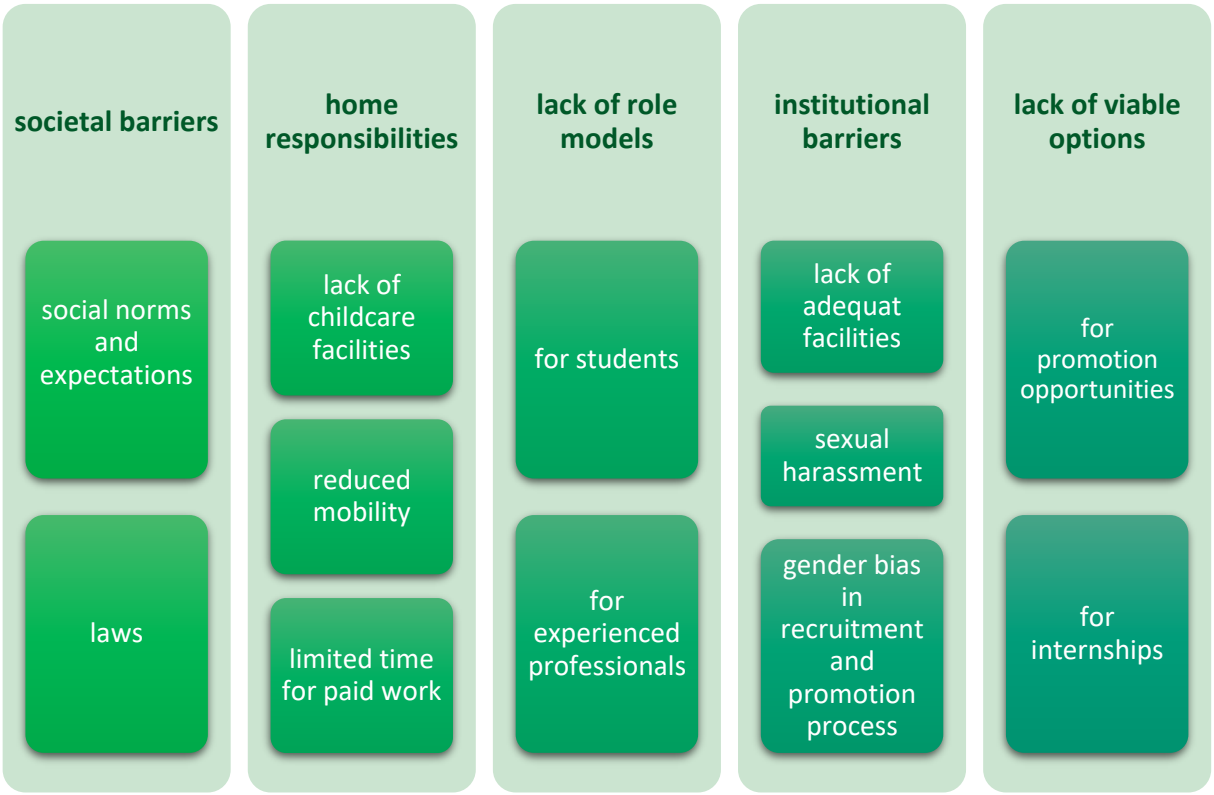
Of course, these figures vary from country to country. A study by the World Bank in 2020 shows that women make up 21 % of the total workforce of power utilities in African countries and 4 % in Pakistan. The average percentage of women in technical positions in this study was 15% in African countries and 2% in Pakistan. Most women work in office-related corporate functions such as human resources, finance, and customer service.[17]

This high degree of gender segregation within electric utilities is typical across all countries. Most women in the energy sector hold occupations in finance, HR, legal, and accounting departments, and few are working in science, technology, engineering, and mathematics (STEM) jobs.[18]

[16] IRENA (2019) Renewable Energy: A Gender Perspective.
https://www.irena.org/newsroom/articles/2019/Jan/Gender-equality-for-an-inclusive-energy-transition.
[17] World Bank (2020) Getting a snapshot of women's employment in the power sector in Africa and South Asia.
https://blogs.worldbank.org/energy/getting-snapshot-womens-employment-power-sector-africa-and-south-asia

[18] EEG (2020) Increasing women's participation in the energy sector – addressing the challenges.
https://www.energyeconomicgrowth.org/blog/increasing-womens-participation-energy-sector-addressing-challenges

Experts see reasons for this unequal employment distribution in a variety of factors.[19]:



The "Status Report on Gender Equality in the Energy Sector" by the C3E initiative suggests that in order to make strides in gender equality, women must attain higher positions and influence in the decision-making process to prepare the way for those entering the field. Unfortunately, numbers here remain especially low.[20]

SE4All sees a reason for this in the limited access to support networks, role models and trailblazers that would help them advance their careers, which women in this sector would need. Furthermore, they lack access to public and corporate policies that would help them realise their goals.[21]

The IRENA Renewables Jobs Report 2020 also argues that girls' and women's career decisions should be influenced particularly early on, while aspirations and affinities are still being discovered in order to increase the proportion of women in STEM jobs in the longer term. However, this career choice is

[19] Pamela Baldinger, Cherub Antwi-Nsiah (2020) at the Grid Reliability and Utility Operations Conference https://www.energyeconomicgrowth.org/content/event-grid-reliability-and-utility-operations-conferencewer-sector-africa-and-south-asia

[20] C3E Initiative (2019) Status Report on Gender Equality in the Energy Sector https://nachhaltigwirtschaften.at/resources/iea_pdf/reports/C3E-Brochure_Gender-Equality-in-the-Energy-Sector_MAY-2019.pdf

[21] SE4All (accessed April 2022). Women at the Forefront. https://www.seforall.org/women-at-the-forefront

often shaped by gender stereotypes and the division into “male” and “female” jobs. However, in order to achieve greater gender equality, it is crucial that girls have access to education and training grants and mentoring opportunities.[22]

Entrepreneurship and Senior Positions

According to a 2019 study, most women hold junior or non-supervisory positions. The share of women in top management in the energy and energy utility sector is slightly lower at 13.9 % than in the non-energy where it lies at 15.5 %.[23]

Of course, these numbers vary between countries. In Pakistan, women in middle management make up 7%, and the number is even lower in senior and top management, at 2% and 4%. In African countries such as Ethiopia, Kenya, and Zambia, women are more likely to be found in management positions, especially middle management, where they occupy 25%.[24]

A study on board appointments to women in private energy companies found 35% in Italy and 27% in Sweden, 18% in Austria, and 16% in Sweden. Canada and Chile were situated at the lower end of the surveyed countries, with 13% and 12%. The figures were even lower when looking at seats on the boards of industry associations, which play a fundamental role in guiding policy decisions by giving stakeholders a collective voice.

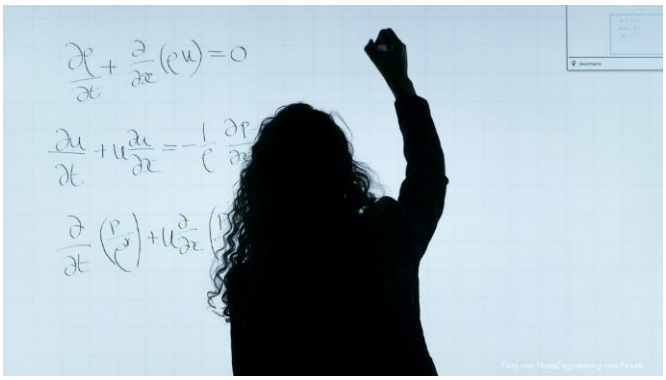
[22] IRENA (2020). Renewable Energy Jobs – Annual Review 2020. https://www.irena.org/publications/2020/Sep/Renewable-Energy-and-Jobs-Annual-Review-2020#:~:text=September%202020&text=Renewables%20accounted%20for%20an%20estimated,Renewable%20Energy%20and%20Jobs%20series

[23] IEA (2019) Energy and gender: A critical issue in energy sector employment and energy access https://www.iea.org/topics/energy-and-gender

[24] World Bank (2020) Getting a snapshot of women’s employment in the power sector in Africa and South Asia https://blogs.worldbank.org/energy/getting-snapshot-womens-employment-power-sector-africa-and-south-asia

Regardless of the institution, women remain incredibly rare in the top CEO and presidential positions; in some countries, none of the surveyed companies were led by women. [25]

The same is true for young start-ups, with only about 11 % female founders in the energy sector. Women are listed in less than 11 % of applications in patent classes closely related to the energy sector.[26]



These figures do not apply to all sectors. The number of female inventors increases in the different technology sectors, with the highest rates in the health and chemical sectors. In all industries, about 20% of all founders are women.[27]

So what is it about the energy sector that makes it lag? One of the reasons it is the low proportion of women in research. The gender gap in technology and research positions can be partly explained by the low representation of female students in STEM subjects - in OECD countries, women make up more than 50% of tertiary graduates, but only 30% in science and technology.[28] Another reason is a gender bias when hiring and promoting staff in scientific institutions. Further women often also have restricted access to funding. Microfinance institutions often do not provide sufficient support to women energy entrepreneurs because they lack expertise and experience in energy lending. In addition, women-owned small businesses often operate with low-profit margins due to the products they produce and/or market, which is why they are usually financed through grants rather than investment capital. This makes it more difficult for businesses to grow.[29]

[25] C3E (2019) Status Report on Gender Equality in the Energy Sector https://nachhaltigwirtschaften.at/resources/iea_pdf/reports/C3E-Brochure_Gender-Equality-in-the-Energy-Sector_MAY-2019.pdf

[26] IEA (2019) Energy and gender: A critical issue in energy sector employment and energy access https://www.iea.org/topics/energy-and-gender

[27] IEA (2020) Gender diversity in energy: what we know and what we do not know https://www.iea.org/commentaries/gender-diversity-in-energy-what-we-know-and-what-we-dont-know

[28] IEA (2018) Tracking gender and the clean energy transition https://www.iea.org/articles/tracking-gender-and-the-clean-energy-transition

[29] Aneri Pradhan, SEforAll (2018). Women Energy Entrepreneurs Need Financing to Reach Vulnerable Populations. https://www.seforall.org/news/women-energy-entrepreneurs-need-financing-to-reach-vulnerable-populations

Green Mentoring program “Women in Renewable Energy in Africa."

The Energy2Equal initiative was launched in 2019 by the International Finance Corporation (IFC) in partnership with the Government of Canada. Within this initiative, IFC partners with several private sector renewable energy companies to reduce gender gaps and promote women's leadership in the renewable energy sector in sub-Saharan Africa.[30]

Energy2equal created a peer-learning platform where companies exchange best practices on closing gender gaps. Companies that join the peer-learning platform make commitments to close gender gaps. Some of the measures taken so far by companies are as follows: Flexible working conditions that support a balance between work and family life; definition of a code of conduct to prevent incidents of sexual harassment and discrimination issues; gender-inclusive recruitment policies; and strengthening policies on maternity leave and childcare.[31]

Also, within this initiative, IFC created the *Women in Renewable Energy in Africa Network (W-REA)* together with partners. W-REA is a professional network for women working in the renewable energy sector in South Saharan Africa working to address a critical barrier to women's participation in the energy sector: the lack of professional networking and mentoring. The W-REA network has the following components: a) B2B social networking platform, b) knowledge sharing, c) training and capacity building, d) women's visibility in the renewable energy sector, e) mentorship.[32]

In partnership with Energy2Equal and the Global Women's Network for the Energy Transition (GWNET), W-REA has launched the 12-months mentoring program "Women in Renewable Energy in Africa." This mentoring program aims to advance the careers of mid-career women working in renewable energy in Africa through networking, soft skills, support to participants to develop career goals, and efforts to increase the number of women in managerial positions. Possible candidates include African women working in middle management and young African female researchers undertaking their Ph.D. or post-doctoral research in a field related to the renewable energy sector.[33]

[30] International Finance Corporation (IFC), 2019: Energy2equal. https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/energy2equal-africa

[31] International Finance Corporation (IFC), 2021: Canada-IFC Renewable Energy Program for Africa. 2020 Implementation Progress Report. https://www.ifc.org/wps/wcm/connect/6446d320-7f6d-41eb-96b9-b0c20d874afe/RenewableEnergy_CanAfrica+2020-PUBLIC.pdf?MOD=AJPERES&CVID=nHOFIKT

[32] International Finance Corporation (IFC), 2021: Women in Renewable Energy in Africa (W-REA). https://www.ifc.org/wps/wcm/connect/9676bedd-6f1b-4c55-a581-975c70af7783/IFC+WREA_InfoSheet.pdf?MOD=AJPERES&CVID=nxACejp

[33] GWNET, 2022: Women in Renewable Energy in Africa (W-REA) mentoring programme. https://www.globalwomennet.org/the-women-in-renewable-energy-in-africa-w-rea-mentoring-program-is-now-accepting-applications/

3. Goals & Policies

All UN member states worldwide have committed to the Sustainable Development Goals (SDGs), including access to sustainable energy by 2030. The gender dimension of the energy transition is integrated into both SDG 5 (gender equality) and SDG 7 (affordable and clean energy). As it is a multidisciplinary policy field, a gender-responsive energy transition serves at least eight SDGs, in line with the SDGs' intention to reinforce each other. One example is the SDG to health and well-being. As fossil fuels and wood mainly cause indoor and outdoor air pollution, the energy transition towards clean and sustainable energy sources contributes to SDG 3. Further potential gains can be found in SDG1 (notably those linked to poverty), SDG4 (education), and SDG 13 (addressing climate change).[34]

However, the European Parliament pointed out that even if energy policies claim to be gender-neutral, they have different impacts on men and women, and if they neglect these differences, they can be described as gender-blind. Creating an energy system that reflects gender differences and is aware of gender relations in society can start with an energy policy that recognizes the socially constructed and dynamic nature of gender relations and reflects cultural differences and the social context.

[34] UN Department of Economic and Social Affairs (2022) Sustainable Development https://sdgs.un.org/goals

Gender inequalities cause injustices in access to affordable and clean energy and energy efficiency. Those who can afford to invest in energy efficiency and renewables benefit from such measures, while low-income and vulnerable groups remain in energy poverty.[35] Women are disproportionally affected by poverty and energy poverty and substantial gender inequalities can be found in the current energy system. There is a growing nexus between energy justice and gender that needs to be addressed. While some countries and regions are well on their way to achieving electricity for all, under current policies and trends, 2.3 billion people will still lack access to clean cooking facilities in 2030.

Enhanced skills development and decent work opportunities for women can be created in the sustainable energy and clean mobility sectors. Training on new energy technologies and the creation of local value chains will contribute to delivering decent jobs for women and improve energy and social justice while contributing to achieving renewable energy and energy efficiency targets.

In recent years, women have moved beyond their traditional roles as "users" and "beneficiaries" to play a role in expanding energy access, making them part of the solution. The energy sector - especially the renewable energy sector - should offer women diverse and rewarding employment opportunities. However, progress in increasing women's employment, engagement, and participation has been slow.

[35] European Parliament (2019) Women, Gender Equality and the Energy Transition in the EU https://www.europarl.europa.eu/RegData/etudes/STUD/2019/608867/IPOL_STU(2019)608867_EN.pdf

While much more needs to be done to address the barriers women face, fortunately, stakeholders have begun to address the intersections of gender, energy, and sustainable development and advance gender equality, social inclusion, and women's empowerment in the energy sector. There is also a growing number of individuals and organizations working to increase women's participation in the energy sector and acting as role models for women and young girls.[3637]

An example is the Equal by 30 campaign. -A public commitment by public and private sector organizations to work towards equal pay, equal leadership, and equal opportunities for women in the clean energy sector by 2030. Several countries and organizations such as the African Energy Chamber have become a signatory endorsing principles and taking concrete action to accelerate the participation of women in the energy sector and close the gender gap.[38]

Even though such commitments do not represent change itself, they do impact those involved. In Kenya's case, for example, companies respond to the country's constitutional requirement that no gender can make up more than two-thirds of the workforce in public companies. The policy is interpreted broadly and affects everything from training opportunities to representation in union leadership. Utilities have started to offer technical and vocational training opportunities to their employees, reaching 31% female trainees within 12 months.

Regarding maternity and paternity policies and other leave-related benefits, all utilities complied with national laws and guidelines but did not go beyond them.[39]

[36] ENERGIA, World Bank, ESMAP, UN Women (2018) Policy Brief 12, Global Progress of SDG 7 – Energy and Gender https://sustainabledevelopment.un.org/content/documents/17489PB12.pdf

[37] EEG (2020) Increasing women's participation in the energy sector – addressing the challenges. https://www.energyeconomicgrowth.org/blog/increasing-womens-participation-energy-sector-addressing-challenges

[38] Equal by 30 (accessed 2022) https://www.equalby30.org/en

[39] World Bank (2020) Getting a snapshot of women's employment in the power sector in Africa and South Asia https://blogs.worldbank.org/energy/getting-snapshot-womens-employment-power-sector-africa-and-south-asia

4. Opportunities by Sector

Women in Wind Energy

Wind energy is one of the fastest-growing renewable electricity sources in the world. The sector has significant future growth potential to contribute to the transition towards a renewable-energy-based energy system. The sector also positively affects direct jobs and offers a diverse range of low-skill to high-skill occupations.[40] The most labor-intensive segment is manufacturing, and the wind industry workforce is prevalently male.

Training is essential along the whole wind power value chain, e.g., manufacturing, procurement, transport, construction, installation, operation and maintenance, and decommissioning wind turbines. The Global Wind Organisation (GWO) and the Global Wind Energy Council (GWEC) estimate that the global training capacity needs to be substantially scaled up to keep pace with the rapid growth and deliver sufficient quality and safety standards (GWO and GWEC, 2021). Given the vigorous growth of the wind energy industry, there are significant opportunities for training and education across all markets. Training standards are essential to protect the health and safety of the workforce.[41]

IRENA (2020)[42]Together with its partner, Women in Wind – a joint program managed by the Global Wind Energy Council (GWEC) and the Global Women's Network for the Energy Transition (GWNET) – conducted a survey and found that women represent approx. 21% of the workforce in the wind energy sector at the global level.

The survey also found job opportunities for women across the wind energy value chain. These include project planning and equipment manufacturing, construction and installation, operations and maintenance of facilities, and decommissioning. These activities require diverse technical and non-

[40] GWEC, 2021: Global Wind Report 2021. https://gwec.net/wp-content/uploads/2021/03/GWEC-Global-Wind-Report-2021.pdf

[41] GWO and GWEC, 2021: Global Wind Workforce Outlook 2021-2025. Global Wind Organisation and Global Wind Energy Council. https://gwec.net/wp-content/uploads/2021/06/Global-Wind-Workforce-Outlook-2021-2025.pdf

[42] IRENA (2020), Wind Energy: A Gender Perspective. IRENA, Abu Dhabi. https://www.irena.org/publications/2020/Jan/Wind-energy-A-gender-perspective#:~:text=Women%20represent%20only%2021%25%20of,major%20barrier%20to%20gender%20equality.

technical skills and support services such as finance, information technology, administration, marketing, knowledge, legal, and business development.[43], [44]

The two main barriers to entry for women in the wind energy workforce identified by the survey are perceptions of gender roles and cultural and social (male-biased) norms followed by a lack of gender targets and prevailing hiring practices. Possible solutions include networking and mentorship, workplace practices, policies and regulations, and mainstreaming initiatives. More support to networking, mentoring, training, and opportunities for experience exchange is necessary.

Women in Wind – Global Leadership Programme

The Global Wind Energy Council (GWEC) and the Global Women's Network for the Energy Transition (GWNET) launched the Women in Wind Global Leadership Program in 2019. The program is designed to accelerate women's careers in the wind energy sector, support them in reaching leadership positions and foster a global network of mentorship, knowledge sharing, and empowerment. The current version features a mentorship program and an education program, and a matchmaking platform for companies seeking female talent.[45]

Competency-Based Occupational Framework for Wind Turbine Technicians in the United States

In collaboration with the Urban Institute, the US Department of Labor's Office of Apprenticeship offers national frameworks for occupations drafted in cooperation with employers, educators, and other workforce and training experts. The frameworks are competency-based rather than time-based, meaning that the person has to demonstrate that she has learned the knowledge and skills she is expected to learn. Competency-based frameworks allow the person to advance at her own pace. Competency-based occupational frameworks (CBOFs) are available for transmission line workers and wind turbine technicians. Given that women require flexibility in their training due to family obligations, Competency-Based Occupational Frameworks can be helpful. [46]

[43] IRENA (2017), Renewable energy benefits: Leveraging local capacity for onshore wind, International Renewable Energy Agency, Abu Dhabi
[44] IRENA (2018), Renewable energy benefits: Leveraging local capacity for offshore wind, International Renewable Energy Agency, Abu Dhabi.
[45] https://gwec.net/women-in-wind/about-the-program/
[46] https://www.apprenticeship.gov/apprenticeship-industries/energy

The on-the-job learning outline for wind turbine technicians encompasses the following aspects:

1. Maintaining a safe and secure work environment
2. Maintaining specialized equipment
3. Commissioning new turbines
4. Assisting with major component repair and replacement
5. Performing preventive and predictive maintenance
6. Troubleshooting and tests systems and components
7. Maintaining records and creating reports

Women in photovoltaics

The solar PV sector requires a large installation, sales, operations, and maintenance workforce. It can create a large number of jobs, so there is a wide range of opportunities available for women.[47] The solar business requires a broad range of skills. Delivering these skills requires close cooperation between companies, educational institutions, non-profit organizations, and governments.

Separate Training for Men and Women in solar PV in Guatemala

In Guatemala, a solar PV training program offered separate training for women in their own homes. This increased women's participation given that women did not have to travel, and training at home provided a safe environment to ask questions without being judged or embarrassed by fellow male trainees. Separate training was helpful, given that men have more authority and tend to dominate the conversations, relegating women to a subordinate position. Consequently, women are less likely to express their opinions or pose questions during the training.[48]

[47] IEA, 2020: Seven Women Entrepreneurs of Solar Energy. International Energy Agency (IEA). https://www.iea.org/reports/seven-women-entrepreneurs-of-solar-energy

[48] Basnet, R., 2020: Gender Mainstreaming in Mini-grids - Entry Points. Energypedia. Gender Mainstreaming in Mini-grids - Entry Points - energypedia

Barefoot college training of illiterate women

The Barefoot college teaches women the skills for making solar panels, lights, and photovoltaic circuits. Women are trained to assemble, install, repair, and maintain solar home lighting systems. The training helps women electrify their communities with agreement from their villages. Training illiterate women in rural areas require adaptations to the training approach. The Barefoot College teaches women to identify the solar parts using shape and color and then execute the tasks by example. Such training helps increase the confidence of the women.[49],[50]

When women from different countries are trained in regional centers of the Barefoot college, sign language is used because many of them may not speak a common language.

Technical solar training can complement other topics to help women develop other skills, such as financial and legal knowledge, protect their health, and increase self-confidence, among others. The Barefoot College, for instance, complements the technical training with a curriculum that includes self-awareness, reproductive health, digital literacy, financial inclusion, micro-enterprise, legal and civic rights, and environmental stewardship.[51]

Women in Solar Programme of GRID Alternatives

GRID Alternatives is a large non-profit solar installer company in the US that focuses on making solar PV affordable to low-income communities.

GRID Alternatives has set up a **Women in Solar Programme**, which provides several opportunities for women to get involved in the solar business as follows:[52]

- Women interested in solar PV can participate in a GRID Alternatives installation as volunteers

[49] Barefoot College International, 2022: Solar. https://www.barefootcollege.org/solution/solar/

[50] SurveyCTO, 2017: Empowering women and demystifying technology with Barefoot College. https://www.surveycto.com/featured-users/empowering-women-and-demystifying-technology-with-barefoot-college/

[51] Barefoot College International, 2022: The ENRICHE Programme. https://www.barefootcollege.org/solution/enriche/ (last accessed 9.2.2022).

[52] GRID Alternatives, 2022a: Installation Basics Training Program. https://gridalternatives.org/get-training/installation-training-programs/ibt-program

- Women can also participate in an Installation Training Program to receive more advanced learning-by-doing training and have the possibility to receive skill certification.
- Women can also apply for a SolarCorps fellowship for a one-year term. Fellows have the opportunity to gain hands-on experience in the solar PV business.
- Creation of the "We Give" circle, a network of women in philanthropy to help create an inclusive energy transition

One of the training programs that GRID alternatives offer is the Installation Basics Training (IBT). The IBT is a competency-based certificate program focused on the skills for entry-level solar installation jobs. IBT focuses on hands-on training that helps trainees demonstrate competencies in real-world solar PV installations and provides individual certificates. Two types of installation basics training are distinguished, solar panel systems (arrays) and electrical training. Competencies gained in these trainings include:

- IBT Array certificate
  - Job site safety
  - Fall protection
  - Array layout
  - Racking installation
  - Module-level power electronics (MLPE) installation
  - Module installation
- IBT electrical certificate
  - Electrical safety
  - Electrical layout and mounting
  - Conduit bending and installation
  - Electrical wiring

GRID Alternatives collaborates with local governments, non-profit organizations, schools, colleges, and private companies to execute the training program. For example, in the District of Columbia, GRID Alternatives has been involved in the Solar Works DC, a low-income solar installation and job training program led by the Department of Energy and Environment (DOEE) and the Department of Employment Services (DOES).[53]

[53] "Solar Works DC is part of Solar for All, a program of the Department of Energy&Environment (DOEE) that seeks to provide the benefits of solar electricity to 100,000 low-income households and reduce their energy bills by 50% by 2032". GRID Alternatives, 2022b: Solar Works DC. https://gridalternatives.org/regions/midatlantic/solar-works-dc [last accessed on 11.02.2022].

Women in geothermal energy

Geothermal energy is the natural heat that comes from the sub-surface of the earth. This thermal energy is contained in the rock and fluids beneath the earth's crust. It is a renewable form of energy available the whole year-round. As such, geothermal energy can be an essential source of baseload power and heat. In addition, geothermal energy is resilient to climate variability. Working fluids with a lower boiling point than water can be used in a closed-loop, for instance, in binary cycle plants, making the process more efficient. Binary-cycle plants are closed-loop plants that retain non-condensable gases and geothermal brine and reinject them into the reservoir, thus releasing minor emissions into the atmosphere.[54] Geothermal electricity generation produces relatively low levels of life cycle GHG emissions in comparison to other electricity generation technologies (NREL, 2019)[55]

The installed geothermal energy capacity has gradually increased worldwide over the last decade, reaching 15.4 Gigawatts (GW) today (IRENA, 2021).[56] Increased awareness, R&D, more demonstration projects, and collaboration among stakeholders are required to accelerate geothermal energy development globally by leveraging synergies. There are only a few initiatives to enhance the role of women in the geothermal sector. More efforts are needed, for instance, through scholarships, apprenticeships, and mentoring programs for women in geothermal.[57] Monitoring and evaluating the progress in women's integration in the geothermal industry is necessary.

Women in Geothermal (WING)

Women in Geothermal (WING) is a volunteer, not-for-profit organization whose aim is to promote women's education, professional development, and advancement in the geothermal community. [58]

WING has created the **WINGman Special Taskforce** as a platform to engage men in gender equality and give them a toolkit to act on gender issues. The task force organizes training sessions for men in the geothermal sector. The main topics covered

[54] Hanson, P., 2019: Greenhouse Gas Emissions and Geothermal Power Plants. Geoenergy. [last accessed 12.2.2022]. https://www.geoenergymarketing.com/energy-blog/emissions-and-geothermal-power-plants/

[55] Millstein, D., J. McCall, J. Macknick, S. Nicholson, D. Keyser, S. Jeong, and G. Heath. 2019. GeoVision Analysis Supporting Task Force Report: Impacts—The Employment Opportunities, Water Impacts, Emission Reductions, and Air Quality Improvements of Achieving High Penetrations of Geothermal Power in the United States. Berkeley, CA and Golden, CO: Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory. NREL/TP-6A20-71933. https://www.nrel.gov/docs/fy19osti/71933.pdf and https://emp.lbl.gov/publications/geovision-analysis-impacts-task-force.

[56] IRENA, IDB, and GGA, 2021: Geothermal, the solution underneath. The value of geothermal for a clean energy transition. International Renewable Energy Agency, Inter-American Development Bank, and Global Geothermal Alliance. https://www.globalgeothermalalliance.org/-/media/Files/IRENA/GGA/Publications/Geothermal---The-Solution-Underneath.pdf

[57] ESMAP, 2018: Gender and geothermal. Energy Sector Management Assistance Programme (ESMAP). GLOBAL GEOTHERMAL DEVELOPMENT PLAN. ICELAND GEOTHERMAL CONFERENCE. REYKJAVÍK, ÍSLAND. 26 APRIL2018

[58] WING, 2022: Women in geothermal. https://womeningeothermal.org/

in the WINGman Special Taskforce include language, unconscious bias, the impact of family, and company culture. Taskforce trainees are engaged to encourage female inclusiveness, support their female colleagues and transform company culture to reduce male bias that can lead to women being disadvantaged. WING is also developing harassment policies and helping geothermal organizations implement their harassment policies.

WING has also implemented the project Matua for parental support in the geothermal industry. The Matua project is conducting activities to help solve discrimination against mothers during pregnancy, when on parental leave, or when they return to work. The project also works on measures to reduce discrimination against fathers on parental leave.

Female Leaders In Energy (FLIE)

The Female Leaders in Energy (FLIE) project is a cooperative partnership between the United States Energy Association (USEA) and the US Department of State, Bureau of Energy Resources to advance the professional development of early to mid-career level women, who work in the energy sector in Indonesia, Laos, Fiji, Malaysia, Philippines, Thailand, Timor-Leste, and Vietnam. [59]

Through a 2-year mentorship program, mentors help guide mentees through a so-called capstone project, e.g., a research paper, the development of a training program, etc. Mentors also support female mentees to set career goals, build confidence and leadership skills, and help them to strengthen their professional networks. FLIE also holds conferences and technical workshops for mentors and mentees.[60]

[59] USEA, 2022: Female Leaders In Energy (FLIE). https://usea.org/program-categories/flie

[60] NREL, 2022: Empowering Female Leaders in Energy. Mentorship Programs Advance Professional Development for Women in Geothermal. https://www.nrel.gov/news/program/2022/empowering-female-leaders-in-energy.html

Besides training and career development aspects for women in the geothermal sector, gender aspects must be considered when developing geothermal projects. Geothermal projects need to respond to disparities between men and women and environmental and social risks to improve community acceptance. Geothermal projects may pose risks and offer opportunities related to (i) changes in land and natural resource use, (ii) changes to employment and economic activities, and (iii) changes to environment and health.[61]

Specific gender risks that may arise in geothermal projects include several factors such as gender-based violence, loss of resources and sources of income, changes in land tenure, particularly in countries where men have stronger property rights, unequal compensation for women, larger difficulties in adapting to resettlement plans, as well as lower chances of employment and unfair procurement practices that favor men or men-headed firms rather than women-headed firms.

[61] ESMAP. 2019. Gender Equality in the Geothermal Energy Sector: Road to Sustainability. Energy Sector Management Assistance Program (ESMAP) Knowledge Series 028/19. Washington, DC: World Bank. https://www.globalwomennet.org/wp-content/uploads/2021/01/Gender-Equality-in-The-Geothermal-Energy-Sector-Road-to-Sustainability.pdf

5. Conclusions

When it comes to women and renewable energy, there is still a significant gender gap in access and consumption as in the workforce. Sustainable modern energy infrastructures and technologies usually reach women and girls last, while they are most dependent on them. Unsafe housing and a lack of clean cooking options causing indoor air pollution are likely to various health problems, especially for women. Electricity and electrical appliances usually reduce the time spent in unpaid energy-intensive household chores and free women to take on paid work and educate young girls and women.

While the figures vary from country to country, women are underrepresented in the energy sector compared to the global labour force. The numbers are slightly higher in the renewable industry (32%) compared to the conventional energy sector (28%). Most women work in office-related corporate functions such as human resources, finance, and customer service. The numbers in higher positions that could influence decision-making and prep the way for other women entering the field remain especially low. Also, the number of women in technical careers is still very low. The low number of female start-up founders and patent registrations is assumed in the low representation of female students in STEM subjects. A best practice example tackling this issue is the Green Mentoring program "Women in Renewable Energy in Africa," which aims to reduce gender gaps and promote women's leadership in the renewable energy sector in sub-Saharan Africa.

When it comes to global policy goals, gender-responsive energy transition serves many SDGs. However, energy policies that claim to be gender-neutral can neglect the different impacts they may have on men and women. Overall, stakeholders have begun to address the intersections of gender, energy, and sustainable development and advance gender equality, social inclusion, and women's empowerment in the energy sector. Public commitments like the Equal by 30 campaign show the positive impact of concisely targeted policy.

The transition towards a sustainable energy system opens up substantial opportunities for a skilled workforce. The number of qualified workers and professionals in the renewable energy sector needs to be substantially scaled up. Integrating women in the clean energy sector is essential to achieve sustainable and peaceful energy systems.

Wind energy is one of the fastest-growing renewable electricity sources globally and offers job opportunities for women across the wind energy value chain. The main barriers to entry are perceptions of gender roles and cultural and gender bias hiring practices. Programs like the "Women in Wind – Global Leadership Programme" are designed to accelerate women's careers in the wind energy sector and support women in reaching leadership positions. Training programs like the "Competency-Based Occupational Framework for Wind Turbine" allow the person to advance at her own pace.

The solar PV sector requires a large workforce for installation, sales, operations, and maintenance and offers new job opportunities for women. Gender-sensitive training for women in solar PV helps women take on technical positions. Best practice examples for such programs are the "Barefoot college" that offers training for illiterate women or the "GRID Alternatives" Program that provides training in the installation basics.

The installed capacity of geothermal energy has gradually increased worldwide over the last decade, reaching 15.4 Gigawatts (GW) today. Geothermal energy is a reliable source of firm power and could grow substantially in the future. Geothermal energy can offer new employment opportunities for women; however, there are only a few initiatives to enhance the role of women in the geothermal sector. Programs like the "Women in Geothermal (WING)" platform to engage men in gender equality or "Female Leaders In Energy (FLIE)" to advance the professional development of early to mid-career level women are the exception. More efforts are needed through scholarships, apprenticeships, and mentoring programs for women in geothermal.

While the number of supportive programs varies depending on the sector, successful measures that are needed are similar. More support to networking, mentoring, training, and opportunities for experience exchange is necessary. Possible solutions include networking and mentorship, workplace practices, policies and regulations, and mainstreaming initiatives.

*The **Global Forum on Sustainable Energy (GFSE)** is a neutral multi-stakeholder platform, which is facilitating international dialogue on energy for sustainable development by taking into accounts the special interests and challenges of developing countries. GFSE aims at the establishment of a sustainable world energy system from a social, economic and environmental perspective.*

GFSE contributes to both international discourse and information dissemination on sustainable energy. The multi-stakeholder platform plays a crucial role in facilitating sustainable energy projects by bringing

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