



COMMUNITY ESSAY

Toward a gender diverse workforce in the renewable energy transition

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Authors' Personal Statement

We explore gender diversity in the energy workforce and highlight the value of systematic assessment of women's participation in the move toward sustainable renewable-energy systems. A gender imbalance in the energy sector workforce is apparent in countries throughout the world, yet women's participation in, and contributions to, the energy industry have not been systematically characterized. As the energy sector transitions from fossil-fuel dominated systems toward more efficient, sustainable renewable-based systems, new opportunities for a more inclusive energy workforce are emerging. We are concerned, however, that if the energy industry does not prioritize gender diversity now, the renewable energy transition could perpetuate and deepen, rather than reduce, gender inequality. Although research demonstrates that diversity enhances innovation and creativity, there is minimal attention to considering and promoting diversity within the energy workforce. In this Community Essay we explore how greater consideration of the role of gender and the value of diversity in energy could provide multiple social benefits, including promoting more sustainable practices, accelerating innovation, enhancing women's opportunities, and empowering communities to engage in energy-system change.

Keywords: women; gender; energy; renewables; sustainability; transitions; fossil fuels

Introduction

Contemporary energy systems are in transition from predominantly fossil fuel-based infrastructures to more sustainable renewables-based systems. As this process continues, it is critical to consider that throughout the world women are less involved in the energy workforce and in energy-decision making than men. A gender imbalance within the energy sector is apparent to many observers, yet the role of women in the energy workforce is not being systematically characterized. Diversity and inclusion are critical in the renewable energy transition. If intentional consideration of gender diversity is not prioritized, the changes have potential to perpetuate and deepen, rather than reduce, gender inequality. Greater understanding of the gender gap in energy-related industries, as well as more widespread acknowledgement of the positive potential of gender diversity in this sector, would likely promote more sustainable energy practices, accelerate energy innovation, expand opportunities for women, and encourage greater social engagement in energy-system change.

In this Community Essay, we review what is known about the level and nature of women's participation in the energy workforce and highlight knowledge gaps. We also describe a broad range of potential benefits of gender diversity and conclude by

highlighting the value of inclusivity and call for systematic data collection on and analysis of the energy workforce to support efforts to reduce the gender gap.

Gender diversity refers to the representation of women and men in a specific organization, sector, or community (Herring, 2009). While assessments of gender diversity, or gender balance, are designed to consider both women and men, we concentrate here on the role of women in the energy workforce and the potential for women's advancement despite persistent inequalities. Gender inequalities are apparent in many major business sectors, but industry analysis suggests that they are particularly acute within the energy sector (Ernst & Young, 2015; Herring, 2009; PWC, 2015).

Knowledge Gaps on Women's Participation in the Energy Workforce

Limited information about the level and nature of women's employment in the energy workforce presents a challenge to exploring the relationship between gender diversity in relevant industries involved in the renewable energy transition (Baruah, 2015). One recent assessment of gender-workforce imbalances suggests a larger gap in the energy sector than other major industries (Ernst & Young, 2015). Within energy organizations, gender diversity is



found to be most advanced in consumer services and consumer goods, while power and utility entities are less gender diverse, and infrastructure entities lag the farthest (Ernst & Young, 2015). The energy industry has the lowest representation of women on boards of directors in the United States and a 2012 study of Russell 3000 companies headquartered in the United States found that 61% of energy companies in the country have no female representation on their board of directors (GMI Ratings, 2012). Only 20% of oil and gas extraction employees were women in the United States in 2013. The corresponding rate was 27% in Canada in 2006 while women's employment in coal mining was about 9% in the United States in 2013 and 12% in Canada in 2006 (Catalyst, 2012).

Women's employment rates in wind, solar, wave, and other renewable energies are generally estimated to be slightly higher than in the fossil and nuclear industries. A recent study prepared for the International Renewable Energy Association (IRENA) reported 33% female employment in the renewable workforce worldwide (Lallement, 2013). For industrialized countries, female employment in this sector is estimated to be 20–25%, mostly in administrative and public relations positions (IRENA, 2013). In the United States, women's employment in solar jobs rose from 18.7% to 21.6% between 2013 and 2014 (IRENA, 2015). Among 22 wind-industry companies in the country surveyed in 2011, women made up 25% of the workforce and 11% of senior management (WoWE, 2011). Similarly in the European Union, women make up 22% of the wind-industry workforce (Blanco and Rodrigues, 2009).

Despite a robust literature on gender and environmental issues (e.g., Leduc, 2010; McCright, 2010; Kennedy & Dzialo, 2015; Leach, 2015), gender-related information and research in the energy sector is more limited. This phenomenon has been attributed to low awareness of the significance of gender in energy planning and energy-system development (Clancy, 2009). To date, research on gender and energy has focused primarily on gendered uses of energy, particularly household-energy use in developing countries (Räty & Carlsson-Kanyama, 2010), rather than women's jobs and decision making within the energy industry. Under the umbrella of renewable energy, preliminary research is emerging on gender in the context of the renewable energy workforce (Baruah, 2015). In addition, several earlier studies called for more attention to gender in all aspects of energy policy (Farhar, 1998; Parikh, 1995) and recent studies in Europe have addressed energy-consumption patterns and the different ways in which

men and women use energy (Carlsson-Kanyama & Lindén, 2007; Räty & Carlsson-Kanyama, 2010).

Comprehensive gender-disaggregated data is not currently available for the energy sector as a whole or for subsectors, including oil and gas, nuclear, and renewables. When gender is excluded as a data point in the collection of information about an industry, sector analysis can be incomplete or misleading and sector-specific initiatives are unlikely to integrate consideration of gender (Doss & Kieran, 2014). Without gender-disaggregated data on employment, the prevalent and accepted practice of justifying the hiring of certain types of employees with claims of "cultural fit" can be perpetuated and often-unacknowledged gender bias can limit opportunities for women (Rivera, 2015). In our data-driven society, we know that what is measured is more likely to be addressed (Moser, 2007)—in other words what has not been counted, does not count. Data collection on the complicated and diffuse energy industry is already a challenge for many countries (Adib, 2014), so adding another metric may be perceived as an additional burden. Although the Bureau of Labor Statistics (BLS) started to collect data on green jobs in the United States starting in the 2010 fiscal year, major budget cuts in 2013 halted systematic assembly of employment data by industry and occupation for businesses that produce green goods and services (BLS, 2013). Thus there is limited current information about the growing renewable energy industry in the country, let alone data on gender in its constituent sectors.

Several major new initiatives to collect gender-related data signal how data monitoring is surfacing as an important tool to achieve gender equality. Data2X, a global project chaired by the World Bank and the William and Flora Hewlett Foundation, intends to spark a gender-data revolution and to close gender gaps through data collection in the categories of health, education, economic opportunities, political participation, and human security (Data2X, 2015). Similarly, the United Nations Evidence and Data for Gender Equality (EDGE) initiative seeks to "accelerate existing efforts to generate comparable gender indicators on health, education, employment, entrepreneurship and asset ownership" (UNSD, 2015). These initiatives, however, are limited to traditional issues that have typically been associated as priorities for women—for example health and education—and do not address the energy sector.

While information on the participation of both men and women is not generally included in employment data, governments, non-governmental organizations (NGOs) and the private sector are increasingly recognizing gender as an important



factor in the energy sector, particularly in developing countries (ESMAP, 2011). Several initiatives are geared toward development of gender-responsive energy policies in African and Asian countries, including the collection of sex-disaggregated national statistics related to energy access (ENERGIA, 2015). Several government and NGO efforts are also working to improve household-cooking technology to reduce life-threatening health impacts that fall particularly on women and children in developing countries (ESMAP, 2011; GACC, 2015). These endeavors recognize that women's needs are often neglected in the design of energy-delivery systems, putting a greater burden on their lives and continuing a cycle of poverty. To more fully understand the global implications of the different levels of participation in the energy transition by women and men, governments, NGOs, and the private sector need to expand their attention to gender beyond the household level to consider the full energy-value chain and to prioritize research and information in the energy-sector workforce globally (Pearl-Martinez, 2014). Given that developed and developing countries share a low level of women's workforce participation throughout the energy sector, we believe that research about women in the energy workforce would be beneficial in multiple ways in developed and developing countries alike.

The Benefits of Gender Diversity

The benefits of greater gender diversity in the energy workforce span multiple levels, including opportunities for women themselves, advantages for energy organizations, and improvements in the overall energy system. These enhancements can be categorized in terms of their environmental, economic, and cultural aspects.

Recent research documenting environmental gains associated with women's leadership suggests potential environmental benefits to gender diversity. Companies with more women on their board of directors are more likely to proactively invest in renewable energy and to reduce carbon emissions throughout their value chain (CRB, 2012). Potential environmental gains have also emerged in the governmental context, as countries with higher female parliamentary representation are more likely to cut carbon-dioxide emissions and set aside protected land areas (UNDP, 2011). Environmental sociologists have also revealed clear gender differences in engagement in environmental issues; in industrialized countries, women are more likely than men to express environmental concern, support environmental protection, and enact pro-

environmental behaviors (Kennedy & Dzialo, 2015; McCright & Xiao, 2014).

Awareness of the economic benefit of women's advancement is gaining ground in the private sector. Gender diversity is now recognized as a force for economic growth and is considered "smart economics" (World Bank, 2012; WEF, 2014). It is now acknowledged that a country's national competitiveness correlates strongly with various metrics of gender equality (World Bank, 2012). In an analysis of the Japanese economy, closing the gender gap in employment and focusing on gender diversity was identified as an avenue for companies and the country itself to significantly boost the economy (Matsui et al 2014). The literature linking women's leadership roles and corporate performance suggests financial, institutional, and environmental gains through closing gender gaps. Fortune 500 companies in the United States with the highest representation of women on their boards (19 to 44% women) were found to enjoy 16% higher net income as a percentage of revenue than companies with no such representation (Catalyst, 2007). Beyond the bottom line, the value to enterprises of investing in women also includes enhanced recruitment and retention as well as the creation of a more welcoming and inclusive work environment. Analysis of enterprise value of investing in women has demonstrated increased innovation through gender-diverse teams and revenue growth through the leveraging of women's relationships to attract new business (Pellegrion et al., 2011).

Cultural benefits related to interactions, communication, and decision making represent another category of potential gain. Research suggests that women's participation in groups can lead to more effective and inclusive outcomes. In one study led by the Massachusetts Institute of Technology, Carnegie Mellon University, and Union College documenting collective intelligence among groups of people who cooperate, researchers found that the tendency to collaborate effectively is linked to the number of women involved. This was attributed to women's strength at reading nonverbal cues and encouraging greater participation of their peers (Woolley et al., 2010).

Within diversity research, the study of gender gaps and inequalities establishes a rich literature on a breadth of negative social impacts of homogenous and gender-segregated groups, communities, and organizations (Seguino, 2000). The growing literature in gender-policy studies also demonstrates that a lack of gender parity in institutional positions can lead to harmful social impacts (Cornwall & Goetz, 2005; Goetz, 2005, 2007; Enloe, 2013). Scholars of peace



studies and of the militarization of society have highlighted women's limited role in many critical political and military decisions (Enloe, 2013). Other research demonstrates that having more women involved in decision making increases governmental transparency, and greater engagement of women enhances the likelihood that issues related to gender equity are integrated into decision making (CAWP, 1991; Carroll, 2001).

At the larger energy-system scale, an additional social benefit of advancing women in the energy sector is the potential for greater social engagement in energy-system change. When more women work in and contribute to the energy sector, social awareness about energy and energy decisions will broaden. As distributed and decentralized renewable energy options expand, individuals, households, and communities throughout the world have new ways to participate in energy decisions and energy-system change (Rifkin, 2011). Energy access plays an increasingly critical role in human livelihood, so diversification and distribution of those who control energy-system change is increasingly important. The term "energy democratization" has emerged to represent new opportunities for more distributed ownership and engagement in energy (Sweeney, 2012; Farrell, 2014). More intentional engagement and inclusion of women throughout the energy sector has huge potential to change community awareness and participation in energy-related issues and decisions.

In addition to gender-specific matters, the general value of equality is important (Wilkinson & Pickett, 2009) and researchers, politicians, and the public increasingly recognize the social dangers of growing inequality (Stiglitz, 2013). Decades of research on diversity in groups, firms, schools, and society demonstrates that diversity strengthens organizations, communities, and entire sectors (Page, 2008). Although studies consistently show that more diverse groups outperform homogenous groups (Hong and Page, 2004), a lack of diversity in many organizations persists due to a confluence of social, economic, and cultural factors including uneven access to education and training as well as conscious and unconscious bias and assumptions (Fine and Handelsman, 2012).

Job Areas with Strong Potential for Gender Diversification

To facilitate the multiple potential benefits of greater gender diversification in the energy workforce, it is worth considering specific types of jobs. Three key job areas in the energy sector appear to

have particularly strong potential for increased gender diversification: 1) engineers and technicians; 2) construction, installation, and manufacturing jobs; and 3) public- and private-sector leadership. These three areas move beyond the more typical participation of women in administrative and public-relations roles within the energy sector.

Engineers and Technicians

Although women make up half of the workforce in the United States, as of 2009 they held less than one quarter of jobs in science, technology, engineering, and mathematics (STEM) (U.S. Department of Commerce, 2009). Some of this gender gap can be attributed to a low share of women in STEM academic studies; however, other factors contribute across educational and professional arenas. While half of American women who complete undergraduate training report being interested in STEM-related careers, 50% of those women depart employment or further training within the first decade after graduation. Girls and boys express the same level of interest in STEM careers and achieve an equal level of success through secondary education, but a major factor for girls and women is the lack of visible role models and mentorship, leading to a culture of isolation in tertiary education and entry-level positions (GSRI, 2012). A study by the American Association of University Women also found institutional culture to be a major factor in attaining gender diversity and recommends the cultivation of girls' achievement and interest in these fields, the creation of college environments that support women, and the establishment of avenues to counteract bias (Hill et al. 2010).

Construction, Installation, and Manufacturing Jobs

Construction, installation, manufacturing, and other trades involved in building, operating, and maintaining energy infrastructure make up a significant portion of energy-industry jobs. In the solar sector in the United States, women account for about 37,500 workers, or 21.6% of the workforce, although only 17.7% are employed in solar installation (The Solar Foundation, 2014). In all energy fields, cultural views often impede women from "blue collar" jobs, as employment in heavy machinery and infrastructure is perceived as male activities. For example, female construction workers in India have been considered unfit to advance their masonry skills, although their capabilities and desire to progress are equal to their male counterparts (Barnabas et al. 2009). Several countries are opening doors for women in these fields, recognizing the benefits of gender diversity. For example, companies



in Chile, Ghana, and Papua New Guinea note that machinery is better maintained and operating costs are lower when women run heavy mining equipment. In addition, some countries have launched women's technical training programs geared toward infrastructure projects. For example in Brazil, one third of all households are headed by women and the rate of female unemployment is almost double that of men. The government developed a program to help women enter better paying infrastructure jobs, resulting in an increase in female employment in hydropower projects in the State of Rondonia to 20 percent (World Bank, 2009). Similarly, companies and industry associations focusing on solar technologies are working to attract more women to installer jobs. In 2014, one of the largest solar companies, SunEdison, initiated programming to improve gender diversity, including having senior executives mentor high-potential women in the company, and organizing a speaker series, peer-support meetings, and trainings on unconscious bias (Barron, 2014).

Public and Private Sector Leadership

In the public sector, there are few female energy ministers worldwide. In Europe, women hold around 2% of senior decision-making positions across the environment, transport, and energy industries, with a higher level of women's participation in environmental fields (EIGE, 2012). The gender imbalance is similar in the private sector. In the United Kingdom, only 5% of executive board seats in the top 100 domestically headquartered energy firms are held by women. One concrete indication of systematic gender-based discrimination is the disparity in compensation between female and male executives. Men often receive higher bonuses than women, and their compensation is generally more sensitive to performance compared to female executives (Kulich et al., 2011). Besides equalizing compensation levels, company leadership can build a solid pipeline toward gender diversity by demanding diverse shortlists for hiring, reporting on gender diversity, and setting and communicating targets (PWC, 2015).

Diversity Contributing to Societal Transformation

The energy transition from predominantly fossil fuel-based infrastructures to more sustainable renewables-based systems is being driven by multiple factors, one of them being increased social awareness of the harmful societal and environmental implications of fossil-fuel reliance and the more sustainable future of renewable energy (Brown et al., 2015; IPCC, 2014; Strunz, 2014). Beyond technical

changes, the energy transition involves complex social dynamics that researchers have only begun to explore (Berkhout et al., 2012; Fri & Savitz, 2014), of which diversity and inclusion are clearly critical issues that have as yet received scant attention.

During this transition, there is a need to integrate social logics from diverse stakeholders whose priorities are influenced by multiple challenges, including growing urgency about the risks of climate change and other types of environmental degradation, geopolitical insecurity, and economic instability. Among those stakeholders actively involved in the energy-system transition, gender is one critical factor influencing framings and articulations of appropriate responses to climate-energy challenges (WEDO, 2008; Alston, 2011; Nagel, 2015). While some proponents advocate minimal change and a minor shift in the mix of fossil fuels, others are actively working toward a radical transition to a completely carbon-free renewable energy system (Jacobson & Delucchi, 2009; Jacobson et al., 2013; Lovins, 2014). The interplay of these different visions influences the legitimacy of the emerging energy system and represents a diversity of opinions regarding opportunities and challenges for energy-system change (Stephens et al., 2015). Different actors involved in the energy-system transition provide multiple perspectives, priorities, and types of influence on the transformational pathway. The incorporation of new voices, particularly women's voices, with more female representation in these critical decisions, will influence future trajectories.

Increased attention to energy-system change has been coupled with recent calls from multiple scholars for more social science in the study of energy (Webler & Tuler, 2010; Sovacool, 2014; Stirling, 2014). Many energy scholars are recognizing the utility of broadening energy research to integrate critical social and cultural dimensions of energy-system change. (Fri & Savitz, 2014). Within this movement toward enhancing social perspectives on energy, there has been only limited acknowledgement of the need for more studies of gender and identity (Ryan, 2014).

Opportunities for women to expand their role in this industry include, but are not limited to, science and engineering as well as installation and operations, management, sales, communication, and finance. The Department of Labor in the United States has advocated for women to pursue employment in the green-energy sector as a nontraditional job opportunity that could lead to greater wage equality (U. S. Department of Labor, 2010). Potential exists for advancement throughout the sector, including women's roles as engineers and



technicians, as construction and manufacturing workers, and as leaders in both the public and private spheres.

Social awareness of, and concern about, women's issues and connections among climate change, human well-being, and sustainable energy systems is growing among scholars and practitioners throughout the world (Alston, 2011; Leduc, 2010; WEF, 2014). As social responses to these challenges expand, paying attention to women's interests and needs and recognizing new opportunities for women in energy would simultaneously provide economic, environmental, and technological benefits while encouraging energy-sector innovation. As energy systems transition away from centralized, corporate-controlled, fossil fuel-based systems, new opportunities are emerging for women to contribute to the development of a more creative, innovative, and dynamic community-oriented energy industry that is more responsive to social and cultural change. However, without gender data characterizing ongoing developments, efforts to broaden the industry through diversity and inclusion will be more difficult to justify and support.

Conclusion

Deeper and more intentional consideration of women's participation and contribution to the rapidly changing energy industry would be valuable for multiple reasons. Systematic collection and distribution of data on gender in the energy work-force will encourage greater awareness about gender equity, support opportunities for women's advancement, and highlight the multiple benefits of hiring and advancing more women. Applying a gender lens to research on energy-system change and energy transitions will encourage positive change in multiple ways including harnessing new opportunities for a more inclusive and innovative energy industry.

The following hypothesis emerges from this initial exploration of the social-change potential of greater gender diversity in energy. Enhanced gender diversity among those involved in shaping energy systems will accelerate both social and technical change in the energy-system transition. We propose that increasing gender diversity in energy-decision making will distribute political power and influence to encourage a more sustainable society. More research is needed to further explore this hypothesis and our proposition.

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