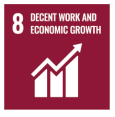



# Employment Gender Gap in the Renewable Energy Sector

**Sumon Vangchuay and Amanda Niklaus**

## 1. Introduction

Energy transformation is increasingly perceived as the pathway towards a more inclusive and sustainable future. The accelerated global deployment of renewable energy sources is believed to create jobs, reduce poverty, improve human welfare, reinforce gender equality and lead to some form of societal re-structuring and "systemic change", through which societies can become more fair and inclusive (IRENA 2016, 2019a, 2019b and 2020). To that end, renewables are mentioned as instrumental in meeting the targets of UN Sustainable Development Goals (the SDGs) which nation-states have committed to delivering by 2030 (e.g., CCSI et al. 2019).

In the context of the SDG 8 (Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all), we investigate the premise of the claim that the renewable energy sector will provide "important opportunities for greater inclusion and equality" (IRENA 2019a). In assessing such opportunities, we examine (1) the rationale for gender equality under SDG 8 and (2) the connections with SDG 5 (Achieve gender equality and empower all women and girls) and, to a lesser extent, SDG 7 (Ensure access to affordable, reliable and sustainable modern energy services for all). Lastly, we discuss (3) the gender gap in the renewables workforce and specific challenges facing women in their renewable energy jobs and employment.

### *1.1. Background and Knowledge Gaps—Gender and Energy*

For the purpose of this study, we categorized the literature on energy transition into two broad aspects of change: technical and socio-politico. The technical change covers specialized questions related to the technology and economics of energy sources of the society (e.g., Odum 1971; Elliott 1997). Proponents of technical energy transition range from those advocating for a minor shift in the use of fossil fuel to those fully committed to a complete transition to 100% carbon-free renewable energy system (e.g., Jacobson and Delucchi 2009). Energy transition movements are supported by different socio-political groups who advocate effective policy awareness campaigns with the promise of more sustainable renewable-based

systems (e.g., EU 2002; WEC 1994) and the fundamental change to the energy system (Stephens 2019).

Social scientists have only until recently begun to inquire into complex social dynamics required to achieve energy transformation (e.g., Fri and Savitz 2014; Berkhout et al. 2012). The transformative potential of renewable energy is often reinforced by the so-called energy democracy movement which connects energy system change to a liberal agenda of social justice and equality (e.g., Burke and Stephens 2018). Central to such a movement is the incorporation of new voices and relevant "social logics" from diverse stakeholders into the energy transition debate (Pearl-Martinez and Stephens 2017; IUCN 2015). Because diversity and inclusion may hold the key to the success of energy transition, gender has been widely documented as one critical factor informing more sustainable responses to climate and energy challenges (e.g., Nagel 2015).

However, the question of gender in the energy sector has only evolved as "a late bloomer" (Clancy 2009), compared to the far more prolific literature on gender and the environment or in sustainable development. Few studies in the early 1990s explored relationships between gender and renewable energy (Farhar 1998) as well as the issues of gender in energy policy and economic development (Parikh 1995). Subsequent studies examined the concepts and issues concerning gender and energy (Clancy and Khamati-Njenga 2003), gendered use of energy in the household in developing countries (Räty and Carlsson-Kanyama 2010; Carlsson-Kanyama and Lindén 2007), how to integrate gender into energy policy (Clancy and Feenstra 2006) and the lack of gender awareness in the development of energy systems (Clancy 2009). In contrast to the environmental and economic benefits of alternative energy sources, social and labor dimensions were much less studied. Prior to 2010, research on gender and the energy workforce was very limited.

Within the last decade, the gender issue in the renewable energy workforce received more research attention. Topics include women's occupational patterns in renewables jobs (Baruah 2016), the value and benefits of gender diversity (Pearl-Martinez and Stephens 2017) and women's professional development, for example, via networking organizations (Allison et al. 2019). The visible role of women in renewable energy deployment and access is now documented and being measured against progress in the context of the ongoing energy transformation (IRENA 2016, 2019a, 2020).

Nonetheless, there is little research on the gender gap in the renewables sector in the context of SDGs. In particular, we found a knowledge gap in understanding why gender should be a compelling rationale for an inclusive energy transition workforce

under SDGs, particularly under SDG 8 (and SDG 7). Given a weak underpinning of gender and labor rights under SDG 8 (Rai et al. 2019), mobilizing a gender-inclusive workforce for energy transition on a large scale is questionable. The authors aim to bridge this knowledge gap and to better understand the gender rationale behind the renewable energy transition under the SDGs.

### *1.2. Object of the Study*

The main objective of this study is to examine the gender gap and assess an outlook for gender equality in the renewable energy workforce under SDG 8 by answering the following three questions:

(1) How are (gender) equity and inclusion considered under SDG 8?
(2) How is SDG 8 (and SDG 7 to an extent) related to SDG 5?
(3) What is the extent of a gender gap in the renewable energy workforce and what are the main challenges and difficulties facing women in their renewable energy jobs and employment?

## 2. Materials and Methods

To answer the above questions, we employed mixed-methods research combining quantitative and qualitative data analysis through a literature review, desk research and a qualitative survey.

### *2.1. Methodology*

We used literature review and desk research to analyze primary and secondary data on the issue of equity/diversity under SDG 8 (Section 3) as well as on the situation of women in the renewable energy employment context (Section 4).

In answering the third question, we supplemented our desk research on the gender gap and challenges facing women in the energy workforce with qualitative survey results gathered from a semi-structured questionnaire and interview (Section 4). We used a small sample of the target population, namely, women currently active in the renewable energy workforce. We adopted this "gender" approach in order to collect and understand the perception and situation of women in the renewable energy workforce as a precursor to subsequent studies where the views of both men and women in the sector should be collected through a larger sample size.

Our 30 anonymized respondents came from renewable energy network partners, comprising national and international women's groups and associations in the renewable energy sector (see Acknowledgments).

The demographic information of the sample obtained is outlined by age group, level of educational background, company size, years of work experience and level of seniority in their company. Figure 1 shows the demographic composition of our survey respondents.

The majority of the respondents are between 24 and 40 years old (71%), obtained a postgraduate level of education or higher (79%), have more than 6 years of experience in the energy sector (56%), currently work in small- and medium-sized enterprises with less than 250 employees (63%) and hold a senior level position within their respective company (53%).

Our questionnaire, comprising 16 closed and open-ended questions, was designed to collect demographic information as shown above and obtain attitudinal and anecdotal information on the following topics:

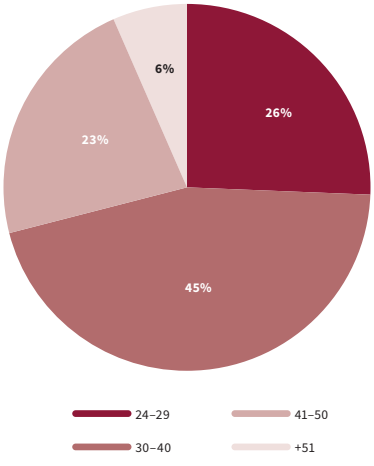
1. Main reason(s) for a low share of women in the renewable energy sector;
2. Challenges, if any, in their career entry and advancement;
3. Their view on women in leadership positions within the sector;
4. The existence and their perception of "glass ceiling";
5. Three personality traits necessary for career success in the sector.

The results were initially grouped into broad categories, i.e., positive, negative, and neutral. Key words and phrases were delineated by recurring themes of gender gap and challenges in the energy workforce and weaved into our line of argumentation in Section 4.

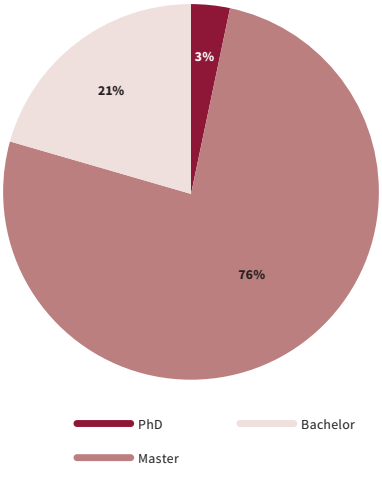
### *2.2. Structure of Arguments*

This paper is structured into two parts: First, we discuss the rationale for pursuing a more gender inclusive energy transition under SDG 8 and the relations to SDG 5 (and SDG 7, when relevant). Second, we examine the situation of women and a gender gap in the renewables workforce, supplemented by qualitative information on women's perception of the gender gap and the difficulties they face at different stages of their career. Finally, we draw key conclusions and provide outlook and recommendations.

(**a**) Age: 45% of survey respondents were between 30 and 40 years old.




(**b**) Education: 76% of survey respondents had a Master's degree.




(**c**) Firmographics: Respondents' company size by number of employees.

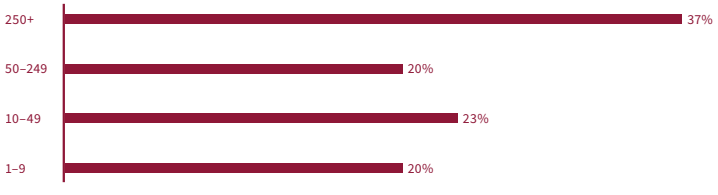



**Figure 1.** *Cont. on next page.*

(**d**) Respondents' years of experience in the energy sector.


(**e**) Level of seniority of respondents.

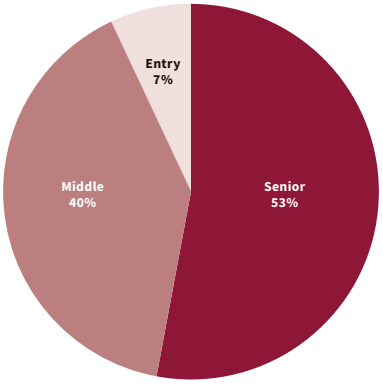



**Figure 1.** Demographics of the survey: (**a**) age, (**b**) education, (**c**) firmographics, (**d**) experience and (**e**) seniority. Source: Figure by authors.

## 3. Rationale for Gender Inclusive Energy Transition under SDG 8

Our first question concerns the relevance of equity/inclusion under SDG 8. To answer this, we first examine how issues of equity or equality are considered in the target requirements under SDG 8. Then, we place SDG 8 in the context of overall SDGs and the extent to which SDG 8 is linked to SDG 5 (on gender equality) and SDG 7 (on sustainable energy).

Under SDG 8, the renewable energy sector can contribute to meeting its twelve targets in two broad areas: (i) economic growth and (ii) expanding employment. To underline relationships between the two, we adopted a three-dimensional approach to welfare (economic, social and environment) (Giannetti et al. 2015; Chancel et al. 2014) to assess gender equality considerations under SDG 8. We then examined the rationale behind the SDG 8 primary measurement for "Decent Work and Economic Growth", namely, Gross Domestic Product (GDP), and assessed whether the approach to welfare under SDG 8 has a gender implication for the energy sector.

*3.1. Macroeconomic Growth of Renewables*

Renewable energy offers solutions not only to meet energy demand while reducing carbon emissions but also to boost to the economy and productivity through innovation and diversification (WEF 2012). As an economic sector, renewable energy contributes to the economy in two major ways. First, jobs and value are created from within the sector by transforming and distributing energy goods and services. Second, its value chains potentially affect the creation and procurement of all products and services, thus supporting economic activities across sectors of the entire economy (WEF 2012). On the surface, the promise of a successful energy transition can enable the meeting of many targets under SDG 8, particularly, Targets 8.1, 8.2, 8.3 and 8.4.

The "economic growth" aspects of SDG 8 are primarily measured by traditional economic indicators, such as GDP (Target 8.1); diversification; technological upgrading and innovation (Target 8.2); growth of micro-, small- and medium-sized enterprises (Target 8.3); and decoupled economic growth from environmental degradation (Target 8.4). Given that the macroeconomic impacts of the renewable energy sector will be measured mainly through GDP, data are encouraging for the sector. With the global average of 6% share to the GDP of the whole energy sector, renewable energy's projected impact on GDP growth ranges between 0.2 and 4% (IRENA 2016; Statista 2015; WEF 2012).

Renewable energy correlates positively with GDP growth in two ways: (1) increased capital formation (Chien and Hu 2008) and (2) cost-effectiveness and investment attraction. Renewable technologies have been shown to lower costs related to energy use or power bills compared to plant capital (Warr and Ayres 2009). Moreover, renewables are an increasingly attractive choice of investment and diversification due to revenue-generating opportunities through its value chains. An increasing share of renewables at all levels can positively affect the global economy through power prices, investment, and trade (e.g., IRENA 2016).

In reality, however, the economic benefits of the renewable energy transition in terms of GDP will vary depending on other factors influencing the economic structure and composition of the available workforce. The target of a minimum 7% annual growth in GDP under SDG 8 set no parameters for measuring or linking to sustainable human socio-economic development. The measurement of GDP should involve other measures for decent work, such as employment rate, and other broader measures of sustainability and welfare, such as equality and inclusion (Coscieme et al. 2020). While some countries (such as Sweden) have implemented SDG 8 targets to positively influence the other SDGs (Weitz et al. 2018), many countries and organizations, such as the European Union (EU), have treated GDP as a separate measurement from

other welfare and equality dimensions (Coscieme et al. 2020). This separate treatment could mean that pursuing SDG 8 with the sole view of GDP can be disconnected with indices on sustainability and welfare, such as equality and inclusion, contradict gender goals and goals on reducing other socio-economic inequalities. Depending on how one links GDP to other equality measurements, the growth of the renewables sector under SDG 8 can have little implication for gender equality.

*3.2. Expansion of Employment and Human Welfare*

Under SDG 8, the "decent work" aspects can be measured by a broad measurement of labor and employment, including "full and productive work for all", "equal pay for equal work value" (Target 8.5), youth employment (Target 8.6), elimination of forced labor and child labor (Target 8.7), working conditions (Target 8.8), sustainable tourism (Target 8.9), access to financial services (Target 8.10) and two supplementary targets on trade support for LDCs (Target 8.a) and global job strategies (Target 8.b).

Growing evidence indicates that renewable energy improves broader socio-economic and human welfare well beyond GDP, particularly in terms of job growth, well-being and human development (WEF 2012). Doubling the share of renewable energy deployment by 2030 projects a 2.7 % increase in global welfare, compared to 0.6% GDP improvement (IRENA 2014, 2016). The global welfare is projected to be higher through heating electrification and transport, improving 3.7% compared to 1.1% GDP (IRENA 2016). Because of a demand for labor in the production and distribution of renewable energy (Wei et al. 2010), renewable energy has created new employment opportunities (formal and informal) while addressing energy scarcity in remote communities. The strongest improvement in human welfare can already be seen across developed countries (such as the US, Australia and Japan) and developing countries (such as India, Ukraine, Indonesia, South Africa and China) (IRENA 2016, 2019b).

According to the 2017–2018 data, renewable energy (including hydropower) is responsible for nearly 11 million direct and indirect gross jobs worldwide, a jump from 7.1 million in 2012 (IRENA 2019b). The strongest job growth has been in the solar photovoltaics (PV) industry, accounting for about 3.6 million jobs concentrating in China, Brazil, USA, India and the EU (see Table 1). Other employers in the sector include wind, hydropower, bioenergy and solar heating and cooling (SHC) (IRENA 2019b).

**Table 1.** Direct and indirect jobs in renewable energy, 2017–2018.

| Technology | World | China | Brazil | USA | India | EU |
|---|---|---|---|---|---|---|
| Solar PV | 3605 | 2194 | 15.6 | 225 | 115 | 96 |
| Liquid biofuels | 2063 | 51 | 832 | 311 | 35 | 208 |
| Hydropower | 2054 | 308 | 203 | 66.5 | 347 | 74 |
| Wind power | 1160 | 510 | 34 | 114 | 58 | 314 |
| Solar thermal heating/cooling (SHC) | 801 | 670 | 41 | 12 | 20.7 | 24 |
| Solid biomass | 787 | 186 | | 79 | 58 | 387 |
| Biogas | 334 | 145 | | 7 | 85 | 67 |
| Geothermal energy | 94 | 2.5 | | 35 | | 23 |
| Solar thermal power (CSP) | 34 | 11 | | 5 | | 5 |
| **Total** | **10,983** | **4078** | **1125** | **855** | **719** | **1235** |

Source: adapted from © IRENA (2019b).

China provides the most renewables jobs, accounting for more than 4 million people. Its PV industry employs nearly 2.2 million people, 80% of them work in manufacturing that produces 70% of the world's panel production. Brazil comes in second place with over 1.1 million jobs, mainly in liquid biofuels. The US is the third-largest employer, covering 800,000 renewable-related jobs, mainly in solar, wind and bioenergy, respectively. Next is India with over 700,000 million people in renewables jobs. The European Union has more than 1.2 million renewable energy jobs (including waste-to-energy), mainly in Germany and France (IRENA 2019b).

The share of renewable energy jobs, both direct and indirect employment, is projected to double to 24.4 million by 2030 (IRENA 2016). Replacing fossil fuels with renewables will lead to job growth across all technologies, particularly in technologies with today's already high employment rate, i.e., solar, bioenergy and hydropower. Compared with coal or natural gas, solar PV creates 100% more jobs per unit of electricity generated. Most jobs will come from installations, manufacturing and bioenergy feedstock supply in new markets (IRENA 2016). In major economies, job growth will concentrate in the skilled trades with high demand for environmental professionals in science and engineering, law and finance (e.g., U.S. Bureau of Labour Statistics 2017).

Because of its job growth potential, the renewable energy sector becomes a valuable vehicle for achieving broad welfare objectives. Various dimensions of green energy employment—including policy development, education and training—must be assessed when judging a successful energy transition for the society as a whole (Strietska-Ilina et al. 2011; UNIDO and GGGI 2015).

*3.3. Diversity and Inclusion under SDG 8*

We consider SDG 8 crucial for a renewable energy transition because of the influence it has on many other SDGs. Based on the wording of its twelve targets, SDG 8 ranks among the top three most interconnected SDGs out of the 17 Goals (Le Blanc 2015). In other words, meeting the targets of SDG 8 in the themes of "sustained, inclusive and sustainable economic growth" and "full and productive employment and decent work for all" is essential to the success of SDGs in their entirety.

However, equity and inclusion seem to be a missing link under both SDG 8 and SDG 7, the two SDGs crucial for the inclusive and sustainable energy transition. While the linkages among targets of the two SDGs can be seen between energy use efficiency (7.3), economic diversification (8.2), and resource efficiency and decoupling economic growth from environmental degradation (8.4), it is unclear how to facilitate inclusive growth from energy transition without addressing existing disparities in the energy workforce. Given a significant deficit in remote areas of Africa and Asia, addressing issues of equity and inclusion in the areas of employment and sustainable energy can significantly improve the livelihoods of millions of women, men and children. Under SDG 7, gender has not received consistent attention among member states, even when progress on accelerating gender equality in all areas is among the required reporting guidelines for SDGs (UN GA 2015). As stated in the analysis of 2018 national reports on SDG 7, the linkages between SDG 5 (gender equality) and SDG 7 are "rarely spelled out" in the country-level reviews (UN DESA 2018a; UN DESA 2018b).

Furthermore, conceptual tensions between SDG 8 and SDG 5 can be observed. SDG 8 emphasizes growth through GDP and productive employment in the formal sector, while SDG 5 emphasizes the equitable value and recognition of women's social reproductive and care work, as well as domestic work. Despite a growing body of labor research indicating that the two forms of labor are often connected (Rai et al. 2019; Runyan 2016), prioritizing the formal labor sector can obscure much of women's true contribution to the economy. The GDP growth benefits mentioned in Section 3.1 above are projected as a best-case scenario, whereby more women are integrated into industry and service sectors (MGI 2015). However, it is unclear how these indicators will address inequalities in the world of work and bring women into the formal sector.

In the energy sector, women in emerging and developing economies are employed in informal activities ranging from procuring fuelwood, to producing charcoal, to traditional biomass and fuel-crop (IRENA 2020). Millions of Sub-Saharan

African women are arguably engaged formally or informally in the biomass sector (Baruah 2016). The production of fuel crops and biofuels at the village level is also an important source of renewables employment for women in countries such as India (ENERGIA 2009).

Furthermore, traditional economic targets, such as GDP, do not account for unintended consequences of pursuing too narrow a GDP growth (Fioramonti et al. 2019; Fioramonti 2013, 2017). The narrow pursuit of economic growth without other human indices linked to GDP has been linked to negative impacts on the environment, health and social relationships, exacerbating the exploitation of labor and female forced labor in particular, and further widening inequalities (Spaiser et al. 2017). The narrow rationale for economic growth under SDG 8 can reinforce occupational segregation by sex and prevailing gendered norms already existing in the energy labor market (Rai et al. 2019).

The principle of equal pay for work of equal value (SDG 8.5) has an obvious gender equity component. This principle is drawn from the ILO's practice under its convention on the subject (Equal Remuneration Convention, No. 100) and focuses on the "value" of work performed rather than the "equal pay for equal work". SDG 8.5 indicators, which focus on the average hourly earnings of female and male employees and the unemployment rate by sex implying the "equal value" of the work performed by women, are not linked to targets and indicators of SDG 5 or SDG 7 (Rai et al. 2019). This principle of equal remuneration for men and women for work of equal value is the only equity consideration under SDG 8.

It should be noted that the ILO has developed a sophisticated understanding of gender equality drawing from its own practices under relevant labour conventions on non-discrimination, equal remuneration and maternity, among others (ILO NORMLEX 2020). The ILO also recognized gender equality in both formal and informal labor (including unregulated and subcontract work) and paid domestic work. With the exception of equal pay, it is unclear how equality practices of the ILO are translated into "decent work" or "inclusive growth" under SDG 8.

The above-mentioned issues led us to cast doubt on achieving an inclusive energy transition workforce under the SDG 8 framework. Not only is the rationale for pursuing gender inclusiveness through SDG 8 not reflected in its main targets and indicators, there are also tensions between SDG 8, SDG 7 and SDG 5. When the equity/inclusion dimensions are not required in the energy transition, the socio-economic benefits of energy transition can hinder progress toward gender equality and widen existing gaps.

## 4. Renewable Energy Workforce: Gender Gap and Key Characteristics

Gender disparities are specifically apparent within the energy labor market (Ernst and Young 2015; Price Waterhouse Coopers PwC). In this section, we outline some of the most salient themes characterizing the share of women in the renewable energy workforce: (i) growing number of women in renewables workforce compared to oil and gas; (ii) underrepresentation in specialized, technical and leadership roles; (iii) barriers in the three stages of employment; (iv) gender pay gap; (v) lack of gender awareness; and (vi) lack of data and measurement.

### *4.1. The Share of Women in Renewables Workforce: A Mixed Picture*

A recent study conducted by IRENA reported 32% female employment in the renewable energy workforce worldwide (IRENA 2019a; Lallement 2013). When compared to other industries, that amount decreases to 19% (see Figure 2).

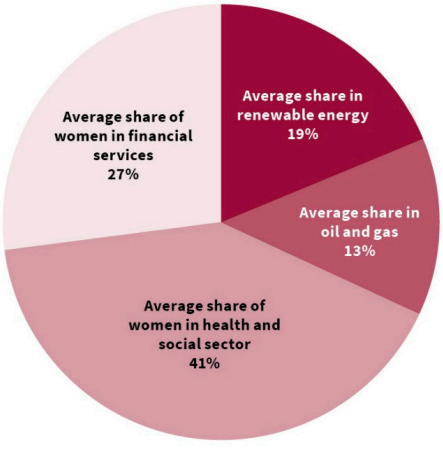



**Figure 2.** Share of women in the renewable energy sector compared to other sectors. Source: adapted from © IRENA (2019a) (Boniol et al. 2019; WEF 2017); used with permission.

A relative increase in women in renewables employment compared to that of the shrinking oil and gas sector is part of a workforce transition trend in the digital and technological age which requires 40–160 million women (7–24%) and 60–275 million men (8–28%) to switch occupations by 2030 (Madgavkar et al. 2019). Women have increasingly navigated outside their traditional female-dominant sectors (such as

healthcare, humanities and social science). They are drawn to the renewable energy sector that offers some "unprecedented" opportunities for women due to its demand for a multi-disciplinary and diverse workforce (IRENA 2019a) coupled with prosocial, humanist aspirations (Allen et al. 2019; Lucas et al. 2018).

However, the 32% share of women in renewables jobs is still much below the 47% average of the global workforce in 2019, and even lower when compared to 56 and 51% in the US and the EU, respectively (ILOSTAT and World Bank 2020). Among popular technologies, progress is uneven. Solar PV became the largest source of renewables employment for women in industrialized countries. In the US, women represented 26.3% of the solar workforce (Solar Foundation 2019). Despite being the fastest growing technology, only 21% of wind power jobs are occupied by women (IRENA 2020).

Figure 3 shows the share of women categorized by three broad job fields: science, technology, engineering and mathematics (STEM) jobs; non-STEM technical jobs; and administrative jobs (IRENA 2019a). The lowest share of women is found in STEM areas, such as facility operations and maintenance; equipment manufacturing, construction and installation project planning; and to a slightly higher extent, in non-STEM technical careers, such as finance, statistician and information technology. Furthermore, 45% of women's participation in the sector is concentrated in non-technical and administrative roles, such as human resources, marketing, knowledge, legal and business development.

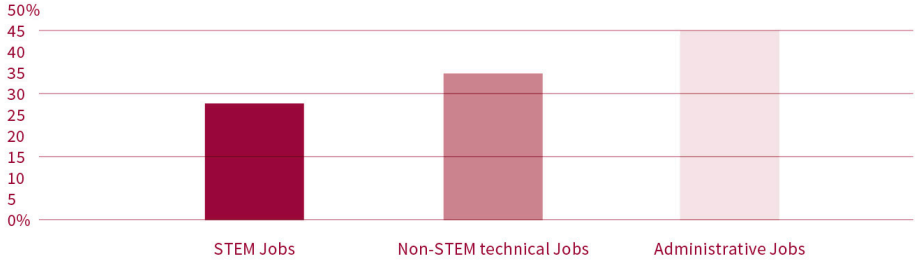



**Figure 3.** Job types of women in the renewable energy sector. Source: adapted from © IRENA (2019a); used with permission.

*4.2. Women's Persistent Underrepresentation in Specialized and Technical Functions*

Renewable energy jobs have largely inherited a pre-existing workforce with aptitudes and skills closely associated with STEM fields that supply the demand for

skilled labor in the traditional energy sector. This means that reasons for the low involvement of women in the traditional energy sector also apply to renewables: (i) women are not interested in technical jobs, (ii) a low number of women graduates from STEM fields and (iii) the fact that the traditional scope of energy and utilities was perceived as technologically complex (See Section 4.3.1). These factors continue to affect the share of women in the renewables workforce throughout value chains and job functions.

Overall, women are underrepresented in finance, trading, technology, engineering and technical sales (Good Energy 2019), particularly in power and utility and infrastructure entities (Ernst and Young 2015). In the renewables sector, men outnumber women in key functions, namely, technical, managerial and policymaking positions. These significant imbalances are a worldwide reality, from within highly developed markets to communities where renewables are only just beginning to extend energy access (IRENA 2019a).

*4.3. Women's Barriers in Three Stages of Employment*

We outline below some recurring themes around the gender gap and challenges facing women in renewables jobs and employment in three stages of employment: (1) entry to employment, (2) job retention and (3) career advancement.

4.3.1. Barriers to Entry: Gender Biases and Assumptions in Technical Jobs

The gender gap in the renewables sector is often attributed to a small share of women in STEM education participation and gender differences in early schooling. Gender differences already exist in the early exposure to science and mathematics in favor of men. These differences become more apparent as the level of education increases, particularly from upper secondary education onwards (Chavatzia 2017). Based on data from the Trends in International Mathematics and Science Study (TIMSS) Advanced 2015, the majority of students taking courses in both mathematics and physics were boys (Chavatzia 2017).

In a UNESCO study of technical education for women in STEM in 120 countries, the assumptions and biases against women's abilities were also identified as factors that affect negatively their interest, willingness and confidence to engage in STEM subjects and subsequent job opportunities (Chavatzia 2017; Huyer 2015). Girls are often brought up to believe that aptitudes related to STEM subjects are not natural to women. There is some level of normalcy when referring to STEM and technical career path in favor of men. This is evident among our respondents, who stated, for instance, that "classic science is reserved for men's expectation". The energy

sector is "rooted in the fact that women do not tend to gravitate towards studying STEM subjects". Normalizing words such as "normal", "typical", "traditionally", "belong to", "natural", "tend to", "suited" and "suitable" are used to describe the STEM and technical fields in men's favor and to disfavor of women. Women do not "really know that they can cope with technical and financing topics" or "have enough confidence themselves to be capable of doing STEM studies".

Women's disinterest in STEM subjects may no longer be a norm among younger generations, however. It has been documented that girls and boys shared similar levels of interest in STEM studies and careers initially in secondary education (GSRI 2012). Nowadays, women actually make up more than 50% of STEM university students in the 144 countries recently surveyed (IRENA 2019a). There is a growing number of women that have been trained in STEM subjects and have graduated in STEM and non-STEM technical fields in the last decade.

In the online survey conducted by IRENA, almost three-quarters (71%) of respondents reported having at least a university degree in a science, technology, engineering or mathematics (STEM) subject. When asked to rank several specific barriers to entry according to their importance, they ranked the perception of gender roles and biases at the top, followed by cultural and social norms, rather than competences in STEM (IRENA 2019a). After schooling, women who have been trained in STEM continue to face biases related to their ability or competences to perform successfully in the energy sector jobs in the recruitment process. This bias persists even when women have the same or even superior STEM qualifications and work experience (Baruah 2016). Their credibility and ability to perform a technical and complex task are often questioned (Baruah 2016).

There is an absence of pull factors for girls and women to pursue STEM career in terms of social support network, role models and mentorship. Such absence leads to a culture of isolation in higher education and in entry-level recruitment (GSRI 2012).

#### 4.3.2. Prevailing Hiring Practices and Workplace Policies

Today, 70% of women across the globe prefer to work a paid job rather than solely care for their families, a figure more closely aligned with 66% of their counterparts (ILO 2018b). Outdated recruitment attitudes may prejudice many women as they enter the industry, assuming, for example, that they will be working intermittently and in lower paid positions (Nelson and Kuriakose 2017).

Our survey and recent studies shine a light on unconscious biases challenging the "Myth of Merit" and the rationale for "cultural fit" in the recruitment and promotion within the energy sector. The perception of gender roles reinforced and filtered by

cultural norms has permeated prevailing hiring practices and framing of a "cultural fit" as being of merit (Rivera 2015). The criteria for a "cultural fit" can translate to a hiring preference for the same gender, race, nationality, class or background as the dominant ones in the organization (GWNET 2020). This applies not only to staff placement but also to employment entry screening, i.e., apprenticeships and internships.

When asked if they think sex/gender has impacted their chance of getting a job or a promotion in the past, roughly 50% of our respondents used words indicating that they were unfairly evaluated compared to male colleagues, such as "Male managers using attribution bias during promotion selection" or "Some males [are] promoted much earlier than females" or simply "Men promote men". While more than 40% of our respondents said they were unsure or there was no influence, many of them are in junior roles or at the beginning of their career.

Recent studies reported a generational gap among the younger generation entering the energy sector. When diversity is seen at the entry to mid-career professionals, the decline in diversity is reported from above the mid-career and senior leadership positions (IRENA 2019a, 2020). One of our respondents, who is from a large company (250 employees or more) commented that, even when efforts are made to recruit more women into the company, "we have found that women plateau mid-career". This gender imbalance at the leadership level will further limit the opportunities of recruiting more women into the organization or providing enabling environments to support women's career progression into senior positions (GWNET 2020).

#### 4.3.3. Barriers to Career Retention Related to Familial Needs

There are barriers related to the expected role of women in the family and their work–life balance which could affect their ability to stay in employment at the mid to senior management level. Difficulty in managing a work–life balance and lack of affordable childcare are common reasons for women's career interruption and eventual departure (ILO 2018b). One in three men still prefers their female partner to be the main family carer and responsible for unpaid housework rather than be in a paid job (Gallup and ILO 2017). Furthermore, 50% of women graduates who indicated interest in pursuing STEM-related careers upon their graduation left employment or further training within the first decade after graduation due to various family and childbearing commitments (GSRI 2012).

When asked whether the perception of women's role in the family (such as pregnancy and care giving) has affected or has been a factor in their career, the majority of our respondents (63.30%) answered yes (Figure 4).

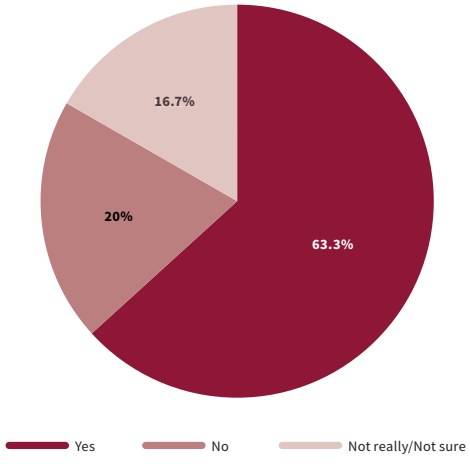



**Figure 4.** Respondents' opinion on whether the perception of women's role in the family (e.g., pregnancy and care giving) has impacted their career. Source: figure by authors.

Women often face the double burden of balancing work and family, particularly during their childbearing years. In Europe, 25% of women picked the reason for care work as their reason to exit the workforce, versus 3% for men (UN Women 2015). Our survey substantiates "the burden of childbearing" on women, where we have gathered comments such as "I delayed telling people that I was pregnant due to how it would affect my career prospects."; "[career advancement] it also affects my thinking and timing around when I would like to get pregnant. I would not announce to my boss that I am pregnant before I have secured my next promotion and pay"; "[for] the past 20 years I have been asked in job interviews when I planned to have children".

The gender gap after having a child is well documented (EIGE 2019; Kleven et al. 2018; Leturcq 2016). Women see a significant decrease in their number of hours worked compared to men after the birth of their first child (Kleven et al. 2018). In Denmark, where there exists generous parental leave for childcare, a significant drop (20%) in salary is observed for women after the birth of the first child (Figure 5).

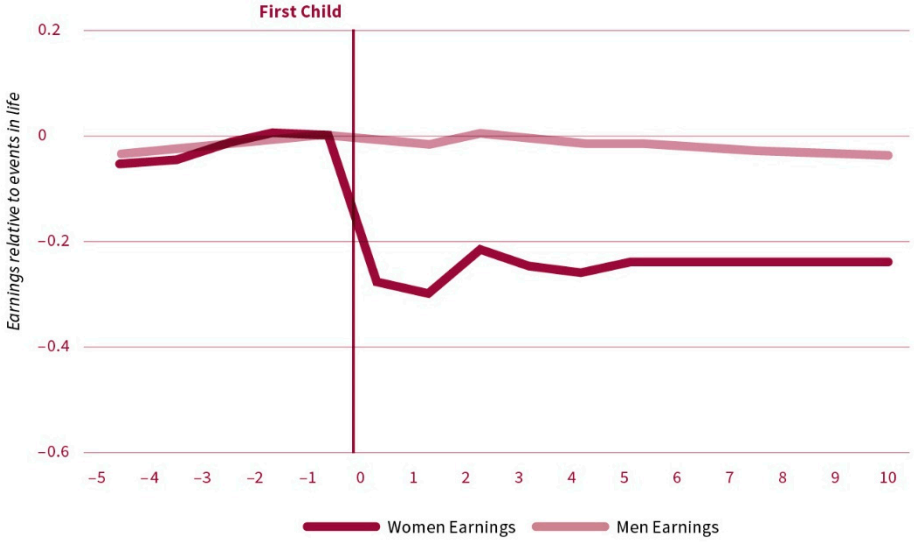



**Figure 5.** Earnings relative to women's' life events. Source: adapted from Kleven et al. 2018; used with permission.

Women's career breaks after having families are also related to a lack of flexibility in workplaces (Kleven et al. 2018; UN Women 2015; Leturcq 2016). Working mothers are 50% more likely than fathers to say that being a working parent inhibited their career advancement (Pew Research Centre 2013). Workplaces often require a strict working schedule and do not provide the flexibility for taking care of family demands. After the first childbirth, women tended to change jobs more often and were 10% more likely than men to seek government jobs for more flexibility. It was reported that, after the arrival of their second child, highly skilled women would reduce their working hours by an average of 5 hours, and 18 hours for lower-skilled women, who have less working flexibility and are more likely to work shift-work (Leturcq 2016). Childbearing can account for 80% of the wage gap overall.

Flexibility in the workplace is a recurring theme among our survey respondents: "Energy projects need a period of continuous time that no women can guarantee they won't pause in a project [due to pregnancy]", [There are fewer women in energy jobs because they do] not have the flexibility required by some roles", "Many roles [in the renewable energy sector] also involve significant travel and nights away from home". After maternity leave, "it's difficult to compete when they (male colleagues)

work 5 days/week whilst I work 3 (days) . . . however the expectations (in terms of job performance) are the same".

Support for working women could be the most efficient means to keep women in the labour force. In a study on 28 EU countries, the affordability of childcare is by far the most often cited reason for unaccommodated needs (50%), followed by a lack of available places (12%), inconvenient opening hours (8%) and distance (5%) (EIGE 2019). Studies have shown that a provision of subsidized childcare services is positively correlated with the increased participation of women in the workforce (Olivetti and Petrongolo 2017).

There is an incentive to invest in the childcare infrastructure and services. An analysis of 7 OECD countries shows that investing only 2% of GDP in the care industry would increase women's employment from 3.3 to 8.2% and from 1.4 to 4% for men (ITUC 2016). Investing 2% GDP in public care services would create up to four times as many jobs for women and could reduce the gender employment gap by 50% in some OECD countries (WBG 2016). Companies, too, can provide more support and flexibility without compromising performance, budgets and revenues.

#### 4.3.4. Barriers to Career Advancement

While the ability for women to persevere and advance in their jobs is shaped by a number of factors, two issues are salient: (i) the absence of women leadership and social networks and (ii) the myth of leadership/what it takes to be a leader.

(i) Lack of Women Leaders, Mentors and Social Networks

Women's underrepresentation in the boards, senior management, policy making and governance of organizations is more acute in the energy sector compared to other sectors (e.g., Emelianova and Milhomem 2019; Deloitte 2019). A study from the International Energy Agency surveying 153 energy companies found that women held an average of 20% of seats on company boards across Finland, Sweden, Italy, Austria, Chile, Canada and Australia and occupied only 21% of the most prominent C-Suite titles (CEO, CFO, CIO, CMO and CHRO) among the top U.S. energy companies (Korn Ferry 2017). CEOs accounted for only 8% on average across the same countries (IEA 2019). The 4 companies with the largest numbers of female board members were Hydro-Quebec, 56%; Engie, 56%; General Motors, 50%; Iren Spa, 46%; and Statkraft, 44%. Of 68 energy companies, 18% of the managerial positions are occupied by women (IEA 2019). Furthermore, 61% of the largest energy companies under the Russell 3000 Index with head offices in the US have no female representation on their board of directors (GMI Ratings 2012).

The situation in the public sector is no better. A 2015 study from the Environment and Gender Index led by the UN found that women occupy only 4% of the World Energy Council positions of which a majority of 18% are administrative positions (IUCN 2015). The International Energy Agency found that only 17% of energy ministerial positions were held by women between 1980 and 2017 (IEA 2019).

The absence of women leaders in the sector reinforces the existence of the "glass ceiling" (Morrison et al. 1987; Hymowitz and Schellhardt 1986). The metaphor has now been applied to a situation of both women and minorities in a business context where they believe that some forms of inequality exist that stop them from moving up in their careers.

According to a Pew Research study, 68% of Americans believe it is easier for men to achieve a top executive position. Both women and men admitted that women have to do more to prove themselves, while more women than men think this is the biggest obstacle to advancing their career (Pew Research Center 2019). In an IRENA study, where the existence of glass ceilings was identified as a key barrier to career advancement, men represent at least 75% of board members in nearly 50% of the participating private sector firms (IRENA 2019a).

Figure 6 shows that the majority of our respondents said they believe a glass ceiling exists in their workplace in one form or another (Figure 6). On a scale of 1 to 5 (5 being evident, and 1 being non-existent), the existence of a glass ceiling was identified as evidently (5) by nearly all women respondents who are currently in leadership/senior managerial positions.

One of our respondents from a medium-size company (50–249 employees) admitted "I was the first woman in management hired in the 35 years of the company's history (5 people informed me of this in my first week). No woman was promoted to management before". Another respondent from a company with over 250 employees elaborated why she believed the glass ceiling evidently exists in her company. "Our leadership team hires/promotes people of a similar perspective/view/nature. In fact, we had a discussion in recent weeks as part of the Diversity and Inclusion [D&I] group, where it was argued that 'strategic hires' should be subject to the same D&I practices that we are trying to implement across the company. There was push back by the leadership team. Also, we are battling for a D&I performance metric to be set in all performance goals, again this has not been implemented for the third year running."

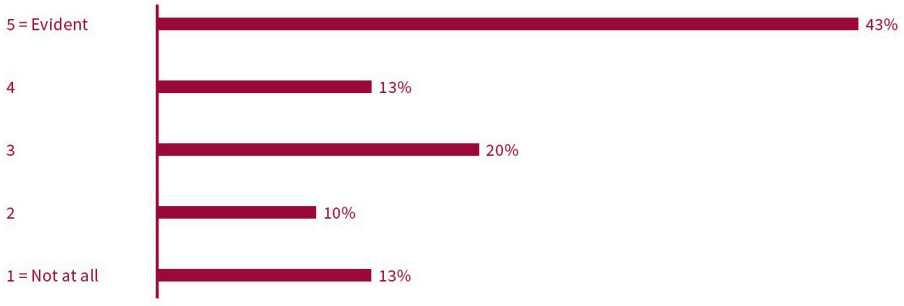



**Figure 6.** Perception of the existence of a "glass ceiling" among survey respondents. Source: figure by authors.

One reason for the "glass ceiling" is related to a doubt in women's abilities to fare well in technical and "powered" roles. Even when women want to thrive in the sector, one respondent reflected from her mid-career experience, "they could be sometimes relegated to more commercial administrative roles, which won't let them grow to the powered positions". Few women who manage to secure top positions can eventually find their leadership situation not tenable as they are less well connected compared to their male colleagues (IRENA 2019a).

Studies have shown that mentoring and networking activities designed for women are key to break through the glass ceiling and to remain in top positions (Richards 2017; Dow 2014). Multi-level mentorship and leadership programs are necessary in providing dynamic social support, including promoting gender awareness and building networks to support sustainable career development. Examples of successful mentoring programs include MetLife's 14-month leadership program training high-potential women in the company's leader pipeline. After 4 years of implementation, over 50% of MetLife's managers are now women. Another example is Sodexo's Mentoring Circle program which led to an increase in the representation of women by 10% at entry and manager level and doubled the C-Suite after 5 years of implementation (Montero 2019). Engie's ambitious gender targets and the progress made to reach them resulted in the company being one of the best FortuneGlobal 200 performers in having women in leadership at the board level (62.5%) and in the management teams (30%) for new operational entities (Engie 2018).

Strategic alliances can be formed with local and national diversity and inclusion independent groups to identify diverse candidates in leadership positions. Good examples include Women of Renewable Industries and Sustainable Energy (WRISE),

the NAACP, Women in Energy Network and American Association of Blacks in Energy (AABE) (SEIA 2017). However, still too few are in place, particularly at the organizational level in energy companies. Numerous non-profit organizations have promoted mentorship programs, such as Women in Renewable Energy (WRE) and Global Women Network for the Energy Transition (GWNET).

(ii) The Myth of Leadership and Management Style

In the energy sector, leadership positions are traditionally reserved for experienced senior managers, technical directors and engineers often with high-level STEM qualifications—who are nearly all men. Knowledge and skills aside, one can also argue that the management level of an energy organization is limited to a familiar culture and personal traits validated by men already in the positions.

Studies have tried to explain the lack of women in leadership by associating it with acceptable leadership qualities and management style. Qualities considered as desirable and effective in negotiation and business settings, such as willingness to take risks in negotiating profitable deals, are often male-biased (Pew Research Center 2019). Positive traits more commonly found in women, such as being diplomatic, agreeable, or considerate, are considered as disadvantageous in a leadership position. While men are on average more than twice as likely to interrupt a woman speaking than a woman would a man (Handcock and Rubin 2015), women are often criticized for being "mean" or "unlikable" when they try to adopt those very same qualities their male counterparts accept as effective in business negotiation (Sandberg 2013).

Regardless of personality traits, women choose to bring to the table, data have indicated the multi-fold impact of women leadership on corporate performance, including environmental and economic returns. A study from EY showed that utilities with greater representation of women showed higher economic performance with the top 20 gender-diverse utilities outperforming the bottom 20 by 14.8% (McPherson 2019). Countries with a higher represented of women in parliament are more likely to lower carbon-dioxide emissions and set aside protected land areas (UNDP 2016). Companies are more likely to increase investment in renewable energy and to decrease carbon emissions throughout their value chain when there are more women on the board of directors (CRB 2012). Although the investment in female business owners is less than half of the investment in their male counterparts, women start-ups generate seventy-eight cents for every USD 1 invested versus thirty-one cents from their male counterparts (Abouzahr et al. 2018). Successes of women's leadership have been associated with increased revenue and improved economic performance through leveraging innovation, pro-social considerations and their relationships (Catalyst Information Center 2013).

As women take on more leadership roles in many parts of the world (Pew Research Center 2019), a systematic analysis of women's contribution to energy transformation will be crucial for effecting impactful changes within the industry. Given that the issue of the gender gap is primarily an issue for the gender concerned, women are more likely to take initiatives regarding issues that relate to women, such as family policies, education and care (NG and Muntaner 2019). Progress towards gender equality will require the presence of women representing women's voice, particularly those in the position to bring about change within an organizational structure (e.g., Sandberg 2013).

*4.4. Gender Pay Gap*

The gender pay gap is a worldwide phenomenon with an estimated level at around 20–23%. This means a woman earns 77–80 cents per USD 1 a man earns in comparable jobs (ILO 2018a; Gallup and ILO 2017). Based on data from 62 countries reported on the SDG progress in 2019, the median hourly gender pay gap is at 12 % (UN 2019). The pay gap exists in low-income countries as well as in countries with high per-capita levels, with some of them with the highest gender wage gaps in the world. The gender pay gap is self-reported by Ireland, Mexico and Switzerland as their main challenge to achieving SDG 5 (UN DESA 2018b).

Despite higher average wages in the energy industry compared to other sectors among OECD countries, women occupy the lower wage class across occupational categories (OECD 2017; Antoni et al. 2015 German data). The gap is widened in managerial and professional occupations (including the bonus gap), in craft and related trades and in plant and machine operation and assembling (Good Energy 2019). Specific examples in renewable energy include EDF Energy the recompenses men 31.9% on average more than women, Innogy Renewables 22%, and SSE 22%. Consultancies active in the sector reported the following: Amec Foster Wheeler Environment and Infrastructure UK offers wages to men that are 22% higher than those of women, and Wood Group 16.6% (A Word About Wind 2018).

IRENA identified the multifaceted causes of the gender pay gap in the renewable energy sector as follows: (1) women's larger concentration in lower-paying, non-technical and administrative jobs and junior positions; (2) women's comparatively weaker negotiating positions; (3) their tendencies to compromise work for family obligations, such as parenting and caregiving; (4) the attitudes and values of employers, and (5) pay discrimination (IRENA 2019a).

Progress on closing the gender pay gap has already been made in Iceland with public utility Reykjavik Energy, who consciously increased its portion of women in

management to 49% and in Australia, where the Australian Institute of company directors provided a deadline to increase boards made up of women by 30% within 3 years to ASX200 companies. This induced a significant positive change, such as with Energy Australia, where women now occupy half of the 10 seats of board members after a careful plan implemented by the company (HRM 2019).

*4.5. Lack of Awareness on the Needs and Benefits of Gender Diversity*

Among the contributing factors to a gender gap in the energy sector is related to a lack of gender awareness and awareness on what gender diversity could bring to the table. On an interpersonal level, this lack of awareness can create unpleasant working environments for women, for example, a culture of isolation and loneliness. Women working as the "only" woman in the team have reported significantly worse work experiences than women who work with other women (McKinsey and Company 2018). Almost two-thirds of women receive regular microaggressions in business settings. Their judgment in their own area of expertise is often questioned and they feel under constant pressure to provide proof of their competence compared to their male colleagues (McKinsey and Company 2018).

An awareness of gender issues is an issue for all men and women stakeholders and cannot be assumed to happen naturally in an organization, let alone in the entire industry. Perceptions of inequity are further shaped by gender awareness and bias, and women are often made more aware than men. In the IRENA study, for example, 60% of men believe that women and men are paid equally, compared to 29% of women responding (IRENA 2019a). While it is understandable that gender awareness in the renewables sector is driven by women (IRENA 2019a), efforts should be made to involve men. Women and men interviewees in the energy sector who had not been exposed to discriminatory issues themselves often did not know how to identify and recognize barriers and enablers in the context of their employment and career progression (GWNET 2020).

To raise gender awareness with buy-ins in an organization is to recognize gender as a factor in creating a competitive advantage, contributing to the bottom line and serving as a force for economic growth (e.g., World Bank 2006; Goldman Sachs 2010; MGI 2015). Research indicates that having gender diversity in a company is linked with greater creativity, innovation and openness. In fact, certain competencies that women display more often than men, such as higher cognitive, social, emotional and skills, are expected to be highly valuable to enterprises (McKinsey and Company 2018).

Investing in gender-inclusive recruitment processes and policies can be justified through a compelling business case or a cost-benefit analysis. By investing in a system for the recruitment and advancement of the best person for the job without the influence of gender bias, the benefits will likely outweigh the costs. In the ILO report on a business case for gender diversity, 57 % of companies surveyed globally agreed that gender diversity initiatives improve business outcomes (ILO 2019). The challenge might lie in ensuring buy-in within the organizational structure through quantifiable measures indicating projected benefits of diversity, such as improvements in profitability and productivity, company image and reputation, ability to attract and retain talent, creativity, innovation and ability to understand consumer needs and interests (ILO 2019).

*4.6. Lack of Data and Measurement*

Gender gaps in the renewable energy workforce and supply chain are less likely to be taken seriously, unless there are clear data to support necessary adjustments. There is not currently a wide range of gender-disaggregated data available for the whole energy sector, let alone for subsector-specific studies. In most employment data, specific information on the participation of both sexes is not generally included (World Bank 2013). In many countries, adding a gender metric to employment data and constituent subsectors would be an additional burden.

Restricted data on the level and nature of women's employment pose a multi-fold challenge to addressing gender diversity in the energy transition (Baruah 2016). Short of having gender as a data point in the collection of information about the renewables workforce and its supply chain, analyses of the energy transition will be incomplete or misleading in multiple ways. For example, without gender-disaggregated data, current employment practices will continue to limit opportunities for women (e.g., Rivera 2015). When gender-sensitive methodologies for data collection and research design are not applied, scientific progress will be developed without reference to women's needs. Overall, when gender biases and disparities are perceived as business as usual, policies and initiatives on the energy transition are less likely to integrate a serious consideration of gender.

In recent years, non-governmental organizations (NGOs) and the private sector have increasingly explored the gender issue in the energy sector of developing countries (World Bank 2013). Some renewable energy companies are taking the lead in providing opportunities for women. Statkraft, a generator of renewable energy, has provided employment opportunities specifically for women in Peru and set the clear targets of developing gender diversity to have 40% top management positions filled by

women (Statkraft 2015, 2018). Fortum, a renewable energy supplier, has been elected among top 100 companies for gender equality (Equileap 2019). Siemens Gamesa, a wind turbine manufacturer, is part of the United Nations initiative Women's Empowerment Principles: "a community of companies committed to making a difference for women in the workplace, marketplace and community, accelerating the global momentum toward gender equality in the workplace" (Siemens Gamesa 2020). These initiatives are mainly undertaken by a few relatively large publicly listed companies, which are perhaps more under the scrutiny of the public eye and incentivized by the likes of Bloomberg (Bloomberg Gender-Equality Index (GEI)).

**5. Conclusions and Recommendations**

We attempted, in this study, to demonstrate that gender equity and its various approximations (equality, diversity, inclusion, parity) are not simply an ethical or fairness issue but an economic issue. Gender diversity is compatible with economic growth when the deficits and benefits of gender parity influence the agenda and outcome of inclusive growth.

It is no secret that women's increased workforce participation in the last decade is a key contributor to economic growth. Closing the employment gap would further increase a significant positive impact on the development of economies and would increase GDP in the Eurozone by 13%, for example. Once employment parity is in place, global GDP should grow to USD 12 trillion, resulting in a 26% increase in global annual GDP or USD 28 trillion by 2025 (MGI 2015). The lack thereof has tremendous economic costs and, thus, underlines the need for diversity. Women's limited access to employment in certain regions (such as in Asia and the Pacific) has been reported to cause a loss equivalent to USD 42 to 47 billion in GDP each year (WEF 2015).

A gender-inclusive energy transition will require, at the very least, indicators which measure progress beyond GDP towards addressing inequalities and tackling barriers which result in those inequalities. This will require an alternative economic theory which embraces equality and diversity as an integral, if not essential, part of economic growth. Theories such as "gender equality as smart economic", one which constructs women as entrepreneurs and a fundamental source of future business growth (World Bank 2006; Goldman Sachs 2010), might be worth exploring for the energy transition. As the renewables sector sees a growing share of women entering through trade, financial and business services, a framework which can broadly integrate and empower them to compete effectively in the sector's workforce is of great urgency.

It is unfortunate to find key targets and indicators under SDG 8, except for Target 8.5, fundamentally at odds with gender equality. As the rationale for pursuing diversity and inclusion is not reflected in SDG 8 main targets, there is no incentive at the national level to ensure that women are accounted for in the energy transition. It is unclear how women can be empowered to participate effectively and grow more innovative and competitive in the renewables workforce and its economy. This is a missed opportunity.

It is crucial, in our view, that gender diversity be taken seriously at the management level among energy companies. Given that the employment gap between men and women across the globe is estimated to be around 27% and in Europe at 12%, there is much to overcome for the renewables sector to take a leap for change. As the renewables workforce is portraying itself as young, technologically savvy and progressive, the sector will be pressured to close the gender gap. Given that gender parity will likely not be realized within the next 100 years (WEF 2019), the industry should be proactive at the forefront of bridging a gender gap as much as it is seeking more sustainable energy sources as an alternative to fossil fuel (Eurostat 2017).

The most important first steps involve collecting gender information and setting concrete gender targets and measurements. Companies should invest in value creation and promote gender equality as a business/economic issue and recognize the return on investment (ROI) benefit for companies to take gender targets seriously. Gender indicators could be part of a financial target for companies. At the organizational level, the awareness of the social and cultural benefits of gender diversity and the consequences of exclusion should be incorporated into companies' key performance indicators (KPIs), involve both women and men and be integrated and measured wherever possible. Institutional policies should be put in place to recruit female talents, promote an inclusive team culture, and tackle gender biases in order to encourage women to stay in their jobs. There can be no inclusive growth if workforces lack diversity.

**Author Contributions:** Conceptualization, S.V. and A.N.; methodology, S.V. and A.N.; validation, S.V. and A.N.; formal analysis, S.V. and A.N.; investigation, S.V. and A.N.; resources, S.V. and A.N.; data curation, S.V. and A.N.; writing—original draft preparation, S.V. and A.N.; writing—review and editing, S.V. and A.N.; visualization, A.N.; supervision, S.V. and A.N.; project administration, S.V. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Acknowledgments:** The authors express special gratitude to their network partners, namely, Global Wind Energy Council's Women and Wind Program and its EU and Asian Network, the Association of Dutch Suppliers in the Offshore Energy Industry (Netherlands/EU), POWERful

Women (UK/EU), Turkish Women's Network in Renewable Energy (Turkey), Women in Clean Energy (WICE), Women in Renewable Industries and Sustainable Energy (WRISE, USA), Women in Energy (AUS) and Solar Wonder Women (UK/EU) for their support in distributing our semi-structured questionnaires within their networks.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

A Word About Wind. 2018. The Blog: Wind Energy Market Analysis. How Can Renewable Energy Businesses Close the Gender Pay Gap? Available online: http://membership.awordaboutwind.com/blog/is-there-a-pay-gap-in-renewable-energy (accessed on 30 January 2020).

Abouzahr, Katie, Frances Brooks Taplett, Matt Krentz, and John Harthorne. 2018. *Why Women-Owned Startups Are a Better Bet*. Boston: BCG.

Allen, Elizabeth, Hannah Lyons, and Jennie C. Stephens. 2019. Women's leadership in renewable transformation, energy justice and energy democracy: Redistributing power. *Energy Research & Social Science* 57: 101233.

Allison, Juliann Emmons, Kirin McCrory, and Ian Oxnevad. 2019. Closing the renewable energy gender gap in the United States and Canada: The role of women's professional networking. *Energy Research & Social Science* 55, pp. 35–45.

Antoni, Manfred, Markus Janser, and Florian Lehme. 2015. The hidden winners of renewable energy promotion: Insights into sector-specific wage differentials. *Energy Policy* 86, pp. 595–613. [CrossRef]

Baruah, Bipasha. 2016. Renewable inequity? Women's employment in clean energy in industrialized, emerging and developing economies. *Natural Resources Forum* 41, pp. 18–29. [CrossRef]

Berkhout, Frans, Peter Marcotullio, and Tatsuya Hanaoka. 2012. Understanding energy transitions. *Sustainability Science* 7, pp. 109–11. [CrossRef]

Boniol, Mathieu, Michelle McIsaac, Lihui Xu, Tana Wuliji, Khassoum Diallo, and Jim Campbell. 2019. *Gender Equity in the Health Workforce: Analysis of 104 Countries*. Health Workforce Working Paper 1. Geneva, Switzerland: WHO.

Burke, Matthew J., and Jennie C. Stephens. 2018. Political Power and Renewable Energy Futures: A Critical Review. *Energy Research & Social Science* 35, pp. 78–93.

Carlsson-Kanyama, Annika, and Anna-Lisa Lindén. 2007. Energy efficiency in residences —Challenges for women and men in the north. *Energy Policy* 35, pp. 2163–72. [CrossRef]

Catalyst Information Center. 2013. *Why Diversity Matters*. Toronto: Catalyst Information Center.

Columbia Center on Sustainable Investment, Equitable Origin, Business & Human Rights Resource Centre, and The United Nations Sustainable Development Solutions Network (SDSN). 2019. *Mapping the Renewable Energy Sector to the Sustainable Development Goals: An Atlas*. New York, Washington, DC and London: UNDP/IFC/IPIECA.

Chancel, Lucas, Géraldine Thiry, and Damien Demailly. 2014. *Beyond-GDP Indicators: To What End? Lessons Learnt from Six National Experiences*. IDDRI Study. N°04/14, September. Paris: The Institute for Sustainable Development and International Relations.

Chavatzia, Theophania. 2017. *Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM)*. Paris: UNESCO.

Chien, Taichen, and Jin-Li Hu. 2008. Renewable energy: An efficient mechanism to improve GDP. *Energy Policy* 8, pp. 3045–52. [CrossRef]

Clancy, Joy. 2009. *Late Developers: Gender Mainstreaming in the Energy Sector*. Twente: University of Twente.

Clancy, Joy S., and Mariëlle Feenstra. 2006. *How to Engender Energy Policy*. The Hague: ENERGIA.

Clancy, Joy, and Beatrice Khamati-Njenga. 2003. *Concepts and Issues in Gender and Energy*. The Hague: ENERGIA.

Coscieme, Luca, Lars F. Mortensen, Sharolyn Anderson, James Ward, Ian Donohue, and Paul C. Sutton. 2020. Going beyond Gross Domestic Product as an indicator to bring coherence to the Sustainable Development Goals. *Journal of Cleaner Production* 248: 119232. [CrossRef]

Center for Responsible Business (CRB). 2012. *Women Create a Sustainable Future*. Berkeley: Haas School of Business, University of California Berkeley.

Deloitte Global Center for Corporate Governance. 2019. *Women in the Boardroom: A Global Perspective*, 6th ed. New York: Deloitte Global Center for Corporate Governance.

Dow, Roselynn S. 2014. Leadership responsibility in mentoring organization newcomers. *Journal of Management Policy and Practice* 15, pp. 104–12.

European Institute for Gender Equality (EIGE). 2019. *Gender Equality Index 2019. Work Life Balance*. Vilnius: EIGE.

Elliott, David. 1997. *Energy, Society, and Environment: Technology for a Sustainable Future*. East Sussex: Psychology Press.

Emelianova, Olga, and Christina Milhomem. 2019. *Women on Boards 2019 Progress Report*. New York: MSCI.

ENERGIA. 2009. *Biofuels for Sustainable Rural Development and Empowerment of Women: Cases Studies from Africa and Asia*. The Hague: ENERGIA.

Engie. 2018. Professional and Gender Equality. Available online: https://www.engie.com/en/commitments/professional-and-gender-equality (accessed on 25 January 2020).

Equileap. 2019. Gender Equality, Global Report and Ranking. Available online: https://equileap.org/2019-global-report/ (accessed on 30 January 2020).

Ernst and Young. 2015. Women in Power and Utilities Index 2015. Available online: http://www.ey.com/Publication/vwLUAssets/EY-women-in-power-and-utilities-index-2015/$FILE/EY-women-in-power-and-utilities-index-2015.pdf (accessed on 27 January 2020).

European Union. 2002. *Directive on Renewable Energy*. Indicative Targets. Brussels: European Union.

Eurostat. 2017. Gender Statistics. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php/Gender_statistics#Labour_market (accessed on 30 January 2020).

Farhar, Barbara. 1998. Gender and renewable energy: Policy, analysis, and market implications. *Renewable Energy* 15, pp. 230–39. [CrossRef]

Fioramonti, Lorenzo. 2013. *Gross Domestic Problem: The Politics Behind the World's Most Powerful Number*. London: Zed Book, 208p, ISBN 9781780322728.

Fioramonti, Lorenzo. 2017. *The World after GDP: Economics, Politics and International Relations in the Post-Growth Era*. Cambridge and Malden: Polity Press.

Fioramonti, Lorenzo, Luca Coscieme, and Lars F. Mortensen. 2019. From gross domestic product to wellbeing: How alternative indicators can help connect the new economy with the Sustainable Development Goals. *The Anthropocene Review* 6: 207e222. [CrossRef]

Fri, Robert, and Maxine Savitz. 2014. Rethinking energy innovation and social science. *Energy Research & Social Science* 1, pp. 183–87.

Gallup, Inc., and The International Labour Organization. 2017. *Towards a Better Future for Women and Work: Voices of Women and Men*. Geneva and Washington: ILO.

Giannetti, Biagio, Feni Agostinho, Cecília Almeida, and Donald Huisingh. 2015. A review of limitations of GDP and alternative indices to monitor human well-being and to manage eco-system functionality to ensure sustainable societal development. *Journal of Cleaner Production* 87, pp. 11–25. [CrossRef]

GMI Ratings. 2012. GMI Ratings Releases Research Findings on Gender Diversity on U.S. Boards of Directors. Available online: http://www3.gmiratings.com/home/2012/07/july-31-2012-press-release-2 (accessed on 4 September 2015).

Goldman Sachs. 2010. *Womenomics 3.0: The Time Is Now*. New York: Goldman Sachs Group.

Good Energy. 2019. Gender Pay Report 2019. Available online: https://www.goodenergy.co.uk/media/18331/good-energy-gender-report-2019.pdf (accessed on 31 January 2020).

Girl Scout Research Institute (GSRI). 2012. *Generation STEM: What Girls Say About Science, Technology, Engineering and Math*. New York: GSRI.

Global Women's Network for the Energy Transition (GWNET). 2020. *Strategies to Foster Women's Talent for Transformational Change: Technical Working Document*. Abu Dhabi: GWNET.

Handcock, Adrienne, and Benjamin Rubin. 2015. Influence of communication partner's gender on language. *Journal of Language and Social Psychology* 1, pp. 46–64. [CrossRef]

HRM. 2019. What Does Closing the Gender Pay Gap in a Few Weeks Looks Like? Available online: https://www.hrmonline.com.au/gender-diversity/closing-gender-pay-gap/ (accessed on 31 May 2020).

Huyer, Sophia. 2015. Is the Gender Gap Narrowing in Science and Engineering? In *UNESCO Global Science Report 2015*. Paris: UNESCO.

Hymowitz, Carol, and Timothy D. Schellhardt. 1986. The Glass Ceiling: Why Women Can't Seem to Break the Invisible Barrier That Blocks Them from the Top Jobs. *The Wall Street Journal* 24 p. 1.

International Energy Agency (IEA). 2019. Clean Energy Ministerial. Status Report on Gender Equality in the Gender Sector. Available online: http://www.cleanenergyministerial.org/sites/default/files/2019-06/Status%20Report%20on%20Gender%20Equality%20in%20the%20Energy%20Sector_0.pdf (accessed on 27 January 2020).

International Labour Organization (ILO). 2018a. *Global Wage Report 2018/19: What Lies Behind Gender Pay Gaps*. Geneva: International Labour Office.

International Labour Organization (ILO). 2018b. *The Gender Gap in Employment: What's Holding Women Back?* Geneva: ILO.

International Labour Organization (ILO). 2019. Women in business and management: The business case for change. In *The Business Case for Change*. Geneva: Bureau for Employers' Activities (ACT/EMP).

ILO NORMLEX. 2020. International Labour Organisation. 2020. Information System on International Labour Standards. Available online: https://www.ilo.org/dyn/normlex/en/f?p=1000:12001:::NO::: (accessed on 31 January 2020).

ILOSTAT and World Bank. 2020. International Labour Organization, ILOSTAT Database. 2020. In *Labor Force Participation Rate, Female. (Compared with Labor Force, Female (% of Total Labor Force)*. Geneva: International Labour Office.

International Renewable Energy Agency (IRENA). 2014. *REmap 2030: A Renewable Energy Roadmap*. Abu Dhabi: IRENA.

International Renewable Energy Agency (IRENA). 2016. *Renewable Energy Benefits: Measuring the Economics*. Abu Dhabi: IRENA.

International Renewable Energy Agency (IRENA). 2019a. *Renewable Energy: A Gender Perspective*. Abu Dhabi: IRENA, pp. 3, 19.

International Renewable Energy Agency (IRENA). 2019b. *Renewable Energy and Jobs—Annual Review 2019*. Abu Dhabi: IRENA.

International Renewable Energy Agency (IRENA). 2020. *Wind Energy: A Gender Perspective*. Abu Dhabi: IRENA.

International Trade Union Confederation (ITUC). 2016. Investing in the Care Economy: A Pathway to Growth. Available online: https://www.ituc-csi.org/investing-in-the-care-economy-a (accessed on 31 January 2020).

International Union for Conservation of Nature (IUCN). 2015. Unleashing the Power of Women in the Renewable Energy Sector. Available online: https://genderandenvironment.org/2015/10/unleashing-the-power-of-women-in-the-renewable-energy-sector/ (accessed on 30 January 2020).

Jacobson, Mark Z., and Mark A. Delucchi. 2009. A Path to Sustainable Energy by 2030. *Scientific American* 301: 58–65. [CrossRef] [PubMed]

Kleven, Henrik, Camille Landais, and Jakob Egholt Søgaard. 2018. *Children and Gender Inequality. Evidence from Denmark*. Cambridge, MA: National Bureau of Economic Research.

Korn Ferry. 2017. Korn Ferry Analysis of Largest U.S. Companies Shows Percentage of Women in Most C-Suite Roles Dramatically Lagging Male Counterparts. *Press Release*, December 18.

Lallement, Dominique. 2013. Infrastructure and gender equality. Chapter 9. In *Handbook of Research on Gender and Economic Life*. Edited by Deborah M. Figart and Tonia L. Warnecke. Cheltenham: Edward Elgar Publishing, p. 592.

Le Blanc, David. 2015. Towards integration at last? The sustainable development goals as a network of targets. *Sustainable Development* 23, pp. 176–87. [CrossRef]

Leturcq, Marion. 2016. The Gender Gap and Childcare. Institut National D'études Démographiques. VOX. Available online: https://voxeu.org/content/gender-gap-and-childcare (accessed on 31 January 2020).

Lucas, Hugo, Stephanie Pinnington, and Luisa F. Cabeza. 2018. Education and training gaps in the renewable energy sector. *Solar Energy* 173, pp. 449–55. [CrossRef]

Madgavkar, Anu, James Manyika, Mekala Krishnan, Kweilin Ellingrud, Lareina Yee, Jonathan Woetzel, Michael Chui, Vivian Hunt, and Sruti Balakrishnan. 2019. *The Future of Women at Work: Transitions in the Age of Automation*. New York: McKinsey Global Institute.

McKinsey and Company. 2018. *Women in the Workplace 2018*. Washington: McKinsey and Company.

McPherson, Sharron L. 2019. *Women Could be the Game Changers in SA's Energy Crisis*. Cape Town: Graduate School of Business University of Cape Town.

McKinsey Global Institute (MGI). 2015. *The Power of Parity: How Advancing Women's Equality Can Add $12 Trillion to Global Growth*. Washington: McKinsey and Company.

Montero, Diana. 2019. 5 Keys to Implementing Successful Women's Leadership Programs. Stratx-exl. Available online: https://www.stratx-exl.com/industry-insights/implementing-successful-womens-lead (accessed on 28 March 2020).

Morrison, Ann M., Randall P. White, and Ellen Van Velsor. 1987. *Breaking the Glass Ceiling*. Reading: Addison-Wesley.

Nagel, Joane. 2015. *Gender and Climate Change: Impacts, Science, Policy*. New York: Routledge.

Nelson, Sibyl, and Anne T. Kuriakose. 2017. *Gender and Renewable Energy: Entry Points for Women's Livelihoods and Employment*. Washington, DC: Climate Investment Funds.

NG, Edwin, and Carles Muntaner. 2019. The More Women in Government, the Healthier a Population. Available online: http://theconversation.com/the-more-women-in-government-the-healthier-a-population-107075 (accessed on 30 January 2020).

Odum, Howard T. 1971. *Environment, Power, and Society*. New York: Wiley Interscience.

OECD. 2017. *The Pursuit of Gender Equality: An Uphill Battle*. Paris: OECD Publishing.

Olivetti, Claudia, and Barbara Petrongolo. 2017. The Economic Consequences of Family Policies: Lessons from a Century of Legislation in High-Income Countries. *Journal of Economic Perspectives* 31, pp. 205–30. [CrossRef]

Parikh, Jyoti. 1995. Gender issues in energy policy. *Energy Policy* 23, pp. 745–54. [CrossRef]

Pearl-Martinez, Rebecca, and Jennie C. Stephens. 2017. Toward a gender diverse workforce in the renewable energy transition. *Sustainability: Science, Practice and Policy* 12, pp. 8–15. [CrossRef]

Pew Research Centre. 2013. *On Pay Gap, Millennial Women Near Parity—For Now*. Washington, DC: Pew Research Center.

Pew Research Center. 2019. The Data on Women Leaders. Available online: https://www.pewsocialtrends.org/fact-sheet/the-data-on-women-leaders/ (accessed on 20 February 2020).

Price Waterhouse Coopers (PwC). 2015. *Igniting Change: Building the Pipeline of Female Leaders in Energy*. London: PwC.

Rai, Shirin M., Benjamin D. Brown, and Kanchana N. Ruwanpura. 2019. SDG 8: Decent work and economic growth—A gendered analysis. *World Development* 113, pp. 368–80. [CrossRef]

Räty, Riitta, and Annika Carlsson-Kanyama. 2010. Energy consumption by gender in some European countries. *Energy Policy* 38, pp. 646–49. [CrossRef]

Richards, Heidi. 2017. Success Factors of Women in Leadership Roles and Breaking through the Glass Ceiling: A Phenomenological Qualitative Study. Ph.D. dissertation, Nova Southeastern University, Fort Lauderdale, FL, USA.

Rivera, Lauren. 2015. Guess Who Doesn't Fit In at Work. *New York Times*. May 31. Available online: http://www.nytimes.com/2015/05/31/opinion/sunday/guess-who-doesnt-fit-in-atwork.html?_r=0 (accessed on 20 February 2020).

Runyan, Anne Sisson. 2016. Gender in Global Restructuring. In *Handbook on Gender in World Politics*. Edited by Jill Steans and Daniela Tepe. Cheltenham: Edward Elgar Publishing, pp. 354–61.

Sandberg, Sheryl. 2013. *Lean in, Women, Work and the Will to Lead*, 1st ed. New York: Knopf Doubleday Publishing.

Solar Energy Industry Association (SEIA). 2017. *Diversity Best Practices Guide for the Solar Industry*. Washington, DC: SEIA.

Siemens Gamesa. 2020. The Power of Diversity in Wind Energy, a World of Opportunities. Available online: https://www.siemensgamesa.com/en-int/sustainability/diversity (accessed on 25 April 2020).

Solar Foundation. 2019. *National Solar Jobs, Census 2018*. Washington: Solar Foundation.

Spaiser, Viktoria, Shyam Ranganathan, Ranjula Bali Swain, and David J. T. Sumpter. 2017. The sustainable development oxymoron: Quantifying and modelling the incompatibility of

sustainable development goals. *International Journal of Sustainable Development & World Ecology* 24, pp. 457–70.

Statista. 2015. Energy Industry: Share of GDP by Country. Available online: https://www.statista.com/statistics/217556/percentage-of-gdp-from-energy-in-selected-countries/ (accessed on 15 March 2020).

Statkraft. 2015. Weaving Their Way to a Better Life. Available online: https://stories.statkraft.com/Archive/2015/weaving-their-way-to-a-better-life/ (accessed on 20 March 2020).

Statkraft. 2018. Annual Report 2018. Available online: https://www.statkraft.com/globalassets/1-statkraft-public/05-investor-relations/4-reports-and-presentations/2018/annual-report-2018/2018-annual-report-statkraft-as.pdf (accessed on 20 March 2020).

Stephens, Jennie C. 2019. Energy Democracy: Redistributing Power to the People through Renewable Transformation. *Journal Environment: Science and Policy for Sustainable Development* 61, pp. 4–13. [CrossRef]

Strietska-Ilina, Olga, Christine Hofmann, Mercedes Durán Haro, and Shinyoung Jeon. 2011. *Skills for Green Jobs: A Global View*. Synthesis Report Based on 21 Country Studies. Geneva: International Labour Office.

United States Bureau of Labour Statistics. 2017. *Labor Force Statistics from the Current Population Survey, Employed Persons by Detailed Industry, Sex, Race, and Hispanic or Latino Ethnicity*; Washington, DC: Bureau of Labour Statistics.

United Nations (UN). 2019. *Report of the Secretary General on SDG progress 2019: Special Edition*. New York: United Nations.

UN Department of Economic and Social Affairs (UN DESA). 2018a. *Analysis of the Voluntary National Reviews Relating to Sustainable Development Goal 7 2018: Ensuring Access to Affordable, Reliable, Sustainable and Modern Energy for All*. New York: United Nations.

UN Department of Economic and Social Affairs (UN DESA). 2018b. *Synthesis of Voluntary National Reviews 2018*. New York: United Nations.

United Nations General Assembly (UN GA). 2015. Resolution adopted by the General Assembly on 25 September 2015. In *Transforming Our World: The 2030 Agenda for Sustainable Development*. U.N. Doc. A/RES/70/1. para. 74. New York: UN GA.

UN Women. 2015. United Nations Entity for Gender Equality and the Empowerment of Women. Progress of The World's Women 2015–2016. Available online: http://progress.unwomen.org/en/2015/ (accessed on 20 February 2020).

United Nations Development Programme (UNDP). 2016. *Gender and Climate Change*. New York: UNDP.

United Nations Industrial Development Organization (UNIDO), and Global Green Growth Institute (GGGI). 2015. *Global Green Growth: Clean Energy Industry Investments and Expanding Job Opportunities, Vol. I: Overall Findings, Vienna, Austria and Seoul, South Korea*. Vienna and Seoul: UNIDO and GGGI.

Warr, Benjamin S., and Robert U. Ayres. 2009. *Increase Supplies, Increase Efficiency: Evidence of Causality Between the Quantity and quality of Energy Consumption and Economic Growth*. Faculty Research Working Paper No. 2009/22/EPS/ISIC. Fontainebleau: INSEAD.

Women's Budget Group (WBG). 2016. *Investing in the Care Economy to Boost Employment and Gender Equality*. London: Women's Budget Group.

World Energy Council (WEC). 1994. *New and Renewable Energy Resources: A Guide to the Future*. London: Kogan Page.

World Economic Forum (WEF). 2012. *New Energy Architecture Enabling an Effective Transition*. Geneva: WEF.

World Economic Forum (WEF). 2015. *The Global Gender Gap Report 2015*. Insight Report. Geneva: WEF.

World Economic Forum (WEF). 2017. *The Global Gender Gap Report*. Geneva: WEF.

World Economic Forum (WEF). 2019. *The Global Gender Gap Report 2020*. Geneva: WEF.

Wei, Max, Shana Patadia, and Daniel M. Kammen. 2010. Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US? *Energy Policy* 38, pp. 919–31. [CrossRef]

Weitz, Nina, Henrik Carlsen, Måns Nilsson, and Kristian Skånberg. 2018. Towards systemic and contextual priority setting for implementing the 2030 Agenda. *Sustainability Science* 13, pp. 531–48. [CrossRef]

World Bank. 2006. *Gender Equality as Smart Economics: A World Bank Group Gender Action Plan*. Washington, DC: World Bank Group, p. 6.

World Bank. 2013. *Integrating Gender Considerations into Energy Operations*. Energy Sector Management Assistance Program (ESMAP). Knowledge Series 014/13; Washington, DC: World Bank.