Abstract
One of the barriers to achieve the expected renewable energy market development is the shortage of qualified human resources. Global data on education and training on renewable energies was analyzed in order to gain an understanding of the current education supply worldwide. Findings are: (i) the shortage is more acute in developing countries; (ii) there is a mismatch between education system offer and industry demand; (iii) there is also a mismatch in the suitability of the curricula; (iv) students and educators are moving towards online training for collaborating and learning. While it remains a challenge to increase, improve, and facilitate access to renewable energy education and training, the high interest of females in renewable energy education represents an opportunity to counter the scarcity of professionals in the sector.

Keywords: renewable energy, education, training, gaps

1. Introduction
The International Energy Outlook 2017 from the US Energy Information Administration projects world energy consumption to increase by 28% in the next quarter of a century (EIA, 2017). Growing prosperity and economic development in non OECD and developing countries are responsible for rising energy demands. According to the report, renewable energy (RE) represents the world’s fastest growing energy source, with a predicted 2.3% consumption increase per year for the period 2015-2040. Non-hydropower renewables are

1 Corresponding author: lcabeza@diei.udl.cat; Tel.: +34-973-003576
projected to more than double their relative contribution until 2040, from 7% of total world generation to 15%. The International Energy Agency, in a recent report, offers similar prospects for renewable energies for 2022. Especially with regards to the solar PV sector in China and India, the IEA projects large capacity expansions, up to 43% between 2016-2022 (IEA, 2017). On the global level, one however needs to recognize the remaining and consisting importance of traditional energy sources, in defiance of individual health concerns (EEA, 2017) and its association with anthropogenic climate change. Nevertheless, RE is growing fast, and with it come implications for employment and related sectoral shifts.

At the end of 2016, renewable energies already employed, directly and indirectly, 9.8 million people worldwide (IRENA, 2017a). Further growth can be expected, with estimates suggesting that RE may provide 24.4 million jobs worldwide by 2030 if the Sustainable Energy for All goals are achieved in time (IRENA, 2016). In terms of technologies, today solar photovoltaics employs 3.1 million people, and liquid biofuels and wind power employ 1.7 million and 1.2 million people respectively. With reference to countries, China with 3.6 million, Brazil with 876 thousand and United States of America 777 thousand people, are the three countries leading the ranking of employment in renewables. Regarding the value chain (IRENA, 2011), the majority of employment is created in construction, installation, as well as operation and maintenance. These are primarily local jobs that are spread well across countries, while manufacturing jobs, particularly in relation to photovoltaic panels and wind turbines, are increasingly concentrated in Asia (IRENA, 2017a).

The existing and projected upsurge in RE opportunities has to be matched by a workforce that is required to rapidly adapt and expand. Design and deployment strategies of renewable energy systems often exceed traditional engineering expertise (Thomas et al., 2008). (Kandpal and Broman, 2014) second this concern, describing the unavailability of qualified professionals as a major barrier to renewable energy advances. According to Negro et al. (2012), it is not only the significantly different technology that creates a shortage of skill, but at the same time the pace at which sectors develop and mutate. Consequently, human capital development constitutes a vital premise for a successful energy transition, already today, but even more so with aforementioned projected sector and employment expansions in mind. This represents a great challenge to present and future societies, demanding rigorous reconsideration of contemporary education systems, training facilities, and course offers.

This paper will add to the emerging literature on renewable energy education by analyzing the IRENA Renewable Energy Learning Partnership (IRELP) database. Descriptive statistics on the world-wide supply of, and demand for, training and course offers, coupled with expert interviews, allows for valuable insights into the market mechanisms of respective education. To our
best knowledge, this represents a novel and important contribution, emphasizing current trends and areas of improvement.

The remaining paper is structured as follows. Section 2 provides a stratified overview of employment in RE, as well as a literature review of relevant contributions regarding renewable energy education. Section 3 outlines the methodological approaches. Section 4 and 5 analyse the offer of courses on the IRELP database, as well as the interest in RE education and training based on the traffic the database has received. Section 6 concludes.

2. Background and Literature Review

2.1. Understanding the Employment Deficit and its Consequences

A transition to renewable energies does not merely represent the development of energy generation technology, but instead marks the emergence of new approaches to energy production and consumption, together with similarly novel skill requirements. Traditional concepts of engineering remain important (Malamatenios, 2016), but they are unlikely to be sufficient. Given the distinctness of renewable energy production technologies, what is required are highly unique sector specific skills (Lucas, 2012). Additional to specific skills, professionals in the field of renewable energies are expected to possess other, sector spanning, competencies, such as environmental awareness (Malamatenios, 2016) and profound understanding of sustainability concepts (Davidson et al., 2010). As such, the RE industry has to deal with a work force that is not easily transferable, neither from conventional to renewable energy, nor within different renewable energy sectors. The work force deficit and the skill gap in renewable energy industries around the world need to be addressed urgently. Not only do they directly represent an obvious barrier to technology dissemination (Thomas et al. (2008); Negro et al. (2012); Kandpal and Broman (2014)), but the adverse effects of deficient knowledge of RE technologies (of both the public and professionals) may also manifest itself through bad reputation (Jennings (2009); IRENA (2013)) or economically inefficient utilization (Acikgoz (2011); IRENA (2013)).

2.2. Is the Education System Adopting Accordingly?

Current professionals need to extend their expertise in order for the industry to be able to bridge the skill gap, and simultaneously education and training of new professionals has to adapt to the new requirements. Unfortunately, this proven to be difficult. Davidson et al. (2010) argues, that too few engineering schools have managed to adapt, partly due to the amount of time it takes for curricula to change or course materials being absent (IRENA, 2012). Even if traditional engineering courses incorporate modules on sustainability and renewable energies, these may be too superficial and lack required detail (Jennings, 2009). Fully specialized degrees could produce the competencies demanded but may represent all-too-fleeting niches (McPherson and Karney, 2015). For example, interest in the few existing geothermal energy programs has
recently declined, partly due to the technology’s deployment correlating with
the recent decline in oil prices and solar PV installation costs, which in turn
renders geothermal energy generation economically inferior (Zarrouk, 2017).

Another focal point in the literature is the link between the education system/
training centers and the industry. Given sufficient cooperation the industry can
signal the required level of skill and knowledge for new and current
professionals (Kandpal and Broman, 2014), which is becoming increasingly
important in industries undergoing rapid and dynamic development. One way of
sustaining this link would be through a practically orientated curriculum at the
under graduate or post graduate level (as well as at training centers), or through
industry and sector relevant doctoral research. For Colenbrander et al. (2015), it
is especially the latter that represents a vital capability needed in sub-Saharan
Africa, as it can provide the technical and entrepreneurial understanding to
deploy established technologies in local contexts. In the wind energy industry,
the education-industry link has been found to be lacking substantially, with the
educational institutions not being able to keep up with technology developments
in the industry (Fitch-Roy, 2013). Analogously, Xie et al. (2013) report short
term technical and vocational education and training (TVET) and on-the-job
training to be lagging behind industry developments in the Chinese wind energy
sector. Absent coordination with the industry appears to be also evident in the
European bioenergy industry. Watkinson et al. (2012) identify a significant
expansion in the bioenergy course offer, however excessive of the demand, with
enrolment rates falling greatly behind. Lacking promotion and overly optimistic
anticipation may be the direct consequence of insufficient coordination
mechanisms.

3. Methodological Approach, Limitations and Definitions

3.1. Methodological Approach

Research had been conducted over three phases. In the initial phase, a
literature review of academic papers and secondary sources on shortages of
skills and education gaps in RE was carried out. In the second phase, a
comprehensive analysis of the International Renewable Energy Agency (IRENA)
Renewable Energy Learning Partnership (IRELP) database was performed in
order to assess the current supply and demand of RE training and education
worldwide.

IRELP had been a project developed at IRENA, aiming to increase access to,
and awareness of, RE education and training offer. IRELP, from April 2012 to
April 2017, offered access to five global databases of RE courses, internships,
webinars, training guides and resources for educators. The IRELP course
database gathered information on over 2,500 existing RE education and training
opportunities offered around the world, including short-term vocational and
professional development courses, apprenticeship programmes, and associate,
bachelors, masters and doctorate programmes. The database was categorized by
course type, topic, location, duration, language, and qualification awarded. The information provided in the database was gathered through IRENA desk research (70%), IRELPs 22 partner organizations, including RE regional centers, industry associations and educational institutions (20%) and volunteer members of the IRELP Global Network (10%). Data that was sourced through partner organizations and volunteers was verified through desk-research by IRENA prior to being made public through the IRELP web portal (IRENA, 2015).

Further, the traffic received by the IRELP database can shed light on the demand for RE education. The Google Analytics service allows for key performance indicator analysis, which was used to identify countries of groups that show strong interest and allows for the evaluation of their user behavior. The main indicators used in this analysis were the amount of sessions, the bounce rate, and the average session duration. The bounce rate can be defined as the rate of website visits that triggered no further interaction, as if the user instantly left without engagement (see Google Analytics Support at Support.google.com).

In the final phase, a survey was designed and circulated to stakeholders working in the field of human resources and RE, to discuss the results from the previous research phases and in order to gain a better understanding of the demand for RE skills and challenges faced by RE companies in fulfilling skill requirements, as well as in order to define solutions to be implemented. The survey was conducted from June 2016 to October 2017 via email and telephone interviews. From the 30 respondents, 10 came from the industry, 13 from the education and training sector, 6 from governments and 1 from civil society.

3.2. Limitations

While the IRELP database offers the most comprehensive overview of available RE education, it does not claim to be in any way exhaustive. It cannot be precluded, that there are no country or region specific differences in the reliability and completeness of the data, which could bias the analysis.

Region specific heterogeneity is certainly thought worthy issue in the analysis of the database usage through Google Analytics. For various reasons, individuals may or may not use the IRELP database as a gateway for RE education. It is impossible to control for these differences in the cross sectional setting of this study.

Further, the database holds qualitative data lacking any kind of standardization that would allow for direct comparison. Consequently, statistics on, for instance, the percentage share of solar energy courses in the database can only be approximations. The reason for this is that many courses cover many topics and technologies, of which all are listed, but little is known about specific weighted contributions.
3.3. Definitions

The analysis in this paper spans multiple forms of what could broadly be defined as education and training. In order to understand heterogeneous demands for specific forms of education, it is required to more formally define respective types of education and training.

Education, often used to simultaneously describe various levels of schooling, can more formally be represented through the UNESCO International Standard Classification of Education (ISCED) (UNESCO, 2012). Of importance for this paper are especially post-secondary non-tertiary education (ISCED level 4), as well as tertiary education (ISCED level 5-8). The former level takes role in providing learning experiences directly building on secondary education with focus on preparing for both labor market entry and tertiary education (see UNESCO, 2016, pp. 494). Tertiary education places higher emphasis on imparting knowledge and experience in specialized fields and disciplines at higher levels of complexity. Besides comprehensive education programs, certain expertise depends on very specific skillsets. The UNESCO defines skills as non-innate capabilities, which especially can entail economics and social advantages for individuals and societies (see UNESCO, 2016, pp. 495). Highly important are also technical and vocational education and training (TVET), which are designed to prepare students for specified occupations, often in regard to technical and applied tasks (see UNESCO, 2016, pp. 495). These forms of training can be offered not only to prospective professionals, but also constitute a form of skill development for the contemporary work force, in the form of on-the-job training.

4. Renewable Energy Education and Training Offer

Education and training data on the IRELP website and databases was analyzed for this paper in order to gain an understanding of the current supply of RE training and education worldwide. Data that is referenced in this paper includes records that were published on IRELP as of May 2015. For the purpose of this paper, RE course data provided by IRELP was analyzed by technology, region, skill type, language, and course type. While the IRELP course database was updated regularly and was the most comprehensive listing of RE education offer to date, the database did not claim to be exhaustive and thus data regarding the geographical and technological spread of RE education included within this paper should be interpreted with a degree of uncertainty. Finally, as mentioned the data is not anymore publicly available on line, but the authors could provide the raw data from May 2015 used for the analysis.

4.1. Renewable Energy Education and Training by Region

IRELP shows that in total, 40.9% of courses are available in Europe, 33.3% in North America, 12.2% in Asia, and only 6.7% in Latin America, 6.3% in Africa and 3.2% in Oceania. The intra-regional distribution of course offers highlights the leading knowledge hubs in respective regions. Ranking globally, the United States is leading in terms of the number of courses currently offered, with 662.
documented RE courses. The United Kingdom and Germany follow behind with 310 and 186 respectively. India, the leading developing country, ranks fifth overall, with 104 courses currently identified.

4.2. Renewable Energy Education and Training by Technology

The most popular category of RE courses imparts multi-technology knowledge, meaning courses that address more than one RE technology (Could still

![Sector Specific Course Offer](image)

Figure 1: Sector Specific Course Offer. y-axis represents the number of courses in the IRELP database. Source: Own calculations based on IRELP database

be one topic only, e.g., finance). These courses are most often broad RE courses, introducing students to generally to all RE sources and technologies, or providing a focus on two technologies (e.g., wind and solar together). Solar energy is the second most popular course focus, representing 23.1\% of all courses, followed by wind with 8.3\%. Geothermal and bioenergy represent 3.8\% and 3.4\% respectively, hydropower 1.7\% and ocean and storage technologies are negligible.

Figure 1 visualizes the sector specific course offer at the regional level\(^1\). The general multi-technology renewable energy course type is most profound in

\(^1\) Approximation: Sector spanning courses (i.e., solar and wind) count towards the first named sector. A total of 119 courses have been approximated in this way. Solar and wind represent the largest multi-technology course, with a total of 17 courses. The approximation does not strongly bias the
Europe and represents the most frequent course type in almost all regions. The only exception is Northern America, where the amount of solar courses offered exceeds the general renewable energy courses by almost a third.

Comparing the sector specific course offer to a regional sector specific renewable energy capacity aggregation (aggregation of capacities of the same sample of countries as featured in the IRELP database (IRENA, 2017b)), as portrayed in Figure 2, highlights the seeming unrelatedness of the industry and the education sector. Without a dynamic panel, the possibilities for statistical inference remain limited. The database itself offers no information on whether for in-

![Regional Capacity Aggregation, 2015](image)

Figure 2: Regional RE Electricity Capacity Aggregation in 2015. Source: Own calculations based on IRENA (2017b)

stance the large Northern American solar course offer represents a reasonable anticipation of a exceeding solar energy sector in the region. Further, there are a comparably small number of wind energy courses considering the relatively large region spanning capacities. Also interesting are the extensive hydro capacities in the absence of a meaningful number of courses. While initially surprising, the following discussion will offer an intuitive explanation.

representation, but provides conservative counts. An alternative method would be to count each mentioned sector, however this leads to only negligible changes in the distribution.
4.3. Renewable energy education and training by course type

Globally, the highest share (32.4%) of RE courses is currently being taught at the master’s level, with short-term professional development training following closely in second (29.1%). Fewer courses are offering hands-on training. Only 15.8% being categorized as vocational training and 3.5% as associate level programmes. The remaining ones are broken down into undergraduate level training and doctorate level education.

At the regional level, Figure 3 shows that there are noticeable differences in the relative distribution of course types. On the African continent, short term professional development represents the most important share of RE courses. Asia, Europe, South America and Oceania show a strong relative reliance on master programmes, while North America finds itself with the lowest regional share of master programmes, in relative terms. However, North America opposes with a strong representation of vocational training and short term professional development training, as well as being almost the only place to go for associate programmes.

![Regional Course Type Distribution](image)

Figure 3: Regional Course Type Distribution. The y-axis is referring to the regional percentage share of respective course types. The share of the grand total represents the relative representation of courses from respective regions in the IRELP database. Source: Own calculations based on IRELP database

4.4. Discussion on the Global Offer of Renewable Energy Education and Training

4.4.1. More Acute Shortage in Developing Countries

From the data it appears that education systems in developing countries, and particularly in Africa, are struggling more than developed countries with adapting to industry needs. Not only the lack of courses, but also the suitability may be of concern. The over proportional offer of short term professional
development, as shown in Figure 3 may hint to exactly this. The scarcity of RE education and training in developing countries raises concern, particularly when examining data on RE potentials. During the interviews, the most common cited reasons hampering the development of education on renewables in developing countries are financial constraints, shortage of qualified teachers and trainers and lack of know-how in developing RE curricula.

4.4.2. Mismatch between Education and Training Offer and Industry Demand

In a standard wind farm project manufacturing represents 17% of the employment, construction 30%, and operation and maintenance (O&M) 43% (IRENA, 2017a). The figures for a PV grid connected project are 22%, 17%, and 56% respectively (IRENA, 2017b). The manufacturing, construction, operation and maintenance of RE projects need specialists with specific experience in one particular field. There is a low percentage of jobs within the sector that demand a broad overview of the sector. Nevertheless, more than half of the educational and training offers in renewables have multi-technology curricula and include not only technological aspects but also introduce students to a broader range of related topics, i.e., legislation and policy making. This represents a clear mismatch between the available education and training offer globally, and industry demands, given that most of the jobs are created in O&M and installation, demanding hands-on and technical/specific training.

This finding was confirmed during interviews, however, several experts also highlighted that in the near future, with countries advancing with the sustainable energy transition, energy systems will increasingly integrate large shares of decentralised generation and advance sector coupling through electrification of all end-uses. This factor will likely lead to an increased demand for multitechnology professionals in the long-term. This will particularly be true for the building and transport sectors.

The very low percentage of education and training offer in hydropower is explained by the maturity of the technology. Hydropower has been gradually incorporated into existing engineering curricula around the world, however it remains questionable if this is sufficiently up-to-date. For example, Thomas et al. (2008) claim that lack of training in social and environmental issues is at least partly responsible for many errors made in the past with large hydro dams.

While the percentage of the education and training in geothermal energy may appear modest, it is in fact quite high when compared to the total share of geothermal energy in the primary energy globally. The database suggests that the presence of geothermal education and training for power generation is strongly linked to the locations with high resource potential, with the majority of programmes being offered in United States, Iceland, Germany, New Zealand and Japan. There are two notable exceptions to this trend the lack of education in the Great Rift Valley in Africa and the Andean region in South America.
The literature review (e.g., Xie et al., 2013) and the interviews conducted suggest that the wind industry is also struggling to communicate with the education system on the skills necessary to further develop the industry. Wind energy companies in Europe are finding it difficult to recruit suitably trained employees and the most frequently cited reason for this constrained supply of labor is the disconnect between skills being taught in educational institutions and those being demanded by the industry, particularly for emerging technologies. While there certainly is a skill gap persisting, there is another factor at least partly explaining the conservative number of wind energy courses in the IRELP database. First of all, wind energy course may also have gradually been incorporated into engineering curricula and hence not been accounted for in the database. Secondly, providers of chartered education, such as the Danish Wind Power Academy or BZEE, centralize and channel education through large training facilities. Given that the IRELP database only counts the number of courses, but does not register their capacity, the representation of wind energy education in the database may be subject to a significant downward bias.

4.4.3. **Mismatch between the Offered Educational and Training Levels and Degrees, and the Industry Demand**

The most prevalent skills shortages, particularly in the wind sector, are appearing in construction and installation and in operations and maintenance (Fitch-Roy, 2013). However, the literature review has shown how skill shortages and/or problematic education-industry links are a sector spanning issue, which is responsible for a multitude of hard to fill occupations (IRENA, 2011). Many of these roles are highly technical and require practical hands-on training and problem-solving skills. The current focus in RE education globally, however, appears to be on higher education (see Figure 3).

For higher level job roles, successful candidates require social and environmental conscience and entrepreneurial skill. Based on the declared course topic in the database, almost half of the courses offer indeed, at least partly, a managerial component. Nevertheless, the interviews emphasized, that when recruiting for managerial positions, human resource departments consider experience to be more valuable than a candidate’s academic background. Considering that RE constitutes a relatively novel sector, suitable candidates are recruited from other sectors or public organizations. This may suggest that there are currently too many higher education programmes being offered that fail to incorporate practical training.

Besides university level education, vocational training represents a valuable form of education, with specific emphasis on practical hands-on training. However, the database shows that only about 15% of existing courses fall into this category, with this being mainly driven by the popularity of vocational training in Northern America. During the interviews, reasons highlighted for the low levels of vocational training are, the small size of the market and the current structure of the industry, in particular for wind and photovoltaics. Due to their
relatively small size, especially (but not only) in developing countries, the sector relies heavily on sub-contracting. These subcontractors do not necessarily have skills specific to the RE sector but are capable of completing, for example, generic electrical work. For the time being, if RE companies are able to outsource these tasks, then they will not have a vested interest in communicating with the education sector nor to work on the formation of global competencies in these specialized areas.

4.4.4. The Age of Online Learning

There is strong evidence that students and educators are moving towards the use of online technologies for collaborating, exchange and learning (ISREE, 2017). Of courses documented through IRELP, 12% are taught through online education platforms. This seems to suggest, that while educational institutions may be struggling in some regard to develop face-to-face learning programmes, there has been dramatic growth in the offer of online distance learning. Whether or not these online programmes can adequately equip students with the hands-on skills needed for technical trades, however, remains to be seen and is an area in need of greater research.

4.4.5. Lower Salary Prospects as a Disincentive to Renewable Education

In addition to the structural issues regarding demand and supply, resulting from an education-industry mismatch, one aspect addressed in all interviews is that of salary prospects. Specifically, one interviewee highlighted the fact that the recency of many renewable energy sector companies means that they are relatively small, compared to companies in the conventional energy sector, resulting in RE companies paying lower wages. This is a perception also shared by many of those successively interviewed. Another interviewee added that renewable energy projects are more likely to be located in rural areas, where salaries are usually lower compared to urban areas. Especially for the wind energy sector, the interviewee finds work to be seldom located in larger cities, altering the jobs less attractive.

5. Interest in Renewable Energy Education and Training

5.1. Inquiries through IRELP

The dynamics of interest in RE education and training were identified by analyzing the access statistics of the IRELP database, through the Google Analytics service. The following figures report data on enquiries to the IRELP databases from January 2014 to May 2015. Data from the United Arab Emirates has been removed in order to account for its over representation resulting from the presence of IRENA in the UAE.

Figure 4a shows, that by continent the highest number of users were coming from Asia (41.1%), followed by Europe (28.4%), Africa (14.0%), North America (10.1%), and Latin America and the Caribbean and Oceania (4.3%). By country, the highest numbers of users accessed the database from India (15.6%),
followed by the United States (8.6%), Germany (6.7%), Turkey (6.3%), Kenya (4.2%), and the United Kingdom (3.4%). Further, in terms of demographics Figure 4b shows that the largest group of users were 25-34 year olds (33.5%), followed by 18-25 year olds (27.5%), 35-44 year olds (15.5%), and 45-54 year olds (5.5%). There were slightly more male users than female, with 54.2% male and 45.9% female.

5.2. Discussion on the Geographical Interest in Renewable Energy Education and Training

Google Analytics provides further interesting insights into the user behavior through performance indicators such as the bounce rate and the average session duration. Turkey, for instance, is the 5th largest source of enquiry, but at the same time has the largest bounce rate (around 85%) and the shortest average session duration (around 1 minute and 10 seconds). To put these figures in perspective, users from France, being responsible for only 2.27% of the sessions, have a bounce rate of below 35% and an average session duration of 5 minutes and 9 seconds. The difference in performance indication is not surprising, the IREL database has 108 displays French courses and only 8 in Turkey. However, the relatively large amount of sessions originating in Turkey highlight the interest/demand of Turkish future professionals a demand that is highly excessive of available educational opportunities.

Similar is true for the African Continent. While the 14% of enquiries coming from Africa may seem marginal, taking into consideration the number of RE education and training offer currently available in the region (only 141 courses in the IREL database) and the lower internet access, the level of interest in Africa should be considered high. Interestingly, user behavior differs substantially across the continent. Eastern Africa generates 43% of the African
database enquiries and makes up about a 25% of the total African course offer, however having a relatively high bounce rate of around 60% and a rather short average session duration of about 2 minutes 50 seconds. Contrary to this, Western Africa, also hosting 25% of African courses from the IRELP database, generates 31% of African traffic, but at a much lower bounce rate (around 40%) and one of the highest average session durations recorded (6 minutes 20 seconds). While it might be surprising that both Western and Eastern Africa make up a similar share of the total African course offer, especially in the light of their difference in capacity (according to the IRENA database (IRENA, 2017b) Eastern Africa had more than twice the amount of installed electricity capacity in 2015), the higher indepthness of Western African database enquiries may be indicative of the strong desire of becoming professionals to integrate well into the developing industries.

Considering the fact that Northern America has the second highest share of the total number of courses offered in the database, the rather marginal share of traffic of around 10% suggests that IRELP was not the main gateway to RE education and training in the region. In Europe, the share of enquiries (around 30%) more closely matches the European share of total offered courses (around 40%), suggesting that a high level of interest not exist, but also that IRELP serves as a valuable source of information (bounce rate for different European sub regions between 35-40%, average session duration between 4-5 minutes).

Asia strikingly produces the highest traffic, claiming more than 40% of the total session captured by the Google Analytics service. With only a share of around 12% of the total courses present in the database actually located in Asia, the extensive database access (mainly driven by India) certainly suggests the interest of, and may suggest the demand for, professionals in Asian economies. Regional differences exist, with South, West, and Southeast Asia making up for 50%, 41%, and 9% of Asian traffic respectively. The regions share similar bounce rates of around 50% and average durations of sessions between 3 minutes 30 seconds and 5 minutes 30 seconds. Most Asian courses in the database are located in India (104 courses, 39%) or China (48 courses, 18%), and still only India produces major traffic according to Google Analytics. As with Northern America, there may be different gateways for becoming professionals interested in renewable energy education in China.

5.3. Discussion on the Demographic Interest in Renewable Energy Education and Training

Regarding the demographics, the enquiries by age follow the same pattern as similar sectors of the economy (i.e., conventional energy) and the high percentage of enquiries from women suggests that there is a higher level of interest from women in RE compared with conventional energy. Companies that were interviewed confirmed that they are witnessing an increased percentage of suitable female candidates in hiring processes. This finding is also supported by
a recent study (IRENA, 2017a). In addition, human resources experts pointed out that employability of women is higher in the renewables than in the conventional energy sector, because most people find a job thanks to their professional network. Professional networks in conventional energies were established long time ago, they are closed and dominated by men. RE professional networks are being built now, are more open and women in these networks are attracting more women.

6. Conclusions

This paper analyzes the offer of renewable energy education based on the IRELP database, as well as the interest in renewable energy education on the basis of the traffic received. While the database cannot be understood as an exhaustive display of all available RE education, it nevertheless represents the largest composition of alike information. Additionally, expert interviews were conducted in order to supplement the discussion on the findings from the data.

In line with contemporary academic literature, this paper arrives at the conclusion that critical skill and workforce deficits remain, varying in intensity across sectors and regions. There is a mismatch between the offered education and the industry demand for qualified workers in general, but more specifically also when considering the quantity of higher education courses offered against the industry high demand for hands-on training.

In the long term, integrating renewable energy into formal education at all levels will be a complex task that requires strong national political will, a systematic approach and sustained action. In the short run, the through here presented findings are at least indicative of the need for sustained efforts towards deploying quality standards in RE education and training, which ought to be developed in close cooperation with the industry. Moreover, training and educative materials have to be adapted and improved, with additional focus also considering the opportunities arising from on-line training and digitalization in general. Importantly, the necessary strategic approach to address the scarcity and inequality of RE education crucially depends on the design and implementation of tailored actions to enforce and respond to female students’ interest in RE. However, future academic literature in this field of research is required to enhance and establish these inferences.

The emergence of a strong workforce will be pivotal in the global transition from fossil fuels to RE sources. This shortage represents one of the greatest barriers to the wider distribution of RE technologies. Consequently, there is a need to increase, improve and facilitate access to renewable energy. Ventures like IRELP or the Training and Education Database from well-established global organizations, like IRENA and REEEP respectively, were unable to be maintained, exacerbating the access to education and relevant data used for policy making, as well as failing to further rise awareness. The analysis of the
interest in RE education through the Google Analytics service has proven that there is considerable demand for RE education, and with databases such as IREL-P ceasing to exist, convergence of what industry and education sectors alike deem an optimal education offer is hampered.

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