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Addressing the skills gap for facilitating renewable energy entrepreneurship

- an analysis of the wind energy sector

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Abstract— **With the rising global energy issues regarding sustainability, environmental degradation and fossil fuel exhaustion, several countries are now focusing on finding alternative sustainable solutions. At the current state, there are no clear alternatives other than renewable energy sources which have recently led to the increase of entrepreneurial businesses primarily dealing with the advancement and uptake of renewable energy technologies. However, being an under-researched area, there is no clarity on the skills associated with the business models of the renewable energy sector. What are the current trends in terms of the interpersonal, professional and core technical skills that employers are actively seeking in this sector? How will nascent entrepreneurs address the skills gap or subject specific knowledge challenges? Using content analysis, this study reviews online job advertisements to shed some light on the skills distribution in management and technical-oriented roles in the renewable job sector. The study found management-oriented roles to have a more widespread skills parameter in the personal skills category as compared to technical-oriented roles. The professional and technical skills distribution shows technical-oriented jobs seeking a higher rate of subject-specific skills or knowledge than management-oriented roles. The study also found a lack of choices for undergraduate degrees on renewable energy when compared with postgraduate degree choices in the UK. This raises several questions like whether such gaps in subject choices at universities are limiting the entrepreneurial prospects among students. Are these factors fuelling the technical skills deficit currently witnessed in the renewable energy job sector? Perhaps, there is a need for universities to revisit their business and programme design models to investigate whether the undergraduate programmes are being too generic for the 21st century entrepreneurial market?**

Keywords— Renewable energy, Entrepreneurship, Skills gap, Wind energy sector, Personal skill, Technical skill

I. INTRODUCTION

Entrepreneurship is the process of uncovering and developing an opportunity and creating something new with value through innovation [1]. In the 21st century, entrepreneurship is making a strong impact by facilitating the economic growth of many countries. Researchers like Houda and Triki [2], Gabriel [3] and Engelken et al [4] have highlighted the crucial connection between entrepreneurship and sustainable development and they label entrepreneurs as the change agents responsible for promoting economic and social growth. As Dean and McMullen [5, pg 73-74] state "*Entrepreneurs play a role in breaking down barriers to the efficient functioning of markets and eliminating the market failures which produce environmental degradation and sustainability….the innovative power of entrepreneurship could be captured to build a sustainable world*".

Today, the renewable energy sector which includes energy generated from natural sources like solar, wind, biofuels, geothermal, hydropower and ocean resources plays an important role in addressing some of the sustainable environment challenges. There has been a significant growth in entrepreneurial businesses related to these areas. In the UK, energy entrepreneurs so far have invested £2.75 billion in over 6,400 renewable projects thus bringing the overall energy capacity from 4.72 GW in 2012 to 12.75 GW in 2016 [6]. However, despite this phenomenal growth as Horst [7] and Gabriel [3] report, these are still under-researched areas. Not many researchers have looked at the business models of renewable energy related enterprises and the skills associated with such businesses. What are the current trends in terms of the interpersonal, IT and core technical skills employers are looking for in the renewable energy sector? Are there differences with the skills expectations between technical and managerial roles in this sector? Are the curricula and programmes offered by Higher Education Institutes (HEIs) and professional organizations on renewable energy in par with the current job market's skills trend? This paper addresses some of these gaps by investigating and analyzing online job advertisements in the wind energy sector.

II. RISING ENTREPRENEURSHIP IN THE RENEWABLE ENERGY SECTOR

With the rising worldwide population growth and living standards, many researchers are now citing concern on the world's heavy dependence on fossil fuel sources. With climate change, the issues of environmental degradation and fossil fuel exhaustion is much more prominent. This has led several countries to look for alternate and sustainable sources of energy. Are renewable energies the solution? Nanda et al [8, pg 227] suggest that there are no clear winning alternatives

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other than renewable energy, "*Innovation in renewable energy has grown in recent years, in part due to the sharp rise in venture capital finance for renewable energy start-ups in the early years of the twenty-first century*". Researchers like Houda and Triki [2], Dean and McMullen [5] and Pacheco et al [9] have noted how a growing interest in sustainable development of the world has led to the rise of renewable energy businesses. Gabriel [3] reflects how this form of entrepreneurial businesses is concerned primarily with the advancement and uptake of renewable energy technologies. It has created a win-win situation as "*entrepreneurs can profit from the economic value created while reducing environmental degradation and enhancing ecological sustainability*" [5, pg 52].

Renewable Energy Entrepreneurship (REE) is defined as the "*starting up, running and potentially growth of a new business venture that focuses on the development, design, production and distribution of renewable energy as well as renewable energy systems and technologies including all aspects of the renewable energy value chain, comprising planning, consulting, financing, installation, maintenance and end of life management or disposal*" [10, pg 52]. Karakaya et al [11] discussed how new business models as a result of entrepreneurship in Solar Photovoltaic (PV) areas have pushed the market growth of countries like Netherlands and Germany. The latter being the lead producer of Solar PV power today accounts to almost one-third of the global PV capacity. Engelken et al [4, pg 803] observe "*Sustainable development is viewed as an opportunity for innovation, and the evolution of business models for renewable energies might even lead to a stronger business-society relationship*". Karakaya et al [4] credits local entrepreneurial businesses for successes in countries like Germany. Using the case study of Hartmann Eneegitechnik GmBH (HET), a local solar company from Southern Germany, the authors explain "*HET's source of competence is composed of several interrelated factors. The first is the fact that the company is led by a local entrepreneur who knows the local traditions and lifestyle very well…*" [pg 1030]. This helps in integrating the society with the sustainable objectives and values of the company leading to what the authors termed "*an intimate-customer*" relationship.

REE provides an important initiative for employment not only in first world countries but also developing countries like India and China. As Surie [12, pg 184] says "*Renewable energy is an attractive option for developing economies as it relies on locally available energy resources, alleviates environmental concerns …while satisfying the rising demand for energy to fuel economic growth*". Ram and Selvaraj [13] reported India's strong engagement with renewable energy emphasizing how it plays an important role in diversifying energy sources and harnessing domestic supply options of the country. The authors conclude "*Renewable energy is a means to combine the goals of youth employment and environmental protection, thereby contributing to sustainable development*" [pg 21]. It is therefore important to understand the challenges with skills gap especially in subject specific knowledge parameter and its impact on entrepreneurial development.

III. CHALLENGES & SKILLS GAP

Recent studies have addressed some of the key drivers that can push or hamper the growth of entrepreneurial businesses in the renewable energy sector and this includes policy measures of the country, market incentives and R&D and knowledge deficits. According to Tantau et al [14, pg 355], *"Business innovation in the renewable energy field has been characterized by new ways of investing, transferring knowledge and diffusing technological innovations"*. One of the common challenges entrepreneurs face is knowledge-related skills gaps. Nanda et al [8, pg 227] report "*there is still a need for experimentation with new technologies and a desire to commercialize radical innovations in renewable energy*.". One might have a desire to develop a business based on their interest and enthusiasm towards the sustainable development of the society, but their entrepreneurial intent might not progress if they do not have some of the requisite subject specific knowledge or business skills. Basic aspects of enterprise like how to get adequate funding to propel the business idea or how to reach the right channels for networking and supply will play a pivotal role in the success of the initial stages of business development. This might require a range of interpersonal, professional and generic skills and in some cases technology know-how depending on the role the entrepreneur wants to play.

Now looking at the functional engagement of budding entrepreneurs, they usually have two routes: they could either choose to play an active role as a technical lead in the business or they might want to adopt an active managerial role thereby phasing the technical expertise to his/her R&D team. Gabriel [3] reports how knowledge deficits caused by a lack of R&D and skills transfer might be a major hurdle for energy entrepreneurs. Their ability to identify and exploit market opportunities will be strongly influenced by factors like their technical competence and understanding or access to skilled human resources. Many authors have noted the shortage of skilled persons in the renewable energy sector with specific skills and knowledge unique to renewable energy technologies such as technology development, installation, maintenance, repair and testing. Gabriel [3, pg 367] explains, "*Improving the affordability of renewable energy technologies may eventually increase the need for suitably skilled labor to support increasing service demands…The end-user is not reasonably expected to possess the know-how necessary to maintain their own technologies, so the onus of servicing, maintenance, repair and part replacement is usually on the entrepreneur him/herself and his/her business…Also, for a new business to grow, input from other individuals with similar skills is required*.". How do energy entrepreneurs overcome these challenges? Can universities and training institutes address some of these skills shortages through their specific curricula and programmes? Snyman [15, pg 279] notes "*There seems to be a communication gap between training institutions and the practical/business world, which definitely needs bridging. A definite need exists for training institutions to market their courses and qualifications more*

intensively". There is still a lack of clarity of the skills desired in this sector and an understanding of the market trends. What core technical, professional, IT and generic skills employers in the renewable energy sector are currently seeking? Reviewing these skills will give nascent or budding entrepreneurs in this sector a better understanding of business and skills management along with an overview of subject specific knowledge. Universities and training institutes can design modules, update teaching methods or programmes using this data to effectively meet the market skills demand. One of the approaches to understanding current skills trends within a sector is by reviewing job advertisements [16, 17]. This study utilizes online job advertisements for skills analysis as they are easily available and accessible indicators of employers' skills gaps. Choi and Rasmussen [18, pg 458] agree "*Job announcements reveal current trends in desired qualifications and skills that employers look for in new personnel*". Given the wide scale of the overall renewable energy parameter, this particular study refines the focus on the wind energy job sector to bring more depth to the analysis.

IV. RESEARCH METHODOLOGY

Content analysis is a method popularly applied for examining textual data in a systematic manner. It is particularly useful for reviewing large textual information for identifying patterns or themes and breaking them into manageable units or pre-defined categories to examine/evaluate any useful information [19, 20]. This study applies this method for coding and analyzing online job advertisements. Three popular job sites in the UK: Reed, Total Jobs and Monster jobs were used to maintain consistency and avoid any potential duplication of jobs. One of the objectives of this study is to examine how the skills expectation varied across jobs that are technical-oriented and jobs that are management-oriented. Popular key words related to the wind energy sector were utilized during job search. The job descriptions from the advertisements were carefully reviewed by the researchers to only select roles that fit the description of a technical vs management job. In total, 325 jobs from the Wind Energy Sector were downloaded and coded in 2017. Each job advert was downloaded into a word document and formatted using a specific naming convention shared by the researchers as shown:

<code>n - <country code>/<job title>

Here,

- Code for Wind Energy was WT,
- n = Job document number

The specific url links for each job advertisements used in this study were added to the word document for future reference. The coding and analyzing of these documents were carried out using NVivo 11. It is a popular software used for analyzing qualitative data with features that helps in coding textual data and deriving any emerging patterns or themes. One of the essential aspects of the coding process is to establish an analytical construct to guide the review process. The following analytical framework was utilized for coding in this study:

- General Job Related factors
  - Job Title
  - Job category
  - Job Sector
  - Salary
  - On-Job Related Trainings

- Essential Requirements
  - Personal/Generic Skills
  - Professional & Technical Skills
  - Role Specific Skills

- Non-Essential Requirements
  - ……..(as defined by the advertising company)

V. SKILLS ANALYSIS

Horst [7] proposed a business model that highlights the consumptive activity and entrepreneurial stages in the renewable energy supply chain shown in fig. 1.

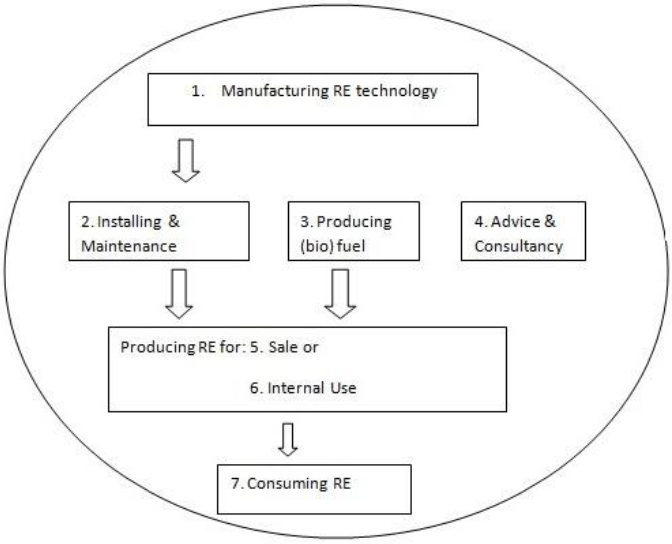

Fig. 1: Basic types of entrepreneurial and consumptive activity along the renewable energy supply chain [7]

According to Horst's model, some enterprises might produce renewable energy for the purpose of internal usage whereas others might look at the potential of generating income by selling their renewable energy sources. A key aspect in this model is the manufacturing of renewable energy technology followed by some of the technical stages such as site survey, installation, maintenance and production of fuel. For any energy entrepreneur, it is obvious that they will need the technical skills in the company to carry out some of these functions. Will the entrepreneur play an active role in such

technical activities or will they rely on others? Either way, this reflects the importance of subject specific skills in this area. Another noteworthy aspect in this model is the advice and consultancy phase in energy businesses. A recent study by Gabriel and Kirkwood [21] found that a majority of energy businesses dealt with consultancy. They noted "*Consultancy businesses were the largest group…. running a consulting business seems to be the early life stage preference because of lower start-up costs…*" [pg 340]. Out of the 43 entrepreneurs in their study, only 5 were found to play an active role in the invention, design and development of technology. This shows that entrepreneurs heavily relied on skills of their workforce.

To get a better understanding of skills in this sector, this paper focuses on two key categories:

- Personal skills
- Technical and Professional skills

Personal skills are defined as the skills needed to interact with others within an organization and accomplish tasks. An integrated model on entrepreneurship proposed by Ward [22] identifies 10 key personal skills vital for establishing and managing an enterprise. This includes communications, judgment, negotiation, creativity, decision making, delegation, customer/supplier relationship, motivation, problem solving and team working. Technical and Professional skills in this study are defined as the knowledge needed to perform subject-specific or field related tasks or duties, some of which might include engagement with technology.

A. Personal skills

Table 1 shows the personal skills distribution in technical and management-oriented roles. Overall, the analysis identified 14 distinct personal skills in the job advertisement samples; the findings closely mirrored that of Ward's [22]. This includes:

- Ability to review and write reports
- Business acumen and commercial awareness
- Communication
- Critical analysis
- Intercultural awareness
- Leadership
- Negotiation
- Numeracy
- Motivation
- Organization and planning
- Presentation
- Problem solving and decision making
- Team working
- Time Management

Based on the frequency of coding, the skills were plotted in a bar chart to evaluate the distribution of importance and possible market trends. Overall, management-oriented roles show a more widespread skills parameter in personal category than that of technical-oriented roles.

As table 1 shows both technical and management-oriented roles have high emphasis on Communication and Team working skills. This is not surprising as roles within this sector will require strong communication and liaison with clients/customers, suppliers, distributors and management team. Gabriel and Kirkwood [21] reported the importance of communication skills for energy entrepreneurs who are involved in consultancy businesses. They noted *"…such entrepreneurs described their businesses as providing advice to customers on their anticipated renewable energy loads, system design and sizing and the best brands to suit their needs*" [pg 340]. Capability of building and leading multi-disciplinary teams and operations, delegating tasks, supervising peers and motivating and encouraging team performance are vital in both engineering as well as management roles. For management-oriented roles, the ability to motivate team members was higher than that of technical-oriented. Motivation plays an important role in creating an enthusiastic work environment and usually managers facilitate this within the organization. So, energy entrepreneurs wanting to play an active managerial role will need to prioritize this.

Ability to review and write reports seems to be another common skill employers in this sector are seeking in both categories. Technical roles seem to place a higher emphasis on problem solving and decision making skills than management oriented roles. As part of a team or project, technical-oriented roles such as engineers will regularly need to monitor equipment, conduct on-site testing, identify any faults or issues, measure and quantify risks and provide solutions to manage these. Management-oriented roles on the other hand sought employees with negotiation ability more than that of technical-oriented. This is possibly because of the nature of managerial roles which usually involve networking, dealing with clients, suppliers and funders, secure contracts and funding, establish relationships and agreements with key stakeholders. Ability to organize and plan was another common skill that employers are seeking in this sector. Technical and management roles in this sector will require an ability to plan and organize meetings possibly with clients or stakeholders, set objectives and meet deadlines. Business understanding and some basic level of market awareness was deemed important in both categories. Understanding the economic environment, ability to analyze the positions and stability of different competitors and ability to speculate and forecast business trends are key in such aspects. It is not surprising to find Universities and other professional organizations incorporating the development of these skills in their programme. Budding or nascent entrepreneurs could look into these areas to measure their own competences. If they are enrolled in a university, they should look for opportunities offered in the academic environment that will help them evaluate, monitor and develop these core personal skills. Others who are not enrolled in HEIs might want to look for short courses from professional bodies to build the skills or confidence in the areas they lack competence. For instance, someone who lacks confident with their critical analysis ability might want to undertake courses or workshops.

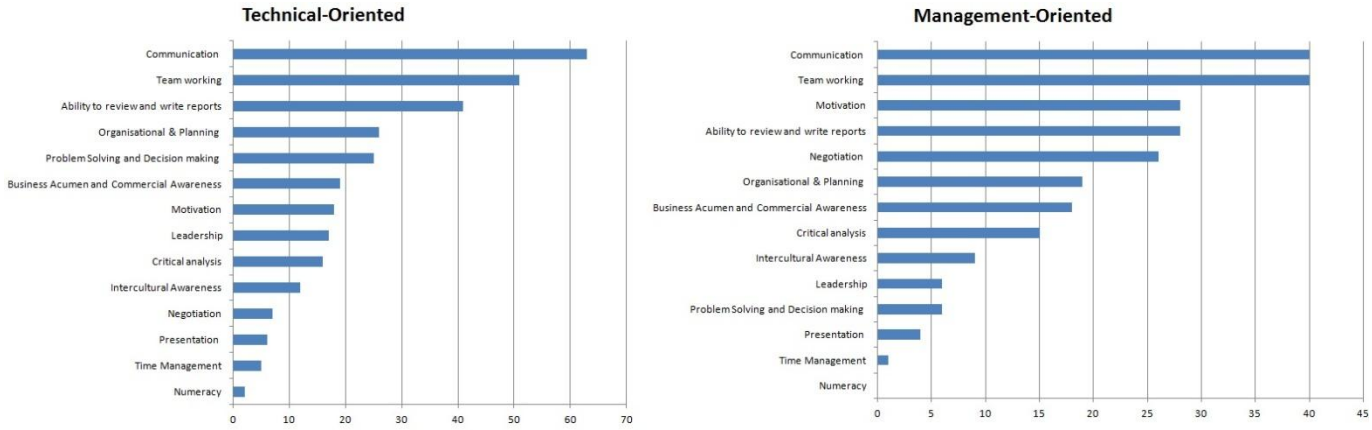

Table 1: Personal skills distribution matrix for technical and management-oriented roles

B. Professional and Technical skills

The professional and technical skills distribution in table 2 shows how technical-oriented jobs are more likely to seek subject-specific skills or knowledge than management-oriented roles. This is not surprising because technical roles within this sector will usually require an understanding of the subject areas involving wind energy, wind generation, wind energy market, power industry and control systems. There is also a strong emphasis on engineering and installation skills in engineering roles. Engineers are expected to install, test and maintain wind generation systems. They play an important role in the operations and design of systems and technical maintenance and monitoring of projects. Subject specific areas such as modeling and simulation knowledge, project design, control and development, risk assessment and quality standard management are among the other highly cited skills in this category. It is worth noting that both technical as well as management roles require a strong degree of cross disciplinary knowledge.

Employers find such interdisciplinary skills vital for the effective survival and comprehensive functioning of the company. This is one of the reasons why the frequency of coding rated this at the top of the skills matrix in both categories.

Project management is a highly sought after skill in the management-oriented roles. Many recruiters are seeking employees who can lead, oversee and deliver projects on time and within budget. They need to be able to conduct methodological investigations to identify stakeholders and market opportunities as well as coordinate customer demands. Given the nature of these management roles, it is logical to see employers rating market awareness, performance analysis, health and safety and some understanding of regulation and standards heavily in the job role descriptions while placing very little emphasis on subject specific technical knowledge.

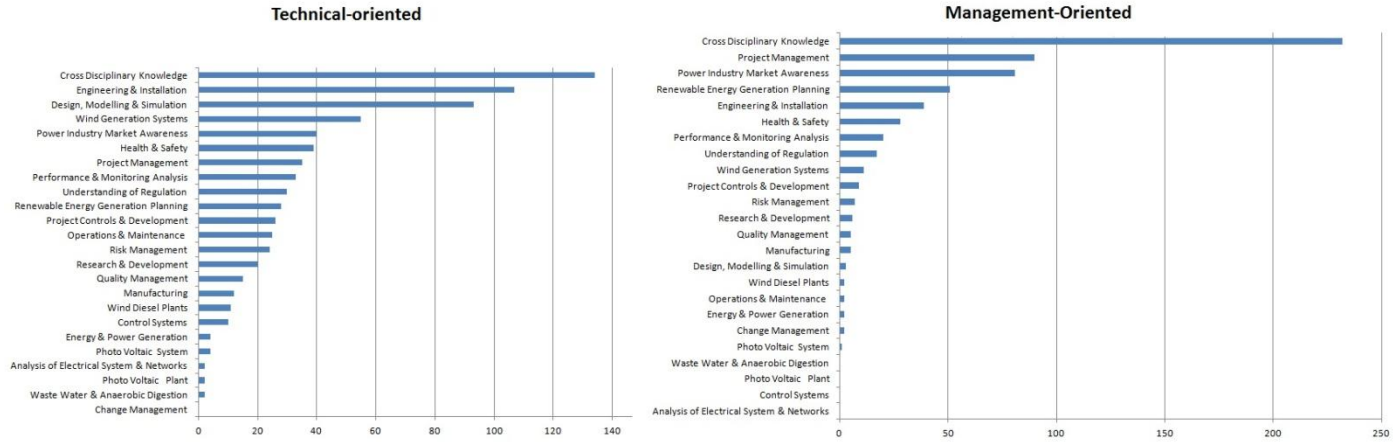

Table 2: Professional and Technical skills distribution matrix for technical and management-oriented roles

Now given the nature of professional and subject specific technical skills in this sector, how do energy entrepreneurs decide their level of engagement with the technical and management roles? Do they have an interest in the

development of a new technology, service or innovation? If so then to what degree do they contribute towards the design and development? Do they possess the technical know-how of renewables to play an active role in the R&D or do they have to rely on the skills of others for the development and management of renewable technology? If they want to venture into consultancy in renewables, do they possess the interpersonal skills and business management skills? These are some of the questions that nascent or budding entrepreneurs will have to review carefully before venturing into entrepreneurial business. Are the courses or programmes offered by universities or professional bodies addressing these gaps? Ward [22] has criticized HEI programmes for being generic sometimes with their curricula approach and for not differentiating between students who wish to start their own company to those who wants to focus their knowledge and skills under a company's supervision. Ward [22, pg 9] noted "*Undergraduate education is primarily aimed at producing qualified individuals in a focused but still broad subject field….At the postgraduate level, with the exception of MBA programmes, the technical focus increases*". This is evident in the latest statistics of the renewable energy education in the UK. There are over 46 postgraduate degree courses at 29 UK universities [23] as compared to 20 undergraduate degree courses in 10 UK universities [24]. This indicates that the choices for a Masters degree on renewables are higher than that of an undergraduate. Does this limit the entrepreneurial prospects among undergraduate students or someone who doesn't want to go to universities? Is this fuelling the technical skills deficit currently witnessed in the renewable energy job sector? Perhaps, this is a time for HEIs to revisit their business and new programme design/delivery models. Are undergraduate programmes being too generic and linear for the 21st century entrepreneurial market?

VI. CONCLUSION

Renewable energy entrepreneurship has the potential to not only drive economic development but also address some of the environment sustainability challenges that plagues the world today. There is a growing interest in this field with some promising engagement by sustainability driven entrepreneurs. The UK has witnessed a growth of over 6,400 renewable projects in recent years with an estimate of £2.75 billion and a capacity of 12.75 GW in the year 2016. It also provides an excellent initiative for employment in both developed as well as developing countries. However, not much has been researched on this area particularly the business models of energy entrepreneurs. There is a need to understand the drivers and barriers of renewable energy entrepreneurship and the characteristics of energy entrepreneurs. What skills are needed to drive and manage such energy businesses? This study sheds some light on the skills distribution on one of the renewable energy sectors: wind.

Using a sample of 325 online job advertisements, the analysis investigated how the skills expectations varied across management and technical-oriented jobs in this sector. The analysis found management roles to have more widespread skills citations on the personal skills category than technical roles. However, the ability to communicate effectively and work in a team were the top cited skills for both management and technical roles. Management-oriented roles heavily emphasized on the report writing and motivation skills followed by an ability to negotiate with clients and stakeholders. Technical roles on the other hand placed problem solving and decision making as one of the highly sought-after skills. This is possibly due to the nature of the role where engineers or technical professionals have to regularly work in multi-team projects, monitor equipment, conduct on-site testing, diagnose faults and issues and provide solutions to quantify risks. This involves taking critical decisions and solving problems.

The analysis of the technical skills indicated that professionals in technical roles are expected to have a higher understanding of subject specific knowledge than management roles. For such roles, given the potential of active engagement with technology, it is not surprising to see employers citing some distinct technical skill like ability to design, install, test and maintain a wind energy system in their job advertisements. Some researchers have noted the issue of skills shortage in the overall renewable energy sector. This can be particularly challenging for entrepreneurs who wants to play an active role in the technology design and management. How do energy entrepreneurs overcome the challenges related to knowledge deficits? Universities too seem to have a gap in the degree programmes on renewables. There appears to be limited choices for an undergraduate degree in these areas. Perhaps the future programmes need to be tailored according to the skills trends on this sector and be more diversified than be generic. This form of entrepreneurship should also be encouraged by political backing and government policies because it is a win-win situation for both entrepreneurs as well as society. Entrepreneurs can profit from the economic viability of their business propositions whereas such businesses can push the economy towards a secure and environmentally sustainable dimension.

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