Using Job Advertisements to inform curricula design for the Key Global Technical Challenges

-an analysis methodology and example curricula

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***Abstract*— This paper introduces an experiment performed as part of the key global challenges design work package of the European Union funded SALEIE Project. It formally 'tests' the value of considering job advertisements in the design of curricula and what employers are seeking in terms of technical, professional and generic skills. It presents the general methodology using results of job advertisements from the renewable energies sector that can be used for comparison against sample Higher Education curricula in the same technical area. A number of jobs advertised on the internet in the area of Solar Photovoltaic (PV) are used as the dataset for this experiment. The full text of each job advertisement has been manually downloaded into NVivo software. Amongst other things, job title and essential or desirable technical/professional and generic skills are coded. These declared essential and desirable technical skills are shown in matrix form across the range of job titles and together both show the required graduate attributes as well as within industry sector career development or progression pathways. Viewed as a sector whole, the analysis also shows those skills that cross sub-areas and hence may be better suited to foundation modules within a programme with the skills more specific to a sub-discipline being the optional or 'programme aligning' modules. The results will help Higher Education develop curricula more aligned to industrial needs and will help different industries see the way skills are expressed in existing curricula. Through these two benefits the qualified graduate supply/demand balance may be improved.**

***Index Terms*—SALEIE, Higher Education Curricula, Job Advertisements, Solar PV, Job Skills**

I. INTRODUCTION

Europe and the world have identified a number of key technical challenge areas that need to be focused on for the future. Some of these challenge areas have particular relevance to Electrical and Information Engineering as subjects taught within Higher Education. Examples of these challenge areas are Green Energy, the Environment and Sustainability, Communications and IT, Health, and Modern Manufacturing Systems (including Robotics). The Strategic Alignment of Electrical and Information Engineering in European Higher Education Institutions (SALEIE) Project - a three year long project funded by the European Union Lifelong Learning Programme sets out to explore and provide models for ways in which Higher Education Institutions of Europe in these Electrical and Information Engineering disciplines can respond to such challenges [1].

The objective of the SALEIE project is threefold, firstly to develop model curricula for a few of the key technical challenge areas that Europe has identified as being critical for the next few decades and ensuring graduates are prepared to respond to these challenges; secondly to ensure that programme and module governance is sufficiently well understood and that issues of mobility, progression and employment are understandable by appropriate stakeholders including the accrediting bodies for professional engineers; and finally to maximize student opportunities by ensuring all learners, irrespective of their background or personal challenges are given equal opportunity to education and thereby appropriately supported. The project reported herein is

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part of the first of these three sections and is undertaken to formally 'test' the value of considering job advertisements in the design of curricula and what employers are seeking in terms of technical and generic skills.

Renewable energy is a large technical area with a number of sub-areas such as Solar PV, on-shore and off-shore wind generation, biomass and ground source heating amongst others. The objective of this paper is to extract the skills stated as being required in the sub-areas as a 'test' against existing and, in the case of the SALEIE project, proposed model curricula. As an initial pilot, a number of jobs specifically in the area of Solar PV advertised on the internet have been considered. The full text of each job advertisement has been downloaded into NVivo software. Amongst other things, job role and essential or desirable technical (professional) and generic skills are coded thereby exposing the skills founded progression pathways within this particular sector. The paper will discuss the results of this pilot which will help Higher Education develop curricula more aligned to industrial needs and different industries can therefore see the way skills are expressed in existing curricula.

II. Job Advertisements For Curricula Design

Good curriculum designs according to Yorke and Knight [2] will help learners construct understandings of the subject matter and develop a number of skilful practices and skills, "*They will also show care for the development of positive efficacy beliefs, meta-cognition and other complex achievements that employers value*" [pg.6]. Authors like Baruah and Ward [3] have emphasized the need for design of Higher Education curricula to cater to different interdisciplinary programmes and develop a range of skills within the overall discipline. Ward and Jackson [4] highlighted how Higher Education engineering programmes today focus their overall learning objectives "*to develop graduates who can add value to a wide range of employers giving the graduate career choice*" [pg.1]. With a growing global interest in environmental sustainability, green job skills requirement are coming across particularly as a crucial challenge for Higher Education to address in their curricula design. These green jobs are jobs in environmentally friendly sectors such as Solar PV whose primary contributions are to use renewable fuels, reduce carbon emissions, protect biodiversity and ecosystems, installation of energy and pollution management systems and adaptation to climate change. These jobs according to Morriss et al. [5] not only offer a revolution in our relationship with the environment but they also bring out many high paying and satisfying jobs. However, these require dramatic shifts in energy production technologies, building practices and food production and calls for radical shifts in day to day lives. '*Strategies for skills for green jobs need to be demand driven'* says a report by the Skills and Employability Network [6] noting that some of the developing countries today emphasize the need of prioritizing generic skills related to sustainability and environment aspects in their education in order to ensure employability of the new generation. However, one of the challenges the report highlights is that not many countries are sufficiently prepared for these shifts especially to undertake steps of integrating greening skills competences for employment through specific training and education system.

It is therefore vital to understand what specific skills different renewable job sectors such as Solar PV are looking for and Higher Education then can introduce new pedagogies or curricula to ensure that skills leading to employability in such green sectors are fairly addressed in their teaching and learning strategies.

One of the resources readily available for Higher Education curricula design to understand these green job skills (and in this particular paper: Solar PV job skills) are job advertisements. Job advertisements are the overt way industry states the people and through the detailed content of the job advert, the skills and personal attributes they seek. In summary, job adverts are an articulation of the demand.

III. Job Skills and Solar PV industry

Solar PV industry in the UK is rapidly increasing through a series of profound changes and is currently an important player in the European market with a 6 % share deployed capacity across Europe according to the European Photovoltaic Industry Association [7]. The 2009 Renewable Energy Directive has set a target to achieve 15% of its energy consumption sources by 2020 which would mean eventually reaching a Solar PV deployment of around 9.3 GW-10.7 GW and such rapid growth in this industry would hold the potential for tens of thousands of jobs [8]. Delivering such ambitions according to the 2013 report of the UK Department of Energy and Climate Change [7] will require greater innovation and thereby new skills. The Solar PV industry currently holds three main markets in the UK- domestic, building mounted and ground mounted with another potential market now arising in the field of building-integrated photovoltaic (BIPV). The employment opportunities available in this industry varies with job roles such as Solar PV installers, Solar designers or Engineers, Solar Installation managers, Sales Representatives or Estimators, Site Assessors or Remote Evaluators, Mechanics, Electrical Equipment Assemblers and Construction Equipment Operators. So, what job skills do employers associate with these roles? Does Higher Education address these skills development in their curricula?

If the job profile of a Solar PV installer is considered for example, there is specific skill requirements generally associated with it. For instance, in the US according to Interstate Renewable Energy Council (IREC), a Solar PV installer is expected to hold a diploma or a two year degree in technology/industrial arts with some experience in mechanical installations, general construction and ladder work, use of hand-held and power tools, electrical wiring of AC and DC systems and good customer service skills [9]. Some employers also provide Solar PV installation training but it is often the case that they prefer hiring workers with roofing, electrical and general construction knowledge. According to a report published by the California Occupational Guides [10], entry-

level PV installers are not involved in system design such as layout however they are expected to read blue prints and plans and are usually involved in activities such as lifting, carrying, staging, mounting and assisting the installation crew. The installation skills involve measuring, cutting, drilling and fastening structural support elements and mounting solar modules whereas the electrical work skills include installing grounding systems, circuit conductors, raceways and individual components (which should be carried out by electricians trained in the areas of photovoltaic or under the direct supervision of a qualified/licensed electrician) [10]. The skills for a Solar Designer/Engineer, Solar Installation Manager, Sales Representative or Site Assessor will similarly have specific skills, duties and expectations attached to the job description. Some of these jobs are entry level and will only require a diploma or training certificate sometimes provided by the employer while others are more specific asking for Bachelors, Masters or even a PhD degree depending on the job profile.

In order to have an effective curricula and improve employability skills among students, it is vital for Higher Education to address various skills development aspects cited by different employers in their teaching modules and pedagogies. Aligning the curricula to specific industrial needs should result in an improvement in the balance of qualified graduate supply/demand. In this paper a simple methodology is shown by which these factors of effective curricula design can be accounted for and this involves extracting and codifying the proposed skills (desirable/essential) in different job adverts.

IV. Research Methodology

A qualitative approach has been utilized for analyzing the job advertisements. A total of 156 Solar PV jobs advertised on the internet were manually downloaded and then added into NVivo software. Each of these adverts was then coded according to the following schema:

- General Job Related factors
  - Job Description
  - Job Responsibility
  - Job Title
  - Job Sector
  - On-Job Related Trainings
  - ……
- Essential Requirements
  - Generic Skills
  - Personal Skills & Values
  - Professional & Technical Skills
  - Role Specific Skills
  - ……
- Non-Essential Requirements
  - ……..(as defined by the advertising company)

The coding of these job adverts subsequently resulted in a total of 23 different titles including Solar PV Project Manager, Solar PV installers/fitters, Solar Sales Consultant, Management Engineer, Chief Liaison Officer, Site Inspector and Solar PV Surveyor to name a few. These job titles from the advertisements were then coded to extract the essential or desirable skills requirement in terms of: Generic Skills (12), Personal Skills & Values (8), Professional & Technical Skills (34) and so on.

Subjective judgment was made on the specific wording used in each job description to identify the specific detail level skills in each of these skill groups which are being asked for. The groupings are based on the findings of the study into the application of the Tuning methodology and the Electrical and Information Engineering Sector, EIE-Surveyor project [11]. As a pilot for this paper, we have limited our discussion and focus within a few of these coded areas such as: Professional & Technical skills, Generic Skills and IT Skills. The aim is to illustrate how academics can utilize this method to design different curricula contents to enhance the employability skills among students intending to pursue specific careers.

V. Job skills Analysis

Job Title	Generic Skills	IT Skills	Professional & Technical Skills
Manager	91	17	120
Sales	72	2	29
Engineer	62	19	134
Business Development	28	2	17
Site and construction	17	2	14
Solar PV Designer	10	8	12
MV Expert	6	2	9
Technical Sales Analyst	6	0	3
Marketing	5	0	0
Technician	5	1	10
Investment Associate	4	1	8
Senior Planner	4	0	7
Yield Specialist	4	0	9
Client Liaison Officer	3	1	0
Electrician	3	0	10
Graduate Placement	3	0	2
Finance	2	1	3
Installer	2	0	11
Consultant or Senior Consultant	1	0	6
Performance Analyst	1	0	6
Accountant	0	3	4
Chief Executive Officer	0	0	1
Solar PV EPC	0	0	0

Table I: Job Title vs. Generic/IT/Professional & Technical Skills

The first matrix shows the overall coding ratios of Job Titles against Generic, IT and Professional/Technical skills extracted from NVivo. It gives a clear indication of the variety of skills expected in different Solar PV jobs illustrating what different companies express their potential candidates to possess. For instance, the percentage of Generic Skills expected in a manager is found to be more than that of an engineer or a Technical Sales Analyst or an Investment Associate. Similarly, with IT/ Professional/Technical Skills an engineer scores higher than others. On further expanding this matrix through the extraction of the specific Job Titles and the Generic Skills gives the coding results as represented in Table II. Again, the figures here give us a vivid picture of the skills expected from different job titles. For instance, a manger in a Solar PV role scores higher in skills like Leadership, Business Acumen and Commercial Awareness or Organizational Skills than others with different job roles. Our coding criteria led to the identification of 34 different skills within the domains of Professional & Technical aspects and Table III shows a matrix with the 23 Job Titles vs. these Professional & Technical Job Skills. Here the variation in skills expectation can be seen. For instance, an engineer is expected to have more skills or knowledge on specific technical areas such as PV system than a manager. The manager on the other hand scores high on areas like project management skills and cross disciplinary knowledge.

	A : Accountant	B : Business Development	C : Chief Executive Officer	D : Client Liaison Officer	E : Consultant or Senior Consultant	F : Electrician	G : Engineer	H : Finance	I : Graduate Placement	J : Installer	K : Investment Associate	L : Manager	M : Marketing	N : MV Expert	O : Performance Analyst	P : Sales	Q : Senior Planner	R : Site and construction related	S : Solar PV Designer	T : Solar PV EPC	U : Technical Sales Analyst	V : Technician	W : Yield Specialist
Analytical Skills		2										4		1					1				
Business Acumen and Commercial Awareness		5					2		1		1	13	1	1		6			2				
Communication & Interpersonal Skills		7		2		1	11	1				24		1		8	1	2	6				
Leadership Skills		1				1				1		6				4		1					
Negotiation Skills		6					2					2				3							
Numeracy Skills		2					1				1	3											
Organisational Skills		3					3					10		1		4		1					
Presentation Skills					1		2				1	2				3							
Problem Solving and Desicion making Skills							1					6		1									
Teamworking Skills		2		1		1	8	1		1	1	7				2	1	2	3				
Time Management		3					1					3				2		1					
Writing & Reporting Skills		4			1		10				1	17		2		1	2	1	1				

Table II**:** Job Title vs. Generic Skills

Rowlands-Jones [12] did a study on the prospective training provisions in Solar PV at Higher Education Level and the Continuing Professional Development (CPD) for up-skilling the workforce in the Welsh energy sector. The author noted that despite identified skills gaps, the HEI were found to offer only general courses typically an overview of energy and its theory and this thereby fails to equip students with the fundamental skills required for industry, "*The target audience for HE provision is mainly focused on engineers and the physical sciences, however there is a lack of content aimed at materials scientists and chemists despite the large number of materials considerations in all PV technologies…*" [pg.5]. One of the core objectives of the 2020 Skills Roadmap and Action plan in order to meet the EU 2020 energy efficiency targets is to address these skills and knowledge gaps by developing appropriate education, qualification and training [13]. Using the proposed simple methodology of extracting and analyzing the desired job skills cited by different industries through various job adverts, Higher Education can collect clues on how to structure or design their curricula course or programme thereby training or preparing students towards specific career paths. So, an engineering student who wants to pursue a management role in a Solar PV industry could be trained or facilitated in the relevant management areas evident in the coding matrix demonstrated in the analysis. Specific modules pertaining to the development of Leadership Skills, Negotiation Skills, Organizational Skills, Writing & Reporting Skills etc aimed at such students should be prioritized in the curriculum design. The Solar Photovoltaic

Academic Research Consortium (SPARC) recommends several training themes in potential areas like fundamentals of PV, PV System Design, Monitoring of PV, Role of Nano-materials in PV, Power Electronics, Energy Storage and Usage [12]. Such specific modules could also be part of the curriculum if it is deemed valid within the programme course.

Viewed as a sector whole, the analysis in this paper shows those skills that cross sub-areas and hence may be better suited to foundation modules within a programme with the skills more specific to a sub-discipline being the optional or 'programme aligning' modules. The application of this methodology is quite extensive and can be used to assess job skills relevant in any Higher Education curricula design regardless of the areas.

	A : Accountant	B : Business Development	C : Chief Executive Officer	D : Client Liaison Officer	E : Consultant or Senior Consultant	F : Electrician	G : Engineer	H : Finance	I : Graduate Placement	J : Installer	K : Investment Associate	L : Manager	M : Marketing	N : MV Expert	O : Performance Analyst	P : Sales	Q : Senior Planner	R : Site and construction related	S : Solar PV Designer	T : Solar PV EPC	U : Technical Sales Analyst	V : Technician	W : Yield Specialist
1 : Array Sizing																							1
2 : AutoCAD							7					1							1				
3 : Cable Sizing							1																1
4 : Communication							5															1	
5 : Cross Disciplinary Knowledge	3	9	1		3		19	2			6	50		3		10		3	3			1	1
6 : Data Input & Interpretation	1						1					3							1				
7 : Electonics design							6					3							1				
8 : Electric Power Systems							2	1						1								1	
9 : Electrical Installation		5					2					4		2									
10 : Energy Auditing							1																
11 : Energy Load Analysis							1																
12 : Engineering Calculation							1							1									1
13 : Health and Safety							4					1						3					
14 : Irradiation Analysis															1								1
15 : LV & HV Electrical Knowledge		1					7							1		1						2	
16 : Management Skills							1					1							1				
17 : Microcontroller and Communications protocols							1																
18 : Performance Analysis						3	8				1	5			1	1						2	
19 : Programing							2																
20 : Project Management							11					28							2				
21 : PV Plants						2	7			1		1											
22 : PV System					1	5	31		2	8		16				1		5	8			3	1
23 : PVSYST User							2								1								1
24 : Quality Standards and Analysis							1																
25 : Reading & Interpreting Design Specifications and Technical Drawings																							
26 : Regulation		2			2		4				1	12				2	1		1				
27 : Renewable Energy Generation Planning		2					5					3		1			6						
28 : Research and Development							5							1									
29 : SCADA							3															1	
30 : Semiconductor device physics																1							
31 : Sketchup												1											
32 : Technical Designs and Drawings							2					1											
33 : Wet Coating Processes and Technology							1																
34 : Yield Analysis							3					1											1

Table III: Job Title vs. Professional & Technical Skills

VI. CONCLUSION

As part of the European Union funded SALEIE Project, this paper presents a pilot study to illustrate the value of considering job advertisements in the design of Higher Education curricula and assess what employers are actively seeking in terms of skills: Technical, IT, Professional or Generic. It utilizes in total 156 jobs advertised on the internet in the area of Solar PV and are coded into NVivo software under various schema such as Job Titles, Job Roles, Professional & Technical Skills, Generic Skills etc. The declared essential and desirable Professional, Technical and Generic Skills are shown in matrix form across the range of 23 job roles and together they show the required graduate attributes as well as within industry sector career development or progression pathways. Viewed as a sector whole, the analysis also shows those skills that cross sub-areas and hence may be better suited to foundation modules within a programme with the skills more specific to a sub-discipline being the optional or 'programme aligning' modules. The results will help Higher Education develop curricula more aligned to industrial needs and will help different industries see the way skills are expressed in existing curricula. Through

these two benefits the qualified graduate supply/demand balance may be improved.

VII. LIMITATION & FURTHER WORKS

The coding of job skills is limited to the information provided by the advertising companies in their advertisements. So, if a job description lacks the necessary details, this eventually impacts the coding aspects. For example, the job advertisement for the Chief Executive Officer in our study didn't have much information and was largely left vague in the skills description by the employers. This therefore led the result in the matrix for this particular role remains irrelevant as no specific skills could be derived from the advert. Another limitation is the consistency with which skills needed are stated or rather the lack of consistency. At present, skills are titled differently and coding requires grouping by similarity. This process is open to interpretation by the codes and hence may lead to miscoding and errors.

This paper is a pilot study intended to illustrate the values of job advertisements in designing Higher Education curricula. It only covers one of the areas of renewable energy: Solar PV and further works is underway into a more detailed study on other job sectors included in renewable energies such as Wind Energy and Bio-Mass. The results from these analyses will be used to check the relevance of this methodology of using job advertisements for curricula designs.

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REFERENCES

[1] *The SALEIE Project*. [Online]. Available: http://www.saleie.co.uk. [Accessed: April 2, 2015].

[2] M. Yorke and P.T. Knight, *Embedding employability into the curriculum*, The Higher Education Academy, York, 2006.

[3] B. Baruah and T. Ward, "Enhancing intrapreneurial skills of students through an Engineering Management Program" in *13th International Conference on Information Technology Based Higher Education and Training, ITHET 2014*, York, 11-13 September, 2014.

[4] A.E. Ward and N.R. Jackson, "Simultaneous development of management skills and behaviours in taught academic programmes," in *13th International Conference on Information Technology Based Higher Education and Training, ITHET 2014*, York, 11-13 September, 2014.

[5] A.P. Morriss, W.T. Bogart, A. Dorchak, and R.E. Meiner, "7 Myths about Green Jobs" Social Science Research Network [Online]. Available at: http://ssrn.com/abstract=1357440 [Accessed: April 10, 2015]

[6] Skills and Employability Network. "*Skills for Green Jobs*". [Online]. Available: http://www.unevoc.unesco.org/e-forum/FINAL%20Skills%20for%20Green%20Job%20Online%20Discussion%20Report.pdf [Accessed: April 8, 2015].

[7] European Photovoltaic Industry Association, "*Global Market Outlook for Photovoltaics 2013-2017*" [Online]. Available: http://www.epia.org/fileadmin/user_upload/Publications/GMO_2013_-_Final_PDF.pdf [Accessed: April 13, 2015].

[8] National Renewable Energy Action Plan for the United Kingdom [Online]. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47871/25-nat-ren-energy-action-plan.pdf [Accessed: April 9, 2015].

[9] Solar Energy Technologies Program, "*Growing Solar Power Industry Brightens Job Market"* [Online]. Available: http://www.fuelcelleducation.org/wp-content/uploads/2011/07/Solar-Market-Jobs.pdf [Accessed: April 6, 2015].

[10] California Occupational Guides, "Solar Photovoltaic Installers in California," [Online]. Available: http://www.calmis.ca.gov/file/OccGuide/Solar-PV-Installers-Green.pdf [Accessed: April 9, 2015].

[11] A.E., Ward, *The alignment of Generic, Specific and Language Skills within the Electrical and Information Engineering discipline - Application of the Tuning approach*, EIE-Surveyor Project Report, 2008, ISBN 2-9516740-2-3.

[12] R. Rowlands-Jones, *Skills and Training Needs Analysis: Solar Photovoltaics Energy Executive Summary*, Welsh Energy Sector Training (WEST), 2014.

[13] Pye Tait Consulting, "*Build Up Skills-UK 2020 Skills Roadmap and Action Plan*," [Online]. Available: http://www.buildupskillsuk.org/94/2020-skills-roadmap-and-action-plan---final-january-2013pdf.pdf [Accessed: April 6, 2015].