



## Renewable energy education in faculties of engineering in Jordan: Relationship between demographics and level of knowledge of senior students'



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### ARTICLE INFO

#### Keywords:

Energy  
Renewable energy  
Engineering education  
Demographics  
Jordan

### ABSTRACT

This research paper is the 2nd part of field investigation about renewable energy education in different engineering departments in state and private universities in Jordan. The prime objective is focused on assessing the influence of some students' related characteristics, namely age, gender, department and university on their levels of knowledge and awareness regarding existing energy situation and renewable energy potential. To achieve such goal, common statistical methods such as ANOVA, Chi-square test & Post hoc comparisons were used for data analysis. The study in hand investigated two aspects of energy knowledge are considered, i.e. energy situation and renewable energy sources. The principal findings of this research showed consistent significant difference in the level of energy knowledge among students with respect to university, but insignificant difference in the level of energy knowledge pertaining to age. On the other hand, gender and department showed inconsistent findings: both were significant with respect to the first aspect, but insignificant with respect to the second aspect. This is due to the fact that some universities have taken necessary steps and introduced new courses related to energy conversion and renewable energy technologies in close cooperation with some universities in Europe. Others such as German-Jordan University went further by introducing new engineering stream which specialized in renewable energy. It is deemed that such programs will reduce the existing gap in energy education and local renewable energy industries as well as disseminating energy efficiency and renewable energy technologies in the country. However, there is still an urgent need to develop energy and renewable energy education and training in order to provide the desired skillful engineers and technicians to support related industries in the local and regional markets.

### 1. Background

Most of researchers, experts and even politicians, in developed and developing countries, have considered that the current world's energy systems are not sustainable due to high dependence on burning fossil fuels in various sectors. This is due to higher rates of energy demand as a result of improved living standards and urbanization, especially in some developing and poor countries. Consequently, environmental degradation in heavily populated urban areas as a result of increased pollution, including GHG emissions, is becoming a reality. The latter is threatening the international eco-system [1–6]. Thus, there is an increasing concern on areas of higher energy efficiency by better management and operation, highly efficient appliances and machines and utilization of renewable energy (RE) sources. Recently, different

countries, including Jordan, witnessed a shifting focus towards renewable energy sources.

As in other countries, Jordan is confronted with long-list of serious local and regional worries. These include but not limited to high rates of energy demand, lack of available natural resources and the increase in the public debt which touched US\$ 34 billion, as reported in the draft budget law for the year 2016 [7]. In addition, the refugees' problem due to armed conflicts in the neighboring countries: this is pressing on the limited available natural resources, such as water and energy, and causing social and environmental challenges in almost all cities and towns. One way of facing such serious challenges seems to be effective use of renewable energy sources, which will help the government to achieve the national goals of a brighter future: reducing dependence on imported energy and consequently the cost of energy

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bill as well as satisfying the growing energy demand. At present, there is a long list of RE projects currently connected to the grid, e.g. the Azraq 5 MW PV station, 3×38 MW Tafilah wind power plant and the Badiya 10 MW PV station east of Mafraq, or in the pipeline which will be connected to the grid and run soon on commercial basis. Other large RE generation projects of about 1600–2000 MW<sub>p</sub> are expected to follow before 2020 and the estimated capital investment in these projects exceeding US\$ 3–4 billion [8]. In addition to these central generation projects, on-grid roof tops PV systems based on net-metering directive witnessed high growth rate during last three years (2013–2015). The estimated installed capacity exceeded 55 MW<sub>p</sub> as of late 2015 and expected to double next year due to (i) increased electricity prices by an average of 15% per year for the period 2013–2016 for almost all tariff categories except low income households and agriculture sectors and (ii) the introduction of wheeling directive and its implementation guideline. Consequently, distributed generation is gaining an increased momentum, not only in Jordan but in the entire Arab region including markets that characterized by low overall access to electricity such as Djibouti, Mauritania, Sudan and Yemen. The adopted relatively simple net-metering scheme, in Jordan, is still in early stages of implementation; however, the market for small PV system has attracted large number of investors. At present, there are hundreds of new companies working in this field in Jordan and well trained engineers and technicians are highly needed for completing design, installation, testing and commissioning as well as operating and maintaining RE systems. It should be stressed again that the success of these projects depends on several factors. The most important are (i) compatibility of electricity sector standards, (ii) regulatory structure, (iii) stability of the renewable policies over time and competitive parity that allows fair spreading of costs over stakeholders, (iv) reduction of industrial barriers that will enable the integration of renewable energy with other power generation technologies, (v) simplicity of the design and administration of the energy policy and finally (vi) the availability of well trained and skillful engineers and technicians specialized in RE technologies and planning. The latter is considered as one of main barriers facing companies working in the field of renewable energy in Jordan and neighboring countries. This is attributed to the existing weak energy and renewable energy education which is considered as primitive and insufficient [9]. RE education is a relatively new field in general education as well as at university level, especially in colleges and faculties of engineering in Jordan. Inspecting open literature revealed that there are very limited studies conducted in this field, in Jordan and the Middle East and North Africa (MENA) region. Most of previous studies related to renewable energy were focused on RE technologies, applications sources and their potential, in Jordan, but none has discussed RE education [10–50]. A deeper look at all of these published papers revealed that most of researchers concentrated on theoretical analysis but not in the development or adaptation of RE technologies. Thus, there is a real gap in studying and investigating practical issues and promotion of these ideas to the public and concerned local industries. Such situation should not be allowed to continue since it is not healthy and could not help in developing the needed local capacities, including qualified engineers and technicians, to ensure better and efficient utilization of RE sources. Hence, it is vital and urgent to start real research and field studies aiming to analyze and evaluate existing energy and renewable energy education programs. These may include, but not limited to, issues related to existing offered courses, qualifications of instructors and the future role of students and researchers in solving energy problems and easing barriers that retarding RE utilization in various sectors of the economy. Researchers, in a recently published study in this field, highlighted the situation of the RE education in faculties of engineering in Jordan [51]. It was concluded that lack of awareness and shallow knowledge about energy and renewable energy technologies among senior students in faculties of engineering is a real fact and without proper education and training

programs in this field, the market will remain suffer from ill-educated and trained engineers and technicians. In the present study, which is a continuation of a past paper and based on reported results [51], the prime objective is to further investigate levels of knowledge about RE education in Jordan. Also the relationship and influence of different key demographic factors on RE education, in the BSc level of various engineering disciplines, are analyzed and discussed. But it should be remembered that it is not the aim of the current study to design new courses, curricula or study plans of various engineering disciplines.

The research paper is presented in three sections, in addition to the previous introduction which represents 1st section. In Section 2, the adopted methodology is outlined, followed by results and discussion in Section 3. Finally, conclusions and recommendations are presented in Section 4.

## 2. Methodology

In the previous paper which aimed to evaluate study plans and courses related to RE education in faculties of engineering, several activities were conducted [51]. The first step focused on reviewing existing situation of energy and RE education in both of state and private universities. In the second step, a special questionnaire was designed to assess levels of awareness of energy in Jordan and knowledge about RE sources and technologies. The employed questionnaire was designed, tested and verified on a preliminary sample of only 4th and 5th year students of the Dept. of Mechanical Engineering at Al-Balqa' Applied University. Then it was distributed on a random sample of senior engineering students in different specialties and universities. The randomly selected sample included 263 students from five state, i.e. Al-Balqa'(BAU), Jordan (JU), Hashemite (HU), Al-Elbait (ABU) and German-Jordan (GJU) universities and Amman Alahlyia (AAU), which is the 1st private university in the country. The third step was organizing and analyzing the collected data. The tailor-made questionnaire consisted of four main parts in addition to demographics of the 263 subjects, who have been administered to the questionnaire. These four parts are related to (i) energy in Jordan, (ii) energy management, (iii) renewable energy sources, and (iv) awareness level and knowledge of RE technologies and applications. It is important to mention here that in all questions a five-point scale (1-strongly agree, 2-agree, 3-may be, 4-disagree, 5-do not know) to evaluate students' responses was considered.

The present study is a continuation of a previous paper [51], but aimed to further investigate the relationships between various variables hypothesized to affect energy and RE education in faculties of engineering. The interactions of independent variables and effect of such interactions have on the dependent variable when more than two groups were compared is analyzed. In this study, the reported random sample representing senior students from six universities and five different engineering departments was employed. This analytical study focused on two aspects of knowledge: (i) energy situation and (ii) renewable energy sources in Jordan. These two aspects are investigated through a well-designed set of questions: nine and five questions for 1st and 2nd set, respectively. The mean score and standard deviation of each question are determined. Tables 1, 2 report the statistics of the first and second aspects, respectively. The overall mean and standard deviation of each of the two aspects are used as an indicator to be further tested as an aggregated measure of knowledge. Although the stratified indicators of each particular question are tested, Post hoc analyses are conducted for aggregated scores only.

Therefore, the criterion variable is the level of knowledge of subjects for each of the knowledge questions within each aspect (the five-point scale). While the explanatory variables were categorical variables, such as gender; department; university; and so on. Since the explanatory variables are categorical in nature, contingency tables are developed and examined using Chi-square and ANOVA tests. Of course, regression analyses can be employed too by converting categorical

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