



## Renewable energy education in engineering schools in Jordan: Existing courses and level of awareness of senior students



Aiman A. Alawin, Taieseer Abu Rahmeh, Jamal O. Jaber\*, Suliman Loubani, Sameh Abu Dalu, Wael Awad, Ali Dalabih

Faculty of Engineering Technology, Al-Balqa' Applied University, Jordan

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### ABSTRACT

In this study a phased comprehensive field survey was conducted to review almost all existing study plans of various engineering disciplines at state and private universities in Jordan. In the 1st phase, a general review of existing study plans in various engineering disciplines was conducted with the aim to identify any courses offered for students related to energy efficiency and management as well as renewable energy sources and applications. In the 2nd phase, a tailor-designed questionnaire was used and distributed on a random sample of senior students at state and private universities. It included questions about the energy situation in Jordan, energy efficiency, renewable energy and utilization and applications, in addition to the general section about demographic information. Lack of awareness and shallow knowledge about energy and renewable energy technologies among senior students in faculties of engineering are identified, at present, as main results obtained in this field investigation. Without removing such obstacles, the market will remain suffer from ill-educated and trained engineers and technicians in this field. Thus, it is important that the concerned governmental institutions, in close cooperation with managements of both state and private universities, to take necessary measures to correct the situation soon.

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### 1. Introduction

In Jordan the energy situation is extremely serious, no indigenous conventional energy sources were discovered, yet, hence the country is almost totally dependent on imported oil and gas [1]. Any shortages in supplies will threaten the stability of the country which lies in the middle of a volatile region and

surrounded with unstable countries due to armed conflicts in almost all the Middle East and North Africa. On the other hand, Jordan is very rich in oil shale and renewable energy (RE) resources but, due to lack of investment and foresight, these resources have not been exploited, on commercial scale, yet. RE energy resources, in particular solar, can technically provide 100 s times more than Jordan's electricity consumption in 2050. More importantly, is the fact that the economics of PV and wind are becoming feasible and even more competitive than fossil fuel based power plants at present in Jordan. Thus the government of Jordan has plans to promote the continued development of the

\* Corresponding author.

E-mail address: [jojaber@gmail.com](mailto:jojaber@gmail.com) (J.O. Jaber).

country's overall energy sector to best enable it to accommodate changing market conditions. One of the primary objectives of Jordan's updated Energy Master Plan is to reduce the reliance on imported energy, with a goal for RE meeting 10% (i.e., 600–1000 MW wind, 300–600 MW solar and 30–50 MW biomass) of energy demand by 2020, while nuclear energy providing a significant portion of new electricity capacity by 2035 [1]. According to the Ministry of Energy and Mineral Resources (MEMR) statistics, in 2010 the generated electricity had grown to nearly 14,258.7 GWh, and in 2011, 2012 and 2013 it reached 14,647, 16,595 and 17,261 GWh, respectively [2,3]. Combined cycle and steam turbines plants contributed about 55% and 40% of total generation, respectively, while electricity produced from RE sources was less than 0.5%, in these years.

At present, the country is in a risky economic situation provided that the natural gas supply from Egypt will never back to the required levels or even reduced prices as used to be before the uprising in Egypt. This led to higher generation costs which caused substantial losses for the National Electric Power Company (NEPCO): accumulated losses exceeded US\$ 6.5 billion until 5015 [4]. Consequently, the government was forced to discuss and adopt alternative strategies for supplying the country with needed primary energy. These included importing LNG and to focus on RE and EE on a more urgent basis. As a part of updated Energy Strategy, the Renewable Energy and Energy Efficiency Law (REEEL) was approved and released in mid-2012 (Law No. 13 for year 2012) [5]. Main objectives of the REEEL include: (i) increasing the contribution of RE into the total energy mix in Jordan; (ii) promoting and exploiting RE for environmental protection and sustainable development purposes; and (iii) enhance energy efficiency in all sectors of the economy. According to Article 10 of this law, rules and regulations to guide implementation of the REEEL were issued by the Ministry of Energy and Mineral Resources and the Electricity Regulatory Commission, which was substituted by the Energy and Minerals Regulatory Commission in 2014 [6–15]. This opened the doors for investors and developers to utilize RE sources and connect to the national and/or distribution grids. Consequently, several RE projects are in the pipeline and some of these expected to run on commercial basis before the end of 2015 such as the Azraq 5 MW PV station, 3 × 38 MW Tafilah wind power plant and the Badiya 10 MW PV station east of Mafraq [16]. Other large generation projects are expected to follow within next two or three years. Table 1 summarizes the current status of RE projects in Jordan [17].

These projects could substantially reduce Jordan's energy dependency and create significant fiscal benefits: (i) expected to generate about 2000 GWh annually and (ii) create between 2000 and 3000 jobs [18]. MEMR is working in close cooperation with the Ministry of Municipalities and the Great Amman Municipality and investors to convert solid waste into energy and the expected

installed capacity estimated at around 60 MW [19]. In addition to these central generation projects, on-grid roof tops PV systems based on net-metering directive witnessed high growth rate during 2013 and 2014. The estimated installed capacity exceeded 30 MW as of early 2015 and expected to double next year due to the fact that the government increased electricity prices by an average of 15% per year for the period 2013–2017 for almost all tariff categories except low income households and agriculture sectors. This price increase was approved by cabinet and would be considered one of the rare situations by which electricity tariff is increased for years ahead [20].

In a previous recent research paper by Jaber et al., [21], it was concluded that the lack of engineering and technical skills and capacities, lack of financing schemes as well as ineffective implementation of regulations are major barriers affecting the future of the RE market in Jordan. Without the needed trained and skilled workforce, including engineers and technicians, for developing, designing, installing, operating and monitoring as well as maintaining RE systems, the use and penetration of such systems in Jordan, and within the MENA region, would be almost impossible. Thus, the current paper is the first of its kind in the country and aimed at identifying strength and weaknesses as well as defining the level of awareness related to energy education among senior students in engineering faculties in Jordan. Specifically, it examines the existing study plans in different engineering disciplines at BSc level from the energy point of view. Special attention is given to RE education with the aim of identifying the level of awareness among senior students enrolled in engineering programs related to (i) energy situation in Jordan, (ii) energy efficiency, (iii) RE and (iv) utilization and applications. It should be stressed that it is not the aim of this study neither to discuss study plans of various engineering disciplines nor to design new courses. Rather it is deemed to provide a general picture of the existing energy efficiency and RE education and provide recommendations on how to enhance the quality of energy education, taking into account the existing legal framework.

The following section presents a review of the related literature. It is followed by the description of the adopted methodology to conduct the study and main results. The paper ends with a discussion of results and conclusions to enhance energy education in faculties of engineering in Jordan. Part II will discuss the interrelation and significance of various factors and variables presented in this paper i.e. (Part I) which affect levels of awareness and knowledge in RE sources and systems.

## 2. Energy and renewable energy education in Jordan

The higher education system in Jordan has evolved considerably in the last two decades, but still a lot should be done to

**Table 1**  
Committed renewable energy projects in Jordan.

No.	Type	Location	Ownership	Capacity (MW)	Status	Commercial operation
1	PV	Azraq	Gov.	5.0	Commissioned	On-line May 2015
2	Wind	Tafila	Private	3 × 38	Commissioned	On-line Oct. 2015
3	PV <sup>a</sup>	Mafraq	Private	10.0	Commissioned	On-line Sep. 2015
4	Wind	Rajef	Private	82.0	Under Development	Expected by end of 2017
5	Wind	Fujij	Private	90.0	Under Development	Expected by end of 2017
6	Wind	Ma'an	Gov.	50.0	Under Development	Expected by end of 2017
7	PV	Qwira	Gov.	50.0	Under Development	Expected by end of 2016
8	PV <sup>a</sup>	Ma'an	Private	200.0	Under Development	Expected by end of 2016
9	PV <sup>b</sup>	Mafraq	Private	200.0	In the pipeline	2016–2017
TOTAL				~ 800		

<sup>a</sup> 1st round direct proposals to MEMR (2013).

<sup>b</sup> 2nd round direct proposals to MEMR (2015).

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