Renewable and Sustainable Energy Reviews xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Electricity system in Jordan: Status & prospects

Murad Al-omary[a,b,*], Martin Kaltschmitt[c], Christian Becker[b]

[a] German Jordanian University (GJU), Amman Madaba street, 11180 Amman, Jordan
[b] Institute of Electrical Power and Energy Technology (ieet), Harburger Schloßstraße. 20, 21079 Hamburg, Germany
[c] Institute of Environmental Technology and Energy Economics (IUE), Eißendorfer Straße. 40, 21073 Hamburg, Germany

ARTICLE INFO

Keywords:
Electricity system
Renewables
Energy policy
Jordan

ABSTRACT

The Kingdom of Jordan, like other countries, faces considerable challenges to cover always and securely the given electricity demand. This is due to e.g. limited locally available fossil fuel resources, insufficient available conversion capacities and the financial weakness of the energy entities. Additionally, the electricity demand is strongly rising due to increasing industrialization and a fast growing population; the latter is also true due to refugees from Syria and Iraq. One option to contribute to a secured and a climatic sound improved electricity generation system is an increased use of renewable sources of energy. For Jordan, this is especially true due to the availability of favourable solar and wind resources. Against this background, this paper assesses the current status of the electricity sector in Jordan and discusses the possible future role of renewable sources of energy for electricity generation within the Jordanian electricity system. The investigation shows that electricity from wind and solar can contribute indeed considerably to a more secure and climatic sound electricity supply system. Thus the realization of an exploitation strategy to increase the share of electricity from wind and solar could clearly be beneficial for the Kingdom of Jordan.

1. Background

Jordan is an emerging country in the Middle East with limited indigenous energy resources [1]. Although the country produces natural gas and crude oil, the overall amounts are low and do not exceed 3–4% of the total energy demand (i.e. they are clearly insufficient to meet the energy demand of the Jordanian Kingdom) [2]. Thus, the country is classified as a non-oil producing country. For this reason, Jordan imports the remaining 96% of its crude oil and natural gas needs from the neighbourhood (i.e. Egypt, Iraq, Gulf countries). But the currently given frame conditions like frequent interruptions of Iraq's oil production and continuously stopping of natural gas supply from Egypt makes it critical and challenging for Jordan to securely cover its energy needs [1,3]. Additionally, crude oil and natural gas imports are a considerable burden on the country's national economy even with low oil prices [1,4].

This situation will probably become even more challenging in the years to come. On one hand side the energy and electricity consumption will increase rapidly. For example, existing projections assume a doubling of the electricity demand in the next 15 years [5]. On the other side due to considerable societal and political challenges and thus increasing uncertainties the supply of fossil fuel energy from the neighbourhood will most likely become even less stable and less reliable [6].

To improve the electricity supply security, the government of Jordan has started to search for alternative sources of energy. The "new" resources to be exploited in the future should be domestic, cheap, technologically mature and economically viable. Additionally, they should contribute to a secure power generation to allow for an uninterrupted electricity supply. At the same time, they should support the governmental plans to stabilize greenhouse gas (GHG) emissions [7,8]. In this context, Jordan's energy policy has decided to promote renewable sources of energy. It is planned to achieve a contribution of 10% related to the total energy mix in 2020. For this reason, the Jordanian government has estimated the size of investment in renewables to fulfil that percentage to 15 billion US$ [1,4,9].

Jordan as a country is located geographically within the sunbelt zone where direct solar radiation is available for roughly 300 days a year within an intensity range of 5–7 kW h/(m^2 d). Beside this favourable solar energy supply, the country has several locations with average yearly wind speeds between 7 and 9 m/s at 50 m height above ground throughout the year. In spite of these very promising frame conditions for electricity generation from wind and solar, these power generation options are still in an early stage of usage despite the fact that within other countries already a considerable share of the electricity is produced from these renewable sources of energy [7,9,10].

* Corresponding author at: Institute of Electrical Power and Energy Technology (ieet), Harburger Schloßstraße. 20, 21079 Hamburg, Germany.
E-mail addresses: murad.omary@tuhh.de (M. Al-omary), kaltschmitt@tuhh.de (M. Kaltschmitt), c.becker@tuhh.de (C. Becker).

http://dx.doi.org/10.1016/j.rser.2017.06.046
Received 25 August 2016; Received in revised form 30 November 2016; Accepted 16 June 2017
1364-0321/ © 2017 Elsevier Ltd. All rights reserved.

Nomenclature

a	Annual / Year
AES – Joradn	Amman East South- Jordan Company
A_{WEC}	Area of Wind Energy Converter
BAU	Business as Usual
BOO	Build-Own-Operate
$c_{a,P}$	Total Yearly Cost
CEGCO	Central Electricity Generation Company
COE	Cost of Electricity Generation
CO_2	Carbon Dioxide
d	Day
d_{Rot}	Rotor Diameter
EMRC	Energy and Minerals Regulatory Commission
EDCO	Electricity Distribution Company
F_P	Yearly Fuel Cost
GHG	Greenhouse Gases
GHI	Global Horizontal Irradiation
G. T	Gas Turbine
g	Gram
h	Hour
h/a	Hour per Annual
i	Interest Rate
I_P	Overall Investment Cost
IGCC	Integrated Gasification Combined Cycle
IDECO	Irbid District Power Company
IPP	Individual Public Private Project
JEPCO	Jordan Electricity Power Company
JD	Jordan Dinar
K_A	Distance Factor
kW	Kilowatt
kWh	Kilo Watt Hour
KEPCO	Korean Electricity Power Company
kV	Kilovolt
km^2	Kilo Meter Square
L	Lifetime
MEMR	Ministry of Energy and Mineral Resources
MW	Mega Watt
MJ	Mega Joule
m	Meter
m^2	Meter Square
m^3	Cubic Meter
m/s	Meter per Second
NEPCO	National Electricity Power Company
O&M	Operation and Maintenance
$O\&M_P$	Yearly Operation and Maintenance Cost
P	Power Generation Technology
PJ/a	Peta Joule per Annual
PV	Photovoltaics
QPCO	Qutraneh Power Company
SEPCO	Samra Electricity Power Company
t/a	Ton per Annual
TWh	Tera Watt hour
US$	United States Dollar
η	Efficiency of Photovoltaic

Against this background, this paper assesses the status of the electricity sector in Jordan. Based on this, the possible future role of an electricity generation based on wind mills and photovoltaic systems as an integrated part of the Jordanian electricity system is analysed. This is performed through an investigation of economic and environmental aspects for different scenarios. Based on this several conclusions are drawn.

2. Jordanian electricity system

2.1. Primary and final energy consumption

Within the Kingdom of Jordan, in 2015 roughly 360 PJ of primary energy have been used mainly from crude oil and natural gas. This primary energy supply has strongly increased between 1990 and 2015 (Fig. 1(a)). The coverage of the primary energy demand throughout the last 25 years has been realized by using growing amounts of these two fossil fuels to a strongly varying extend. For example, between 2003 and 2011 the Jordanian primary energy provision depends mainly on natural gas from Egypt due to supply interruptions from Iraq. Compared to these sources, other fossil primary energy carrier (e.g. coal, nuclear) are not used for the time being [11].

After removing the given transportation and refinery losses as well as losses in power plants and within the industry sector, this energy is used as final energy to cover customer needs (Fig. 1(b)); in 2015 roughly 300 PJ are used as final energy. The development of the final energy supply mirrors the increased energy use related to the use in the various sectors. All over, the transport and agricultural sector shows the highest and lowest consumption, respectively [11].

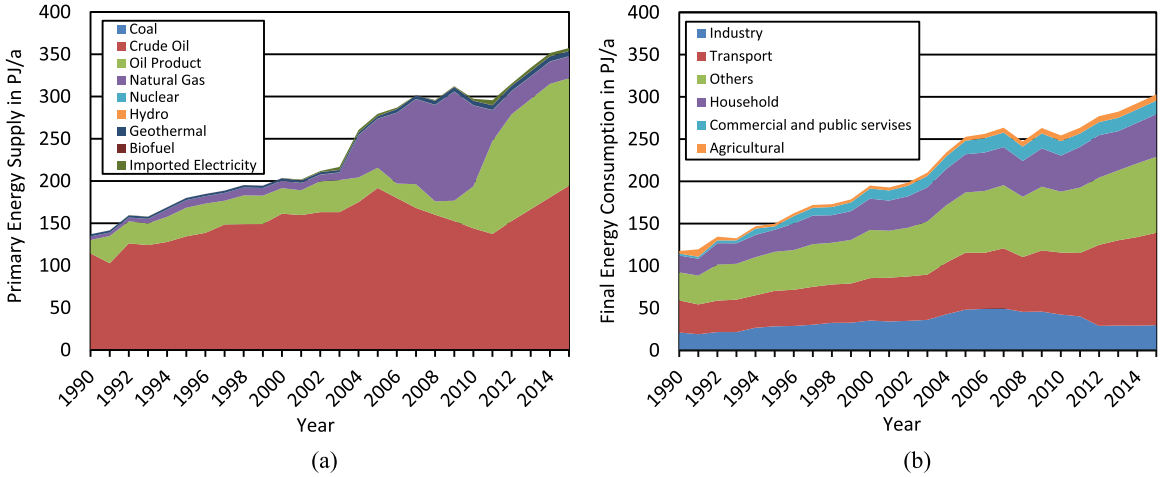

Fig. 1. Primary energy supply (a) and final energy consumption (b) in Jordan for the period 1990 till 2015 [11].

Download English Version:

https://daneshyari.com/en/article/8112330

Download Persian Version:

https://daneshyari.com/article/8112330

Daneshyari.com