

# Wind Energy in Jordan - Use and Perspectives

Ziad J. Sabra; Ministry of Energy & Mineral Resources, P.O.Box 140027, Amman-Jordan

## 1. Introduction

Jordan like other developing countries depends entirely on imported oil for meeting its needs of commercial energy and pays more than 10% of its GDP for the energy bill. The annual growth rate of energy and electricity demand is amounted to 3% , and the maximum power demand is expected to be doubled by the next decade.

In 1997 The demand for primary energy was 4.7 million ton oil equivalent (TOE), the average energy consumption per capita was 1028 kg oil equivalent (KgOE), and the total installed generating capacity in the country was 1265 MW . The generated electrical energy for local consumption in that year amounted to 6261 million kWh, and the average per capita consumption of electricity is 1361 kWh.

The electricity sector ranked first in energy consumption, comprising 34.3% of the total primary energy during 1997. The share of electricity in the total energy consumption is steadily increasing since it is a more efficient and cleaner source of energy, in addition to its widespread in more than 99.6% of the Kingdom's population [1].

Since the energy resources discovered locally are limited, and considering the big burden that the imported energy has on the national economy; the Government gives special attention towards renewable energy for the purpose of assessing, developing and planing of the local energy demand.

Jordan has pursued intensive programs for promoting renewable energy, this involved systematic monitoring of the technological developments, implementation of appropriate know-how and execution of demonstration and pilot projects since the early seventies. The already accomplished projects and studies in this field provided Jordan with scientific and practical experience, qualifying it for entering a new phase of local manufacturing of renewable energy systems; specially wind turbines by means of co-operation and joint ventures between local institutions and foreign companies.

Recent statistics and studies in Jordan indicated that renewable energy contribution is reaching about 2% of energy consumption and expected to reach 5% by the next decade [2].

## 2. Wind Potential and Use in Jordan

### 2.1 Wind Potential ( Wind Data)

Jordan possesses high potential of wind energy resources where the annual average wind speed exceeds 7 m/s (at 10 m height) in some areas of the country. The long term climatic data are available at the Jordan Meteorological Department (JMD). Some other institutions like the Ministry of Energy and Mineral Resources (MEMR) and the Royal Scientific Society (RSS) have some measurements of such data especially wind and solar data for the purpose of assessing the potential of these resources for power generation and other applications in Jordan.

In 1988, the MEMR, JMD and other local institutions by co-operation with RISO National Laboratory in Denmark, have conducted the Wind Atlas for Jordan. This Atlas is the first of its kind in the region and is considered as a reference for determining and selecting the areas that have promising potential for electricity generation in Jordan. Fig. 1. shows the Wind Map of Jordan in this Atlas which was recently updated by MEMR and the Royal Jordanian Geographic Centre depending on the new wind measurements conducted by MEMR for several years [3].

The Wind Atlas indicated out two windy regions in the northern and southern parts of Jordan. The estimated potential for wind power generation in these regions is about 50 MW (25 MW in the north and 25 MW in the south) without major changes in the grid and power system, and this potential could amount due to variations of wind speeds to 65–145 GWh per year [4], which corresponds to 1.5–2.5 % of the total electric energy generated in the country in the year 1997 .

The preliminary results of the wind measurements at several locations in the country are quite promising for power generation. The diversity of Jordan's topography (400 m below sea level at the Dead Sea and up to 1700 m above sea level at the northern and southern parts of the country), as well as the distribution of the electric grid all over the country especially through the windy areas, present good conditions for the utilisation of wind energy for power generation.

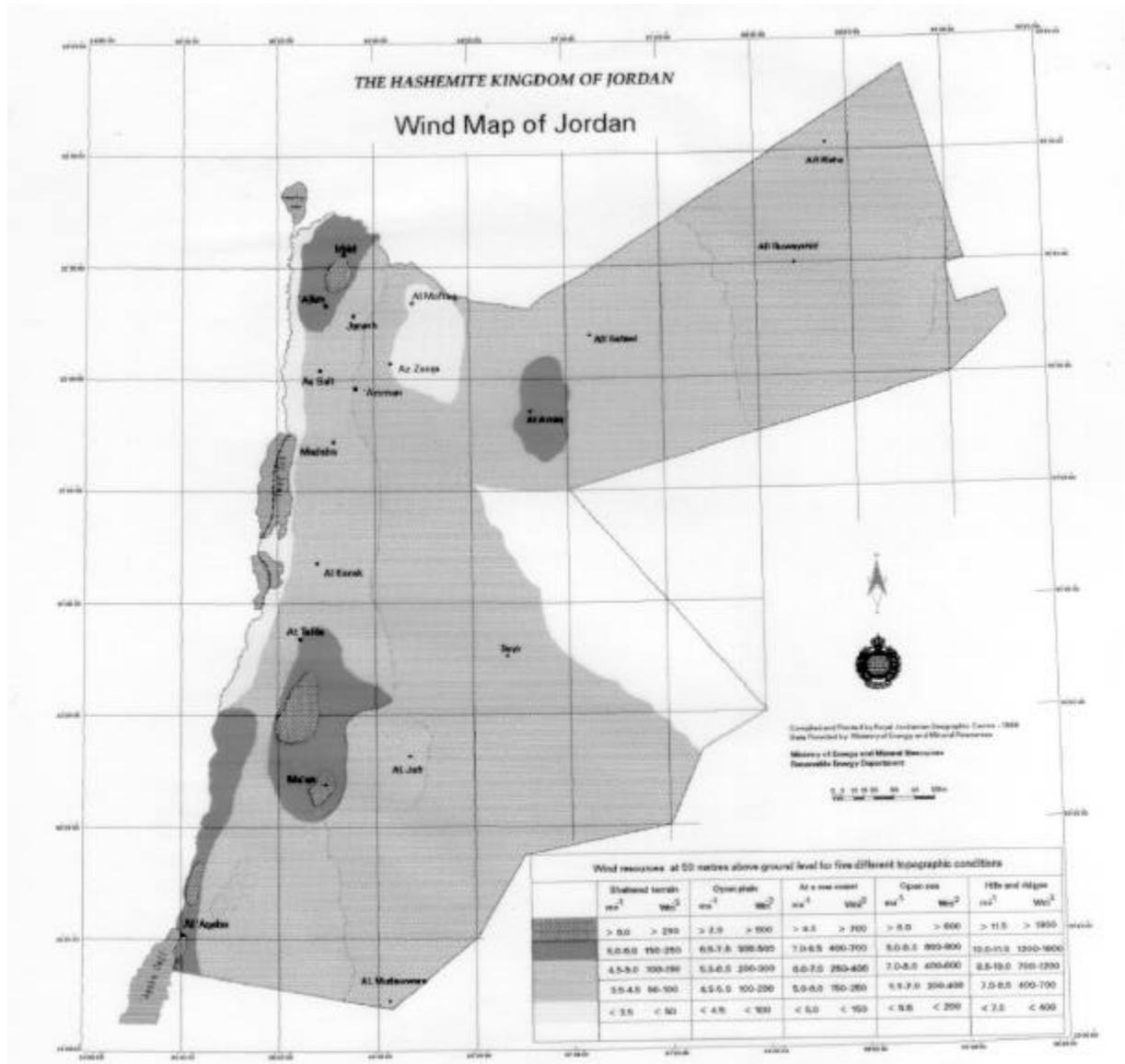


Fig. 1: Wind potential in Jordan

### 2.2 Wind Utilisation

Wind energy in Jordan is used mainly for electricity generation. There are two wind farms connected to the grid in the northern part of the country; one with a capacity of 320 kW in Al-Ibrahimiyya, consisting of 4 stall regulated wind turbines of 80 kW each, established in 1988 in co-operation with a Danish firm and considered as the pilot project. The other most recent one, has a capacity of 1125 kW in Hofa, consisting of 5 pitch regulated wind turbines of 225 kW each, established in 1996 in co-operation with the German Government under the so-called ELDORADO program.

Wind energy is used successfully, through a Hybrid Power System to electrifying a remote village in the southern part of the country called Jurf El-Darawish. This system was constructed in 1987 and consists of 2 wind energy converters of 20 kW each, a 10 kW peak Photovoltaic field, storage battery system of 330 kWh capacity, and a back up diesel generator of 65 kW.

Water pumping in remote areas using mechanical and electrical Wind mills is also used intensively in Jordan . There are more than 20 pumping stations in this field using mechanical wind mills manufactured locally. There exist also some attempts for local manufacturing of electrical wind turbines especially the blades and the tower.

### 3. Present Situation

#### 3.1 Energy Sector in Jordan

The MEMR has primary responsibility for energy sector policy formulation and planning including energy sector co-ordination. Under the supervision of the MEMR, the former Jordan Electricity Authority (JEA), Jordan Electric Power Company (JEPSCO), and Irbid District Electricity Company (IDECO) are involved in power service in the country.

In 1996 JEA was privatised and transformed to governmental company called the National Electric Power Company (NEPCO), operating on commercial bases and is in charge of the generation and transmission of power all over the country. It also distributes power for most parts of the country outside the concession areas of JEPSCO and IDECO . During 1998 as part of the Energy Sector fundamental restructuring, NEPCO was restructured into three separate entities with responsibility for generation, dispatch & transmission, and distribution. The two companies responsible for generation and distribution will be privatised, while the government will own the dispatch & transmission company [2].

JEPSCO is a private distribution company in charge of the country's most affluent region including the capital city of Amman, Balqa and Zarqa Governorates. IDECO is a semiprivate distribution company and distributes power in the northern part of the country including the Governorates of Irbid, Mafraq, Ajlun and Jarash.

The interconnected system in Jordan consists of the main generating power stations and 400 kV and 132 kV transmission network. The 132 kV transmission network interconnects the power stations with the load centres and different areas in the country. The distribution system in the country comprises the voltages of 33 kV, 11/10, 6.6 kV and 0.4 kV networks. The feeders of the 33 kV, 11/10 and 6.6 kV are over-head lines and underground cables. Regarding the type of generation employed in the country,

about three-quarters of the electric energy was produced by steam generation units (heavy oil), and less than one-fifth by gas turbines (natural gas). Diesel oil gas turbines and diesel engines accounted for most of the remaining share. It is worth mentioning that NEPCO is the largest consumer of primary energy in the electricity sector in the country having consumed about 93.3% of the fuel used in electricity generation in 1997. In 1998 and 1999 NEPCO will install 3X130 MW steam generation units. So the total installed generating capacity in the Kingdom after this installation will be 1658 MW, and this will meet the increased demand for electrical energy with a high availability until the end of the year 2001.

#### 3.2 Private Power Generation

The Jordanian economy has continued to improve as a result of implementing government's policies to achieve the goals of the Economic Reform Program. The government is keen to achieve these goals through the adoption of several basic principles such as improving the production, management and operation efficiency and encouraging the participation of the private sector to invest in principal infrastructure projects including

electricity industry. In 1996 and 1997 the government has taken important measures to ensure a suitable competitive environment within the energy sector and to attract significant private investments in this sector; a new Electricity Law has been issued. This law will allow for MEMR to license new power producers, and provide for an independent regulator to design electricity tariffs on the basis of economic and financial principles.

To encourage the private sector to invest in electricity projects, the government has decided that the next generation expansion shall be implemented by the private sector, and has assigned the responsibility of managing the implementation of the project to the MEMR.

Accordingly, in 1997 the MEMR has initiated the process of issuing a Request for Proposal (RFP) for an Independent Power Producer (IPP) for the first private power plant in Jordan with the capacity of 450 MW gas-fired combined cycle. This plant has to start operation up 2001 in order to cover the power demand after this year [2] .

#### **4. Conclusion**

It is worth mentioning that Jordan has benefited from the operational experience of the accomplished wind energy projects, especially in Al-Ibrahimyya and Hofa. This experience has proven the feasibility of utilizing wind energy in Jordan in case of manufacturing some parts of the wind turbines locally.

As the Wind Atlas of Jordan indicated and also as the wind map showed, a capacity of 50 MW wind turbines can be installed in the northern and southern parts of the country. The New Electricity Law and the Environment Protection Law, which were recently issued, opened the door for foreign and local investment to contribute more towards utilisation of renewable energy projects, especially wind energy, for power generation.

#### **5. References**

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