

## استخدام الطاقة المتجدده في الاردن: دراسة تحليله للواقع وتحديد المعيقات التي تحد من التوسع في استغلالها

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### الملخص

تهدف هذه الدراسة الميدانيه الى عرض واقع استخدام الطاقة المتجدده في الاردن، وتطوير مصفوفة تلخص نقاط القوه والضعف بالاضافه الى الفرص والتحديات التي تؤثر في تطور استخدام هذه المصادر مستقبلاً. حيث تم القيام باجراء لقاءات ومقابلات وجهاً لوجه مع كافة الجهات المعنيه من القطاعين العام والخاص، مستخدماً استبياناً بسيطاً يتضمن مجموعه من الاستفسارات و الاسئلة حول الطاقة المتجدده واستخداماتها. مع الأخذ بعين الاعتبار الخطط والبرامج الحكوميه الهادفه لزيادة مساهمة الطاقة المتجدده في خليط الطاقة الكلي ليصل الى 10% من اجمالي الاستهلاك المتوقع عام 2020. وبعد الانتهاء من جمع البيانات والمعلومات والملاحظات، تم تصنيف وتبويب نقاط القوه الموجوده معاً ومكامن الضعف وكذلك الفرص المتاحة لتطوير استغلال مصادر الطاقة المتجدده في المملكه، كل على حده، واهم المعيقات (التحديات) التي قد تحد من التوسع في ذلك مستقبلاً. حيث تبين بأن اهم الاسباب التي يمكن ان تعرقل تطوير مصادر الطاقة المتجدده في الاردن تتلخص بما يلي: (1) توفر مصادر التمويل المالي و(2) تعريفه بيع الكهرباء لمختلف القطاعات.

لا زال من غير المألوف في الاردن ان تجد بنكاً تجارياً يوفر برنامج تمويل خاص لتركيبة انظمة الطاقة المتجدده او وسائل ترشيد استهلاك الطاقة، كما ان صندوق الطاقة المتجدده وكفاءة الطاقة، والذي تم استحداثه في وزارة الطاقة والثروة المعدنيه عام 2012 لكي يساهم في تطوير استخدام مصادر الطاقة المتجدده وتحسين كفاءة الطاقة، لا زال في مراحلها الاولى. ويتطلب المزيد من الدعم المؤسسي وتدريب الكادر الفني والمالي لادارة مثل هذا النوع من المشاريع. كما انه لا بد من بذل المزيد من الجهد لرفع مستوى الوعي وتدريب المهندسين والاداريين العاملين في القطاعات المختلفه حول كيفية تحضير واعداد المشاريع التي يمكن دعمها وتمويلها من صندوق الطاقة او غيره، وبدون ذلك سيكون من الصعب جداً تحقيق الاهداف الوارده في استراتيجيه الطاقة الجديده.

الكلمات المفتاحيه: الطاقة المتجدده، تحليل نقاط القوه والضعف، مؤشرات الاسعار، التلوث، الاردن

### Current status and SWOT analysis of renewable energy sources in Jordan

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### Abstract

The aim of this investigation is to assess the current status of renewable energy sources and systems in Jordan and develop a matrix of strength (S), weakness (W) as internal issues and opportunities (O) and threats (T) as external factors. The conducted analysis was developed through a series of face-to-face meetings with all concerned stakeholders from the public as well as the private sectors, using a semi-structured questionnaire, taking into account the government plans to increase the contribution of renewable energy in the national energy mix to reach 10% of the total energy consumption in the year 2020. After collecting and analyzing the notes, strong points were grouped in a matrix together and same for weakness, opportunities and threats. Among the most important weaknesses that may hinder efforts in developing renewable energy sources in Jordan are (i) the available financing schemes and (ii) the future price of electricity generated by renewable sources. It is still uncommon, in Jordan, to find banks' that have special financing programs, with reduced service charges, to support renewable energy and energy efficiency projects. Equally important is that the Jordan Renewable Energy & Energy Efficiency Fund (JREEEF) which was created, in 2012, to contribute to the development of renewable energy and energy efficiency in Jordan, is still not operational, yet. Without providing needed support for renewable energy through public awareness and training, project preparation, access to credit, cost of financing and access to equity financing, the national goals could not be achieved.

*Keywords:* renewable energy, SWOT analysis, indicative prices, emissions, Jordan

## Background

Unfortunately, unlike other Arab neighboring countries, it is a non-oil producing country with limited natural resources and minerals. Its economy was based primarily on agriculture and farming; however, in recent decades the importance of the agricultural sector has declined both in terms of its contribution to the national income and as main source of employment. The country has become more dependent on services and manufacturing sectors as well as upon tourism and transport activities. As other developing Asian countries, it has a rapid population growth of about 2.2%. The population and economic growth as well as development that Jordan experienced since its independence, in mid 1950s, implied a gradual shift of the population from rural to urban areas. Thus, urban population has increased from about 70%, in 1990, to more than 82%, in 2011, of total population, putting the kingdom among the most urbanized countries in Asia [1]. If present policies remain unchanged, urban population is expected to exceed 85% by the end of this decade. A major structural phenomenon of urbanization is the increasing shift of large proportions of the population to modern centers with relatively high incomes, requiring higher rates of energy consumption to sustain the new life.

Jordan is considered as an upper middle-income country with a population of 6.4 million, without refugees or foreigners resident in the country, and a per-capita GDP of about US\$ 4800, in 2012 [2]. Approximately 60% of the population is young and under 20 years old, being mostly students or trainees, i.e. not productive. The country has limited natural resources, potash and phosphate are its main export commodities, limited agricultural land, and water is especially scarce: Jordan is among the world's five poorest countries in terms of available water resources. Services account for more than 70% of the gross domestic product and absorb more than 75% of jobs. As one of the most open economies of the region, Jordan is well integrated with its neighbors through trade, remittances, foreign direct investment, and tourism, and has especially strong links to the Arab Gulf states. As a result of its open economy and high degree of regional integration, Jordan is vulnerable to the political, economic and social volatility of the region. The political upheaval that swept the Arab region has had a significant impact on Jordan taking the form of economic shocks as well as inspiring domestic demands for stronger citizen voice, greater accountability and improvements in living conditions. The regional political upheaval impacted Jordan economically through two channels: (i) the sharp drop in natural gas supplies from Egypt led to a surge in Jordan's current account and fiscal deficits; and (ii) the Syrian conflict which led to a large influx of refugees is further straining Jordan's difficult fiscal position. Equally important is the instability in the region as a whole [3-6].

Since the beginning of the crisis in Syria, in March 2011, the number of Syrian refugees who fled to Jordan exceeded 1.3 million [7], and are distributed in camps around and in Jordanian cities and towns (the number of those so far registered or in the pipeline with UNHCR is almost 800 thousand). The daily flow of refugees during the past two years was between 600-1000 refugees per day. This requires establishing several new camps to accommodate coming thousands of refugees. As Syrian refugees in urban areas are granted access to public services (including health, education, shelter, water and electricity), the pressure on scarce national resources and subsidized services and items has dramatically increased, and the GoJ and the families hosting vulnerable Syrians are facing numerous challenges as the unrest in Syria continues. Consequently, the GoJ with its limited resources cannot support the in-flood of refugees and it is essential to support Jordan's efforts to continue hosting Syrian refugees and providing them with basic services [8].

Jordan faces numerous fiscal and economic challenges and has started a fiscal reform program with the IMF that should be implemented successfully to overcome the fiscal challenges over the medium term. The additional burden of hosting Syrians has added to the challenges Jordan faces and could threaten its fiscal reforms if Jordan is not provided with the international adequate support and assistance to compensate for the cost of hosting such large numbers of Syrians across all sectors. The absence of such support would seriously undermine the GoJ ability to continue providing needed services. By the end of 2012, Jordan was hosting more than 500,000 Syrian refugees (equivalent to almost 8% of the Jordanian population in the Kingdom). Hosting this large number of refugees has resulted in significant direct and indirect costs for the GoJ during a period of severe slowdown in growth and employment rates and all-time high budget deficit and higher demand on scarce resources of water, imported fuels and electricity. The Government of Jordan had incurred over US\$ 226 million during 2012 to provide services and basic needs in the form of subsidies

and current expenditures for more than 350-500 thousand Syrians in cities and communities (not including costs of establishing and operating camps covered mostly by UN agencies) [9]. This cost for the GoJ of services and basic needs is expected to increase to US\$ 500 million, or more, in 2013 as the Syrian population reaches 700 thousand or 11% of Jordanians living in the Kingdom.

Economic and fiscal conditions have improved slightly in early 2013, after a challenging year in 2012. With gas supplies from Egypt shrinking to 16% of contractual terms in 2012, Jordan had to rely on expensive fuel imports to generate electricity. This led to a rapid deterioration of Jordan's balance of payments and fiscal positions in the first half of 2012. As a result, an IMF SBA was approved in August 2012 (800% of quota or about US\$ 2 billion). For the year 2012, the current account deficit reached 18% of GDP (up 6 percentage points of GDP from 2011) while the overall fiscal deficit reached 8.5% of GDP (up about 2 percentage points of GDP from 2011) [2]. The elimination of all petroleum product price subsidies except for LPG, used in the residential sector and local small public restaurants, and a doubling (from a low base) of the natural gas flows from Egypt since November 2012 helped reduce the acute macroeconomic pressures. However, and after the recent political developments in Egypt, there were several cuts and major shortages in gas supplies due to terrorist attacks against the main pipeline in the Sinai Peninsula. Supply has been cut since the military cue in July 2013, and total gas quantities received by Jordan were less than 20% of that agreed upon [10]. Previously the Egyptian government agreed to substitute for the lost quantities of natural gas over a period of three years starting from this year, 2013, depending on the technical situation at their side, but after amending the favorable pricing agreement between the two countries under which Jordan received natural gas for less than half the international market price. During the past three years, the national power generation level was critical, and sometimes felled short behind the national demand, especially during the summer season [11]. In the near future, Jordan will remain a net importer of oil and natural gas from the Arab neighboring countries, especially Saudi Arabia and Kuwait as well as electricity from Egypt, to meet peak-load and sometimes part of base-load. Thus, the current situation presents an ideal environment for development of renewable sources including mini-hydropower schemes whose financial and technical demands can be met by small investors with relative ease.

Following pressures in late 2012, policy measures and external assistance have since boosted foreign reserves and confidence in the peg is returning. Although net international reserves (NIR) halved in 2012 to US\$ 5.4 billion (to 3 months of imports), NIR improved in late 2012 and early 2013 due to (i) monetary policy tightening by the Central Bank of Jordan, (ii) a doubling of the natural gas inflows from Egypt, and (iii) the receipt of US\$ 1.2 billion in grants in early 2013. The large drop in NIR in 2012 was mostly driven by a widening of the current account deficit, and a notable switch from dinar deposits to foreign currency, some of which was kept in cash. The current account deficit stemmed mostly from a worsening of the trade balance as exports stalled due to the Syrian-crisis related disruption of trade routes, while imports jumped as energy and food imports surged [2]. The latter jumped more than 20% due to the large influx of Syrian refugees. Inflation accelerated towards end of 2012 to about 7.25%, mostly driven by food prices, rising public sector wages, and the elimination of petroleum product price subsidies [8,12,13].

### **Energy Policy and Strategy**

The Government of Jordan plans to promote the continued development of the country's overall energy sector to best enable it to accommodate changing market conditions, and in particular, the rapidly growing local demand for electricity and refined petroleum products. One of the primary objectives of Jordan's Energy Master Plan is to further increase private sector investment in the development of the energy sector until the year 2020 [14]. The plan was approved by the Council of Ministers in December 2004, and its 2007 updated version calls for an estimated investment of US\$ 13 to 17 billion from 2007 to 2020, which would be financed by the private sector across the downstream, electricity, natural gas, oil shale, and renewable energy. Implementation of the plan is expected to stimulate further growth in the Jordanian economy and will create a number of investment opportunities which will be structured to encourage and promote private sector participation. The plan aims to reduce the reliance on imported products from the current level of approximately 97%, with a goal for renewable energy meeting 10% (i.e. 600-100 MW wind, 300-600 MW solar and 30-50 MW biomass) of energy demand by 2020 and nuclear energy providing a significant portion of new electricity capacity by 2035. However, since the launch of the

updated Energy Sector Strategy in 2007 and until now, nothing has been added on the ground and all proposed renewable energy projects are still on paper.

During the last decade and due to the country's dependence on low cost natural gas imported from Egypt, the government had failed, as of 2013, to initiate any meaningful progress in renewable energy and energy efficiency despite the obvious strategic importance of the same in providing energy security and establishing the basis for economic development. Jordan has not been in a strong financial position to support RE projects as a result of cheap natural gas supplies, while the nuclear industry - despite a lack of support from parliament - has received significant investment on the false promise of cheap and abundant energy. Exacerbated by the increasing cost of power generation as reported by the government, (up to 184 fils per kWh which is equivalent to USD 0.26/kWh) due to the disruption of cheap Egyptian gas supplies, the urgency of developing RE has escalated dramatically [15].

Today, Jordan finds itself in a very precarious economic situation given that discounted Egyptian gas supply will not resume at the required quantities and that any resumption is uncertain at best. As of early Sep. 2013, and after the complete cut of natural gas supplies since the last terrorism attack in Sinai, Jordan's power sector again became totally dependent on imported heavy fuel oil and light diesel fuel to supply power stations. The cost of power generation for the National Electric Power Company has steadily increased from a low of approximately 5-7 USD cents/kWh (for base load gas generation) and a blended cost of generation of 10 USD cents/kWh in 2010, to today's high of 25 USD cents/kWh [16]. Very little of this increase has been passed on to the consumer due to socio-economic pressures. This has greatly affected Jordan's balance of payments, and has forced the kingdom to initiate plans for importing LNG, to fast-track energy efficiency programs, and to focus on RE on a more urgent basis. The price difference between natural gas and fuels is absorbed by the government represented by NEPCO, its accumulated debts touching US\$ 5.2 billion.

As a part of updated Energy Strategy, the temporary law approved by the cabinet under No. 3 for year 2010, The Renewable Energy and Energy Efficiency Law (REEL), and was released in mid 2012 as a permanent law (No. 13 for year 2012) after the parliament approval to define Jordan's plans to introduce renewable energy generation to the local sector. Primary objectives of the REEL include: (i) increasing the contribution of renewable energy to the total energy mix in Jordan; and (ii) promoting and exploiting renewable energy for environmental protection and sustainable development purposes, and (iii) enhance energy efficiency in all sectors of the economy [17]. According to Article 10 of this law, rules and regulations to guide implementation of the REEL were issued by the Ministry of Energy and Mineral Resources (MEMR) and Electricity Regulatory Commission (ERC). The Government of Jordan, with the assistance of donors is currently in the process of further defining gaps in regulations and identifying potential funding sources to enable the development of these assets.

Jordan will face major challenges in trying to meet the growing energy and especially electricity, while, concurrently, developing the energy sector in a way that ensures reducing the adverse impacts on the economy, the environment and social life. Fast depleting fossils fuels and their environmental effects forces to look towards renewable sources for sustainable development. Among all renewable sources, solar, wind and small or mini hydro-power schemes are promising sources for sustainable water and energy development in the country [18]. In this research paper, the prime objectives were concentrated on conducting a comprehensive investigation of the current status of renewable energy (RE) sources and systems in Jordan and develop a matrix of strength (S), weakness (W) as internal issues and opportunities (O) and threats (T) as external factors. It should be stressed that it is not the aim of this study to discuss the design or performance of RE systems or related costs. Rather it is deemed to provide a general picture of the existing situation and specifically the current obstacles preventing the expansion in utilizing commercially available RE sources in Jordan, taking into account the existing legal framework [19-28].

### **Existing Electricity Generation Mix**

Electricity generation in Jordan has greatly increased over the past few decades in response to rapidly rising demand. In 2004, total electricity generation sold by NEPCO, the sector off-taker, to the country's distribution companies and wholesale consumers stood at approximately 8,447 GWh. In 2010, just six

years later, this amount had grown to nearly 14,258.7 GWh, and in 2011, 2012 & 2013 it reached 14,647, 16,595 & 17,261 GWh, respectively [29,30]. Of which combined cycle and steam turbines plants contributed about 55% and 40%, respectively. While electricity produced from renewable sources was less than 0.5%, in years 2011, 2012 & 2013.

Most of the generation plants are located reasonably near to load centers, except the Aqaba Thermal Power Station which is located on the Gulf of Aqaba to benefit from the sea water for cooling purposes. In-land power stations are equipped with dry cooling systems due to lack of surface water supplies in Jordan.

Table 1: Primary Generation Assets as early of 2013

Generation Type	Existing Plants	Primary Fuel	Secondary Fuel	Nominal Capacity	% of Total Capacity
<b>Thermal</b>	Aqaba Thermal	Natural gas	Heavy fuel oil	647	30.1
	Hussein Thermal	Heavy fuel oil	-	366	
<b>Combined Cycle GT</b>	Samra	Natural gas	Diesel oil	562	49.4
	Rehab	Natural gas	Diesel oil	357	
	Amman East (IPP1)	Natural gas	Diesel oil	370	
	Al Qatrana (IPP2)	Natural gas	Diesel oil	373	
<b>Gas Turbine</b>	Al Risha	Natural gas (local)	Diesel oil	150	18.5
	Samra Expansions	Natural gas	Diesel oil	284	
	Marka	Diesel oil	-	80	
	Amman South	Diesel oil	-	60	
	Hussein Thermal	Diesel oil		30	
	Karak	Diesel oil	-	20	
<b>Other (Hydro, wind &amp; biogas)</b>				17	0.5
<b>Industrial (self generation heavy fuel oil and diesel)</b>				50	1.5
<b>Total</b>				<b>3,366</b>	<b>100.0</b>

Table 2 provides information regarding total electricity supplied from 2006 to 2012 by the generation companies, IPP1, and various industrial self-generators, in addition to the amount imported from Egypt and Syria in times of local supply shortage. The compound annual growth rate for the period is 5.8%. CEGCO's power plants are the main supplier with a contribution ratio of about 47%, in 2012, followed by SEPGCO with a sharing ratio of nearly 28% of the total generated power in Jordan.

Table 2: Jordan Annual Electricity Generation and Imports (GWh) [29,30]

Generator	2006	2007	2008	2009	2010	2011	2012	2013
CEGCO	8,966	9,852	8,851	8,009	7,655	8,051	7,789	7,381
SEPGCO	1,660	2,733	3,736	3,629	3,467	3,597	4,594	4,499
AES Jordan (IPP1)			896	2,350	3,287	2,267	1,596	2,640
Qatraneh (IPP2)					53	454	2,352	2,436
Imported from Egypt	472	200	534	363	446	1,458	748	381
Imported from Syria	42	8	13	20	224	280	-	-
Potash Co.	105	96	64		35	11	11	79
Indo-Jordan Chemicals	84	56	59	58	66	66	66	64
King Talal Dam	14	13	15	14	15	13	16	13
Jordan Biogas Company	6	10	9	7	9	8	6	6
Other Large Industries	285	241	208	205	190	180	185	143
Growth Rate (%)	9.4	13.5	8.9	1.9	5.4	6.1	13.6	1.5

In terms of fuels used for power generation in Jordan, which does not enjoy significant natural resources such as oil and gas, and has only a very limited supply of natural gas from the Al-Risha gas field in the north-eastern corner of the country, near the Iraqi border, therefore, it is dependent on imported fossil fuels to meet growing local energy demand in various sectors of the economy, including power generation. Heavy fuel oil was the dominant fuel used in power generation until 2003 [31]. At that time, the Egypt-Jordan Arab Gas Pipeline was completed, and natural gas from Egypt became available to supply main power stations at preferential terms. Natural gas contributed approximately 71.2% of the total electricity generation in 2010, down from 91% in 2009 (see

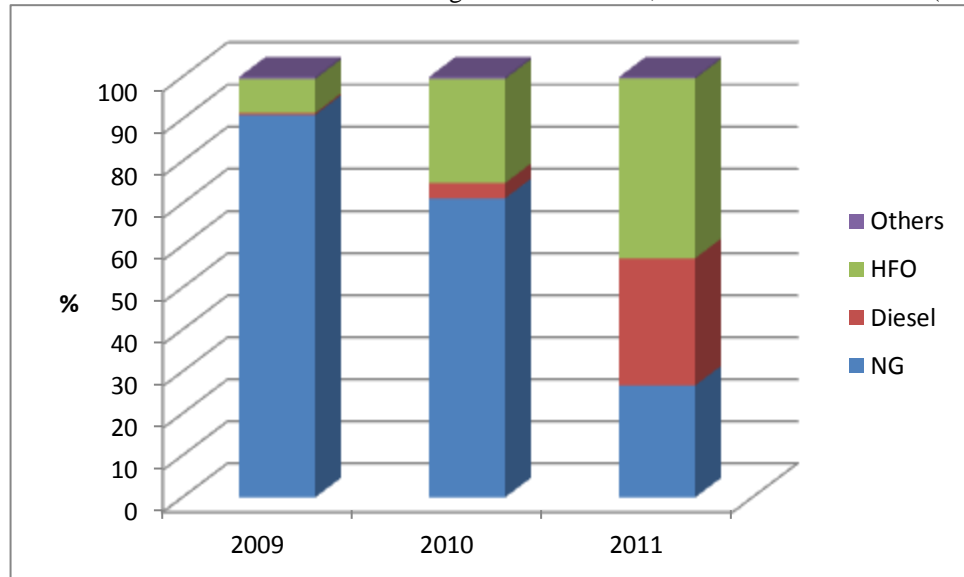
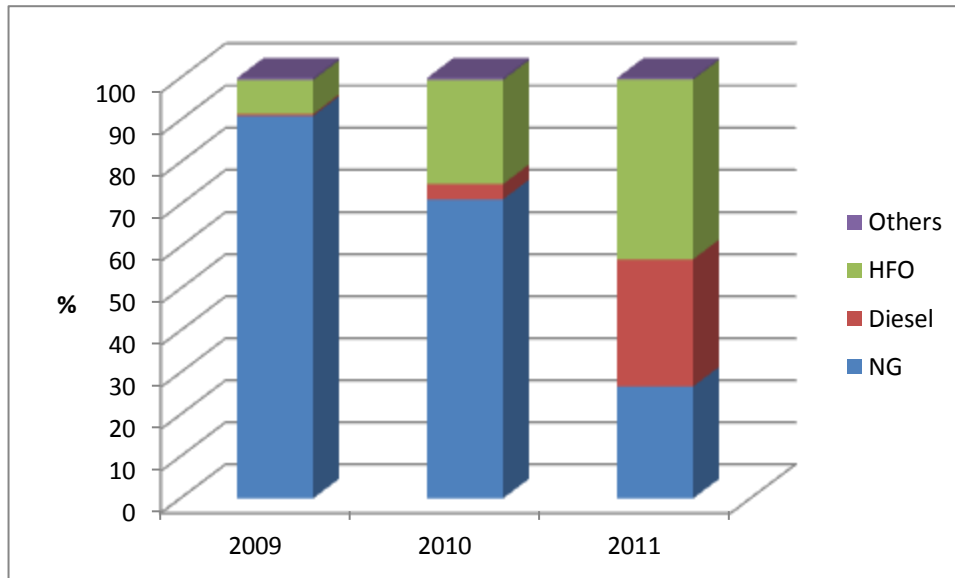


Figure ). In 2011, this ratio was dropped further to reach less than 27%, and 19% in 2012 [32]. The experience from 2009 is not representative for 2010-2013, as heavy fuel oil and diesel contributed to a larger share of the mix during the last years (i.e. in 2011-2012 and continued in 2013) due to increased demand and shortage of natural gas supplies from Egypt. However, the share of HFO is expected to increase due to IPP3 and IPP4 power generation projected which designed to run on HFO or natural gas when available. Finally, a direct combustion oil shale fired power plant of about 458 (2x229) MW will be installed within next 3 years in the Attarat area, about 70 km south of Amman, by Estia Energia (Enefit) using the technology of fluidized bed boiler [30,32].



**Figure 1: % of Fuel Consumption by Type of Fuel of the Total used for Power Generation in Jordan during 2009-2011**

Diesel fuel oil, priced at international market prices, is used mainly to fuel small gas turbine units, which are operated solely to cover electricity demands during peak loads and emergencies. Heavy fuel oil is also used in thermal power plants employing steam units when natural gas supply from Egypt is not sufficient. Electricity harnessed via renewable sources, such as hydro-power, bio-gas and wind, accounted for a negligible percentage of less than 0.5% of the total during the last five years (2009-2013) [33], and will continue in 2014 and most probably 2015, until new solar and wind projects would be implemented and commissioned on BOO basis.

The cost of generation realized by NEPCO varies depending upon the availability of natural gas supply from Egypt. If natural gas is available, then the efficient combined cycle plants are able to generate at less cost than other units. For example, between 2008 and 2009, the cost of generation fell by about 12.5% (from US\$ 0.064/kWh to US\$ 0.056/kWh), largely because Egyptian natural gas was readily available and supplied at concessional prices. In 2010, the cost increased by around 33% to reach US\$ 0.075/kWh due to continued interruptions of gas supplies from Egypt. But in 2011, it jumped to reach about US\$ 16.2/kWh, i.e. more than 213% of that in the previous year and in 2012 it increased further to be more than US\$ 26/kWh as a result of increased fuel prices and shortages of natural gas supplies from Egypt [15]. Consequently, in May 2012, the government decided to increase electricity retail price for all consumers in various sectors of the economy, except residential consumers with average monthly consumption of less than 600 kWh, in an attempt to reduce NEPCO's accumulated losses, which estimated at US\$ 5.2 billion during 2011-2013 [34].

### **Strength, Weakness, Opportunities and Threats (SWOT) Analysis**

SWOT analysis is a strategic planning tool, usually used as part of doing an environmental scan, that help identify internal factors (i.e. strengths and weaknesses) that need to be planned for, and external factors (i.e. opportunities and threats) that need to be planned for in determining where a business should be going in the future. More specifically, the process involves identifying Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T), which is what the acronym SWOT stands for.

The SWOT analysis can be done as part of strategic planning, but it can also be done independently from other processes as standalone. By capitalizing on strengths and eliminating or correcting weaknesses, a company is better able to take advantage of opportunities as they emerge and cope with threats before they become reality.



The four elements of the SWOT analysis as applied to the assessment of any process, company, institution, etc., can be seen the strengths and weaknesses are internal issues, while opportunities and threats are external factors. By investigating and assessing both internal and external factors affecting the performance, a clearer vision of success and failure possibilities is achieved. This vision can be easily translated into objectives and activities thereof to achieve the following:

- Enhance or sustain the points of strengths,
- Delineate or solve the points of weaknesses,
- Capitalize on the points of opportunities, and
- Prepare for the points of threats.

It is well known that several criteria will affect the success of any renewable energy policy. These factors include but not limited to: (i) minimizing cost of generation, (ii) maximizing competition, (iii) meeting and maintaining firm development targets, (iv) maintaining and creation of sustainable purchase market, (v) encouraging diversity, (vi) enhance political support, (vii) develop local industrial infrastructure, (viii) compatibility of electricity sector standards, (ix) regulatory structure, (x) stability of the renewable policies over time, (xi) competitive parity that allows fair spreading of costs over stakeholders, (xii) reduction of industrial barriers that will enable the integration of renewable energy with other electricity sectors, and finally (xiii) the simplicity of the design and administration of the energy policy. The GoJ, represented by MEMR took the 1<sup>st</sup> important step and issued in 2012 a new law under the title “Renewable Energy and Energy Efficiency Law” No. 13 for the year 2012, after the approval of the Parliament. This new law aimed to (i) introduce the needed regulatory framework for RE and EE activities, (ii) encourage private-sector investment, (iii) diversify energy sources in Jordan and (iv) establish a “Renewable Energy and Energy Efficiency Fund”. Such law is considered as the cornerstone for the development of RE projects in the country, i.e. all efforts before the introduction of this law were fragmented and not organized with a legal background especially when it comes to the involvement of the private sector.

The SWOT analysis, in this study, is developed based on such facts, and obtained through a series of face-to-face meetings with all concerned stakeholders from the public, including but not limited to MEMR, NEPCO, CEGCO, EDSCOs, EMC (former ERC), NERC, HCST, etc, as well as the private sector, e.g. RE developers, local banks, independent consultants, and NGOs. The interviews were conducted based on scheduled appointments using a semi-structured questionnaire and personal contacts, taking into account the government plans to increase the contribution of renewable energy in the national energy mix to reach 10% of the total energy consumption in the year 2020. Then deep analysis of notes was conducted in order to group strong points together and same for weakness, opportunities and threats.

### Final Results

Based on the conducted analysis of RE sources and systems in the local market, the following matrix summarizes the SWOT analysis of RE in Jordan.

STRENGTHENS	WEAKNESS
1- Commitment of GoJ to implement RE strategies, targets are national strategy 2- Legal framework is developed 3- Availability of good (solar and wind) resources, while no other fossil fuels commercial resources, yet 4- Infrastructure and industrial base exists in Jordan 5- Location is attractive as regional hub for future connections 6- Jordan enjoys political stability 7- The market is open to private investment 8- Incentives for local and foreign investors 9- Availability of land for RE applications	1- The electrical network needs to be upgraded and converted to be a smart grid 2- Lack of deep technical know how about different RE technologies 3- Feed-in-tariff scheme does not exist and lack of possible financing due to increasing deficit of NEPCO, thus it is impossible to develop a governmental financing scheme to promote RE projects at present. 4- Initial cost of RE projects, i.e. capital investment, is still higher compared to conventional technology 5- Lack of public financing resources 6- Inadequate incentives that may attract



<ul style="list-style-type: none"> <li>10- Existence of human capital stock in academic, professional and engineering fields</li> <li>11- Existence of several engineering graduate programs and master programs</li> <li>12- Research centers and universities are operational and active in RES</li> <li>13- The national electricity grid capacity can absorb significant RE capacity</li> <li>14- Several RE pilot projects are already in place since the 80's</li> <li>15- The licensing procedure is clear and up to international standards</li> <li>16- There is adequate funding for applied research</li> </ul>	<ul style="list-style-type: none"> <li>investors</li> <li>7- Bureaucracy in the implementation of licensing procedure that results in delays and frustration of investors</li> <li>8- Lack of coordination among concerned institutions dealing with approvals and licensing procedure</li> <li>9- Lack of adequately trained and experienced staff at MEMR, ERC and distribution companies</li> <li>10- Jordan is a small market which may prevent the establishment of RE industries</li> <li>11- Some of RE technologies (e.g. CSP) are still not deployed and are still expensive in Jordan</li> <li>12- Lack of professional expertise in technical and economic appraisal of some RE projects (like CSP)</li> <li>13- Lack of professional certification scheme for RE engineers</li> <li>14- Lack of awareness among public and consumers about the importance of supporting RE systems and their economics</li> <li>15- Electricity for households and agriculture is still heavily subsidized</li> <li>16- Results of applied research are not commercialized</li> <li>17- Lack of standards and certification of RE equipment and manufacturers/importers of equipment</li> </ul>
<b>OPPORTUNITIES</b>	<b>THREATS</b>
<ul style="list-style-type: none"> <li>1- Some donors are ready to fund RE projects</li> <li>2- Attractive investment climate</li> <li>3- Jordan is interconnected electrically with Egypt and Syria. Plans are underway to enlarge interconnection with six countries</li> <li>4- Availability of resources which guarantee continuous supply of electricity and other energy forms</li> <li>5- There are RE projects under development</li> <li>6- Expanding utilization and research related to RE in all sectors of the economy including education at different stages</li> <li>7- New jobs for engineers and technicians</li> <li>8- Development of the economy and social aspects of rural areas where most of RE would be located</li> <li>9- Develop commercial and industrial capabilities through cooperation with international specialized companies</li> <li>10- Saving fossil fuels, thereby protecting the environment</li> <li>11- Reduction of the budget deficit as result of reduced imported energy bill</li> <li>12- GoJ enjoys good relation with countries within the region and those manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>1- Lack of awareness and know how about RE technologies</li> <li>2- RES is still perceived as uncertain and risky investment local and foreign investors and by the local banking sector</li> <li>3- The volatile geo-political situation in the region</li> <li>4- Most of funding comes from abroad</li> <li>5- Lack of local financial schemes to RE projects (JREEEF and others)</li> <li>6- The incomplete legal and regulatory framework to promote RE technologies</li> <li>7- Lack of transparency in official procedures starting from application to final approval of RE projects</li> <li>8- Too many governmental institutions concerned with RE approval and licensing (MEMR, ERC, NEPCO, DESCOS, MoEnv, MoF, etc.)</li> <li>9- Weak management of the funding available for RE research projects</li> <li>10- RE systems with energy storage can be costly in Jordan</li> </ul>

Among the most important weaknesses that may hinder efforts in developing renewable energy sources in Jordan are (i) the available financing schemes and (ii) the future price of electricity generated by renewable sources. It is still uncommon, in Jordan, to find banks' that have special financing programs, with reduced service charges, to support RE and EE projects, despite the credit-line (special loan) offered by the French Agency for Development (AFD) through two commercial banks (Investment Bank and Cairo-Amman Bank) allocated to green projects. JREEEF was created by the REEEL as an operating unit within MEMR to contribute to the development of renewable energy and energy efficiency in Jordan. However, it is still not operational, yet. The JREEEF would provide support at each stage of development, from demand for renewable energy and energy efficiency through public awareness and training, to early stages of project preparation, access to credit, cost of financing and access to equity financing.

The GoJ has decided to fix the indicative prices per unit electricity (kWh) produced from different RE technologies as Feed-in-Tariff on annual basis, e.g. for PV systems the price was 0.12 JD/kWh until 31<sup>st</sup> December 2013, then in early 2014 reduced to 0.10 JD/kWh until the end of the year. After this date, it is not clear what would be the government's plan? Such uncertainty about the future price may discourage investors to bid for building RE plants in Jordan. Thus, the GoJ should concentrate its efforts to help investors in RE to have access to soft loans or easy financing mechanisms as well as having a long term plan regarding the unit prices of electricity generated via renewable energy sources. Moreover, other weaknesses and obstacles should be eased and removed soon before developing and implementing a national plan to promote investment in RE and provide needed incentives in order to attract and encourage foreign investors to invest in such projects and ensure the creation of stable and reliable RE market.

### **The Tree Problem**

Since the launch of the first Energy Sector Strategy in 2007, Jordan's vision has been to integrate local renewable sources into its energy mix, with targets of 7% and 10% by 2015 and 2020 respectively. Due to the country's dependence on subsidized and low cost natural gas imported from Egypt, GoJ had failed, as of 2011, to initiate any meaningful progress in renewable energy and energy efficiency despite their obvious strategic importance in providing energy security and establishing the basis for economic development due to the sick economy and lack of financial resources needed to support RE projects as a result of cheap natural gas supplies. However, the nuclear power generation project, despite the lack of support from the parliament, has received significant investment on the false promise of cheap and abundant energy.

Jordan is facing serious challenges in the energy sector with the rising cost of energy supplies into the country. With every challenge comes an opportunity, and that is to become self-sufficient, and reliant on indigenous natural resources. On the other hand, in fact, it is very rich in oil shale and renewable energy resources but, due to lack of investment and foresight, these resources have not been exploited, on commercial scale, yet. Renewable energy resources, in particular solar, can technically provide as much as 60-100 times more than Jordan's electricity consumption in 2050. More important, is that the economics of solar and wind is feasible at present, and with the declining cost structure of these technologies, they will be at and below cost parity with other indigenous fossil fuel based power generation. Economic modeling results show that a target of 100% renewable energy by 2050 can be attained and can lead to total accumulated savings of approximately US\$ 100 billion (or \$15 billion in present value terms), while providing more than 30,000 new jobs [35]. The gradual diversification of Jordan's energy mix, with a gradual phase out of fossil fuels (i.e. imported natural gas and petroleum products), in the short to medium term is a more plausible and practical scenario for Jordan.

As in other developing countries, the GoJ is trying to develop the local RE market, with its economy facing difficulties due to the increasing external debt and costs of imported energy as well as the wars and conflicts in the nearby countries. Main problems that affecting the local RE market at present are summarized in the following Table 3.

Table 3 Main problems affecting the renewable energy market in Jordan

Problems		Objectives	
1	Weak funding of RE projects by local banks and funds	1.1	Establishment and provision of RE funding services by local banks
		1.2	Establish flow of funds from local banks to local and international investors for RE projects
		1.3	Establish business case for RE projects that can generate revenues for local banks
2	Banks do not have mechanisms to evaluate and promote RES projects	2.1	Establish or enhance capacity of local banks to create and commercialize funding schemes for RE projects
3	JREEEF is not active	3.1	Establish an operational public fund for RE and energy efficiency projects
4	Inefficient management of international or regional funds for RE	4.1	Establish a regular pipeline of RE projects that are financed by these funds
		4.2	Establish transparent procedures for the management of these funds
5	The market for ESCOs is not functioning	5.1	Make RE projects attractive for low-income and middle-income class people
		5.2	Facilitate the establishment of ESCOs market
6	Lack of political will	6.1	Elevate the RE policy at the national priority level
7	Lack of professional management of RE affairs	7.1	Create a management system that is based on principles, procedures and rules accepted by the RE market
8	Engineering and technical skills and capacities are not adequate to match the needs in RES	8.1	Enhance the quality and quantity of qualified local engineers and technicians on RE technologies
9	Ineffective implementation of regulations deter investments in RE projects	9.1	Incentivize or enforce the proper and adequate implementation of regulations by distribution companies
		9.2	Ensure that net metering RE projects will be installed in due time and operate without problems
10	Lengthy duration of the procedures to approve FiT RES projects	10.1	Streamline the procedures for the approval of FiT RES projects
		10.2	Enhance the capacities of the units which are responsible for the implementation of the approval procedures
11	Lengthy duration of the procedures to approve RE NM projects	11.1	Streamline the procedures for the approval of NM RES projects

		11.2	Enhance the capacities of the units which are responsible for the implementation of the approval procedures
12	No certification testing of equipment for RES systems	12.1	Establish, man and equip official testing and certification entities
		12.2	Allow only tested and certified equipment to enter the Jordanian market
		12.3	Develop reliable repair services for the RE equipment
13	No certification of local installers and manufacturers	13.1	Enhance the credibility and the quality of the RE services (installation, maintenance) in the Jordanian market
14	NM RE projects for households (with consumption <500kWh/month) and the agricultural sector are not feasible	14.1	Make RE projects feasible and attractive for middle- and low-income consumers
		14.2	Make RE projects feasible and attractive for farmers
15	Quality assurance of RE projects does not exist	15.1	Establish credible monitoring services for RE projects
		15.2	Create the expertise in the Jordanian market for quality assurance services
16	Applied research results are not utilized in the market	16.1	Create research projects with a strong exploitation activities and business plans for the results
		16.2	Crease or reinforce business incubators in RE
		16.3	Finance large research projects that results in RE pilot technologies installations
		16.4	Strengthen the industrial uptake of research results
17	Small scale organic biomass is not used for energy generation	17.1	Alleviate the environmental pollution and land use problems caused by landfills
		17.2	Promote the use of wastes as a source of energy in the RE technology market
		17.3	Raise awareness on RE technologies that utilize wastes
		17.4	Demonstrate the feasibility and usability of RE waste-to-energy technologies
18	Inadequate use of biomass in industry, agriculture and stockbreeding	18.1	Establish biomass supply chains
		18.2	Strengthen the know-how of industry, farmers and stock-farmers associations
19	University curricula and vocational training do not adequately cover RE technologies	19.1	Enhance the capacities of technicians in the market

		19.2	Create interest in RE technologies for the young people
20	Serious fiscal problem of NEPCO budget	20.1	Provide an enabling and reassuring business environment to investors
21	Concentration of large RE projects in the South will create a transmission problem	21.1	Utilize the free land areas in the Central and North regions for RE projects
22	Lack of plans to introduce smart grid functionality	22.1	Improve the grid to integrate intermittent renewable resources
		22.2	Reduce the grid losses and emissions
		22.3	Avoid grid congestions
		22.4	Improve safety, reliability and efficiency of the grid utilization
		22.5	Create new market opportunities for distributed generation and storage
		22.6	Promote smart electricity metering
		22.7	Reduce use of inefficient generation to meet system peaks
		22.8	Eliminating or deferring large capital investments in centralized generating plants, substations, and transmission and distribution lines

As can be seen that the existing problems related to RE market in Jordan could be grouped into four main clusters as follows:

1. Lack of incentives and financial resources to support RE projects.
2. Lack of know-how of RE technologies and inefficient management of RE affairs.
3. Lack of political will and inefficient implementation of RE regulations.
4. Lack of applied research and inadequate study and training curricula related to RE sources and technologies.

To sum up, and to overcome the above listed problems, the GoJ through the concerned ministries and public institutions should be committed to a non-reversible path and vision for renewable targets, and does so by adopting the following key principles:

1. A commitment to a phased approach involving an investment program that exploits the cost and technical potential of each RE technology option.
2. Removal of obstacles and facilitation of on-going projects as a matter of urgency and concomitant strengthening of public institutions.
3. Developing a national RE master plan with stakeholder buy-in engaging with the rural communities as a key cornerstone of the renewable energy program.
4. Picking the lowest hanging fruit with the immediate launch of projects that eat away at the peak demand, including distributed energy projects that can yield immediate employment opportunities.
5. Encouraging technological innovation.

Without the development of local energy sources, including renewable energy and oil shale, Jordan will remain net importer of fossil fuels to meet its growing energy demand which may double the current consumption in 2020 [36-38].

## Conclusions

Jordan is facing major challenges in trying to meet the growing energy and especially electricity, while, concurrently, developing the energy sector in a way that ensures reducing the adverse impacts on the

economy, the environment and social life. Fast depleting fossils fuels and their environmental effects forces to look towards renewable sources for sustainable development. Among all renewable sources, solar, wind and small or mini hydro-power schemes are promising sources for sustainable water and energy development in the country. The major legal obstacles were removed by introducing the Renewable Energy and Energy Efficiency Law, related rules and regulations to guide implementation of the RE projects in Jordan. Consequently, the local market is opened for exploiting renewable energy sources for various applications in different sectors of the economy.

According to the conducted SWOT analysis of the RE market in Jordan, there are good opportunities and potential which needs to be further developed. But on the hand there are serious weakness and threats that still exists which should be strengthened or removed in order to ensure efficient utilization of RE systems. Among the most important weaknesses that may hinder efforts in developing renewable energy sources in Jordan are available financing schemes and future prices of electricity generated by renewable sources. It is still uncommon, in Jordan, to find commercial banks' that have special financing programs, with reduced service charges, to support RE and EE projects. Furthermore, JREEEF was created, by the REEEL, as an operating unit within MEMR to contribute to the development of renewable energy and energy efficiency in Jordan. However, it is still not operational, yet. The JREEEF would provide support at each stage of development, from demand for renewable energy and energy efficiency through public awareness and training, to early stages of project preparation, access to credit, cost of financing and access to equity financing. Also the indicative prices per unit electricity produced from different RE technologies, as Feed-in-Tariff, are not fixed for one year and it is not clear what would be the government's plan for the next year. Such uncertainty about the future price may discourage investors to bid for building RE plants in Jordan. Thus, the GoJ should concentrate its efforts to help investors in RE to have access to soft loans or easy financing mechanisms as well as having a long term plan regarding the unit prices of electricity generated via renewable energy sources and the gradual removal of all existing obstacles as shown in the SWOT matrix. The current analysis could be applied to other neighboring countries as first step to promote the utilization of RE systems.

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