



Middle East North Africa Sustainable ELECTricity Trajectories

Energy Pathways for Sustainable Development in the MENA Region

Background Paper: Country Fact Sheet, Jordan

Energy and Development at a Glance, 2017

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**BACKGROUND PAPER JORDAN \ KOMENDANTOVA, N., IRSHAID, J., MARASHDEH, L., AL-SALAYMEH, A.,
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The International Institute for Applied Systems Analysis (IIASA) is a non-governmental research organization supported by national academies of sciences from several countries in Africa, Asia, Europe, North and South America. IIASA conducts interdisciplinary scientific studies on environmental, economic, technological, and social issues in the context of human dimensions of global change.

The long-term aim of the IIASA Risk and Resilience (RISK) program is to conduct conceptual and applied analysis that contributes to decreasing the risk and vulnerability of societies and ecosystems and promoting their adaptation and resilience to stresses imposed or aggravated by global change phenomena. The RISK program has extensive experience in modeling, stakeholder interviews, participatory processes, and conflict resolution in many different risk contexts, most recently with respect to public resistance to energy transmission lines. RISK staff have pioneered stakeholder approaches based on the theory of multiple perspectives (also known as cultural theory).

The Governance in Transition Group within the RISK program is working with policy makers worldwide to find solutions to global and universal problems through applied systems analysis in order to improve human well-being in a variety of respects. The group has many years' experience of how governance structures shape policy outcomes, having contributed to research on decision-making processes, public acceptance, risk perception, cognitive biases and cultural perspectives, as well as participatory governance design.

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SUMMARY

Jordan is experiencing steady economic growth, which is leading to improved living standards and a higher degree of urbanization. The country's economic growth is linked to i) ongoing tendencies, such as increased population due to immigration and climate change impacts on, for instance, scarce water resources; and ii) growing energy demand, especially for electricity. Electricity, a necessary precondition for economic growth, is required for industrial development and transportation and for electricity-intensive technologies such as cooling and water desalination. Jordanian economic growth is also coupled with fossil fuel consumption, with the biggest share of the country's electricity supply coming from imported fossil fuels. Because of the unstable political situation in the Middle East and North Africa (MENA) region and the volatility of energy prices, Jordan's reliance on energy imports is threatening its security of supply.

The Jordanian government is seeking alternatives to imported energy. Renewable energy sources are a high priority, with the government having set the target of reaching 10% of renewable energies in the final energy mix by 2020. While there are several strategies and action plans on how to reach this target, other options such as nuclear, natural gas, and exploration of offshore gas fields are also currently under discussion. Nuclear energy, for instance, could constitute 6% of the overall energy mix by 2020. Jordan has favorable conditions for renewable energies such as wind and solar. Even though the share of renewable energies is not currently significant, this could soon change, given that several projects for deployment of renewable energies are currently in the planning or implementation phases. The goal of this background report is to understand the socioeconomic and political context of the ongoing energy transition in Jordan. The background report is organized around the following questions:

- What are the current socioeconomic challenges in Jordan?
- What are the political background and framework conditions for participatory governance?
- What is the energy context, including current supply and demand and the state of electricity transmission grids?
- What is the institutional and regulatory structure of energy policy in Jordan?

Addressing these questions is essential for understanding the feasibility of each of the nine technologies discussed in the MENA-SELECT project, including fossil fuels, nuclear, and renewables. It is also essential for understanding the human factors of the energy transition, such as the different views of the main stakeholder groups involved in the energy policy process.

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ABBREVIATIONS AND ACROCNYMS

CEGCO	Central Electricity Generating Company
COD	Commercial operations date
EDCO	Electricity Distribution Company
EMRC	Energy & Minerals Regulatory Commission
EPA	Environmental Protection Act Law
EPC	Executive Privatisation Commission
ERC	The Electricity Regulatory Commission
FAO	Food and Agriculture Organization of the United Nations
GCC	Gulf Co-operation Council
GOJ	Government of Jordan
GTZ	German Organisation for Technical Cooperation
IDECO	Irbid District Electricity Company
IRENA	International Renewable Energy Agency
ILO	International Labour Organization
JEA	Jordan Electricity Authority
JEPCO	Jordan Electric Power Company
JUST	Jordan University of Science and Technology
MDGs	Millennium Development Goals
MEMR	Ministry of Energy and Mineral Resources
MOE	Ministry of Environment
MOF	Ministry of Finance
MVA	Mega Volt Amp
MWI	Ministry of Water and Irrigation
MOPIC	Ministry of Planning and international Cooperation
NCHR	National Center for Human Rights
NEP	National Executive Programs
NEPCO	National Electric Power Company
NERC	National Energy Research Center

OECD	Organization for Economic Co-operation and Development
PM	Particulate matter
REEL	Renewable Energy and Efficiency Law
SEPCO	Samra Electric Power Company
SFP	Sahara Forest Project
UNDG	United Nations Development Group
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNRC	Office of the United Nations Resident Coordinator
WHO	World Health Organization

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1 SOCIOECONOMIC, POLITICAL, AND ENVIRONMENTAL BACKGROUND AND CHALLENGES

1.1 Socioeconomic background

Jordan is classified by the World Bank (2011) as an upper middle-income country. It is currently facing several economic challenges and vulnerabilities, which are closely linked to the socio-political situation in the Middle East and North African (MENA) region. Within MENA, Jordan is considered as the fifth freest economy (IBP, 2013). It also ranks 35th among countries with the best infrastructures in the world, according to the World Economic Forum (IBP, 2013). The Jordanian banking sector is classified as “highly developed” and the AOF Index of Globalization ranked the country as the most globalized in the MENA region (IBP, 2013).

Since the 1990s Jordan has seen improvements in both economic and social development terms. These are credited to key reforms such as i) privatization, ii) budget and financial sector reforms and integration into the international economy through accession to the World Trade Organization, iii) the ratification of a free trade agreement with the United States in 2002, and iv) its association agreement with the European Union in 2002 (OECD, 2013). Jordanian GDP has been growing by 3% per annum for the last two years. Current purchasing power parity (PPP), which predicts the cost of living, is US\$82.73 billion; GDP is currently US\$37.62 billion (CIA, 2016), compared with US\$26.4 billion in 2010 (IRENA, 2012). Figure 1 shows a breakdown of GDP by economic activity in Jordan. Government services and the finance sector make up the largest percentage of the GDP, and agriculture and mining the smallest.

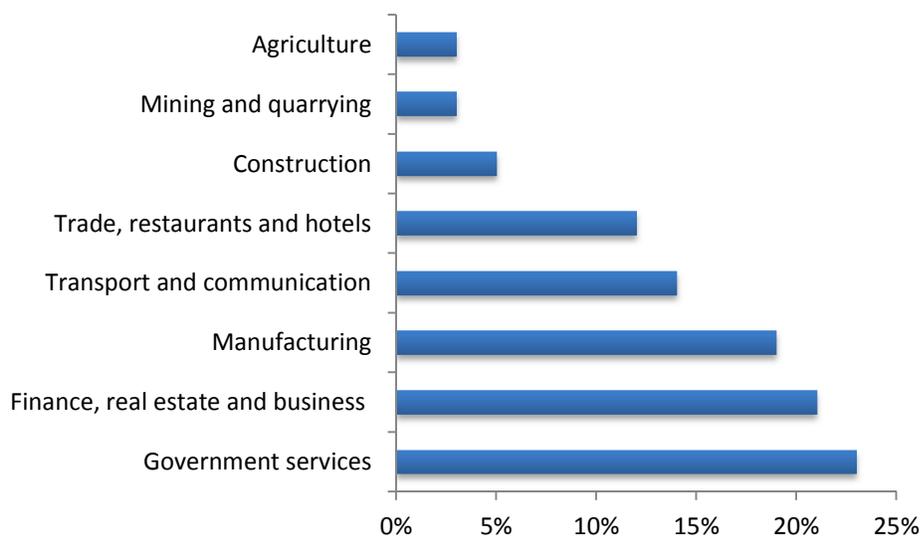


Figure 1: Breakdown (rounded) of Jordan's GDP by economic activity in percentages.

Source: Barakat et al. (2015).

The Jordanian Human Development Index (HDI) stands at 0.748, which is slightly above the average of countries in the Arab region (0.686) and above the average of countries in the high human development group (0.74) (UNDP, 2015). In 2010 the Inequality Adjusted HDI (IHDI) was introduced, which discounted average HDI values according to inequality levels. When adjusted for inequality, Jordan's HDI (0.748) is reduced to 0.625, that is, by 16.5% (UNDP, 2015) compared with the average HDI reduction for inequality in the MENA region of 25.4% (UNDP, 2015).

According to the GINI coefficient, income inequality in Jordan is considerably lower than in countries such as the United Kingdom or United States. In 2010 the Jordanian GINI coefficient was 33.7%, which is similar to that of several countries of the Organisation for Economic Co-operation and Development (OECD) (UNDP et al., 2015). In terms of income inequality, differences among governorates (Jordanian administrative divisions) account for 8% of inequality, while urban/rural divides have little effect. Services such as sanitation, road network, and digital connectivity, however, are shown to be less equally distributed among income quintiles (UNDP et al., 2015b).

According to the Bertelsmann Foundation, Jordan is one of the few countries in the MENA region to have improved its transformation management during the past few years. The country's current Bertelsmann Index for transformation management is 4.7 and the state of the market economy in Jordan is ranked 6.1, which indicates a

market economy with functional flaws¹ (BTI, 2016). The improvement in the country's transformation management index can be explained by the positive influence of the Israeli–Palestinian agreement on the usage of water from the Jordan River and an increase in the deployed capacities of renewable energy sources (BTI, 2016).

Despite positive overall socioeconomic development, Jordan is still facing a number of challenges such as government debts, existing fossil fuel subsidies and their impacts, a low level of foreign direct investment, population growth and immigration, and unemployment. The country is also strongly dependent on energy imports; the tensions in the region in recent years, such as local conflicts and regional migration, especially in the neighboring countries of Iraq and Syria, are also affecting the country's economic and political landscape (UNDP, 2015). According to a global study by the World Economic Forum (2015), the five most problematic factors for doing business in Jordan are lack of competitiveness and efficiency, low level of foreign direct investment (FDI), government debts, and the trade deficit.²

\ **Lack of competitiveness:** According to the Global Competitiveness Index Rankings of 2015, Jordan, as an “efficiency-driven economy,” currently ranks 64th worldwide with a score of 4.23 (World Economic Forum, 2015). This score represents neither an improvement over previous assessments nor a decline. It captures several fundamental aspects of the country's economy such as commodity prices, currency strength, and geopolitical uncertainty, all of which are emphasized by the World Economic Forum and need to be taken into consideration when interpreting the score.

\ **Lack of efficiency:** Jordan ranks 75th on the Basic Requirements Index score with an overall rating of 4.48. This Index is based on four pillars: institutions, infrastructure, the macroeconomic environment, and health and primary education (World Economic Forum, 2015). The country ranks 67th with an overall rating of 4.09 in the Efficiency Enhancers Index, which takes into account the following pillars: higher education and training, goods market efficiency, labor market efficiency, financial market development, technical readiness, and market size (World Economic Forum, 2015). With respect to business, Jordan ranks 40th with a score of 3.99 in the Innovation and Sophistication Factors Index (World Economic Forum, 2015). Overall, Jordan ranks highest in the Levant although it lags behind other Arab countries such as Qatar, United Arab Emirates

¹ According to the Bertelsmann Transformation Index, market economies with functional flaws lie between functioning market economies and poorly functioning market economies. While these market economies are flawed, they are nevertheless functioning.

² This country study is based on a survey distributed in the country where respondents ranked the problematic on a scale from 1 to 5.

(UAE), Saudi Arabia, and Bahrain. According to the World Economic Forum (2015) the region is marked by fragility and vulnerability. The Forum's report emphasizes the need for improved employment opportunities particularly for youth, economic diversification, and the development of a stronger private sector.

- \ **Government debts:** The country's net savings have been in steep decline since 2009 (see Figure 2) (World Bank, 2014). Between 2005 and 2012, adjusted net savings, which takes into account investments in human capital, depreciation of fixed capital, depletion of natural resources, and damages caused by pollution, fell below zero to -0.7 of Gross National Income (GNI) (World Bank, 2014).

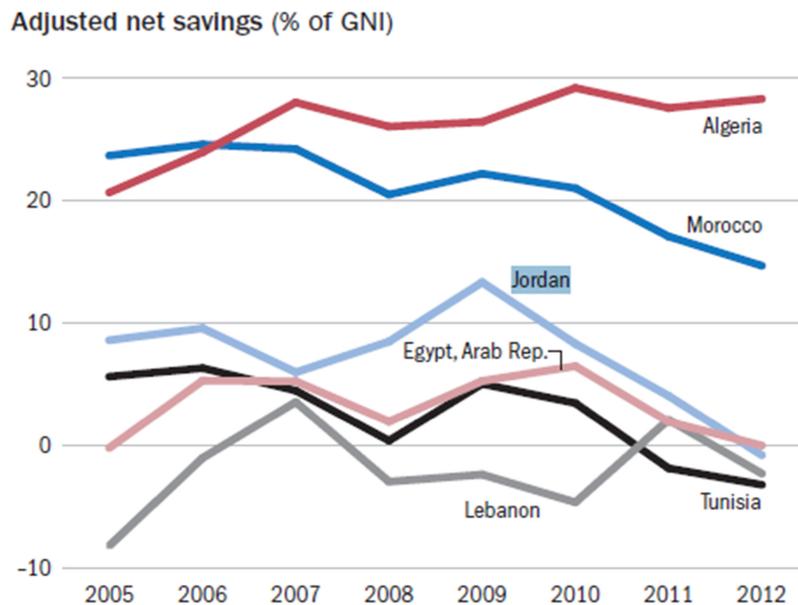


Figure 2: Adjusted net savings 2005–2012.

Source: World Bank (2014).

In 2008 Jordanian government debt constituted 60.24% of Gross Domestic Product (GDP) (see Figure 3): the lowest level since reporting started in 1990 (Trading Economics, 2016a). Since 2008, the debt has increased because of the global economic crisis, political unrest in the MENA region, and an increase in commodity prices (World Bank, 2013).

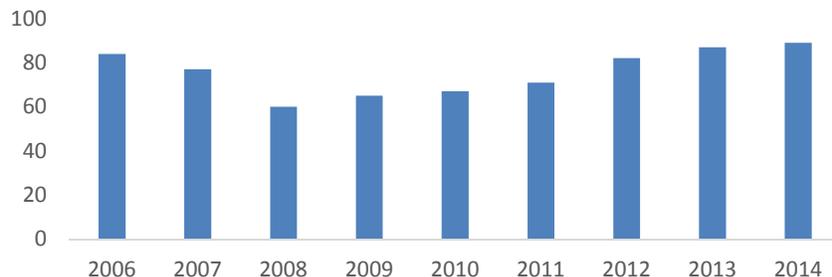


Figure 3: Dynamics of the Jordanian government debt to GDP (2006-2014).

Source: Trading Economics (2016a).

- \ **Fossil fuel subsidies:** The increase in government debt was mainly due to the country's energy security policy. Prior to the Arab Spring, Jordan relied almost entirely on natural gas imports from Egypt, but during the Arab Spring these imports were disrupted. To satisfy its energy needs, Jordan was forced to switch to petroleum imports, a more expensive energy source. So as not to pass on the high increase in fuel prices to the population, additional subsidies were put into place, which resulted in an increase in government debt (Atamanov et al., 2015). In 2012 energy subsidies accounted for 8.8% of government expenditures. The fiscal crisis, increasing debt and inflation, and the substantial decrease in bank deposits and available public sector funds, forced the government to remove petroleum subsidies in 2012, which resulted in a 23% increase in heating costs and a 14.6% increase in transportation costs, as well as persistent inflation (World Bank, 2013). Recently, new subsidies were introduced, which aim to help low-income households cover their energy bills (Atamanov et al., 2015).
- \ **Trade:** Jordan's trade deficit has been steadily increasing, with recent figures showing an overall deficit of approximately US\$14,355 million. Historical data show that while export expenditures remained more or less stable from 2006 to 2014, imports have doubled. The sudden increase occurred in 2013. While in 2012, import expenditures accounted for approximately US\$106 billion, in 2013 they reached US\$215 billion (World Integrated Trade Solution, 2016). Figure 4 shows the Jordanian trade deficit in recent years.
- \ **Decline in foreign direct investment:** Following the economic reforms in the late 1990s mentioned above, foreign direct investment (FDI) increased significantly, especially from the Gulf countries (OECD, 2013). Compared to the early 1990s, FDI grew from 0.2% to 10% of GDP from 2000 to 2011 (OECD, 2013). In 2012 FDI accounted for US\$1,497 million (World Bank, 2014). However, as a result of increasing government debt and economic insecurity, as well as unrest and economic decline in the Gulf States, FDI dropped significantly, as seen in Figure 4

(OECD, 2013; UNDP, 2015). According to *Trade Economics*, FDI in Jordan dropped from an approximate 1,800 million JOD to approximately 250 million JOD from 2010 to 2015.³



Figure 4: FDI in Jordan in the time period from 2010 to 2015 in JD million.

Source: *Trading Economics* (2016).

- \ **Absorptive capacity:** Absorptive capacity and FDI are closely related especially in the Arab countries where financial sectors are largely bank-based (Krogstrup & Matar, 2005). According to Hermes & Lensink (2003), for the potential technology diffusion of the FDI to be absorbed, the domestic credit provided by the banking system should exceed 12% of GDP. A 2005 study finds Jordan, for example, needing to increase its stock market capitalization to potentially benefit from FDI (Krogstrup & Matar, 2005). As of 2008 research and development activities in Jordan made up 0.4% of the country's GDP (Knoema, 2016). These figures are in line with the World Economic Forum's (2015) assessment of Jordan as an "efficiency driven economy" as opposed to an "innovation driven economy."
- \ **Population growth and migration:** The Jordanian population has increased significantly since 2011 to 9.523 million, which is much higher than was projected by official Jordanian statistics in 2010. This increase was mainly due to the large number of refugees and immigrants. Approximately 1.265 million Syrian refugees, 636,270 Egyptian immigrants, and 634,182 Palestinians who do not hold a Jordanian national ID number currently live in Jordan. More immigrants and refugees came from other neighboring countries such as Iraq, Yemen, and Libya (Department of Statistics, Jordan, 2015). Until now, there has been no consensus about the short- and long-term economic impacts of this

³ Using January 2015 exchange rates, the FDI dropped from approximately US\$2,538 million in 2010 to US\$352 million in 2015.

immigration (Carrion, 2015). Some Jordanian communities hosting refugees benefited from inflows of international aid. However, the refugee inflow itself also resulted in rent increases and increased pressure on public services (Carrion, 2015). As Jordanian law does not allow refugees to work either in the public or the formal private sector (World Bank, 2013), many refugees work in the informal labor market (Carrion, 2015). Given the current situation in Iraq and Syria, it is highly uncertain if or when refugees will be able to return to their homelands. The government will thus need to find a long-term sustainable strategy for hosting refugee communities.

\ **Unemployment:** The public services and defense sectors are the largest employer in Jordan, employing 256,000 people in 2009 (see Figure 5) (ILO, 2012). Tourism is the biggest private formal-sector employer (UNEP, 2011). The informal sector is also an important employer and accounts for 44% of all those employed in Jordan (Gatti et al., 2011). Since 2011, however, Jordanian informal workers have been competing with Syrian refugees for informal employment (World Bank, 2013). The unemployment rate in Jordan is 12–14% (ILO, 2016) and the majority (61%) of unemployed are women with education at secondary or lower level (Manar Project Database, 2009). While 53% of unemployed in Jordan hold less than a secondary education diploma, the women seeing employment tend to have a higher level of education (Guegnard et al., 2005).

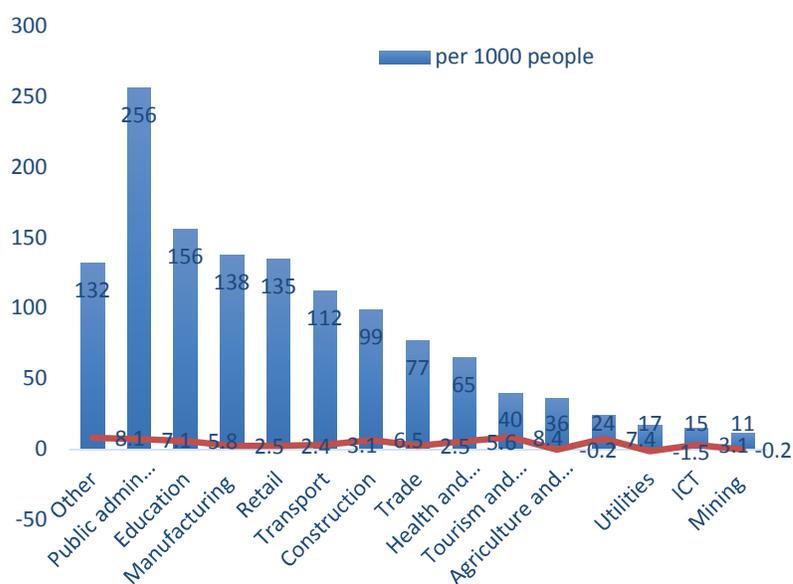


Figure 5: Employment in Jordan by sectors in 2009.

Source: International Finance Corporation and Islamic Development Bank (2011).

1.2 Political background

Jordan is located in the northern part of the Arabian Peninsula in West Asia, bordering on Syria, Iraq, Saudi Arabia, and Palestine. The country consists of 12 governorates or administrative divisions and Amman is its capital. The official name of the country is the Hashemite Kingdom of Jordan. The country also understands itself as an Arab Muslim country (Government of Jordan, 2016).

Jordan is a hereditary constitutional monarchy with a representative government. The monarch, currently King Abdullah II, is the head of state, chief executive, and the commander-in-chief of the armed forces. The Jordanian constitution was adopted in 1947 and ratified in 1952 (Government of Jordan, 2016) and has been amended numerous times. The most recent amendment in August 2016 grants the monarch authority to choose high-ranking military and security officers (Al-Jazeera, 2016). In accordance with the constitution, the monarch appoints and dismisses governments and may suspend parliament (Freedom House, 2012).

The government itself consists of the prime minister, the cabinet, and the house of deputies. While the prime minister and the cabinet are appointed by the monarch himself, the house of deputies is the only entity elected by the Jordanian citizens (European Forum for Democracy and Solidarity/EFDS, 2014). It is worth mentioning that the monarch is not obliged under the constitution to appoint a prime minister or to form a government (EFDS, 2014). The monarch's veto can be overruled only by two-thirds of votes in the parliament.

Jordanian society is strongly based on its tribal roots, although in modern times and especially urban centers, tribal traditions have weakened. However, in rural and non-urban areas, tribal communities are still present and shape the country's cultural landscape (Ecoconsult, 2011). According to the most recent Freedom House report on Jordan (2012), up to two-thirds of the national population claims to be of Palestinian origin. Armenian and Circassian minorities each make up around 1% of the population (CIA, 2016). The majority of the population (97.2%) are Sunni Muslims, while 2.2% are Christian, mainly Greek Orthodox (CIA, 2016). Other religions such as Buddhism, Hinduism, and Judaism are also represented in small fractions (CIA, 2016).

In recent years, especially since the Arab Spring, Jordan has taken several steps to deal with the country's internal socio-political challenges. While Jordan has significantly improved its status in many aspects on the regional and global spectrum, some challenges, such as gender equality and exclusion, are yet to see significant improvements.

\ **Decentralization:** The decentralization of the Government of Jordan was initiated by His Majesty, King Abdullah, in 2005 with the goal of developing

bottom-up rather than top-down processes (SOFRECO, 2010). On 23 August 2015 the Jordanian parliament passed a decentralization law to delegate more power to local governments and councils (EFDS, 2015). The law stipulates that local, or governorate, councils are to be elected directly by the citizens. Women's rights activists have, however, voiced their disappointment over the removal of the 15% quota for women on a governorate council (Freedom House, 2015).

- \ **Participation of civil society:** While economic reforms have greatly improved Jordan's economic development, political reforms have lagged behind (Jarrah, 2009). According to that author, the strengthening of the party system, parliamentary mechanisms, and civil society organizations is needed. However, the political landscape in Jordan rapidly changed during the Arab Spring, which saw over five thousand protests and demonstrations taking place (Shteiwi, 2013). Subsequently, civil society organizations played a vital part in the political reform process of 2011–2012 (Shteiwi, 2013).
- \ **Transparency:** Jordan, in comparison to its neighbors, is one of the least corrupt countries in the MENA region (Transparency International, 2016). Transparency in Jordan, alongside Saudi Arabia and Kuwait, significantly improved over the last year. While in 2012 Jordan's Corruption Perception Index was 48, it has now increased to 53⁴ (Transparency International, 2016).
- \ **Freedom of speech:** In Jordan, freedom of speech is limited by acts which are regarded as crimes, such as insulting the monarch, slandering the government and other foreign leaders, "stirring sectarian strife or sedition" and offending religious beliefs (Human Rights Watch, 2015).
- \ **Good governance and social justice:** Political reforms, such as the creation of an independent election commission and a National Integrity Strategy aimed at, among others, fighting corruption and increasing transparency aim to improve governance and democratic accountability in Jordan (USAID, 2016). However, much room for improvement can be observed in areas such as the political participation of young leaders and women, freedom of speech, and women's rights (USAID, 2016). One effort to improve governance in Jordan, set forth in the UN Anti-corruption Convention ratified by Jordan in 2005, was the establishment of the Jordan Transparency Centre (JTC). In 2014 the JTC conducted a Corruption Perceptions Index study based on guidelines provided by Transparency International. Seven reasons for corruption in Jordan were identified. These included structural flaws such as the lack of financial and administrative independence of anti-corruption entities and other institutions; a lack of

⁴ These scores indicate the perceived level of corruption within the public sector on a scale from 0, meaning highly corrupted, to 100, meaning very clean.

competency, capacity, and necessary governance standards; restricted access to information and weak regulatory legislation to prosecute corruption (World Bank, 2014). Other reasons are more socially rooted such as the unofficial immunity that public officials appear to enjoy (World Bank, 2014).

- \ **Exclusion:** Despite an overwhelming part of the population being of Palestinian origin, Palestinians are generally underrepresented in the government and public offices. For example, Palestinian-dominated urban districts have been disadvantaged in terms of getting parliamentary seats based on the national election votes (Freedom House, 2012). The kinship links, or *'asha'iriyya*, within Jordanian society further differentiate between tribal and non-tribal Jordanians; between “West Bankers” and “East Bankers,” and between urban and rural dwellers (Watkins, 2014). These divides in the national identity have the potential to fuel disputes between groups (Watkins, 2014). The parliamentary quotas also set limits for religious and national minorities. Another example is the military, where religious minorities, specifically Christians, occupy 4% of upper-level positions while all senior command positions are held by Muslims (Abu-Nimer et al., 2007).
- \ **Gender bias:** Women’s economic participation in Jordan is significantly lower than that of their male counterparts, despite the fact that more women (51.9%) have a higher education than men (49.1%) (UNDP, 2012a). The United Nations Development Programme (UNDP) ranks Jordan as the second-lowest country worldwide in the HDI Gender Empowerment Measure (UNDP, 2016). Nevertheless, Jordan has seen some improvements in recent years such as the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), which passed into Jordanian law in 2007. The Convention, however, restricts a woman’s legal capacity to pass on her nationality to her children and spouse (UNDP, 2012). The Personal Status Law No. 36 of 2010 states that women are to remain under guardianship until the age of 30 while men remain under guardianship until 18. This law gives the guardian the right to manage a woman’s education and place of residence (Gender Index, 2016). The legal age of marriage for women is 18.

1.3 Environmental background

Jordan’s overall country area is currently 89,206 km², at least 79.6% of which is currently desert, while the remaining area is at threat of desertification in the future (Abahussain et al., 2002). The country’s climate is predominantly Mediterranean with the wet season typically lasting from October to March (JNEECC, 2010). The territory of Jordan is divided into desert plateau in the east and highland areas in the west. The Great Rift Valley separates the eastern and western banks of the Jordan

River, with 88% of the entire Jordanian population living in the valley (CIA, 2016; JNEECC, 2010).

Since 2011 the Jordanian population has constantly been increasing. In addition to the economic and political challenges, a rising population has accelerated the rate of urbanization (3.7%), with 83.7% of the country's population now living in urban centres (CIA, 2016). The changing lifestyle puts additional stress on already limited land and water resources (Abahussain et al., 2002).

Agricultural land makes up only 11.4% of the total country area. This area can be further segmented into arable land (2%), permanent crops (1%), and permanent pastures (8.4%) (CIA, 2016). Agriculture is closely related to the country's water scarcity and land degradation. While agriculture accounts for only 3% of the country's GDP, irrigation, which is essential for the agricultural sector in this semi-arid country, currently accounts for 64% of Jordan's water usage, calling into question the economic benefit of such high water use (MIW, 2009). Although 400,000 hectares would be suitable for dry farming, only half is utilized because of the uncertainties and risks of erratic rainfall. Today 80% of the country's food security relies on virtual water imports (Water Resource Group, 2012). The National Water Strategy aims to increase water efficiency by 2020 through incentives such as higher economic returns for efficiently irrigated agricultural products; however, because of existing uncertainties, it does not foresee switching to dry farming (MWI, 2009). At this point, it is crucial to point out that public spending on the environment in Jordan is less than 0.5% of the government budget (UNDP, 2012b)

In 2015 the energy sector water need in Jordan was 14 million m³. Taking into consideration projected growth and development, the estimated water demand will be 150 million m³ by 2030 (Water Resource Group, 2012). The Jordanian energy sector could significantly decrease its water consumption by integrating solar and wind energy options (Water Resource Group, 2012). Currently, in terms of water consumption, the fossil fuel-dependent energy sector in the MENA region consumes 0.05 billion m³/year for coal, 0.4 billion m³/year for oil, and 0.8 billion m³/year for natural gas (Damerou et al., 2015). Energy technologies such as wind power and PV consume little to no water during energy production (IRENA, 2015). Concentrated solar power (CSP), however, consumes a maximum of around 0.008 to 3.7 m³ per MWh of energy produced (Mielke et al., 2010; Nuclear Energy Institute, 2013). This variation depends on the CSP technology, that is, whether recirculating cooling systems or air cooling systems are used (Mielke et al., 2010). Nuclear power plants, depending on the cooling technology applied, use approximately 1.5 to 2.7 m³ per MWh of energy produced (Nuclear Energy Institute, 2013).

Jordan is among the 18 countries in the world with the highest risk of water insecurity and the fourth water-poorest country in the world with an annual 150m³

availability per capita per annum (JNEECC, 2010). Jordan has 12 groundwater basins and 15 surface water basins. The annual renewable water resources are 940m³: in comparison, Germany has 154km³ (CIA, 2016). Nevertheless, despite the scarcity, the availability and coverage of water services is nearly universal and indiscriminate of place of residence or income (UNDP, 2015). However, up to 51% of the country's water is wasted due to the inefficient use of water resources (UNEP, 2011) such as illegal wells, which exploit groundwater twice as fast as it is recharged (MWI, 2009). Most water resources in Jordan are used for irrigation and drinking water (MWI, 2013). While domestic water use accounted for 380.7 million m³ and irrigation accounted for 474.8 million m³, total industry water consumption amounted to 39 million m³ (MWI, 2013).

Despite its water scarcity, Jordan is considered to be at medium-to-high water risk according to the Aqueduct Water Risk Atlas. In fact, Jordan is a world leader in wastewater treatment for irrigation and urban water supply (Water Resource Institute, 2016), largely due to the current subsidies for wastewater treatment (MWI, 2009). The wastewater treatment is the only available option, as the country's limited coastline permits hardly any water desalination activities. Jordan's current renewable internal freshwater resources, that is, freshwater resources that are spatially located inside the country, amount to 103m³ per capita, and 750 million m³ of renewable water resources are available (World Bank, 2016). The safe yield of renewable groundwater is around 275 million m³. In 2013 more than 30 wastewater treatment plants were in operation with a total production of 121 million m³ of treated wastewater (MWI, 2013). Regarding water quality, in 2013 around 42,218 water quality tests of drinking water were conducted, showing that the water is 99.7% in compliance with Jordanian Quality Standards.

As one of the world's water-poorest countries, Jordan is facing several challenges that are highly water-related. Among these are a possible increase in land and soil degradation, an increasingly warmer climate, and the related loss of precipitation. As the country tries to bridge the energy gap and to expand the energy sector by other energy technologies, such as wind and solar energy, and also nuclear energy, it is further challenged by its currently inadequate hazardous solid waste management facility.

\ ***Land and soil degradation:*** The quality of the soil and the lack of water resources as well as unreliable rainfall further reduce the potential for major land uses. The major type of land degradation in Jordan is wind erosion, which accounts for 3,237ha of land degraded (FAO, 1992), followed by chemical degradation and water erosion, accounting for 367ha and 332ha, respectively. Jordan's surface aquifers are projected to be severely depleted by 2030 (UNEP, 2011), and the productivity of agricultural lands will be severely reduced due to salinization and water logging (Abahussain et al., 2002). As water and land are

highly interlinked, this will result in 80% of all land areas in Jordan degrading into semi-arid or arid areas (UNEP, 2011).

- \ **Precipitation:** In 2013 Jordan experienced 8,120 million m³ of rainfall per year, of which 7,689 million m³, or 94.7% were lost due to evaporation (MWI, 2015). During recent years, annual precipitation decreased at a rate of 1.2mm per year, and projections based on historical data show a decline in precipitation by 15% by 2100 (Government of Jordan, 2014). Simultaneously, due to increased temperature, humidity will increase by 0.088mm per year (MOE, 2014).
- \ **Climate change:** Jordan has experienced several events related to climate change such as heatwaves in summer 2010 and droughts in 2010 and 2011 (Beck & Collet, 2011). In future, climate change will potentially affect the Jordanian landscape by increasing desertification, and will also pose a threat to the Jordan River valley (MOE, 2013; IPCC, 2014). According to Jordan's Third National Communication on Climate Change (2014) projections based on the historical data, climate change will result in an increase of +2.1 to +4 degrees Celsius by 2085, and the average maximum temperature could exceed 44°C. Recognizing this challenge, Jordan's climate change policy plan stresses the need to urgently address climate change mitigation and adaptation challenges (MOE, 2013).
- \ **Greenhouse gas emissions:** While greenhouse gas emissions in 2000 were below 20 million tonnes, emissions have increased to an equivalent of 28.72 million tonnes of CO₂ in 2006 (MOE, 2013; MOE, 2014). The energy sector emitted 72%, industrial processes 8.9%, agriculture 4.6%, waste 10.6% and land use, land use change and forestry 3% of greenhouse gas emissions in 2006 (MOE, 2014).
- \ **Air pollution and quality:** In Jordan, 50-90% of air pollution is caused by traffic and transport, and black carbon particles in the air are more concentrated in urban areas than in industrial areas (UNEP, 2015). More concrete data on air pollution in Jordan are still lacking. However, the World Health Organization's Global Urban Ambient Air Pollution Database indicates the country group that includes Jordan will have PM₁₀ levels of 55 micrograms per m³ in 2015 (WHO, 2016). The Ministry of the Environment is responsible for monitoring industries and activities that cause air pollution and, in 2014, launched an air quality monitoring system that includes seven monitoring stations (Jordan Times, 2014).
- \ **Greenhouse gas emissions** in Jordan are much lower than in other North African countries. For instance, Jordan's total CO₂ emissions are 8,722 (1,000 tonnes) compared with 42,415 in Morocco. Similarly, CO₂ emissions from electricity generation are 593 (1,000 tonnes) per GWh compared with 839 in Morocco. However, natural gas and heavy oil produce the major share of CO₂ emissions, that is, 5,548 (1,000 tonnes) per GWh. Jordanian media sources claim that the

Jordan Petroleum Refinery Company has failed to expand refining facilities and upgrade the quality of its products, thus causing significant pollution. For instance, the amount of sulfur in diesel fuel in Jordan varies between 10,000 and 12,000 parts per million (ppm). The Jordanian standards were set at a limit of 350 ppm in 2005, but were not controlled or enforced (Dayyeh, 2015).

- \ ***Hazardous waste management:*** Jordan generates 45,000 tonnes of hazardous solid waste per year, with just one hazardous waste processing facility in operation (Alhyasat et al., 2014). However, only 10% of hazardous industrial waste is treated or stored per year at the site in Sawqa (Alhyasat et al., 2014). According to the Mediterranean Environmental Technical Assistance Programme (2002) most hazardous waste is stored at the production site or disposed of at landfills intended for domestic waste. The Sawqa site is operated by the Jordanian Ministry of Environment. The fee for waste management and disposal as well as the transport, of a distance up to 150km, ranges from 40 to 256 JOD per ton (Alhyasat et al., 2014).

2 ELECTRICITY SYSTEM: DEMAND, SUPPLY, AND TRANSMISSION

2.1 Electricity demand and costs

The energy sector is crucial for Jordan's sustainable development. On the one hand, it is a critical infrastructure that is vital for the functioning of Jordanian society; on the other the high costs of primary energy make it a big burden on the Jordanian economy. This burden is mainly caused by heavy reliance on energy imports, such as oil and gas, and fluctuations in prices and volumes of supply.

The period between 2007 and 2013 saw a steady growth of electricity loads (see Table 1) with an actual increase in consumption of electricity of 6.8% on average.

Year	Actual electricity loads (MW)	Actual peak (MW)	KWh/capita
2007	10.553	2.160	2.277
2008	11.509	2.260	2.403
2009	11.956	2.320	2.427
2010	12.843	2.560	2.518
2011	13.535	2.680	2.167
2012	14.074	2.790	2.227
2013	14.564	2.995	2.220

Table 1: Electricity demand in Jordan in 2007-2013.

Source: Ministry of Energy (2007).

Electricity demand is growing steadily in Jordan and is projected to grow by 7.4% on average per year between 2014 and 2020, from 3,000 MW in 2012 to 15,000 MW in 2040 (Worley Parsons, 2011). It is also expected that Jordanian electricity demand will triple by 2030, according to a 2014 speech of the Jordanian Energy Minister Mohammad Hamed. However, NEPCO corrects this estimate, projecting growth to be more moderate and that electricity demand will reach 4,300 MW by 2020 and 8,130 MW by 2030 (NEPCO Statistics, 2015).

The highest share of electricity is consumed by private households and public buildings (43%), followed by industry (25%), services (15%), water pumping systems (14%), and street lighting (2%) (NEPCO, 2014).

The costs of generating electricity were the highest in 2005 (19.5% of GDP), 2011 (19.6%), and 2012 (21%) due to disruptions of gas supply from Egypt (see Table 2).

Year	Average cost of KWh sold (Fils)	Costs of electricity (million JD)	Energy bill in % of GDP
2005	46.93	9100	19.5%
2009	54.46	17816	10.9%
2010	68.27	18762	13.9%
2011	129.88	20476	19.6%
2012	145.69	21965	21.1%
2013	143.30	23851	17.1%

Table 2: Electricity costs in Jordan in 2005–2013.

Source: NEPCO (2013).

The government of Jordan provides massive subsidies to the energy sector; electricity tariffs in the Arab region on average are very low compared to world prices (Al Jayyousi, 2015). More than 6% of Jordanian GDP, equaling US\$1.719 million, was spent on energy subsidies in 2010 (World Bank, 2010). This year, the Jordanian government announced its intention to phase out subsidies on electricity.

2.2 Electricity supply

Currently, fossil fuels, such as oil and gas, remain the main sources of electricity supply in Jordan. In 2011 more than 82% of Jordanian electricity was supplied by imported oil and 12% by imported natural gas. Around 4% of electricity supply came from imported electricity and 2% from renewable energy sources.

As Jordan is highly dependent on energy imports, the number of interruptions it experiences in energy imports has a negative impact on its energy security. For instance, Saudi Arabia stopped supplying Jordan with oil in 1990, when Jordan supported the Iraqi invasion of Kuwait. For a decade, Saudi oil was replaced by Iraqi oil. However, Iraqi imports ceased in 2003 with the end of the Saddam Hussein regime and Iraqi oil was replaced by Egyptian gas, which was priced substantially

below market rate at that time. Then again, Egyptian imports became more and more erratic as a result of political instability in the country; the pipeline across the Egyptian Sinai Peninsula was sabotaged and supplies cut off when the political regime of Hosni Mubarak was overthrown. Since then, Egyptian imports have been partly replaced by heavy oil and diesel, a more expensive and polluting option.

It is planned to significantly reduce Jordan's dependency on imported oil by 2020, from 82% to 40%. This reduction will be filled by an increased share of natural gas (29%), deployment of shale oil (14%), nuclear energy (6%), and renewable energies (10%). The share of imported electricity will be reduced to 1%. The 10% of renewables translate into 1,200 MW from wind energy and 600 MW from solar energy.

2.2.1 Fossil fuels

Despite favorable conditions for renewable energies, most of Jordan's electricity is produced from non-renewable energy sources. Energy security in Jordan is driven by the dominance of natural gas from neighboring countries such as Qatar, Saudi Arabia, and Egypt. In 2014 around 80% of all imports of natural gas were provided by the Arab Gas Pipeline from Egypt (see Figure 8).

Almost all (97%) of Jordanian energy needs are met by imported oil and gas. Energy costs reached their peak in 2011 and amounted to 19% of the Jordanian GDP in 2011. The share of consumed primary energy relative to GDP fluctuates from year to year but on average it grew from 11% in 2009 to 17% in 2014. Domestic oil reserves are negligible, less than one million barrels in total, and natural gas reserves are around 60.96 billion m³ (U.S Energy Information Administration, 2014).

In 2014 the growing Jordanian energy demand was met through the introduction of two new power generating plants, known as IPP3 and IPP4 with capacities of 573 MW and 240 MW, respectively. These plants are located close to Amman, the capital, and are so-called tri-fuel plants because they use diesel oil, heavy fuel oil, and natural gas.

As well as these power plants, there are five other power stations in Jordan. The largest is in Aqaba and has a capacity of 656 MW. It was built as an oil power station but was then switched to natural gas after the construction of the Arab Gas Pipeline. The second largest power station is at Samra and has a capacity of 600 MW. The third largest, Al-Qatrana, lies 100 km south of Amman and generates 373 MW from natural gas and diesel oil. The fourth, the Rehab plant, is 70 km north of Amman and has a generation capacity of 397 MW. The Hussein power station is located 30 km north-east of Amman and provides the industrial area of Zarqa with energy from

heavy oil and diesel. The Risha power station is close to the border of Syria and generates 150 MW.

The perspectives of the gas industry within Jordan are affected by the following: discovery of the gas reservoir in the Mediterranean Sea, termination of the British Petroleum (BP) company contracts, and plans to import gas from Israel. It was hoped to extract 213.36 million m³ per day (mcf/d) of natural gas from the Risha field 270 km northeast of Amman in eastern Jordan, close to the border with Iraq. The field was discovered in 1987, and it was believed that its natural gas reserves would meet Jordanian demand as the potential of the field was estimated twice as high as daily consumption at the time.⁵ In 2009 BP signed a deal with the government of Jordan to develop and explore the natural resource basin at the Risha field. However, in 2013 BP decided to abandon the plans in Jordan. According to Bloomberg New Energy (2010), the decision of BP was motivated by the absence of the available resource, as the field was too poor. This, after having spent US\$240 million and drilled two exploration wells.

As the Risha field venture was not successful, imports of natural gas from the Israeli offshore fields Tamar and Leviathan in the Mediterranean Sea through the Arish-Ashkelon pipeline were another option for Jordan. However, this option is contested by many Jordanians for political reasons connected with Israeli policies over the West Bank. In 2014 the Israeli side also supplied NEPCO with a non-binding letter of intent to supply gas from the Leviathan field. In April 2015 the Israeli government approved an agreement to supply natural gas from the Tamar field to two Jordanian industrial companies with facilities near the Dead Sea.

Another option would be to supplement the gas from Israel by imports from the Gaza Marine field. But this option will only be viable if political circumstances allowed it to be developed further.

Energy imports from Egypt became more unreliable largely due to Egypt needing its energy to meet its own growing domestic needs. It is still uncertain if the discovery in 2015 of the large offshore Zohr gas field 150 km off the Egyptian coast will change this situation. The pipeline from Egypt has also also subject to frequent sabotage resulting in interrupted energy supply and falling gas volumes (from 2.5 billion m³ to 0.8 billion m³) Gas supplies from Egypt stopped completely in 2013, leaving Jordan without the energy source that had supplied 80% of its electricity.

⁵ In 2015, these estimates were corrected, and the new estimates show that 300 mcf/d would be possible (Master Strategy for Energy in Jordan for the period of 2007 to 2020, 2007).

As a result of this uncertain supply situation, the Jordanian government decided to construct infrastructure for liquefied natural gas and shale oil. In 2014 the government signed an agreement with the Estonian company ENEFIT for the construction of the Attarat power station with a capacity of 470 MW, burning oil shale, at an estimated investment costs of US\$2 million. Another project is the Al Lajjun power station, located in the state of Karak. In 2015 Jordan signed a deal with China that would provide funding for the project. This project is planned to become operational in 2018 and will use local oil shale reserves. Oil shale is expected to produce 500 MWh of electricity and around 38,000 barrels of oil by 2018/2019 (Dayyeh, 2015).

Another project is the liquefied natural gas (LNG) port in Aqaba, which became operational in 2015. The port was constructed to improve the import of LNG from Egypt, which began in 2003. However, LNG imports were heavily affected by Egypt's decision to cut gas exports, which resulted in a drop in LNG electricity production from 80% by 2010 to 20% in 2012 (Dayyeh, 2015). There are also concerns that Jordan will no longer be able to afford expensive LNG imports.

Recently an agreement was signed to connect the liquefied gas port with the Arab Gas Pipeline. The Arab Gas Pipeline has a total length of 1,200 km and transports Egyptian natural gas to Jordan, Syria, and Lebanon. However, in 2012 the gas supply to Jordan was attacked by Bedouins, who were protesting against neglect by central government in Cairo. In 2013 although the gas supply to Jordan was resumed, the pipeline remains a target for attacks by militants. The link between the Arab Gas Pipeline and the liquefied gas port will be 800 m long and have a diameter of 24 inches.

Currently, two pipeline projects are in the planning phase: the construction of the Aqaba-Zarqa pipeline and the rehabilitation of the Saudi-Jordan Tap Line. The Iraqi-Jordan oil and gas pipeline was planned to start at Basra, but was postponed in 2014 because of political instability in Iraq. The crude oil pipeline from Iraq to Aqaba will have an expected capacity of around one million barrels per day. The project is expected to be completed by 2018.

2.2.2 Renewable energies: Solar and wind

In Jordan 14,713 GWh per year of electric energy are produced by thermal stations, and 64 GWh from renewable energy sources such as hydro, solar, and wind, the latter being relatively low in comparison to other North African countries. Morocco, for instance, produces 4,290 GWh from hydro, solar and wind, Egypt 13,996 GWh from hydro and wind, and Tunisia 189 GWh from hydro, solar, and wind (ESCWA, 2012).

Jordan has favorable conditions for deploying solar power in terms of sunshine duration and solar radiation with 6,400 terawatt hours per year (TWh/year). The annual sunshine duration is around 3,602 hours, and the daily average sunshine duration is 9.9 hours. Long hours of sunshine can also guarantee longer hours of electricity generation. The solar irradiance ranges between 5 and 7 KWh/m² (see Figure 6). The majority of the regions in Jordan offer direct normal insolation (DNI) above 2,000 KWh/m²/yr. The best sites, which are in the south, exceed 2,300 kWh/m²/yr (Al Zou'bi, 2010). The areas of Ma'an and Aqaba have the highest levels of solar irradiance in the country and globally, ranging between 6-7 KWh/m² and 1.2-1.35 KWh/m² for diffuse irradiance (Al-Sayed, 2013). As Figure 6 shows, in some places the solar intensity reaches 2.600 kWh/m² (USAID, 2011).

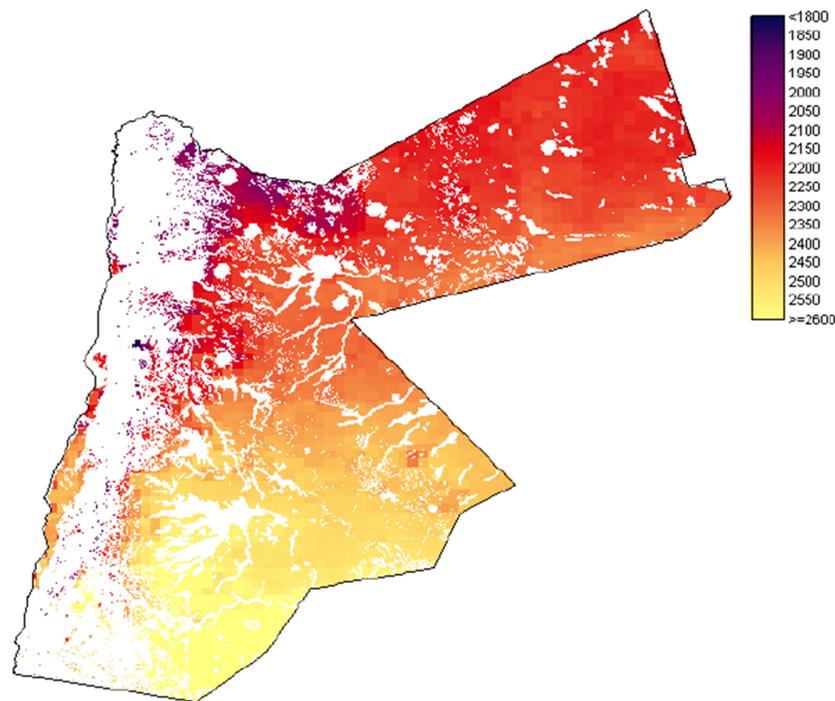


Figure 6: Solar irradiance per year.

Source: USAID (2011).

Currently, different types of solar systems are in use in Jordan. Small stand-alone PVs and large grid-connected PV systems are used for heating water in households, for electricity in educational, public buildings and commercial institutions, water pumping systems, and agricultural applications such as greenhouses.

Thus, Jordan has abundant resources of solar and wind energy. The annual daily average solar irradiance on a horizontal surface in the country is one of the highest in the world and ranges between 5 and 7 kWh/m². Based on these potentials,

several solar projects in Jordan are in planning and under construction. Table 5 in the Annex shows the current solar projects and their status. These projects are both large-scale centralized projects and also decentralized solar PV systems to provide energy services to remote and rural villages for lighting, pumping, and other public services. We describe some of these projects below, as they represent innovative technological solutions: the Sahara Forest Project with its water-energy nexus solution; the Kirchner solar group with its new PV technology; the Qweirah/Aqaba and Northern Badia Project, , with their innovative financing solutions involving private capital; and the Shams Ma'an project which has a significant impact on electricity generation in Jordan.

- Projects under construction: Solar Park in Ma'an, Sahara Forest Project, Kirchner Solar Group project, Qweirah/Aqaba project
- Projects in operation: Northern Badia project, Shams Ma'an project

The Sahara Forest Project (SFP) aims to generate electricity and to contribute to energy, food, and water security in the desert areas through a combination of concentrated solar power (CSP) and seawater-cooled greenhouses. It will be located in the Wadi Araba and is supported by the government of Norway and the European Union. The project is planned to produce 500 GWh of electricity; it will cover around 3,000 hectares, employ 8,000 people, and produce 200,000 tonnes of fruits and vegetables. The project was planned in 2011 and the building process started in October 2016.⁶

The Kirchner Solar Group project is a PV power plant; it is a cooperation project between the Kirchner Solar Group, Jordan's Ministry of Energy and Mineral Resources, the National Centre for Research and Development, Al-Balqa Applied University (BAU) and the company, Al-Jaar Est for Environmental and Industrial Consultations (AEEIC). The main aim of the project is to use solar power through two axis-tracked photovoltaic systems. These systems are usually used for passive solar, heating, and individual solar rooftop systems, and can also be a solution for off-grid generation and transportable solar home systems. This will be a demonstration project, which will aim to show Jordanian stakeholders the benefits of using such a technology. The project also includes research and development components to see if such solutions in Jordan are technically feasible and to develop concepts and guidelines for implementation of this technology in the country (SWEM, Sun and Wind Energy, 2016).

The Qweirah/Aqaba project is a 100 MW PV plant located in the Aqaba region and funded by the Abu Dhabi Fund for Development. The project consortium includes

⁶ <http://saharaforestproject.com/>

the Spanish TSK Group and the UAE's Environmental Power Systems group. The project is planned to become operational in 2017.

The Northern Badia Project is a 10 MW PV plant and has been operational since late 2015. It is situated in the Manarah village in the Northern Badia region. The project provides 22 GW of electricity per year. This is the first commercial PV solar plant project in the country with a total cost of JOD 22 million and an operational license for 20 years (Jordan Times, 2015).

The Shams Ma'an project with a capacity of 52.5 MW is the largest PV plant in the region; it became operational in October 2016.⁷ It is currently generating 1% of Jordan's total electrical energy production, which is sufficient for 35,000 households. It is located in the Ma'an development region, 220 km south of Amman. The Shams Ma'an project is planned to produce 168 GWh a year and will enable prevention of about 90,000 tonnes of CO₂ emissions annually (Al-Salaymeh et al., 2016).

The government supports the deployment of infrastructure projects to reach its target of 10% of renewable energy by 2020. Several agreements were signed in 2014 to purchase electricity generated by solar and wind power plants with an overall capacity of 560 MW and financed by international investments at a cost of about US\$850 million. In particular, 12 projects with an overall 200 MW of solar capacity using solar irradiance in the Ma'an region were agreed upon.

Jordan has favorable conditions for wind power generation in terms of wind speed and long periods of windy weather. Wind speeds in Jordan can reach 7.5 meters/second and up to 11.5m/second in hilly areas. Large areas of Jordan have a wind speed exceeding 6–6.5 meters/second; some areas in the north have a wind speed of 7–11 meters/second (Zafar, 2013). Hofa and Ibrahimia are the best locations for wind power in terms of wind speed and hours of wind. Fujeij near Showbak and Wadi Abara in the north are also favorable locations in terms of a wind regime (Halasa, 2010). There are two reasons favoring deployment of wind energy in Jordan: First, the diversity of the topography, which is favorable for high wind speed, as Jordan lies 400 m below sea level at the Dead Sea and up to 1,700 m above sea level in the north and south. Second, the Jordanian electricity grid is well distributed in the areas most suitable for electricity production from wind.

That is why several wind energy projects have been established in Jordan, some of which we describe below:

- Projects under construction: Ma'an wind power plant and Ar Rajiwind farm

⁷ <http://www.shamsmaan.com/>

- Projects in operation: Ibrahimia plant, Hofa plant, Al-Fujaije Wind Power Project, Tafila Wind Farm

The Ma'an Wind power plant is a 66 MW wind project in south Jordan, being undertaken by Spanish companies Elecnor and Gamesa. The project will be carried out in two phases. During the first phase 33 x 2 MW turbines will be constructed. During the second phase, the project will be expanded by a further 7 turbines, which leading to a capacity of 80 MW (Reve, 2016).⁸

The Ar Rajifwind farm will have 80 MW capacity and will be located 16 km south of the historical city of Petra. The wind turbines will cover 7.5 km² and will mainly be located on private land. The project is planned to become operational by the end of 2018 (MEMR, 2015).

The Ibrahimia plant is the first wind project in Jordan. It is a small grid-connected wind farm, implemented in the northern Jordan in 1987 by MEMR, the Jordan Electricity Authority (JEA) and the Danish firm, Tellus. It has a capacity of 320kW (it consists of four horizontal axes 80kW wind turbines 24m in height). The power plant currently produces 700 MWh annually which is equivalent to 60 toe (RSS & FES, 2011).

The Hofa plant is a large wind turbine plant with a total annual output of 2.5 GWh. It incorporates five x 0.225 MW wind turbines. The power plant was constructed in the Al-Hoffa region of northern Jordan with the help of German development funds (RSS & FES, 2011).

The Al-Fujaije Wind Power Project is located in the Al-Shawbak area, approximately 150 km south of Amman. It is a 80–90MW power station and became operational in 2014 (RSS & FES, 2011). The project, including all support facilities, is planned to provide electricity to the National Electric Power Company (NEPCO) for a period of 20 years (World Bank, 2014).

The Tafila Wind Farm is located in the Tafila region, 180 km south of Amman. It has 117 MW of installed capacity and is utilizing 38 Vestas wind turbines (V112/3.035 MW). The wind farm has increased the country's total power capacity by 3% and will account for almost 10% of Jordan's 1.8 GW renewable energy target for 2020 (MASDAR, 2016).⁹ The project became operational in September 2015. It was developed by the Jordanian Wind Project Company in partnership with InfraMed, Masdar and EP Global Energy. It creates enough electricity to power

⁸ <http://www.evwind.es/2016/06/07/wind-energy-in-jordan-gamesa-wind-turbines-for-a-wind-farm/56428>

⁹ <http://www.masdar.ae/en/energy/detail/tafila-wind-farm>

83,000 homes, producing approximately 390 GWh of electricity annually. It also displaces almost 235,000 tonnes of CO₂ emissions per year (Masdar, 2016).

2.2.3 Nuclear

Jordan has pursued options to deploy nuclear energy in the past. In 1955 a high-level Jordanian official spoke of the country's energy needs at the International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland. In the same year, the US Atomic Energy Commission proposed construction of the first nuclear power station for desalination. In 1988 together with other Arab countries, Jordan formed the Arab Atomic Energy Agency to coordinate nuclear energy research among Arab states. After Saudi Arabia reduced its oil supply to Jordan, plans to deploy nuclear energy were revived during the 1990s. These plans finally materialized in 2007 when the Jordanian government established a Committee for Nuclear Strategy and—a year later—the Jordan Atomic Energy Commission, following such drivers for the use of nuclear energy as soaring oil prices, the abundance of uranium in Jordan, and the need to meet growing electricity demand, mainly for the desalination of sea water and cooling purposes. These institutional bodies were tasked to develop a program to install nuclear power generation capacity, sufficient to provide 30% of electricity by 2030 for domestic consumption and for export. Nowadays, projections on the share of nuclear energy in the energy mix show that nuclear energy might constitute a 6% share of the overall energy mix by 2020 and that with increased grid capacity the share of nuclear energy might increase to 18% in the primary energy mix by 2025 (Dayyeh, 2015).

Having established the institutional structure, activities followed in the research and technology transfer fields. In 2007 the Jordan University of Science and Technology established the first nuclear engineering program. During the same year, the Jordanian Atomic Energy Commission started a feasibility and cost-benefit study for nuclear power in Jordan. The Korean Atomic Energy Research Institute and Daewoo Corporation signed an agreement with the Jordanian government to build a 5 MW reactor at the Jordan University for Science and Technology. Two years later a contract was provided to WorleyParsons for preconstruction consulting on the first Jordan nuclear power plant, conducting a feasibility study and providing a financial assessment (Ramana & Ahmad, 2016).

Currently, several countries are interested in constructing the first Jordanian large-scale nuclear reactor. In 2008 France offered to build such a reactor and, only a year later, so did Japan, South Korea, China, the United States, and Russia. In 2014 the Jordanian government approved an implementation agreement for the first nuclear power plant in Jordan in cooperation with the Russian Company ROSSATOM. This approval was based on the offer submitted of US \$10 billion, which included the construction of two nuclear reactors each with a capacity of 1,000 MW. This

agreement also included a feasibility study on the power plant site, construction costs, costs of generated energy, and costs of energy sold to NEPCO. The first reactor is expected to be completed by 2023 and the second by 2025 (NEPCO, 2014).

The government of Jordan has been facing difficulties in implementing their plans, for instance, finding a suitable project site. The first nuclear site chosen was near Aqaba on the Red Sea, but this plan was dropped some years ago. The first experimental reactor was then constructed in the north of Jordan, only a few kilometers away from the Syrian border. Two 1,000 MW commercial reactors were also planned in the north of Jordan at Majdal; however, protests from local communities motivated the government to move the proposed site to the southeast of the country, near Amra Castle just 50 km southeast of Amman. False expectations regarding the size of exploitable uranium reserves in Jordan led to AREVA, which had signed a uranium exploration agreement with Jordan, leaving the country after discovering a very low concentration of uranium.

The public discourse about nuclear power in the country is driven by parliamentary calls for a feasibility study, assessments regarding its environmental impact, water scarcity, the terrorist threat and emergency evacuation plans (Dayyeh, 2015). This is a highly sensitive topic to the extent that in July 2012 local people attacked and burned the South Korean offices responsible for the first experimental reactor. Public concerns were driven by i) lack of consultation with local communities, ii) none of the announced deadlines being met, iii) construction works starting before the preliminary licenses were issued, iv) the feasibility study not being announced, and v) conflicts over land use issues. An environmental impact assessment was conducted by the Jordan University of Science and Technology. However, this came in for criticism because i) the task force was not adequately experienced, and ii) there was conflict of interests with the university being deeply involved in the preparation of the nuclear program and not a neutral entity. The existence of fake nuclear spare parts and a corruption scandal in South Korea also had an impact on public opinion (Friends of the Earth, 2014).

2.3 Electricity transmission

The transmission grids in Jordan are mainly located along the north-south axis of the country. The system consists mainly of 132 KV and 400 KV transmission networks (NEPCO, 2012). The system is operated by NEPCO, a company wholly owned by the government of Jordan, which is responsible for the transmission of electricity and the operating of the electricity system and the electricity interconnection line (Figure 7).

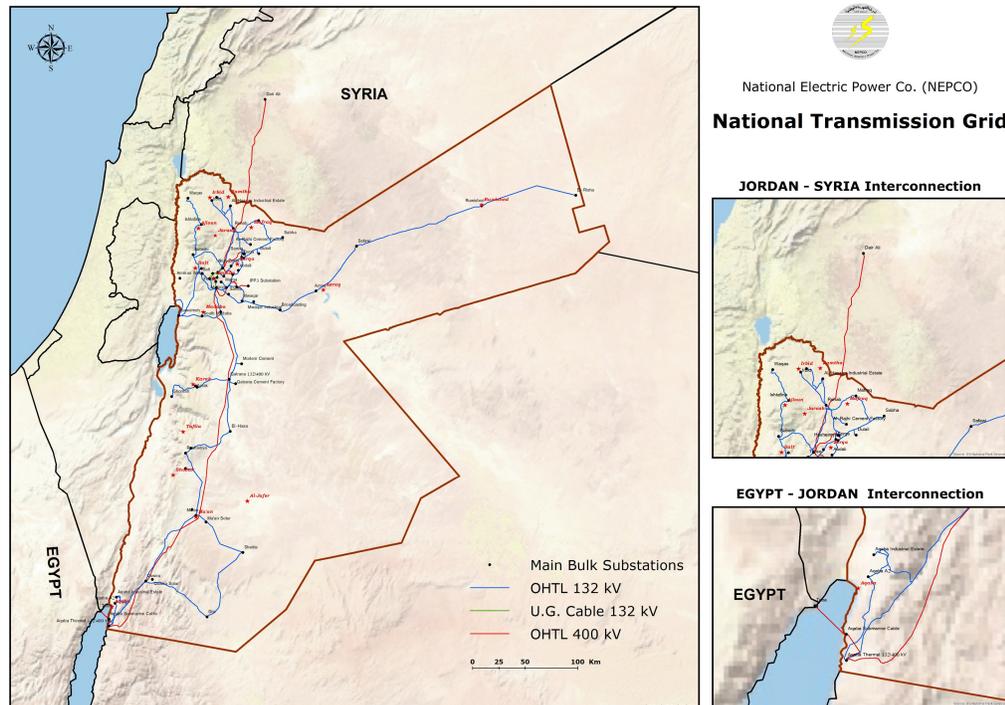


Figure 7: National transmission grid.

Source: NEPCO (2014).

The current capacity of the Jordanian grid is limited and presents a major bottleneck for scaling electricity generation to cover growing electricity demand. Its capacity stands at 3,200 MW and it can only accept another 500 MW. For example, in 2015 the government needed to cancel proposals to build five wind power plants with a total capacity of 400 MW as the grid was unable to absorb additional loads.

In 2014 the Ministry of Energy and Mineral Resources announced a plan to expand the national electricity grid capacity by 1,000 MW to enable more renewable energy projects to connect to the grid (Davies et al., 2016). However, given the current state of the electricity transmission grids and the speed of construction of further electricity grids, it is only by 2030 that the capacity of electricity grid might exceed 10,000 MW (Davies et al., 2016).

Most Jordanian grids within the country do not exceed 132 kV and are a mixture of overhead lines and cables. The total length of the 132 kV network is about 4,121 km, and the total installed capacity of substations is 10,303 Mega Volt Amp (MVA). One major 400 kV grid crosses the entire country. The system also includes 230 kV and 400 kV lines with Syria and one 400 kV line with Egypt. The distribution networks serve around 99% of the Jordanian population (NEPCO, 2013).

3 REGULATORY AND INSTITUTIONAL FRAMEWORK

3.1 Regulatory framework

3.1.1 Development policy

The first national Millennium Development Goals (MDG) Report for Jordan was published in 2004. As the goals, targets, and indicators were adapted to and aligned with national plans and development priorities, its goal was to contribute to national policymaking. In 2006 the government of Jordan released two significant documents articulating its vision for development planning, namely, the “National Agenda” and the “We are all Jordan.” This vision was operationalized into a three-year National Executive Programs (NEP) specifying policies, programs and projects for government institutions. MDG indicators relating to social welfare, healthcare, poverty reduction, and education were integrated into those plans (Al-Kilani, 2015).

Jordan’s second MDG Report, released in 2010, entitled “Keeping the Promise and Achieving Aspirations,” shows the extent of progress made toward those targets and highlights the challenges still confronting the country in achieving them. The review of the MDG indicators shows accomplishments overall across the board for all goals: in eradicating poverty and hunger, achieving universal basic education, promoting gender equality, improving child and maternal health, ensuring environmental sustainability, and building partnerships for development. However, and particularly because of the repercussions of the global economic crisis and emerging challenges, obstacles still remain to full achievement of the MDGs (Al-Kilani, 2015).

Jordan is one of the 88+ countries that carried out national consultations worldwide and were selected to run “The Post-2015 National Consultations.” The Jordanian national consultations, in 2012, were a leading contributor to the first preliminary report of the UN Development Group (UNDG) of March 2013, entitled “The Global Conversation Begins – Emerging Views For a New Development Agenda,” and also to the UNDG Global report “A million voices: The World We Want,” launched by the UN Secretary-General and UNDG Chair on 9 September 2013 (UNRC, 2013).

The messages from the post-2015 National Consultations in Jordan were clustered into four “areas for change”:

- \ Strengthen the link between education and the labor market and support entrepreneurship to reduce unemployment and ensure decent work opportunities;

- \ Combat stereotypes to ensure gender equality and decrease geographical disparities, reduce poverty, and ensure equal access to social services;
- \ Enhance accountability, respect human rights, and contribute to regional stability;
- \ Enhance environmental awareness, promote renewable energy, and address water scarcity (UNRC, 2013).

Under Jordan's National Agenda "environmentally-sustainable economic development" is a key policy goal reflected in a wide range of sectors, including energy, transport and waste management. Within its Executive Programme, the government of Jordan announced the launch of "a programme for green services and industries to meet the requirements for adhering to environmental standards and turning Jordan into a regional centre for green services and industries" (UNEP, 2011).

3.1.2 Energy policy

The energy policy in Jordan is framed by a number of national strategies, such as "National Energy Strategy," "National Master Strategy of Energy Sector," or "National Renewable Energy Strategy," as well as several laws for the electricity sector.

A major target of the **National Energy Strategy** (for 2011–2020) is diversification of the energy supply to decrease dependence on energy imports. Its main target is development of solar and wind resources, nuclear energy capacities, and shale oil. As of 2011, the largest share of the Jordanian energy supply was oil products (82%), followed by natural gas (12%), while the share of renewables was only 2%. The National Energy Strategy foresees the following energy mix by 2020: decrease in the share of oil products to 40%, increase in the share of natural gas to 29% and of renewable energies to 10%, and introduction of new energy sources such as oil shale (reaching potentially 14% of the national energy mix) and nuclear (potentially 6% of the national energy mix) (EMRC, 2015). The strategy aims to transform Jordan into a net energy exporter by 2030.

To reach these targets, the strategy adopts four goals:

- \ To utilize oil shale. It is planned to reach this goal with construction of the Attarat Power Company (APCO), which will be a direct burning power plant with a capacity of 470 MW. The construction of the power plant began in 2015 and is planned to become operational in 2019 (NEPCO, 2015).
- \ To develop Jordan's civil nuclear program with a functioning nuclear reactor by 2023/2025

- \ To generate 10% of Jordanian's electricity from renewable energies sources, mainly solar and wind, by 2020
- \ To introduce energy efficiency measures

The ***National Master Strategy of the Energy Sector*** was developed for the 2007–2020 period (MEMR, 2007). Its main objective is to reduce energy consumption without lowering the standard of living but rather by improving it. Other targets include the balancing of energy imports and exports, the reduction of production costs, enhancement of competitiveness of local industries, and reduction of required investments in energy generation and distribution (PEERA, 2010).

In 2004 a Royal Commission was tasked with reviewing and updating the national master strategy of the energy sector. The aim is to confront the challenges that impede implementation of several projects intended to meet the Kingdom's energy needs by improving the level of available investments, opening up the energy market, and achieving energy supply security (MEMR, 2007). The Royal Commission formed subcommittees within three hubs: i) oil, electricity, and natural gas, ii) renewable energy and energy conservation sector, and iii) an alternative and local energy sector in addition to the necessary additional legislation. A technical committee was also formed and chaired by the secretary general of the Ministry of Energy & Mineral Resources, whose members comprise representatives from the Ministry of Energy & Mineral Resources and other energy-sector-related bodies, to assist the subcommittees in completing the required work (MEMR, 2007).

The ***National Strategy for the Development of Renewable Resources*** is part of the National Energy Strategy and foresees large-scale deployment of renewable energy sources as a key priority. The target of 10% by 2020 foresees 600 MW of wind energy projects and 300–600 MW of solar thermal projects. The power purchase agreements have already been signed for 300 MW of solar-power and 200 MW of wind-power projects. Jordan's Energy Minister announced in mid- 2014 that the government expects to commission a further 1.8 GW of solar and wind capacities by 2018. Currently, the share of renewable energy sources is around 2% (MEMR, 2015); however, in 2016 the government of Jordan announced that a 20% target by 2020 is also possible, taken into account the capacity of all solar and wind projects currently under construction (around 1 GW) (Petra Agency, 2016). The strategy also makes the following two recommendations: to implement wind energy projects with at least 600 MW capacity by 2020 and to continue development of the Renewable Energy and Energy Efficiency Fund (Davies et al., 2016).

The strategy also provides recommendations on energy efficiency and its implementation in different sectors such as industrial, commercial, housing, transport, services, and water pumping. Further, it emphasizes the need for wide-reaching awareness-raising campaigns on the rational use of energy targeting all

sectors plus the establishment of local citizen offices. The latter would raise awareness of energy-efficiency measures, such as how to benefit from energy-saving equipment that is exempt from sales tax and customs duties. The strategy also outlines ways of facilitating access to equipment such as solar water heaters and energy-saving lamps to encourage citizens to rationalize and decrease energy consumption.

Besides strategies, there are also a number of laws, which set framework conditions for energy policy in Jordan.

The **General Electricity Law** is the main law for the electricity sector. It creates the Electricity Regulatory Commission (ERC), the main implementation body, which is seen as a capable and reliable means of liberalizing the Jordanian market and guaranteeing its efficiency, reliability, and development (OECD, 2005). Article 47 of the General Electricity Law provides for the ERC to set tariffs for all sectors, except generation. The tariffs for generation are determined in conformity with any agreements in force between the generation licensee and NEPCO as a bulk supply licensee (General Electricity Law, Article 37 (B) and 47 (A)). In common with any licensed service, the ERC must take into account the following when determining tariff methodologies (OGEL, 2013):

- Allow a licensee that operates efficiently to recover the full costs of its business activities and to earn a reasonable return on capital investment;
- Provide incentives for the continued improvement of the technical and economic efficiency with which the services are provided and for the continued improvement of quality of services;
- Give consumers economically reliable signals regarding the costs that their consumption imposes on the licensee's business;
- Avoid undue discrimination among consumers of the same category and among consumer categories;
- Gradually phase out or substantially reduce cross-subsidies, except when providing lifeline tariffs (General Electricity Law, Article 4 (A), 4 (B) and 4 (C)).

The General Electricity Law regulates the license-granting process. Under this law, the regulatory authority issues licenses to firms that wish to generate, distribute, or sell electricity. Generating plants with a capacity of up to one MW are allowed to operate without a license. Local supply networks with a maximum capacity of 100 kW can be operated without a license, as can power plants used solely to generate electricity for self-consumption. Power supply companies or middlemen wishing to purchase electricity from a power station with a capacity greater than 5 MW may conclude appropriate supply contracts only after competing in a public tendering process (Article 35). These rules apply equally to conventional thermal power

stations and stations that generate electricity from renewable energy sources (GTZ, 2007).

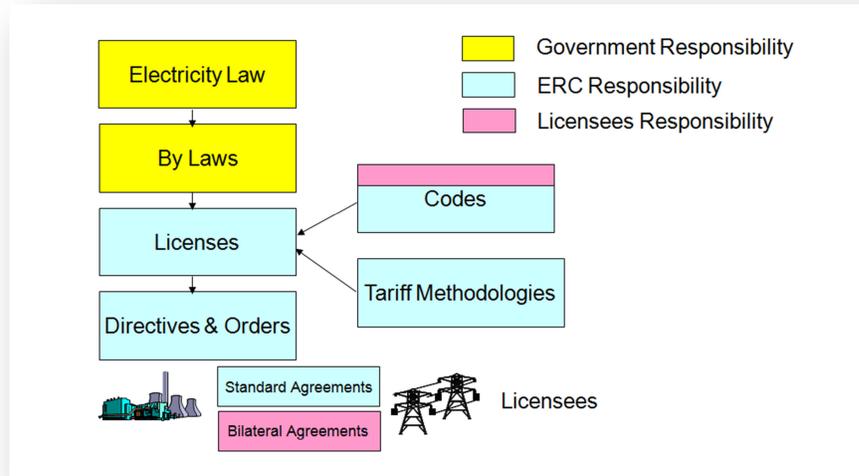


Figure 8: Hierarchy of the Regulatory Framework for the electricity sector in Jordan.

Source: EMRC (2015).

The electricity sector operates on a single buyer model, where there is strong competition among power generators. While the Jordanian power sector is comprehensively overseen by the MEMR, the 2002 General Electricity Law delegated the electricity sector to the Electricity Regulatory Committee (ERC) (MEMR, 2003).

Once Jordan understood the need to develop its electricity market, the country's Council of Ministers (COM) created the Executive Privatization Commission which is responsible for carrying out a national privatization reform in various sectors, including electricity. The main reasoning behind such a reform is to attract investment, strengthen the local capital market, install new generation plans, implement schematic projects, and meet local demand. The reform also assigned the policymaking role to the Ministry of Energy and Mineral Resources (MEMR) and regulation to the Electricity Regulatory Commission (ERC). It also granted investment or operational roles within the market to private entities (OGEL, 2013).

According to the Electricity Law, prices must be in line with prices and fees determined by the Electricity Sector Regulatory Commission (MEMR, 2003). Electricity generated by companies is sold to the state-owned National Electric Power Company (NEPCO), the single buyer on the market, which operates the

transmission systems.¹⁰ Large electricity consumers, such as industries, are supplied through NEPCO directly (OGEL, 2013). The generation companies also include the privately owned Central Electricity Generating Company and state-owned Samra Electric Power Generating Company. These generation companies may compete in a bidding process initiated by the government or also submit direct unsolicited proposals quoting a fixed tariff (FES, 2016). The electricity is then distributed to consumers through the three privately owned distribution companies: the Jordanian Electric Power Company (JEPCO), the Irbid District Electricity Company (IDECO), and the Electricity Distribution Company (EDCO).

The *Renewable Energy and Energy Efficiency Law* (known as REEL) aims to stimulate private sector investment in renewable energy. This was the first law issued to stimulate renewable energy generation in the country. It contains guidelines on implementation of renewable energies and energy efficiency measures (Marei, 2016). The law also establishes the direct proposal regime for private companies to allow them direct negotiation with the Ministry of Energy and Mineral Resources (MEMR) for renewable projects. The law requires the National Electric Power Company (NEPCO) and regional distribution companies to purchase electricity generated by renewable energy projects and to pay for the grid connection. It also exempts all systems and equipment for renewable energy projects from customs duties and sales tax.

The law sets four main objectives for renewable energies (MEMR, 2012):

- Exploitation of renewable energy resources;
- Increasing the contribution of renewable energies to the total energy mix;
- Contribution to environmental protection;
- Sustainable development and improving energy efficiency in various sectors.

REEL tasks the MEMR with identifying suitable locations for renewable energy applications and coordinating this selection with the land use list. It also foresees establishment of a Renewable Energy and Energy Efficiency Fund (which took place in 2013) and grants tax exemption to this fund. The fund's purpose is to finance exploitation and rationalization of renewable energy sources and systems. The fund is co-financed by the Jordanian government, the EU, PROPARCO, and the Gulf Cooperation Council (GCC). It is managed by MEMR and channels money from international donors to renewable energy and energy efficiency demonstration projects in the country (Davies et al., 2016).

¹⁰ On approval of a proposal, the National Electric Power Company agrees to buy the electricity and fund the grid connection for developers (FES, 2016).

3.1.3 Environment policy

Jordan has been signatory to several international treaties to protect the environment. The country passed the first environmental protection law in 1995. This law established the Department of Environment (DOE) at the Ministry of Municipalities and Rural Affairs, as a financially and administratively independent organization. The law was amended in 2003 and the DOE was abolished. The new law on environmental protection in Jordan was ratified in 2006. It gives the Ministry of Environment full authority to deal with environment protection issues (Al-Sharari, 2014). There are several other provisions on environment-related issues such as agricultural and public health laws.¹¹

The first institutional entity responsible for environmental protection in Jordan was the Department of Environment, established in the Ministry of Municipal and Rural Affairs and Environment in 1980 and continuing until 1995. In 1993 Jordan ratified the Kyoto Protocol and established national focal points for climate change issues. In 1996 the financially and administratively independent General Corporation for Environmental Protection (GCEP) was established as the official body responsible for environmental protection in Jordan. In 1996 Jordan started its climate change mitigation efforts with a GEF-UNDP supported program for capacity building in documenting national emissions of GHGs and preparing the country's national communication to the United Nations Framework Convention on Climate Change (UNFCCC). The Second National communication was published in 2009 (UNEP, 2011) and the third in 2014.¹²

The increased attention to environmental issues and increased pressure on the elements of the environment, led to the establishment of the Ministry of the Environment (MOE) in 2003 under the Environment Protection Law No. (1) of 2003; this was approved by the Parliament to become the Environmental Protection Law No. (52) of 2006. The government of Jordan is currently supporting various policies, initiatives, and programs aimed at achieving a green economy, such as:

- \ Complete removal of subsidies for oil;
- \ Adoption of the renewable energy law and fiscal incentive package on renewable energy and energy efficiency equipment (approved in 2010) to help achieve the renewable energy target of 7% by 2015 and 10% by 2020. However, the NEPCO annual report showed that that only 2.5% of Jordan's energy came from renewable sources by 2015 and that the target of 7% was missed (NEPCO, 2015).

¹¹ Environmental Protection Law No. 52, Agriculture Law No. 20 and Public Health Law No. 21

¹² <http://unfccc.int/resource/docs/natc/jornc3.pdf>

- \ Establishment of the Eco-Cities Forum, the Eco-Financing Seminar, and the Zarqa River rehabilitation project.

The Jordanian Government Executive Program, adopted in 2010, aims to achieve a green economy in the long run based on the implementation of environment standards and on turning Jordan into a regional center for green services and industries (UNEP, 2011). Jordan has adopted a number of innovative policies and regulations in certain areas to help transform key economic sectors and to enable the move toward a green economy. In addition, the Ministry of Environment (MOE) and the Global Green Growth Institute (GGGI) signed a Memorandum of Understanding (MoU) on the development of a green growth action plan for Jordan on 15 January 2015 [GGGI, 2015]. The agreement aims to integrate the Green Economy and the Sustainable Consumption and Production sectors (Energy, particularly Energy Efficiency and Renewable Energy, Water, Agriculture, Waste Management, Transport, and Sustainable Tourism) for a comprehensive National Green Growth Strategy and work plan. Collectively the work plan will have the potential to attract sustainable green investments amounting to US1.3 billion dollars and creating 51,000 new jobs in the next 10 years (MOE, 2016).

Jordan's environmental protection efforts and the scarcity of natural resources were the motivation behind the adoption of the first Environmental Protection Act Law (EPA) and the establishment of the Ministry of Environment (MOE) as a separate ministry in 2003. Since its establishment, the MOE has aimed to improve treatment of industrial wastewater, medical and hazardous waste—in partnership with the private sector—and to enhance the inspection system through updated and comprehensive regulations to be adopted soon (Cervigni and Naber, 2010). To reach these goals the MOE established the Environmental Rangers Department in 2006 to improve the efficiency of vehicle and industrial inspection and enforcement. The MOE also has a mission to promote environmental protection and to prevent pollution; this will be implemented in partnership with local NGOs. Different ministries and state institutions also have departments dealing with environmental issues. Their main mandate is the protection and/or measurement of pollution rates in Jordan (UNEP, 2011).

3.1.4 Institutional framework for the electricity sector

This chapter describes the main stakeholders involved in the electricity sector in Jordan (Figure 9).

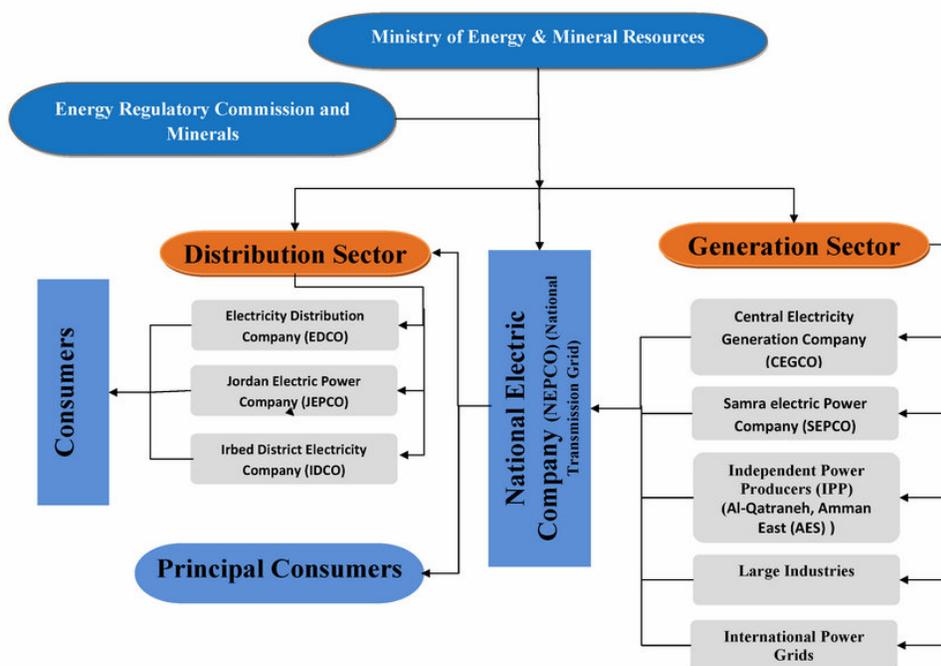


Figure 9: Structure of electricity sector in Jordan.

Source: FES (2016).

Government Organizations

The *Ministry of Energy and Mineral Resources (MEMR)* is the overarching legislative authority on energy-related issues in Jordan and, as such, lays down the goals and political framework conditions for the development of the energy market. Its core task is to facilitate the continuing development of the country by ensuring adequate availability of energy with as little expenditure as possible while maintaining high standards. The ministry is also responsible for identifying sources of foreign direct investment for energy generation projects and development of locally available sources of energy (GTZ, 2007; FES, 2016).

The MEMR was established in 1984 and entrusted with administering and organizing the energy sector in a way that achieves the national objectives. The role of the MEMR is to define policy, fix tariffs, and regulate all activities impacting the energy sector. The MEMR is responsible for all activities related to the exploration and development of minerals and hydrocarbons (RSS and FES, 2011). In light of the

electricity sector restructuring process, the Ministry is responsible for the comprehensive planning process of the sector, establishing the overall plans, and ensuring their implementation in accordance with the general objectives of the energy sector.

The 2002 General Electricity Law mandates the MEMR to propose policies to the Council of Ministers for approval and to engage and cooperate with other countries to foster electricity trade. The most important objective is providing energy, in its various forms, for the development process, the management of energy, and attracting international capital for investment in this field, especially generation of electric power, production of oil derivatives, transportation of oil and gas, and utilization of local energy sources. MEMR is also tasked with adopting measures necessary to ensure secure and dependable electricity deliveries, including the provision of supplemental electricity generation in cases of prolonged shortfalls (MEMR, 2003; MEMR, 2016).

The **Ministry of Environment** was established pursuant to the 2003 Temporary Environmental Protection Law No. 1. It is the competent entity to manage and protect the environment of Jordan. The ministry is in charge of designing and implementing environmental policies in Jordan. There is a strong trend toward bringing environmental standards into line with international norms. MOE has a strong focus on the water sector, which is a high energy-consuming sector and a high emitter of carbon.

The **Ministry of Planning and international Cooperation** (MOPIC) works with MEMR, reviews energy sector plans and incorporates them into the national planning process. MOPIC also coordinates foreign borrowing requirements for development projects.

The **Ministry of Finance** (MOF) is responsible for designing Jordan's fiscal policy and supervises its implementation, steering government investments in line with 17 fiscal policies. It also manages internal and external governmental debt and, in cooperation and coordination with the Central Bank of Jordan and related institutions, achieves integration between fiscal and monetary policies to support the national economy.

The **Ministry of Health** is accountable for the protection of public health in Jordan. It is also responsible for monitoring water and food quality to ensure their safety and adequacy for human consumption.

The **Ministry of Water and Irrigation** is responsible for water protection and prevention of pollution; modernizing and implementing water policies; execution of water projects; and caring for and defending Jordan's water rights in the region.

The **Ministry of Agriculture** is responsible for protecting environmental elements such as soil, flora, and fauna, and monitoring the quality of local and imported food products, pesticides, and insecticides sold on the local market to ensure that they meet Jordanian Standards and do not contain material harmful to the environment and human health.

The **Ministry of Municipal and Rural Affairs** has responsibility for planning urban and rural areas (zoning), providing construction licenses, and collecting solid waste.

The **National Electric Power Company (NEPCO)** is a successor of the Jordan Electricity Authority (JEA), an autonomous governmental institution established under the Jordan Electricity Authority Law in 1967. The task of JEA was to operate the generation, transmission, and distribution of electricity in non-concessional areas (Marei, 2016). In September 1996 JEA was converted to a public share-holding company wholly owned by the government called the National Electric Power Company (NEPCO). This company replaced the Jordan Electricity Authority and continued to operate until the creation of the Electricity Provision Law. This law allowed for a restructuring of the electricity sector, separation of the various components of electricity production, and greater private investment.

In 1999 NEPCO was restructured into three companies based on activity:

- Transmission Company: NEPCO currently acts as a single buyer of electricity in Jordan, which means it purchases electricity from different sources and sells it to distribution companies.
- Generation Company: Central Electricity Generation Company (CEGCO), privatized in 2007.
- Distribution Company: Electricity Distribution Company (EDCO), privatized in 2009.

The **Electricity Sector Regulatory Commission (ESRC)** is an independent institution and has a range of tasks. It fixes electricity tariffs and the charges for services related to the sale of electricity. It arbitrates between operators and electricity customers to find solutions that are as amicable as possible. It mediates between power generators or operators of distribution networks in the event of disagreement. Its overriding principle in all matters relating to the electricity sector is to ensure the interests of the public (GTZ, 2007). Further competencies of the ESRC are to review and set up of tariffs and costs. These activities are the heart of a regulator's function and are crucial for protecting consumers and facilitating investment. The General Electricity Law provides the ESRC with considerable independence from the government and other stakeholders. This characteristic, which is crucial for achieving effective governance and regulation, enhances the

credibility of the government of Jordan in the eyes of the investors who are afforded considerable protection as a result of such autonomy (OGEL, 2013).

In 2001 the Electricity Regulatory Commission (ERC) was established to fulfil the government targets of attracting private investment and carrying out the electricity sector restructuring program which aims to unbundle its main activities (ERC, 2011). In 2014 Law No. (17) was issued to merge the Electricity Regulatory Commission (ERC), the Jordan Nuclear Regulatory Commission (JNRC), and the regulatory activities of the Natural Resources Authority (NRA) into the Energy and Minerals Regulatory Commission (EMRC). EMRC is an autonomous Regulatory Authority reporting directly to the Minister of Energy and Mineral Resources.

The ***Energy and Minerals Regulatory Commission*** (EMRC) According to the 2014 Law No. (17) on the restructuring of institutions and governmental organizations, EMRC is a governmental body that possesses a legal personality with financial and administrative independence; in terms of its regulatory tasks, it is considered to be the legal successor of the Electricity Regulatory Commission (ERC), the Jordan Nuclear Regulatory Commission (JNRC), and the Natural Resources Authority (NRA). In December 2012 EMRC announced the introduction of a feed-in tariff system for net metering; this was designed to reduce energy demand and to allow the sale of surplus energy back to the national grid. This is the first feed-in tariff implemented in the Middle East. The EMRC later issued wheeling regulations designed to enable and regulate off-site renewable energy production and on-site consumption by private off-takers. This market, although in its infancy, is particularly active (Davies et al., 2016).

The ***Standards and Metrology Organization*** is entrusted with ensuring the health and safety of Jordanians and protection of the environment through the issuance of national standards and ensuring that local and imported products also comply with these and any other technical regulations adopted by the Organization for that purpose.

The ***Nuclear Regulatory Commission*** aims to i) regulate and monitor the use of nuclear energy and ionizing radiation, ii) protect environment and human health and property from the hazards of radiation and related pollution, and iii) ensure the availability of conditions and requirements of general safety, radiation protection, and nuclear safety and security. Under Article 5 of the same Law, the Commission is responsible for granting licenses and permits for nuclear facilities, radiation institutions, and workers operating in the radiation and nuclear fields.

The ***Executive Privatisation Commission*** (EPC) was established in 1996 to reduce the government's involvement in direct production activities through the restructuring and privatization of public institutions or enterprises owned by the

public sector. Its activities included the unbundling of the Jordanian power and utility sector.

The ***Royal Administration for Environmental Protection*** introduced the concept of environmental security by applying and implementing policies and national legislation to protect the Jordanian environment. The administration derives its authority from the eighth and ninth articles of the Criminal Procedure Code. The administration acts as police officers authorized to track environment-related crimes and enforce the laws of the Kingdom.

The ***National Energy Research Center (NERC)*** was established in 1998 to promote scientific research in the fields of renewable energy sources and efficient energy use. The Center is also tasked with exploring the potential use of oil shale, readily available in Jordan, for energy. NERC is also responsible for training and the technology transfer in the above-mentioned research areas. NERC cooperates with, among others, the Ministry of Energy and Mineral Resources (MEMR), the Royal Scientific Society, and the Natural Resources Authority. The energy minister also acts as Chair of the Center (GTZ, 2007).

Electricity generation and distribution companies

The ***Central Electricity Generating Company (CEGCO)*** is a public shareholding company founded in 1999 that generates electricity and sells electricity wholesale to the National Electric Power Company. The generating capacity of the company was 1,392 MW at the end of 2015 (MEMR, 2015).

The ***Samra Electric Power Generating Company (SEPGCO)*** is a private shareholding company founded in 2004 whose shares are wholly owned by the government. The company is responsible for generating electricity and selling it to NEPCO. The generating capacity of the company reached around 1059 MW at the end of 2015 (MEMR, 2015).

National Electric Power Company (NEPCO) is a public shareholding company owned by the government and responsible for the construction, operation, and maintenance of the transmission system in Jordan as well as the electric transmission system that connects the system with other neighboring countries' systems. It also secures power supply through expansion of generating units by the private and/or public sector (MEMR, 2015). In Jordan, the electricity market follows the single-buyer business model where a central entity, namely, NEPCO buys electricity from all the generating companies and then resells it to distributors or wholesale traders. Thus, NEPCO, a governmental entity, acts as a single buyer and a single bulk seller of electrical power (OGEL, 2013).

The ***Jordanian Electric Power Company (JEPCO)*** is a public shareholding company licensed for 20 years. JEPCO is responsible for distributing electricity in the Zarqa, Ma'daba, and Balqa governorates excluding the Central Jordan Valley (MEMR, 2015). In 2007 JEPCO's assets amounted to JOD 362 million, while the total equity was JOD 96 million and liabilities totaled JOD 266 million (ESMAP, 2010). The Jordanian Social Security Corporation (SSC) holds 8% of the company. When this state-owned power companies were privatized, the government took a minority shareholding in JEPCO and CEGCO (ESMAP, 2010). In 2012 the company experienced losses of over US\$400 million due to the interruptions in the gas supply from Egypt (Al Jazeera, 2012). The government renewed its concession to JEPCO in 2013 for an extended time period of 20 years.

The ***Irbid District Electricity Company (IDECO)*** is a public shareholding company responsible for distributing electricity in the Irbid, Mafraq, Jerash, and Ajloun governorates excluding the Northern Jordan Valley and Eastern areas. The company was granted a 25-year license in 2008 (MEMR, 2015). In 2007 IDECO went through a privatization process in which the Kingdom's Electricity for Energy Investments Company (KEC) acquired the government's 55.4% stake in the company. In mid-2009 KEC transferred the ownership of its shares in IDECO to the Electricity Distribution Company (EDCO). Since the acquisition of its shares by KEC, IDECO has been enhancing its service capacity, quality, and offerings, supplying Jordan's energy market with essential electricity utility services to meet the growing electricity demands of various economic sectors to support the national economy. The concession area of the company includes the governorates of Mafraq and Irbid and Jerash and Ajloun, and some parts of the Balqa governorate, where the concession area covers an area of about 23,000 km², around (26%) of the area of the Kingdom.

The Electricity Distribution Company (EDCO) is a public shareholding company responsible for distributing electricity outside the concession areas of JEPCO and IDECO, namely, in the Southern, Eastern, and Jordan Valley areas. The company was granted a 25-year license in 2008 (MEMR, 2015).

Civil society organizations

Civil society organizations (CSOs) have been playing a prominent role in spreading environmental awareness through outreach programs. They have been successful in terms of adding environmental content to school curriculums and creating environmental social clubs. CSOs also been working to find a sustainable balance between economic development and the protection of the environment. They have been very active in managing environmental matters and affairs, and addressing environmental problems and challenges in collaboration with government agencies (Al-Sharari S., 2014).

The ***Royal Society for the Conservation of Nature (RSCN)***. The Ministry of Agriculture delegated the responsibility for nature reserve management in the Kingdom and protection of the country's wildlife to RSCN. The society is also responsible for implementing the International Convention on International Trade in Endangered Species (CITES) that prevents the trafficking of endangered wildlife (plants and animals facing extinction). It also manages and controls hunting areas and provides hunting licenses.

The ***Jordan Environment Society (JES)***: The primary objective of JES is to protect the environment and its basic elements (water, air, soil, and wildlife). JES collaborates with other organizations and concerned individuals and specialists to identify environmental problems and find solutions to them. It also works toward the adoption of policies and the application of necessary standards and procedures to protect the environment, and control pollution in the country. It promotes environmental awareness to all sectors of society and helps create individual and national commitment to preserve the environment and address environment-related issues.

The ***Jordanian Society for Desertification Control and Badia Development***. The main objectives of the society are to conduct research and studies to determine the causes of desertification, develop and implement solutions to combat desertification, and protect agricultural land and the wildlife affected by desertification in order to maintain environmental balance. It also oversees the construction of dams in the Jordanian deserts for water harvesting.

The ***Friends of the Environment Society of Jordan*** aims to create an environmentally conscious generation. It works mainly with schools to increase environmental awareness on the part of young school children. The society collaborates with the private sector, government organizations and other non-profit societies to address Jordan's chronic environmental issues and to reach sound comprehensive outcomes.

3.1.5 Participatory governance framework

A set of laws and regulations govern and regulate relations between the authority and society. Some still require amendments to bring them into line with international standards and best practices, especially in the field of protecting and improving human rights. Amendments to the legal, judicial, and administrative protection of human rights, human dignity, and fundamental freedoms are needed. The legislative system of Jordan recognizes the right to information and participation, and also the duty of accountability.

Right to information and participation. The Jordanian Constitution, international and regional conventions, and national laws demonstrate how this right is regulated. In Jordan any legal rule based on the Constitution is paramount, followed by international conventions, ratified by the Jordanian State, and then national laws (NCHR, 2008).

Article 15 of the Constitutional Regulation of the Right to Access Information and participation is dedicated to freedom of expression (NCHR, 2008):

- \ The state shall guarantee freedom of opinion. Every Jordanian shall be free to express his/her opinion by speech, in writing, or by means of photographic representation and other forms of expression, provided that such does not violate the law.
- \ Freedom of the press and publications shall be ensured within the limits of the law.
- \ Newspapers shall not be suspended from publication nor shall their permits be revoked except in accordance with the provisions of the law.
- \ In the event of the declaration of martial law or a state of emergency, a limited censorship on newspapers, publications, books and broadcasts in matters affecting public safety and national defence may be imposed by law.
- \ Control of the resources of newspaper shall be regulated by law.

Article 17 of the Constitution provides that: "Jordanians are entitled to address the public authorities on any personal matters affecting them, or on any matter relative to public affairs, in such a manner and under such conditions as may be prescribed by the Law."

These two articles represent a positive commitment by the state to freedom of opinion for every Jordanian as well as the right to address public authorities. The latter invariably involves demands by Jordanians to access information that touches upon them individually or that are related to public affairs. Thus, the provisions of Articles 15 and 17 constitute a major citation source for the legal establishment of the foundation of the individual right to access information (NCHR, 2008).

The international conventions ratified by the Hashemite Kingdom of Jordan, which regulate the right to access information and participation are based on the following documents (NCHR, 2008):

- \ International Convention on Civil and Political Rights;
- \ The Arab Charter on Human Rights;
- \ Convention on the Rights of the Child;
- \ United Nations Anti-corruption Convention.

According to the National Legal Organization of the Right to Access Information and participation in the area of ordinary laws, it may be said that, on the basis of the aforementioned Article 15 of the Jordanian Constitution, several press and publications laws have been promulgated emphasizing the right to an opinion and to self-expression and regulating the work of newspapers (NCHR, 2008).

Right to accountability: to ensure transparency and accountability, local and international human rights groups are allowed to investigate allegations of human rights abuses and can publish and disseminate findings critical of government policy. The International Committee of the Red Cross is granted permission to visit prisoners and assess the condition of detainees. Moreover, local groups such as the Arab Organization for Human Rights and the Peace Center for Humanitarian Studies are registered with the government and have raised human rights cases with government officials.

Article 27 of the Jordanian Constitution states: “The Judicial Power is independent and shall be exercised by the courts of law in their varying types and degrees. All judgments shall be given in accordance with the law and pronounced in the name of the King.”

Article 97 of the Jordanian Constitution states: “Judges are independent and, in the exercise of their judicial functions, are subject to no authority other than that of the law,”

Article 101 of the Jordanian Constitution states: “The courts shall be open to all and free from any interference in their affairs and every civilian may not be tried in a criminal case before a court whose judges are not all civilians, with the exception of crimes of high treason, espionage, terrorism, drug crimes and counterfeit currency. Courts hearings shall be public, unless the court decides that they should be secret in the interest of public order or morals. In all cases, the verdict shall be pronounced during a public session. The accused is innocent until proven guilty.”

4 CONCLUSION

The Jordanian government is aware of the importance of achieving sustainable development, including social development, economic growth, and conservation of natural and environmental resources. It has also identified major targets to reach equitable green growth, such as increased reliance on local energy sources, an increased share of renewable energy sources in national primary energy production, and increased investment in renewable energy sources. However, there are a number of socioeconomic, political, and environmental challenges.

Socioeconomic development in Jordan is faced with challenges like the lack of competitiveness of local industries in the global market, need for improved employment opportunities for population groups like women and young people, for economic diversification and development of a stronger private sector. Currently the majority of Jordanians are employed by public services, tourism, defense, and the informal sector. Another challenge is the growing government debt: the country's energy security policy, including expensive fossil fuel imports and extensive subsidies, is the major driver of this debt increase. Other reasons are the consequences of the global economic crisis, political unrest in the MENA region, and increasing commodity prices. The trade deficit has been also increasing during recent years due to the increased costs of energy imports. Despite the relatively high absorptive capacity of the Jordanian economy due to its relatively high stock market capitalization, Jordan is experiencing a decline in foreign direct investment resulting from economic insecurity in the region during the last decade.

In the political area, while Jordan has one of the most advanced political systems in the region, further improvements are still needed to address such challenges as gender equality and exclusion of minority groups, which are underrepresented in the government, public office, the parliament, and the military. There are a number of laws restricting mobility for women as well as a quota system limiting the participation in public affairs for national and religious minority groups.

Jordan's most acute environmental challenge is its severe water scarcity. Jordan is the fourth water-poorest country globally, suffering from erratic rainfall. The risk of water insecurity in the country is also very high and there is a probability of the rate of precipitation declining to 15% by 2100 and even of complete depletion of the country's aquifers by 2030. This situation is caused not only by climate change but also by unsustainable water usage, even though Jordan is a world leader in wastewater treatment for irrigation and urban water supply. For instance, agriculture accounts for 64% of water usage but only 3% of GDP. The energy sector can also reduce pressure on water resources by utilizing less water intensive technologies such dry cooling and cleaning systems, and by switching from fossil

fuels to renewable energies. Currently more than half of the country's water resources is wasted due to inefficient use such as illegal wells and exploitation of groundwater. Despite water scarcity, access to water is almost universal and non-discriminating in terms of place of residence and income.

Although Jordan's CO₂ emissions are significantly lower than those of other MENA countries, additional measures must still be implemented to reduce greenhouse gas emissions in the country. A mechanism to control and enforce implementation of national greenhouse gas emission limits is needed. Land and soil degradation due to wind erosion is another challenge in Jordan. The productivity of land resources will be also severely reduced due to salinization and waterlogging, resulting into degradation of 80% of land into semi-arid and arid areas. Increasing severe events such as heatwaves and droughts will also lead to increased desertification and pose a threat to the Jordan River valley. Air pollution and quality as well as hazardous waste management are other environmental challenges. Waste management is also insufficient.

Economically, the energy sector is a major challenge to the Jordanian economy because of the country's reliance on energy imports, and the connected uncertainty of supply and the fluctuation of prices. Imports of fossil fuels such fluctuations in imported energy supply pose significant challenges for Jordan, increases the country's electricity bill and also threatening its energy security. Energy imports in Jordan are heavily reliant on the political stability of neighboring exporting countries. For example, Jordan was previously reliant on gas imports to meet energy demand, but was forced to switch to more expensive oil imports when gas imports were seized during the Arab spring.

Currently almost all Jordanian energy needs are covered by imported oil and gas, which consumes around 19% of Jordanian GDP. Jordan's own oil reserves are negligible with less than one billion barrels in total, while and natural gas reserves amount to some 60.7 billion m³. Expensive energy imports have added to the increasing government debt, which in 2014 exceeded compared with the rest of the MENA region, and place significant pressure on the government budget. Economic growth needs to be urgently decoupled from fossil fuel consumption. For instance, during the last decade fossil fuel energy consumption grew much faster than GDP. Energy demand in the country is growing steadily due to population growth (including an increasing number of refugees and immigrants) the increase in living standards and the need for electricity for cooling and, potentially, water desalination. Electricity consumption is growing at a rate of over 7% annually and will triple by 2030. Private households and public buildings consume the highest share of electricity, followed by industries, services, water pumping systems, and street lighting.

There are plans to diversify the energy supply by drawing on such sources as the gas reservoir in the Mediterranean Sea and the Risha field, close to the border to Iraq. These plans also include deployment of such technologies as liquefied natural gas and energy imports from Israel. However, the feasibility of these plans is currently uncertain. The deployment of nuclear energy is also problematic due to difficulties involved in finding suitable sites, public protests, and limited uranium reserves. Energy imports from Egypt are also unreliable due to political instability and the fact that Egypt needs to meet its own growing energy demand. The government of Jordan aims to reduce energy imports by 42% in 2020 by expanding the renewable energy sector (10%), installing nuclear energy plants (6%), and the deployment of oil shale (14%) resources. The current state of electricity grid, however, is one of the major barriers to scaling up electricity generation to meet growing electricity demand. Despite the overall limited transmission capacity, the majority of the grids do not exceed 132 kV and there is only one grid with 400 kV. The distribution network is well established and serves 99% of the Jordanian population. Currently, the grid is being expanded to meet rising demand. However, it still needs to be upgraded significantly with an additional expansion of 1,000 MW. Currently, electricity in Jordan is generated domestically to a large extent from imported fossil fuels. In 2012 more than 82% of electricity was produced via imported oil resources and 12% via imported natural gas. Despite favorable geographical conditions only 2% of electricity in Jordan was produced from renewable energy resources.

To address existing challenges, which to a large extent are connected with electricity generation or influence it, the Jordanian government has developed a number of strategies. The Jordanian Energy Strategy focuses mainly on the deployment of shale oil, nuclear energy, and solar and wind energy to diversify its energy portfolio and reduce import dependency. The National Strategy for Development of Renewable Resources foresees exploitation of renewable energy sources as a key priority and sets the target of reaching 10% of renewable energy in the total primary energy mix by 2020. The strategy also aims to transform Jordan from energy importer to energy exporter by 2030. The National Energy Efficiency Strategy has the main objective of reducing energy consumption without reductions in living standards, including such measures as exemption of equipment–energy savers from sales tax and customs duties to encourage the use of energy saving equipment, as well as national building codes to encourage thermal insulation.

Following these targets, the Jordanian government expects to commission through power purchase agreements several megawatts of solar and wind energy projects and to develop support mechanisms for private investment in renewable energy projects. It is also currently executing several new electricity generation projects. In 2014 the Ministry of Environment and Mineral Resources (MEMR) announced plans to commission 1,800MW of new solar and wind power capacity by 2018. Currently,

300MW of solar power projects and 200MW of wind power projects have been approved, for example, the 117 MW Talifa wind farm, which is the first commercial utility-scale wind power project in the Middle East. Further solar plants have been approved for the Southern Ma'an region and the Sahara Forest Project located in Wadi Araba.

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