Economics of Energy & Electricity Consumption in Jordan

How and Why Should We Care?

August 2018

منتدى الاستراتيجيات الأردني
JORDAN STRATEGY FORUM

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The Jordan Strategy Forum (JSF) is a not-for-profit organization, which represents a group of Jordanian private sector companies that are active in corporate and social responsibility (CSR) and in promoting Jordan's economic growth. JSF's members are active private sector institutions, who demonstrate a genuine will to be part of a dialogue on economic and social issues that concern Jordanian citizens. The Jordan Strategy Forum promotes a strong Jordanian private sector that is profitable, employs Jordanians, pays taxes and supports comprehensive economic growth in Jordan.

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@JSFJordan
/JordanStrategyForumJSF
Jordan Strategy Forum

Amman, Jordan
T: +962 6 566 6476
F: +962 6 566 6376

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1. Background

No one can argue that energy is not part and parcel of modern life. Energy resources are consumed for the services they provide. Among others, energy is used to heat, cool, and light buildings, power industries, and to fuel transport systems. Within the context of the socio-economic importance of energy, and notwithstanding the fact that the uses of energy can impact health and the environment in negative manners, access to sufficient, affordable, secure, safe, and clean energy is beneficial for human mankind.

In a recently published report by the World Energy Council (2017), it is stated that the "energy industry is facing decades of transformation". The energy industry's new world, it is argued, will be characterized by several factors including "lower population growth, radical new technologies, greater environmental challenges, and a shift in economic and geopolitical power". These factors will re-shape the economics of energy. Based on these observations, the World Energy Council's main findings are quoted below.

1. **THE WORLD'S PRIMARY ENERGY DEMAND GROWTH** will slow and per capita energy demand will peak before 2030 due to unprecedented efficiencies created by new technologies and more stringent energy policies.

2. **DEMAND FOR ELECTRICITY** will double to 2060. Meeting this demand with cleaner energy sources will require substantial infrastructure investments and systems integration to deliver benefits to all consumers.

3. **THE PHENOMENAL RISE OF SOLAR AND WIND ENERGY** will continue at an unprecedented rate and create both new opportunities and challenges for energy systems.

4. **DEMAND PEAKS FOR COAL AND OIL** have the potential to take the world from "Stranded Assets" to "Stranded Resources".

5. **TRANSITIONING GLOBAL TRANSPORT** forms one of the hardest obstacles to overcome in an effort to decarbonize future energy systems.

6. **LIMITING GLOBAL WARMING** to no more than a 2°C increase will require an exceptional and enduring effort, far beyond already pledged commitments, and with very high carbon prices.

7. **GLOBAL COOPERATION, SUSTAINABLE ECONOMIC GROWTH, AND TECHNOLOGY INNOVATION** are needed to balance the Energy Trilemma.

As one might expect, the global and local energy and electricity consumptions have been increasing at some alarming rates. For example, global primary energy consumption has increased from 3.7 trillion tons of oil equivalent to more than 13 trillion tons by the end of 2017. Similarly, global electricity generation has increased from 9882 terawatt-hours in 1985 to 25551 hours by the end of 2017.

At the local level, Jordan's experience also reflects some marked increases in primary energy and electricity consumption. For example, primary energy consumption has increased from 3605 tons of oil equivalent in 1992 to 10009 tons by the end of 2017. Jordan's electricity consumption also increased from 877 gigawatt hours in 1980 to more than 17570 hours by the end of 2017.

Relative to all of the above-mentioned observations and arguments, it is useful to note that for so long, energy and electricity have attracted the attention of academia, think tanks, international organizations, and other stakeholders. Indeed, in the professional economics literature, there are many journals that publish research articles about the "economics of energy". To name but a few, these include **"ENERGY ECONOMCS", "RESOURCE and ENERGY ECONOMICS", "THE ENERGY JOURNAL", ECONOMICS of ENERGY and ENVIRONMENTAL POLICY",**

"INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY", and many others.

As expected, the subject matter of the **"economics of energy"** deals with many research issues. However, it can be argued that the overriding objective of the scholarly effort is to understand how energy resources are allocated within society, especially to power society's productive abilities. This is why, for example, the relationship between energy and electricity consumption and real economic growth has been examined in so many research papers. Even the World Bank has published a paper entitled "Energy, Economic Growth, and Poverty Reduction / A Literature Review" (Bacon and Kojima, 2016)!

"Energy is at the heart of development. Without energy, communities live in darkness, essential services such as clinics and schools can barely function, and businesses operate under crippling constraints. Energy also makes possible the investments, innovations and new industries that are the engines of jobs and growth for entire economies" (World Bank).

"Globally, the energy sector is going through a revolution. Renewable energy costs have dropped precipitously in the last ten years, and energy storage such as batteries are starting to show the same pattern. The world now adds more renewable power capacity annually than it adds in net new capacity from all fossil fuels combined. Disruptive technologies are starting to be widely deployed, such as smart grids, smart meters and geospatial data systems that have upturned energy planning" (World Bank).

In this Analytical Paper, the JSF examines the issue of energy and electricity consumption in Jordan.

1. We provide some basic information about global, regional and local primary energy and electricity consumption. In addition, we provide some further information about the share of energy and electricity consumptions by type of fuel.

2. We provide some information about Jordan's primary energy and electricity consumption. We also provide some further information about the share of energy and electricity consumptions by type of fuel.

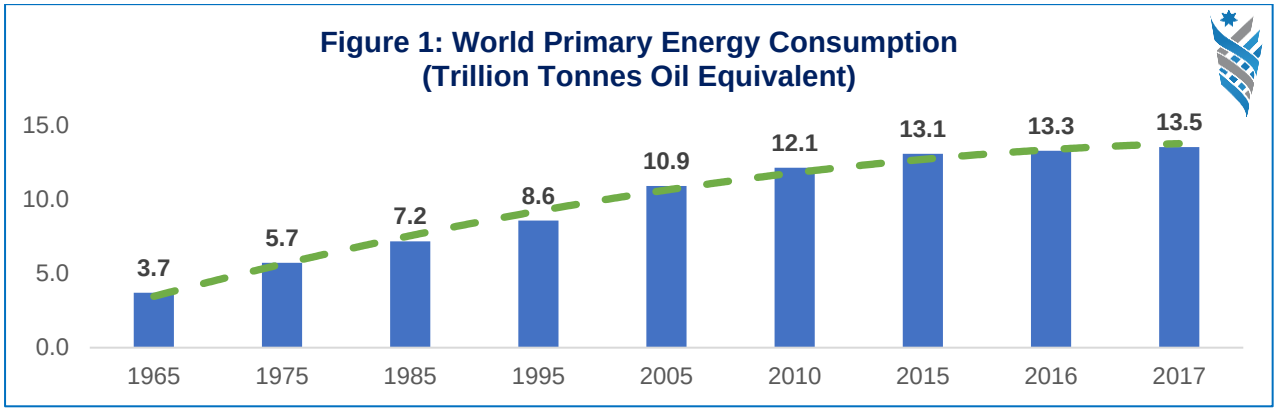
3. We examine the impact of total electricity consumption, total industrial electricity consumption, and total commercial electricity consumption on economic growth.

4. Based on the arguments, observations, and the empirical results, we provide some recommendations whose objective is to enhance the economic role of electricity consumption in the Jordanian economy.

2. Energy & Electricity Consumption: Global Observations

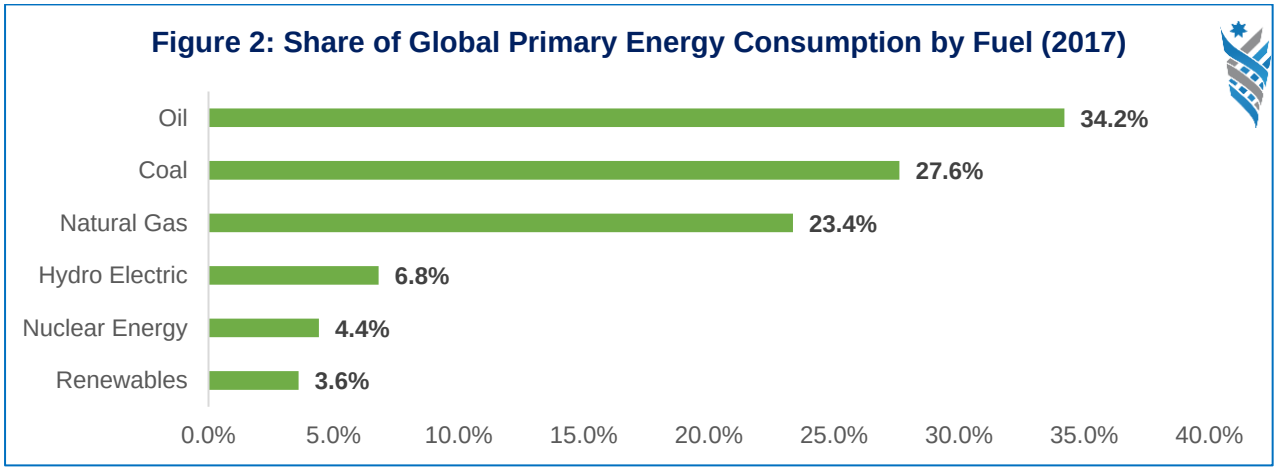
The world has witnessed some remarkable increases in energy and electricity consumption. Moreover, the shift in the type of fuel that generates the consumed energy and electricity has also been remarkable. What follows are observations about these statements.

A. At the global (world) level, primary energy consumption ("direct use at the source, or supply to users without transformation, of crude energy, that is, energy that has not been subjected to any conversion or transformation process") has increased from 3.7 trillion tons of oil equivalent to more than 13 trillion tons by the end of 2017 (Figure 1). During the period 2010-2017, the mean annual increase in this consumption was equal to 2.0%.



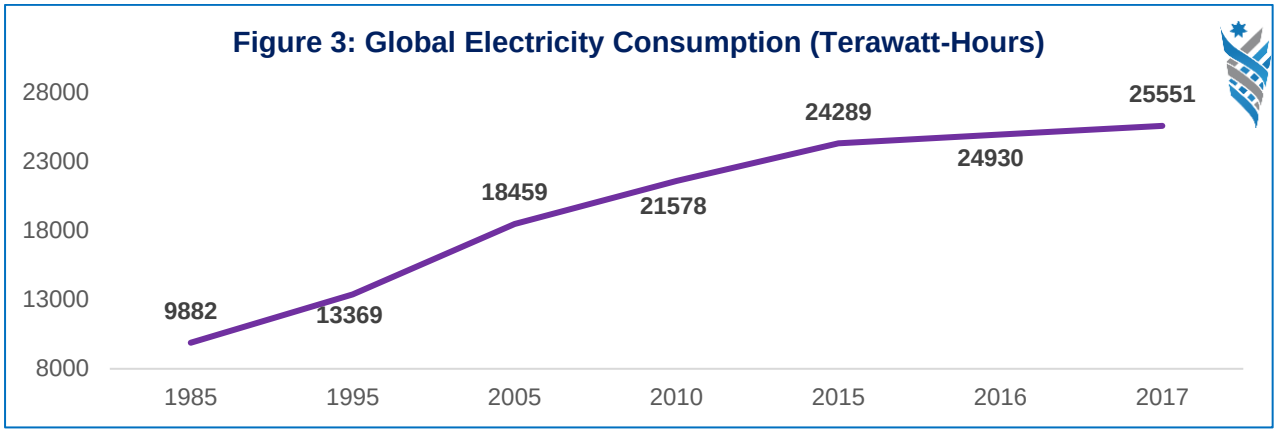
Adapted from BP Statistical Review of World Energy 2018.

B. In 2017, oil and renewables accounted for 34% and 4% of the global primary energy consumption (Figure 2). Renewables, on the other hand, accounted for only 3.6% of total energy consumption.



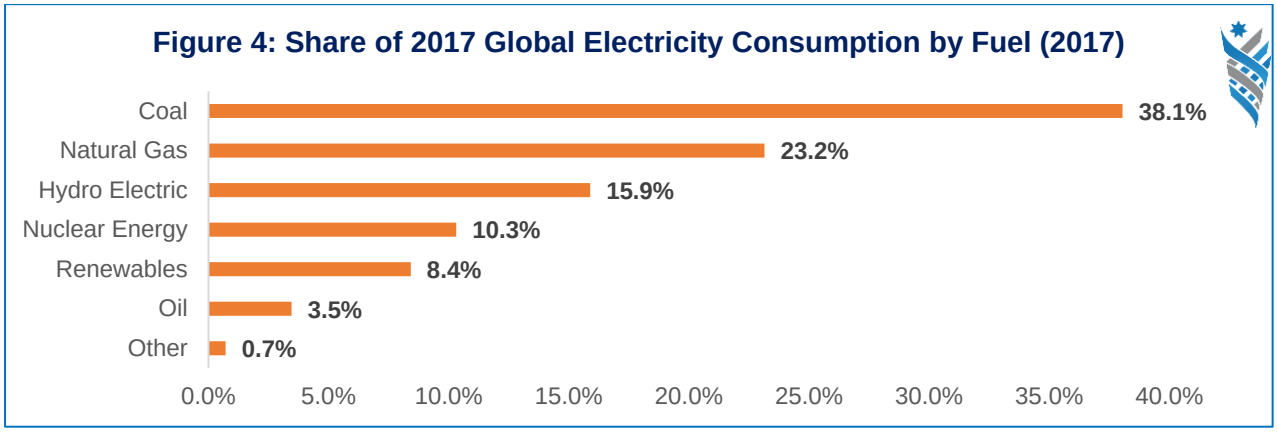
Adapted from BP Statistical Review of World Energy 2018.

C. Global electricity generation has also witnessed some significant increases. In 1985 and 2017 the global generation has increased from 9882 terawatt-hours to 25551 hours by the end of 2017 (Figure 3). During the period 2010-2017, the mean annual increase in this consumption was equal to 2.9%.



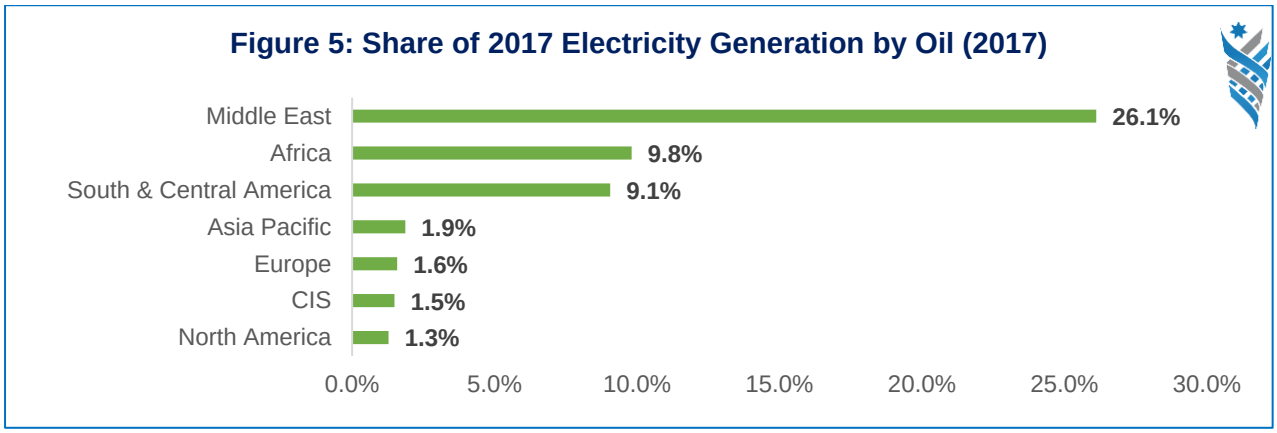
Adapted from BP Statistical Review of World Energy 2018.

D. In 2017, coal and natural gas accounted for about 38% and 23% of the global electricity consumption (Figure 4). Oil, on the other hand, accounted for only 3.5% of total electricity consumption.



Adapted from BP Statistical Review of World Energy 2018.

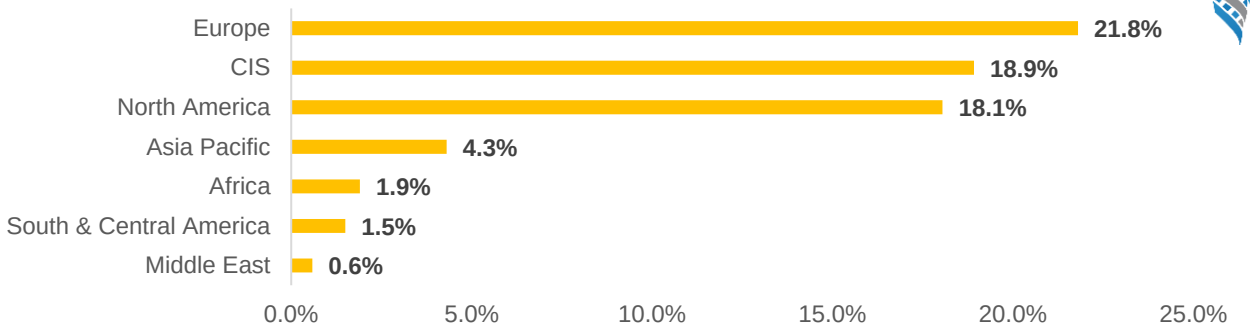
E. Middle Eastern countries are "unique" in their reliance on oil in the generation of electricity. Indeed, 26.1% of their electricity consumption is fueled by oil (Figure 5) and this proportion is much higher than in all other regions.



Adapted from BP Statistical Review of World Energy 2018.

F. Europe, CIS countries, and North America rely on a lot more nuclear energy in the generation of their consumed electricity than other regions (Figure 6).

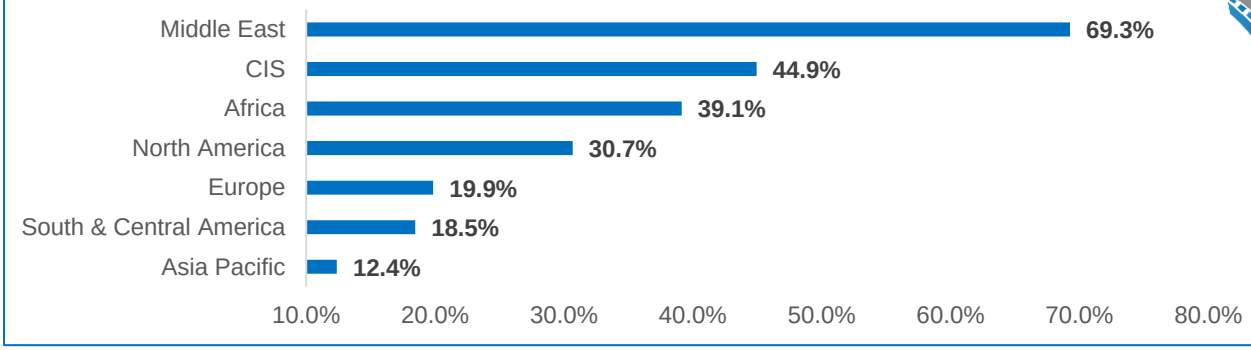
Figure 6: Share of 2017 Electricity Generation by Nuclear Energy (2017)



Adapted from BP Statistical Review of World Energy 2018.

G. On average, the Middle East relies more on natural gas in the generation of their consumed electricity than other regions (Figure 7).

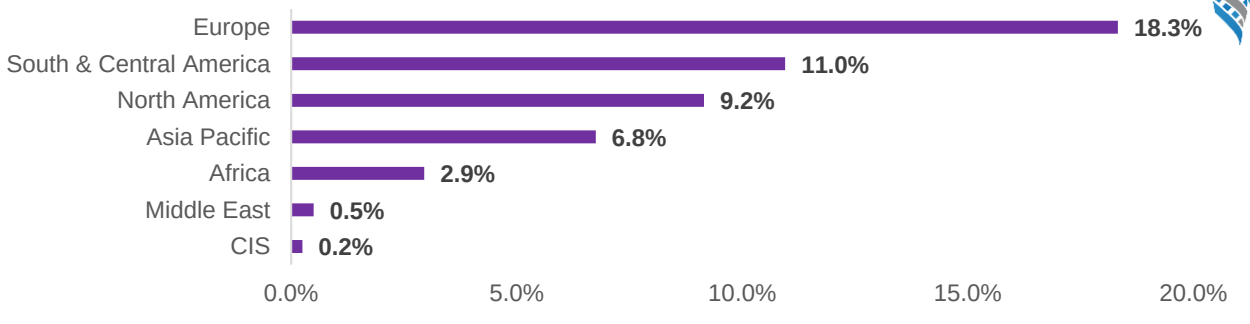
Figure 7: Share of Electricity Generation by Natural Gas (2017)



Adapted from BP Statistical Review of World Energy 2018.

H. Europe is "unique" in their reliance on renewable sources of energy in the generation of electricity.

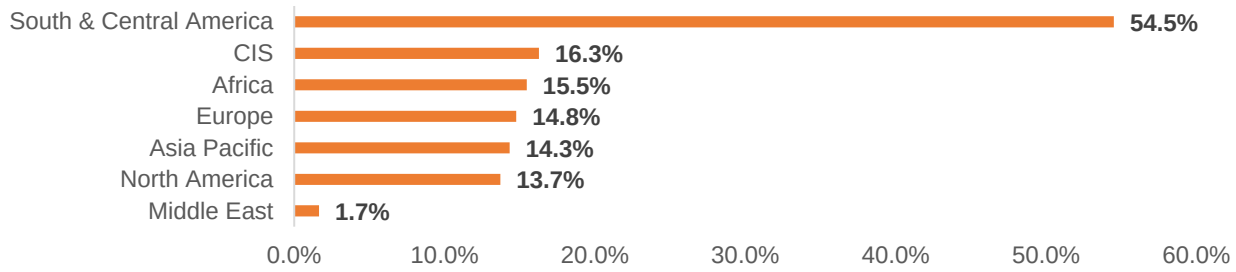
Figure 8: Share of Electricity Generation by Renewables (2017)



Adapted from BP Statistical Review of World Energy 2018.

I. South and Central American countries are "unique" in their reliance on hydro-electric power in the generation of electricity. Indeed, 54.5% of their electricity consumption is generated from this source of energy (Figure 9).

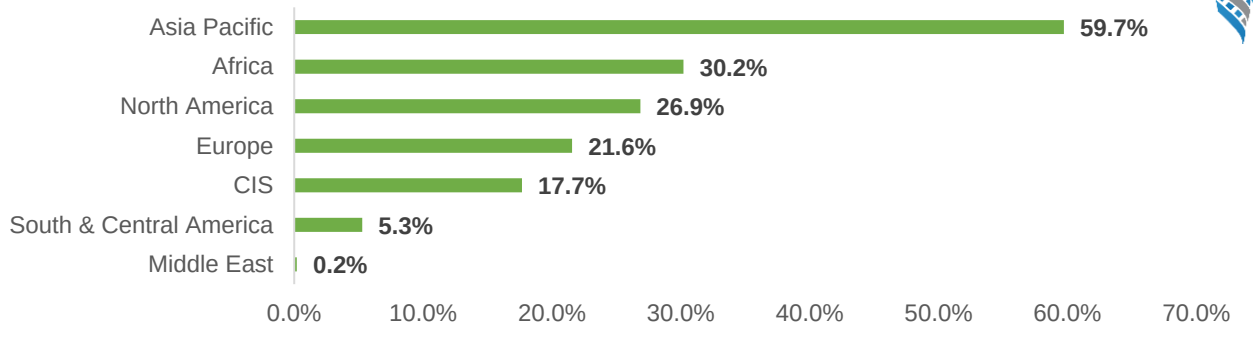
Figure 9: Share of Electricity Generation by Hydro Electric Power (2017)



Adapted from BP Statistical Review of World Energy 2018.

J. The Middle East hardly uses coal in the generation of their electricity consumption. 59.7% of the Asian and Pacific countries' consumption of electricity, on the other hand, is generated from coal (Figure 10).

Figure 10: Share of Electricity Generation by Coal (2017)

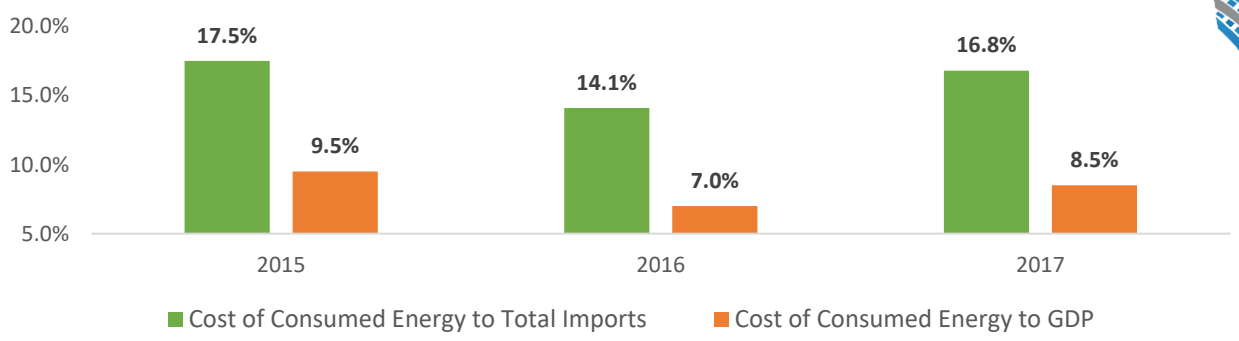


Adapted from BP Statistical Review of World Energy 2018.

3. Energy & Electricity Consumption and Growth: Jordanian Observations

It is commonly known that Jordan faces two energy-related challenges and these are growing demand and limited domestic resources. Indeed, the cost of consumed energy to total imports and to GDP were equal to 16.1% and 8.3% respectively (Figure 11).

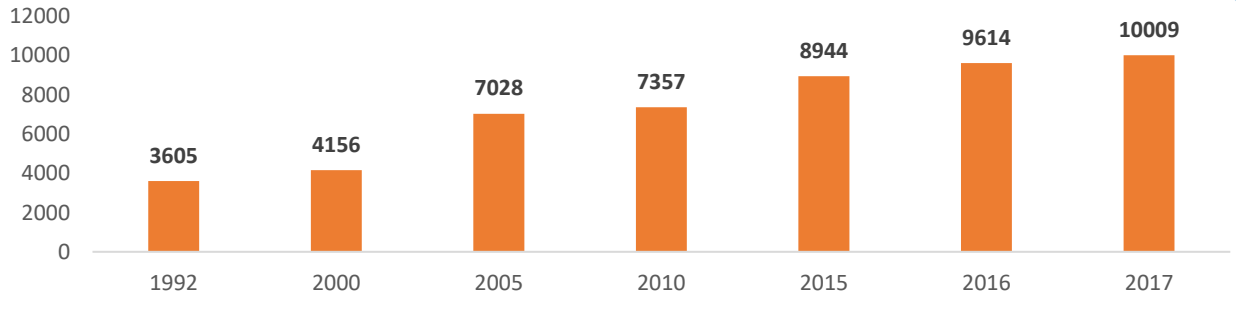
Figure 11: Cost of Energy in Jordan



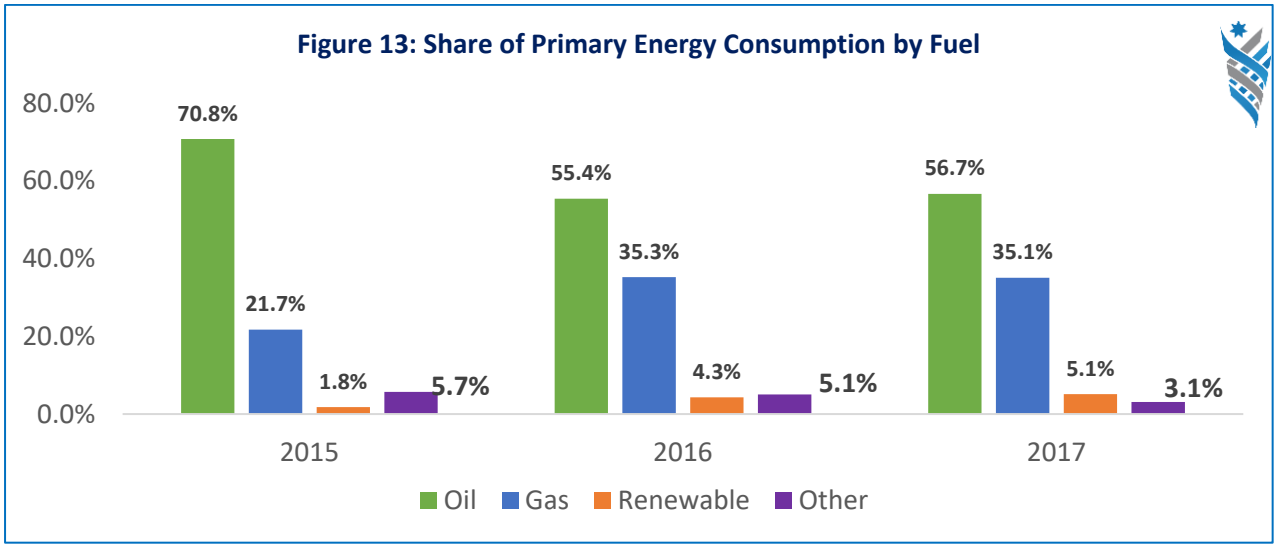
Below, we report some general observations about energy and electricity in Jordan.

A. Jordan's primary energy consumption (ton oil equivalent) has increased from 3605 tons in 1992 to more than 1000 tons by the end of 2017 (Figure 12).

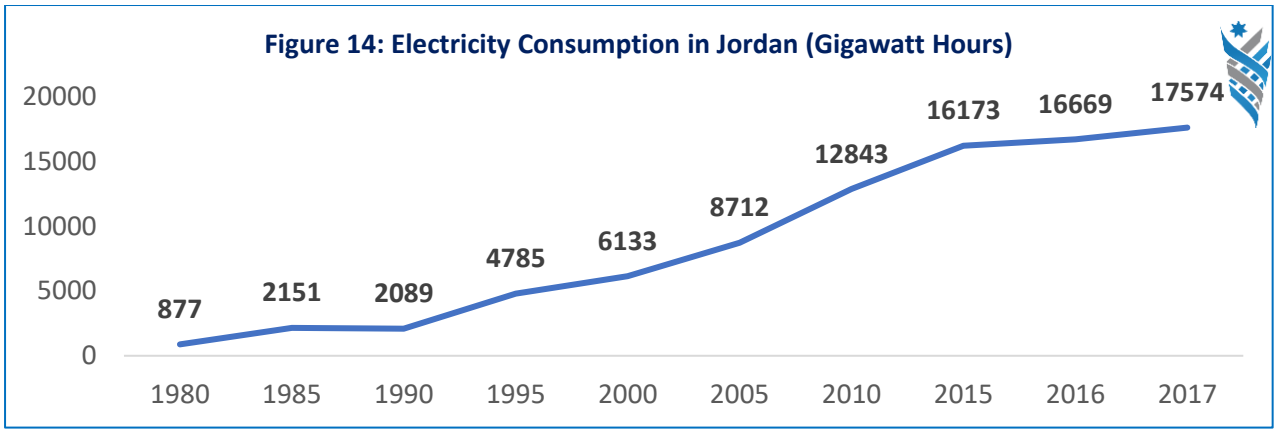
Figure 12: Primary Energy Consumption in Jordan (Thousand ton oil-equivalent)

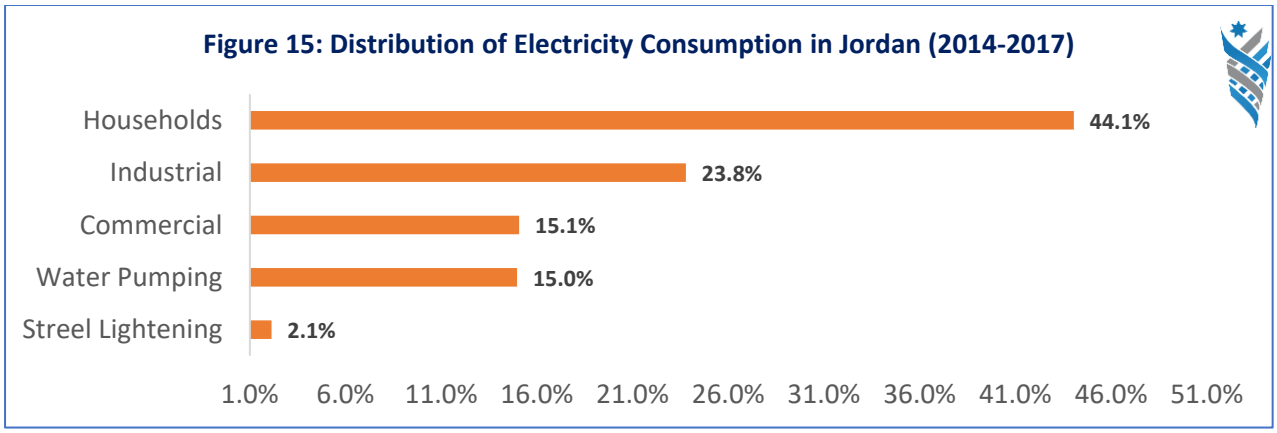


B. Jordan relies heavily on oil and gas in its primary energy consumption (Figure 13). What is encouraging, however, is the fact that the proportion of renewable energy in the consumed primary energy has been increasing, and by the end of 2017, this proportion has passed the 5% mark!



C. Jordan's electricity consumption has increased from 877 gigawatt hours in 1980 to more than 17570 hours by the end of 2017 (Figure 14). During the period 2014-2017, households accounted for about 44% of the total consumption. Street lightening, on the other hand, accounted for 2.1% of this consumption (Figure 15).





To examine the impact of electricity consumption on economic growth in Jordan, we use annual data (1994-2017) of real GDP (RGDP), and electricity consumption (EC). For the technical reader, we outline the basic model, used techniques, and the detailed results in Appendix A.

The results could not be more than encouraging.

A. The impact of electricity consumption on real economic growth is positive. When electricity consumption increases, real GDP increases.

The long-run elasticity between total electricity consumption and growth is equal to +1.379.

The long-run elasticity between industrial electricity consumption and growth is equal to +1.975.

The long-run elasticity between total commercial electricity consumption and growth is equal to +1.017.

B. The relationships between total electricity consumption, total industrial electricity consumption, and total commercial electricity consumption and growth are all stable in the long-run.

C. Total, industrial, and commercial electricity consumptions reflect increasing power in explaining the variability (changes) of real GDP over time.

D. In the short-term, there is no relationship between electricity consumption and economic growth.

4. Summary & Recommendations

In common with many countries around the world, electricity consumption in Jordan is too important not to think about it strategically. Indeed, notwithstanding the fact that electricity consumption promotes real economic growth, Jordan's reliance on oil and gas in generating most of its electricity consumption is a source of "uncertainty" and "cost" to the national economy. Jordan must rely increasingly more on renewable sources of energy. Within this context, it is encouraging that the proportion of renewable energy in the consumed primary energy has been increasing, and by the end of 2017, this proportion has passed the 5% mark! Quick and heavy investments in this sector must start at the earliest possible date.

References

1- Bacon, R. and M. Kojima (2016), "Energy, Economic Growth, and Poverty Reduction / A Literature Review", World Bank Group.

2- World Energy Council (2016), "World Energy / Scenarios 2016".

Appendix A

The Model:

The basic model specifying the impact of electricity consumption (EC) on real GDP (RGDP) is expressed by:

$RGDP_t = \alpha_0 + \beta_1 EC_t + \varepsilon_t$

Both variables are in their natural logarithm form. The focus of the analysis is on the parameter β. If there is an impact of EC on economic growth, the term β will have a positive sign ($\beta > 0$).

We estimate the above model in three versions. The first includes total electricity consumption (TEC). In the second and third versions, we include industrial electricity consumption (IEC) and commercial electricity consumption (CEC) respectively.

In such an exercise, the usual techniques are applied and these include stationarity test, co-integration, Vector Error Correction Model (VECM), and variance decomposition analysis.

The Results:

TABLE 1
Augmented Dickey-Fuller Unit Root Test

	Level	First-Difference	Level	First-Difference	Level	First-Difference
	None		Constant		Constant & Trend	
RGDP	6.458	-1.578***	0.274	-4.242*	-2.008	-4.266*
TEC	3.086	-4.117*	-0.734	-5.139*	-2.976	-5.058*
IEC	5.833	-1.296	-3.432**	-7.942*	-1.424	-4.787*
CEC	2.571	-1.011	-0.630	-3.645*	-0.849	-3.664**

TABLE 2
Johansen Multivariate Co-Integration Test (GDP & EC)

Hypothesized No. of CE(s)	Trace Statistic	P-Value	Max-Eigen Statistic	P-Value
None*	39.223	0.000	31.791	0.000
At most 1	7.432	0.105	7.432	0.105

TABLE 3
Johansen Multivariate Co-Integration Test (GDP & IEC)

Hypothesized No. of CE(s)	Trace Statistic	P-Value	Max-Eigen Statistic	P-Value
None*	23.055	0.020	15.235	0.063
At most 1	7.819	0.089	7.819	0.089

TABLE 4
Johansen Multivariate Co-Integration Test (GDP & CEC)

Hypothesized No. of CE(s)	Trace Statistic	P-Value	Max-Eigen Statistic	P-Value
None*	34.250	0.004	22.895	0.015
At most 1	11.354	0.078	11.354	0.077

TABLE 5
Long Run Relationship (RGD & EC)

Variable	Coefficient
EC	1.379*

TABLE 6
Long Run Relationship (RGDP & IEC)

Variable	Coefficient
IEC	1.975*

TABLE 7
Long Run Relationship (RGDP & CEC)

Variable	Coefficient
CEC	1.017*

TABLE 8
Estimates of VEC Model (RGDP & EC)

Variable	Coefficient	t-statistic
λe_{t-1}	-0.479	-3.723*

TABLE 9
Estimates of VEC Model (RGDP & IEC)

Variable	Coefficient	t-statistic
λe_{t-1}	-0.332	-4.251*

TABLE 10
Estimates of VEC Model (RGDP & CEC)

Variable	Coefficient	t-statistic
λe_{t-1}	-0.261	-2.619*

TABLE 11
Variance Decomposition of EC

Period	RGDP	EC
1	100.000	0.000
2	95.698	4.302
3	92.864	7.136
4	93.211	6.788
5	91.605	8.395
6	90.619	9.380
7	90.241	9.758
8	89.643	10.356
9	89.179	10.820
10	88.865	11.134

TABLE 12
Variance Decomposition of IEC

Period	RGDP	IEC
1	100.000	0.000
2	98.255	1.744
3	88.321	11.678
4	90.352	9.347
5	91.160	8.839
6	86.789	13.211
7	87.227	12.773
8	88.134	11.865
9	86.815	13.184
10	86.561	13.438

TABLE 13
Variance Decomposition of CEC

Period	RGDP	CEC
1	100.000	0.000
2	95.662	4.337
3	95.707	4.292
4	91.504	8.496
5	89.893	10.106
6	88.468	11.531
7	86.845	13.155
8	85.671	14.328
9	84.669	15.330
10	83.743	16.256

Table 14
Pairwise Granger Causality Tests

Null Hypothesis:	F-Statistic	Probability
EC does not Granger Cause RGDP	1.188	0.327
RGDP does not Granger Cause EC	1.662	0.217

Table 15
Pairwise Granger Causality Tests

Null Hypothesis:	F-Statistic	Probability
IEC does not Granger Cause RGDP	1.292	0.299
RGDP does not Granger Cause IEC	0.093	0.912

Table 16
Pairwise Granger Causality Tests

Null Hypothesis:	F-Statistic	Probability
CEC does not Granger Cause RGDP	2.459	0.114
RGDP does not Granger Cause CEC	2.222	0.137

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Tel: +962 6566 6476 Fax: +962 6566 6376
info@jsf.org www.jsf.org
/JordanStrategyForumJSF @JSFJordan