

# Energy Sector in Jordan 2

Crude Oil and Non-Renewable Resources

Jordan Independent Economy Watch



July 2015



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## Contents

Introduction .....	2
I. Dilemma of Energy in Jordan - Causes & Impact .....	3
General Impact .....	4
Impact on Public Sector .....	6
Impact on Private Sector .....	8
II. Petroleum - Domestic Sources & Imports .....	11
Domestic Production .....	11
Imports .....	13
Jordan Petroleum Refinery .....	15
Shale Oil .....	16
III. Jordan's Nuclear Programme .....	20
Uranium Mining .....	21
Nuclear Power Plant .....	22
Nuclear Research Reactor .....	23
Feasibility & Disadvantages .....	23
Conclusion .....	26



## **Introduction**

The energy sector is considered to be one of the most strategic sectors in any economy, as it impacts the cost of most goods and services, albeit to varying degrees. Therefore, a country's access to affordable energy supplies is a crucial driver behind economic growth, which is the reason why many of the modern conflicts and wars were stimulated by disagreements over energy sharing and pricing.

Traditionally, energy was considered to be synonymous with non-renewable energy sources, namely crude oil and the different petroleum products derived from it. However, renewable sources of energy have emerged as an alternative in the past decade. Their emergence was primarily motivated by the sharp rise in oil prices during the 1990s, and was strengthened by environmental concerns. Today, many countries across the world are aiming to increase the share of renewable energy in their total energy mix.

This report intends to shed light on Jordan's energy situation and the impact that energy has on Jordan's economy. This report constitutes the second in a series of reports focusing on different areas of Jordan's energy sector, it focuses on the Kingdom's access to petroleum products, the oil shale sector and Jordan's peaceful nuclear programme. The previous report focused on the kingdom's access to natural gas in addition to the electricity sector of Jordan, while the third and final report of the series will focus on the renewable energy sector and associated legislation.

The first section of the report provides a comprehensive overview of the energy situation in the kingdom, particularly in the period after 2008. It investigates the reasons behind Jordan's energy dilemmas as well as the impact of such dilemmas on Jordan's economy, from the perspectives of both the public and private sectors. The second section will investigate Jordan's domestic petroleum production sector and petroleum imports, in addition to the performance of the Jordanian Petroleum Refinery Company and the Jordanian oil shale sector. The third section provides an account of the Jordanian Nuclear Programme containing all the different information on the different components of the programme. The final section will conclude.

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## **I. Dilemma of Energy in Jordan - Causes & Impact**

The energy sector is considered to be the most critical sector to the performance of the domestic economy, mainly due to the high value of Jordan's energy import bill and its implication on public finances and the private sector. Although Jordan had always relied on external sources to satisfy the majority of its energy needs, the unprecedented developments in the energy sector witnessed over the past five years have exposed the Kingdom's vulnerability to disruptions in energy supplies. This has been compounded by unfavourable regional conditions over the past few years in terms of instability and insecurity. The severe implications of high energy costs have materialised in Jordan's electricity sector, which has been the major source of public finance troubles and the associated dramatic increase in the value of public debt over the past five years.

Before 2003, Jordan used to rely overwhelmingly on oil imported from Iraq at discounted prices, and at that time, oil prices were much lower than their level seen in the past decade. Due to the war on Iraq that took place in 2003 and the associated toppling of the Iraqi regime, Jordan had to resort elsewhere to meet its energy needs. Therefore, two important developments took place at the time: (i) the development of the National Energy Strategy, which aimed at utilising domestic sources of energy, and (ii) the signing of a natural gas import agreement with Egypt to supply the Kingdom with an affordable source of energy, mainly for electricity generation.

The first development stemmed from a realisation that Jordan possesses domestic energy sources (both renewable and non-renewable) which should be exploited. This culminated in the development of the National Energy Strategy, which highlighted the great risk associated with losing access to cheap Iraqi oil and provided a number of different alternatives to invest in and utilise domestic energy sources. Such sources include the huge shale oil reserves present in Jordan's territory, uranium reserves that could be used to generate nuclear energy, domestic crude oil and natural gas production that can be further developed, as well as a range of possibilities to generate power from renewable energy including solar and wind energy.

The second development was the signing of the gas import agreement with Egypt which entailed supplying Jordan with its needs to generate electricity and distribute it domestically at affordable prices. The deal signed with Egypt provided Jordan with large quantities of natural gas at discounted prices. The rationale was that Jordan can be supplied with a cheap source of energy until it starts exploiting domestic energy sources, most of which require investments spanning a number of years.

In 2010, more than 6 years after the signing of the agreement, natural gas imports began to decline drastically until they were almost completely halted in 2014 as a result of the continuous bombing of the Arab gas pipeline. It was later revealed that the fall in natural gas imports was the result of Egypt's inability to cope with the high amount of exports to which it was committed, alongside its rising domestic demand. In fact, Egypt has now become a net importer of natural gas after it had been a major exporter in the region for about a decade.

Throughout the period between 2003 and 2010, Jordan did not take any concrete steps to implement any part of the national energy strategy. Authorities have always put the "shortage of

fund" and inability to attract a strategic partner, as the main reason for not utilising domestic energy sources and diversifying its energy sources. This was despite the fact that oil prices were increasing at an alarming rate, an increase which had apparent consequences on the deterioration of public finances. Furthermore, Jordan's capacity to keep strategic reserves was also disappointing, as it had always been reliant on dependable energy sources in the past.

Rather than securing alternative energy sources to bring down the energy bill, the government embarked on a gradual elimination of subsidies from 2005 to 2008, but the subsidies were reinstated in 2011 as a result of growing domestic opposition to the cuts, and demands for genuine and comprehensive socioeconomic reforms. The year 2011, however, also witness the imposition of special taxes - that reached up to 24% (excluding the 16% sales tax) - on petroleum products, in an attempt balance out the loss in revenue resulting from the resumption of subsidies on treasury.

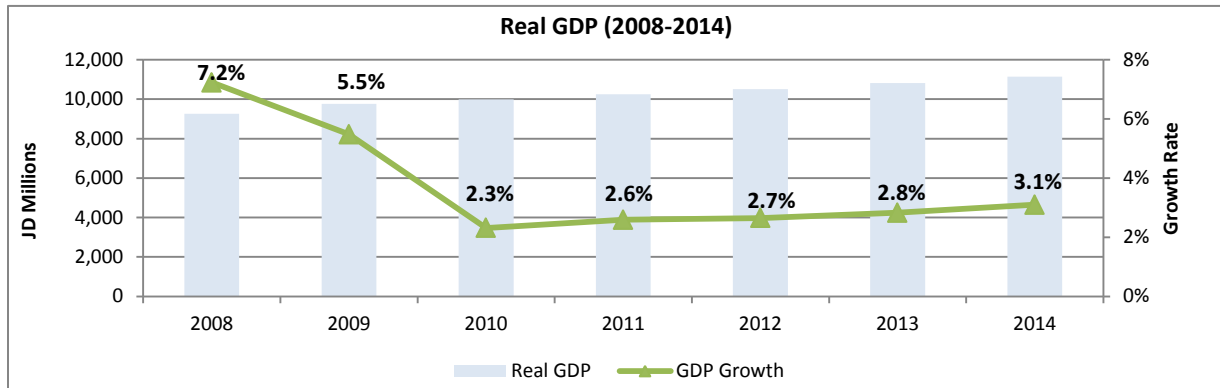
Energy subsidies were eventually eliminated in late 2012, when the deterioration in public finances reached critical levels, thus leading to a spike in the domestic energy prices. In fact, the negative fiscal effects of the energy sector in Jordan are the main reason for resorting to the IMF in late 2012 for a bailout and the subsequent signing of the Stand-By Agreement, under which Jordan would receive financial support on the condition of implementing a series of reforms to shore up its public finances. Most recently, and as part of the reform programme supported by the IMF, electricity tariffs were increased by an average of 15% in 2014, and by 7.5% in 2015, despite the trend of falling oil prices in this period. This was because of the fact that the National Electric Power Company was bearing the costs of the high energy import bill, and its cumulative losses are a main source behind the surge in Jordan's debt over the past five years.

Before moving on to show the impact of the spike in energy prices, it is worthwhile noting here that fiscal consolidation efforts by the government over the past 2 years focused on raising public revenues and lowering public expenditures of the central government budget. On the other hand, measures to control the indebtedness of independent agencies have not been as effective. This will be explained in more detail in the following sections of the report.

## General Impact

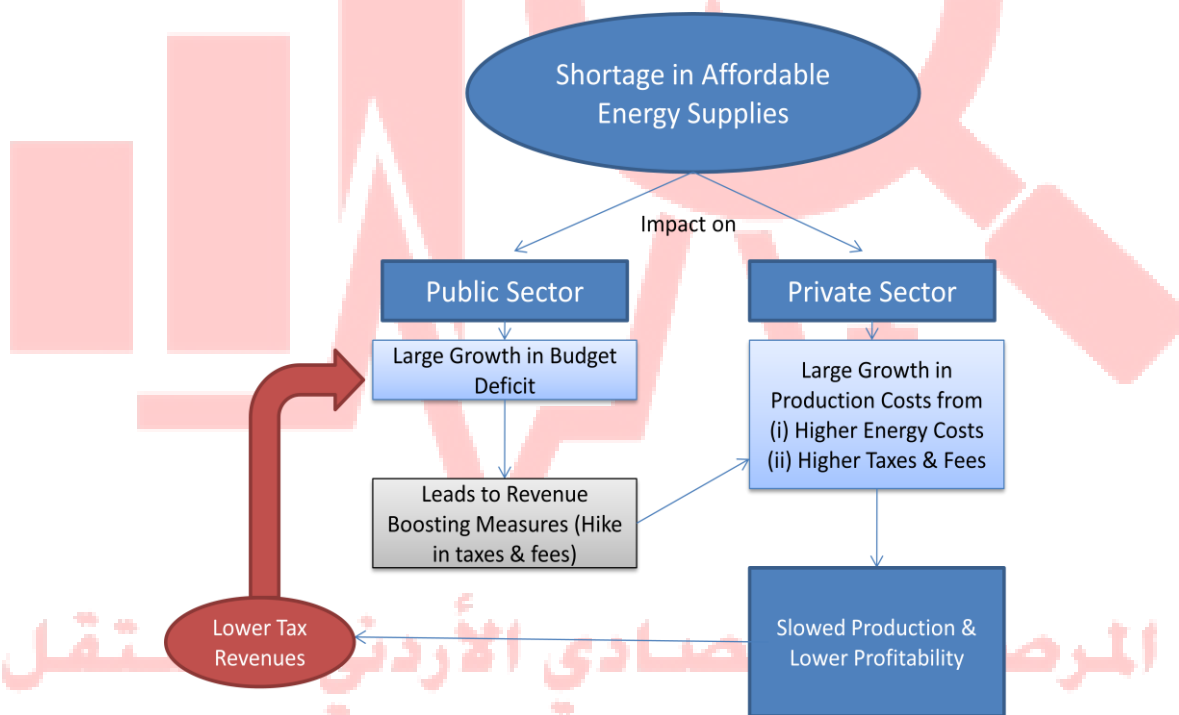
The previous section was aimed at providing a description of the developments that culminated in the problems faced by the Jordanian energy sector and the lack of strategic planning with its regard. The report will now show the impact that such shortcomings had on the domestic economy.

The lifting of subsidies at a time of rising oil prices had dealt a blow to the Jordanian economy, which was unable to grow to its full potential. Annual economic growth in the years between 2010 and 2013 remained under 3%, while growth picked up in 2014 to reach 3.1%. The drastic fall in oil prices in the second half of 2014 was a major driver behind this improvement, where the price of Brent crude oil fell by more than \$40 from June to December of 2014. This led to an economic growth rate of 3.3% in the 4th quarter of the year, the highest quarterly growth rate since 2009, the year in which Egyptian gas imports were at their peak. This strong correlation between energy and economic growth indicates the crucial impact this sector has on economic activities.



Source: Central Bank of Jordan

Rising energy prices had a double negative effect on the Jordanian economy. One major impact was on the public sector, while the second was on the private sector. The below figure explains these effects and how they are interrelated in a viscous circle

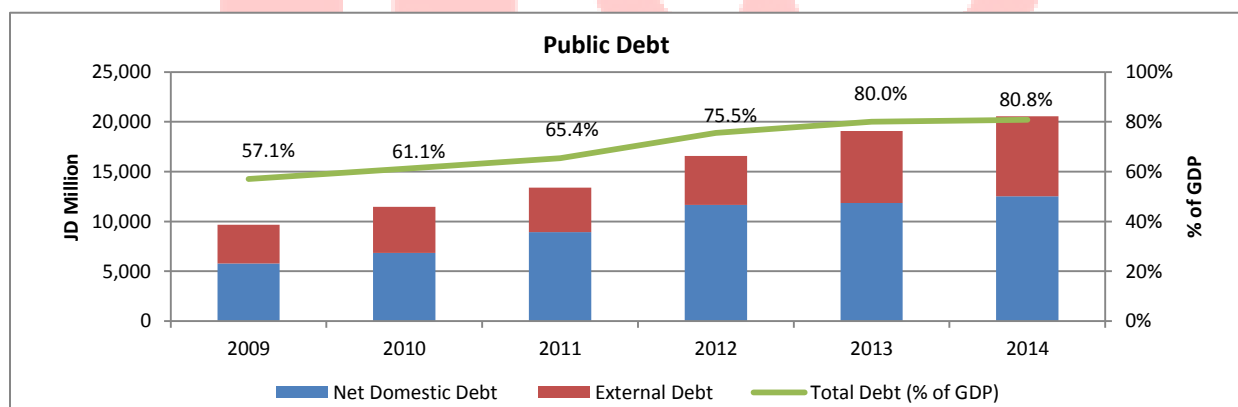


The disorientation of the Jordanian energy sector had eventually led to a prolonged shortage in affordable energy supplies which impacts both the public and private sectors. According to the scenario above, the effect on the public sector is in the form of higher energy expenditures leading to a growth in the budget deficit, whereas the effect on the private sector is higher energy costs, which entail a decline in profitability or an increase in the price level to maintain a consistent profit margin. To deal with larger deficits, the public sector then introduces revenue boosting measures in the form of tax hikes and fees with the objective of reaping additional revenues to cover the higher level of expenditures on energy. Public expenditures would also be curtailed.

In turn, the higher taxes and fees will contribute to raising production costs of the private sector, above the increase already induced from higher energy prices. This leads to another slow-down in production and decline in profitability. And with a lower level of production, tax revenues accrued from the private sector will decline leading to a lower than expected level of public revenues. This in turn induces the government to introduce further measures, culminating in a dangerous vicious circle that would put the economy in a prolonged depression. In fact, according to the IMF, public revenues accrued in 2014 fell short of expectations due to a less than expected economic growth rate.

## Impact on Public Sector

The above theoretical model can be simply applied to the case of Jordan. After suffering a major blow to public finances and a staggering increase in public debt as a result from a large increase in the energy import bill, authorities resorted to the IMF for a bail out, signalling the beginning of a reform programme supported and conditioned by the IMF. The below figure shows the evolution of public debt between 2009 and 2014.

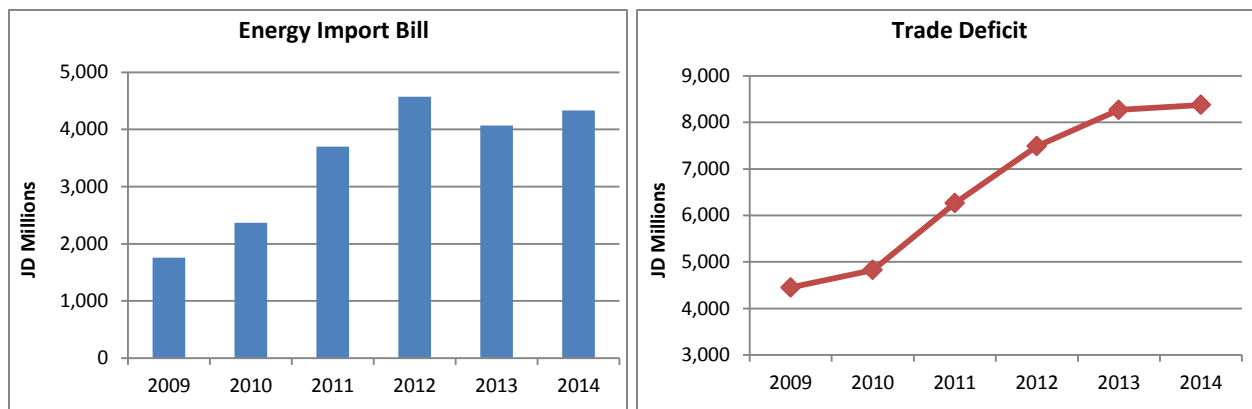


Source: Ministry of Finance

As can be seen from the above figure, public debt witnessed a drastic increase between 2009 and 2014, the period in which the only affordable energy source for electricity generation (i.e. Egyptian natural gas imports) was being disrupted and eventually halted. Public debt grew from 57.1% of GDP in 2009 to 80.8% of GDP in 2014, raising concerns over the risk of Jordan falling into a debt trap, as interest payments are also growing at a drastic rate. In absolute terms, public debt more than doubled over this period.

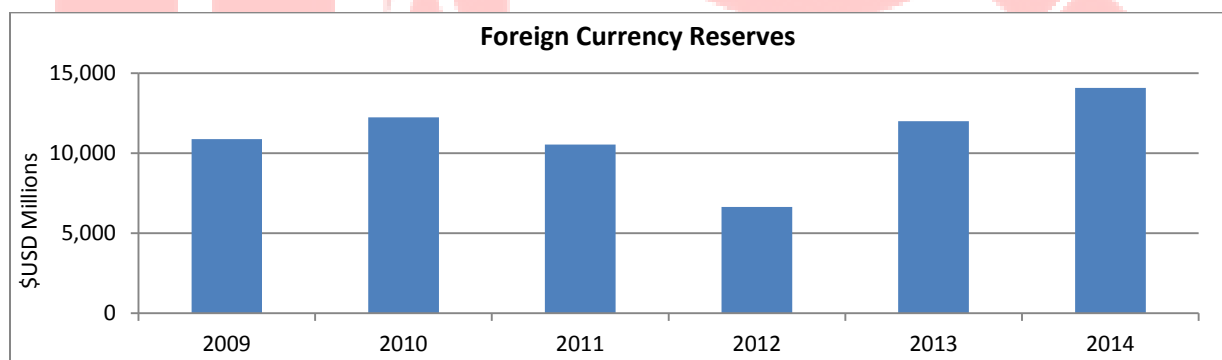
The impact on the public sector was not only felt on public finances, but also on the trade account. The below figures show the growth in the energy import bill over this period as well as the evolution of Jordan's trade balance over this period as well.





The above figures show the large increase in the value of Jordan's energy import bill, which grew from around JD1,755 million in 2009 to JD4,334 million in 2014 indicating a surge of 147%. This of course led to a rapid widening of the gap between exports and imports, where the trade deficit grew by 88% over the same period.

The deterioration of the fiscal and trade account eventually led to mounting pressures on the foreign currency reserves of Jordan, which are highly strategic for the Jordanian economy, as they are used to finance some government expenditures and to finance the gap between exports and imports. The below figure shows the trend in foreign currency reserves.



Source: Central Bank of Jordan

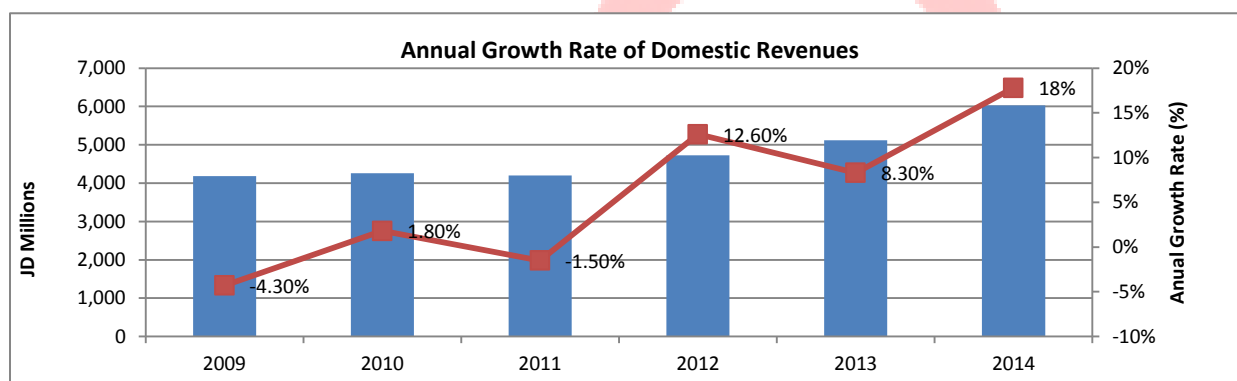
Foreign currency reserves dropped significantly after the natural gas import disruptions became more severe after 2010. In fact, reserves fell from over \$12 billion in 2010 to \$6.6 billion in 2012, indicating a decline of around 46%. Reserves would have dropped further had it not been for the IMF bailout in late 2012 and the subsequent disbursements throughout 2013 and 2014. Coupled with a considerable increase in foreign borrowing, the IMF payments drove up reserves significantly to reach their highest level in more than six years, covering more than 7 months of imports.

However, the main problem is that the external loans and IMF payments will have to be repaid in the coming years which will once again put pressure on the level of reserves. But luckily, the recent fall in oil prices and associated decline in the trade deficit are expected to soften the pressure on reserves in the short run. Moreover, fiscal authorities are working hard to restructure Jordan's external debt in such a way that it is spread out over a larger number of years with a low interest

rate. The recent issuance of eurobonds, as well as upcoming ones, fall within the purpose of restructuring public debt.

Finally it is worth noting that other exogenous factors contributed to the deterioration of public finances and foreign currency reserves, but the impact of oil remains to be the most significant. One of the those factors is the level of foreign grants which dropped by 73%, from JD1,215 million in 2011 to 327.3 million in 2012, its lowest annual level since 2006.

In the past couple of years, the government introduced a large number of tax and fee increases under this reform program in an effort to boost domestic revenues. This resulted in a considerable rise in the growth rate of domestic revenues as can be seen in the below figure



Source: Central Bank of Jordan

## Impact on Private Sector

The private sector was deeply impacted from the spike in domestic oil prices from 2010 until mid 2014 both directly and indirectly. The direct effect was an increase in production costs due to the increase in the value of energy purchases resulting from the lifting of energy subsidies as well as from the increase in the international price of crude oil in this period; energy intensive sectors were most affected. On the other hand, the indirect effect was an increase in private sector transfers to the government through higher tax rates and fees introduced by the government to boost the level of public revenues to cover the large increases in expenditures and debt.

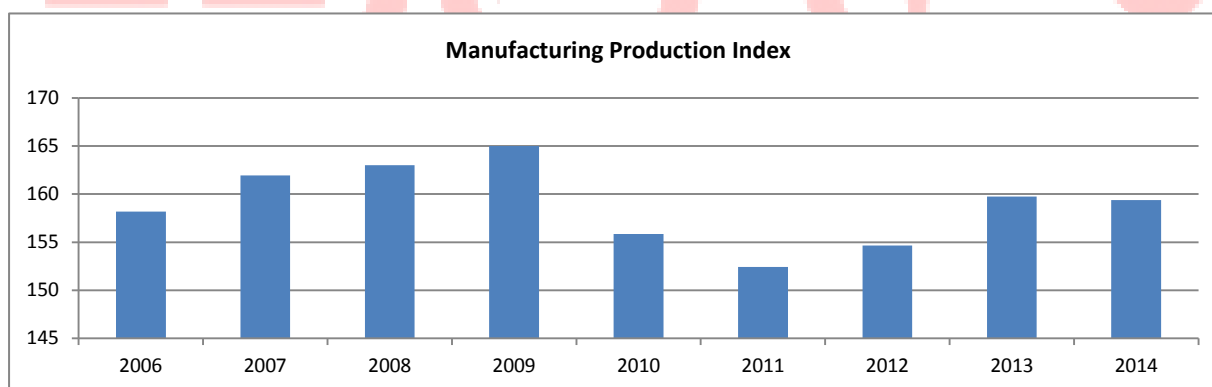
A number of tax rates and fees were hiked in this period. The special tax rate on mobile communication was doubled in 2013 and prices charged on telecom licensing renewals was exaggerated, negatively affecting the performance of the three main telecom companies in Jordan, inducing Orange to file a lawsuit against the government of Jordan for violating signed agreements. In 2014, the government imposed a 1% customs 'service fee' on tax exempted imports, thereby violating principles and regulations of the World Trade Organisation of which it is a member. Taxes on a number of other goods such as imported clothing products were increased. A large array of fees were substantially increased including a doubling of passport renewal fees, tourist visa fees, sanitation fees, and work permit fees among others. A new social security law raised employee and company contributions which will continue to grow in coming years. Finally, the new income tax

law raised the income tax rate charged on the commercial or services sector (excluding financial and mining sector) from 14% to 20%.

All these measures have had negative effects on the profitability of the private sector, which has already been suffering from high energy and electricity costs. Taking an example of an industrial company operating in Jordan would further illustrate the seriousness of the situation. With these new measures, the company would now face higher production costs including higher energy and electricity costs, higher storage and transport fees, a 1% customs fees on exempted intermediary products, higher work permit fees for foreign workers and higher social security contributions for all workers. According to the Jordan Chamber of Industry, around 1,500 manufacturing factories have shut down and relocated in the past two years as a result of measures and policies followed by the government which has weakened the competitiveness of the sector.

This is not only limited to the industrial sector but also extends to others. Most services companies are now burdened by a higher income tax rate; the tourism sector faces higher visa fees, construction contractors have to deal with higher tax on intermediary products, and telecom companies exaggeratedly high licensing fees and doubling of the special tax on mobile companies. The implications of all this is being now reflected in official data; for example, 'Orange Jordan' reported a 30% drop in profits in the first quarter of 2015.

The manufacturing sector is the best example of an energy intensive sector and is considered to be strategic for Jordan given its significant weight in the domestic economy and its contribution to exports. The below chart illustrates the performance of the manufacturing sector in the period of rising domestic oil prices and adverse government measures to boost revenues.

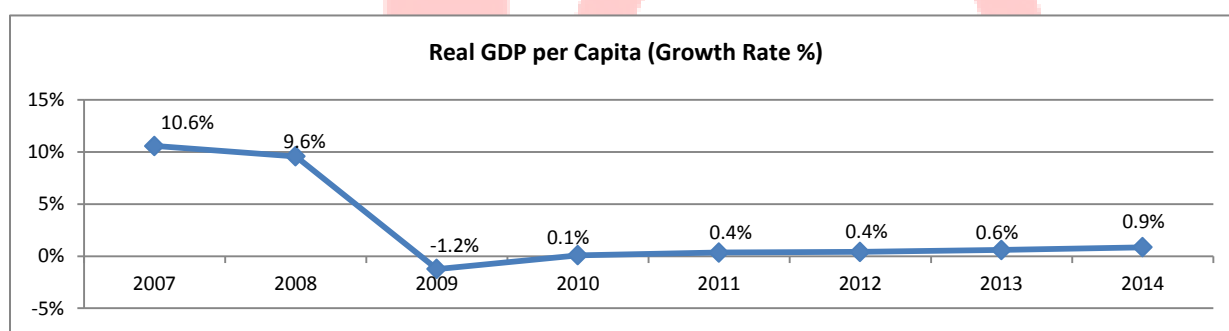


Source: DOS

Between 2003 and 2007, the performance of the manufacturing sector was very strong, as manufacturing production increased by an annual average of 7.7%, supported by affordable energy supplies, but also by a boom in the global economy. After this period, manufacturing production began to grow at a decreasing rate until it plummeted in 2010, the year in which the manufacturing production index declined by over 5.5% compared to its level in 2009. Manufacturing production continued to drop in 2011, dropping by 2.2% from 2010. The halt in production was likely the result of higher production costs in terms of energy and to a lesser extent taxes and fees. The sector then recovered slightly in 2012 and 2013, before falling again in 2014.

It is worth noting here that manufacturing production in 2014 was almost the same as its level in 2006, with severe drops experienced in 2010 and 2011 as a result of rising domestic energy prices. Moreover, the recovery witnessed in this sector was very weak after this decline, registering an annual growth rate of almost 1.1%, and then dropping in 2014 compared to 2013. Nevertheless, the recent plunge in oil prices is expected to provide a boost this sector, in spite of the adverse effects of government policies.

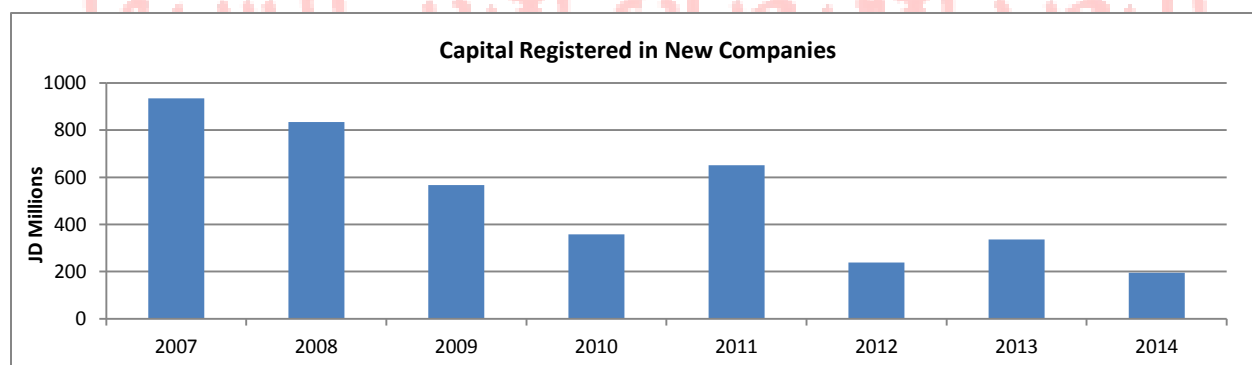
Another major effect is the impact on the purchasing power of individuals in the economy. With a larger share of income being spent on energy and on taxes & fees, an individual has less disposable income to spend on goods and services. This means that the total level of aggregate demand was strongly affected. In fact, the annual growth rate of real GDP per capita was unable to reach 1% for the past six years, as can be noted from the below figure.



Source: Central Bank of

This very low growth rate of per capita GDP points towards the low growth rates of real individual incomes in light of rising expenses in terms of energy and taxes and fees. The growth of GDP per capita was much higher before 2009, achieving a growth rate of 10.6% and 9.6% in 2007 and 2008 respectively. After this period, per capita GDP contracted by 1.2% before growing sluggishly until 2014, with the annual growth rate remaining below 1%.

The impact can be even observed on the level of investments in new companies.



Source: Companies Control Department

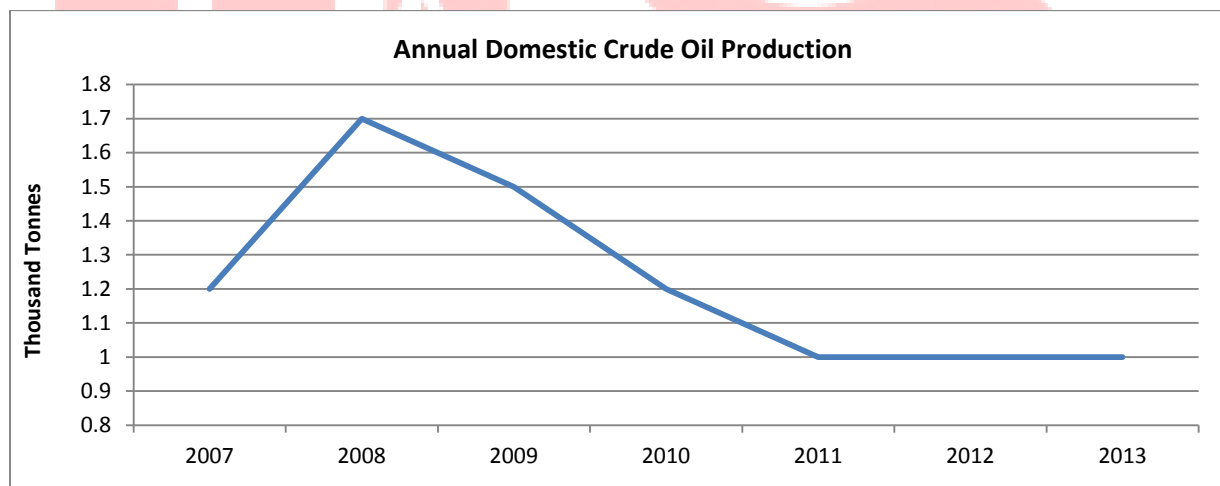
The above figure illustrates how investments in new companies have been on a consistent downward trend since 2007, with the exception of 2011 the year in which investments rebounded, but then continued to drop. The value of investments made in new companies in 2014 was almost 21% of investments made in new companies during 2007.

Before moving on to the next section, it is worth noting here that factors other than energy prices and taxes influence the variables described above. Nevertheless, it is believed that domestic energy prices and higher taxes and fees are major factor behind the trends described.

## II. Petroleum - Domestic Sources & Imports

### **Domestic Production**

Jordan's proven reserves of crude oil are very small, and are currently limited to the Al Hamza oil field located near the southern borders with Saudi Arabia. The following chart illustrates Jordan's crude oil production from Al Hamza oil field over the past decade



Source: Ministry of Energy

As the above figure shows, domestic production of crude oil has been declining over the past period, with some analysts suggesting that the Hazma oil field used to produce more crude oil in the 1990s than today. Annual domestic production of crude oil actually declined around 41% from 2008 to 2011, and by 2014, it had a total of 17 oil wells but produced only 20 oil barrels/day, according to a statement made by the Minister of Energy. This indicates that the capacity of this oil field has not been developed over the past period.

The declining production has been attributed by some analysts to the involvement of weak or in some cases 'imaginary' foreign firms in oil exploration activities in Jordan. This has been recently underlined by the energy committee at the Lower House of parliament, which emphasized the need to reconsider the methodology of contracting international oil & gas companies for oil exploration

and development in Jordan. This statement came after a number of international firms were awarded oil exploration and development contracts over the past period, with no concrete results stemming from their operations.

According to a statement made by the Natural Resource Authority in 2012, six international companies were working on oil exploration and development projects across different parts of Jordan, including on the development of existing oil & gas fields, Al Hamza and Al Risha. Similar contracts were awarded to international firms even before this period, but with similar consequences.

A number of these international companies are shown in the below figure, which was obtained by a technical study prepared in 2012 by a petroleum geologist expert for the benefit of the Natural Resource Authority (NRA)<sup>1</sup>. The figure illustrates the 8 exploration areas determined by the NRA, in which different companies were working. The paper provided a scientific description that indicated the existence of large amounts of crude oil reserves in different parts of Jordan. The study also provides a historical overview of oil exploration and development activities in Jordan. Between 1949 and 1978, a number of oil companies worked in Jordan by drilling several wells. While those drilled in areas

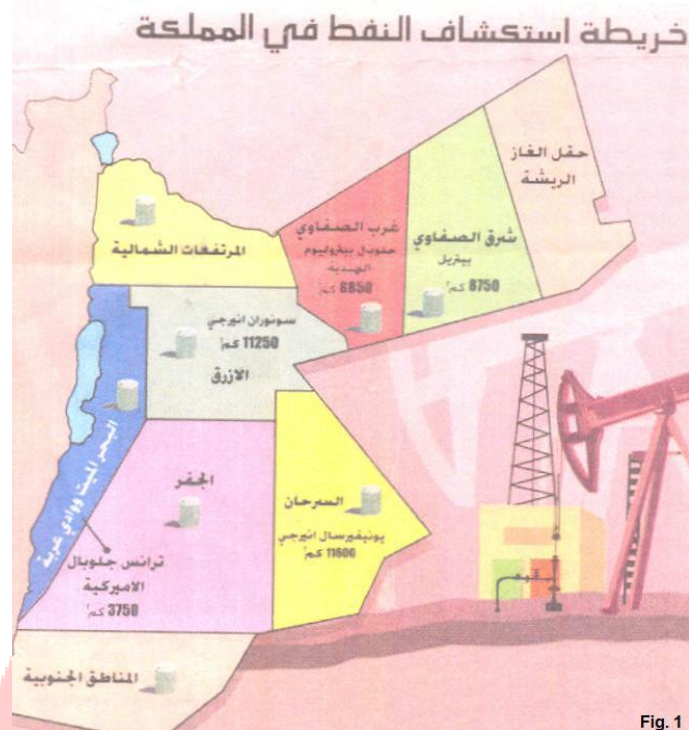


Fig. 1

of the West Bank showed weak indicators of the existence of oil and gas, those in other areas including Wadi Azraq /Sirhan, and Wadi Rajil encountered good to strong indicators of the existence of crude oil.

More precisely, the study covered the following geographical regions:

- Azraq: A study prepared for the NRA evaluated the hydrocarbon potential in the area and thus concluded that an estimate of around 430 million barrels of oil existed in this area
- Hamza oil field: Studies indicate that crude oil reserves in underground wells ranges between 15.2 to 22.5 million barrels of oil. In spite of this, no more than one million barrels were produced from the oil field since 1988. The study notes that the two heavy wells that have

<sup>1</sup> AlSadiq, Z. O. (2012) "Oil Opportunities in Jordan"



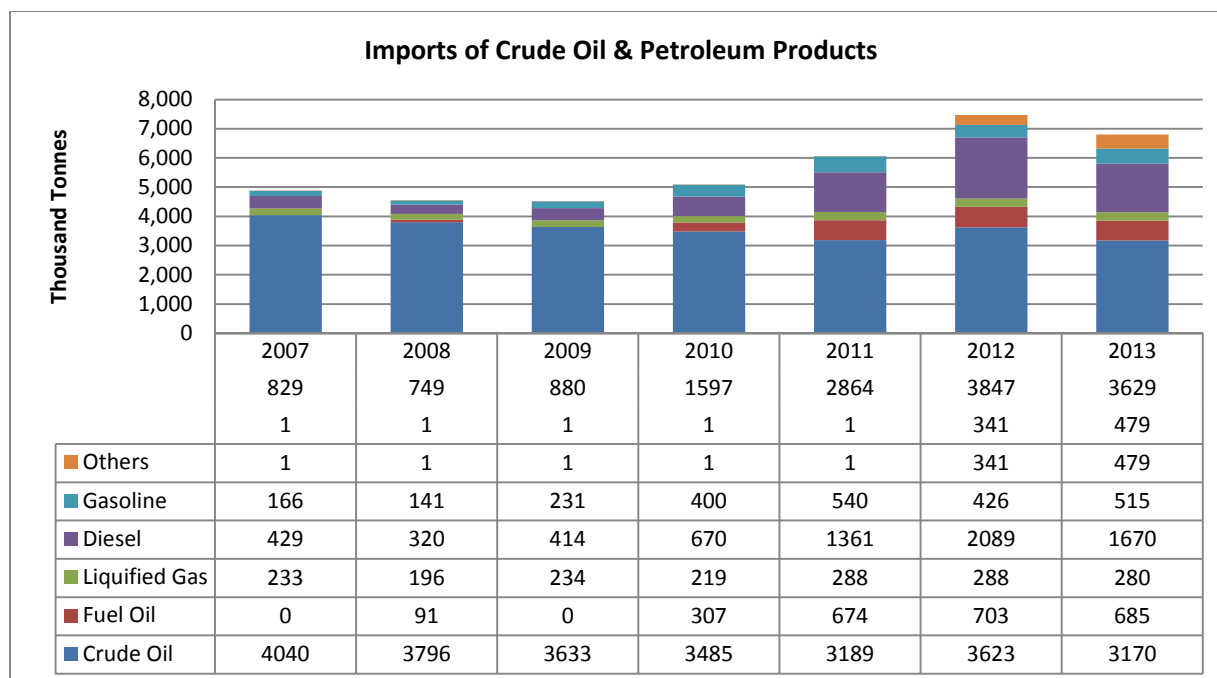
been drilled in this area indicated the presence of vast amounts of heavy oil and asphalt which could be converted to crude oil through different technical methods.

- Dead Sea area: This area contains many oil seeps which is the usual indication of the presence of oil fields. Significant oil seep exists in Wadi Asal on the eastern shore of the Dead Sea, and another historic seep at Ain-Hummar, located 5 km south of Wadi Mujeb.
- Wadi Sirhan area: This area also holds much potential, according to the study. One of the wells drilled in this area resulted in the discovery of one of the best quality crude oil (sweet oil).
- The study indicated that the other 5 blocks in Jordan still holds much potential for exploration and development including East Safawi Block, West Safawi Block, North Jordan Block, Jafr-Central Jordan Block, and Wadi Sirhan Block. Therefore, the study concluded that Jordan is still poorly explored.

Unfortunately, the government made little effort to build on the different oil exploration studies and surveys. This was reiterated several times by the energy committee at the Lower House of parliament. Nevertheless, there is currently an increased oversight by the energy committee of the Lower House on the various contracts intended to be awarded to international companies for oil exploration and development projects. To that extent, a number of potential contracts were cancelled after a careful investigation of the energy committee while others were endorsed. During the latest World Economic Forum held at the Dead Sea in May 2015, a number of other investment opportunities were announced in the field of oil exploration and development, reflecting the government's renewed commitment to discover and exploit local traditional energy sources.

## Imports

In light of the weak exploration and development of existing resources, Jordan had to continue to rely on crude oil imports to meet energy needs. Before 2003, Iraq used to provide Jordan with an annual oil grant valued at \$300 million over and above the sale of petroleum products to Jordan at preferential prices. After 2003, Jordan shifted to using more natural gas and less petroleum products for its electricity generation requirements. But the halt in Egyptian gas imports implied a return to depending on traditional petroleum products to meet energy needs. The following diagram shows the value of petroleum imports over the past period.



Source: Ministry of Energy

The above figure and associated table provide important information on the development of the domestic petroleum & refining sector. First thing to note is the increase in the total volume of energy imports which corresponds with the increasing energy demand over this period, the drop in natural gas imports from Egypt beginning in 2010, and the slowdown in domestic production as noted above. In total, the volume of petroleum imports increased by almost 30% from 2007 to 2013, and by a staggering 58% from its low value in 2009 to its peak in 2012.

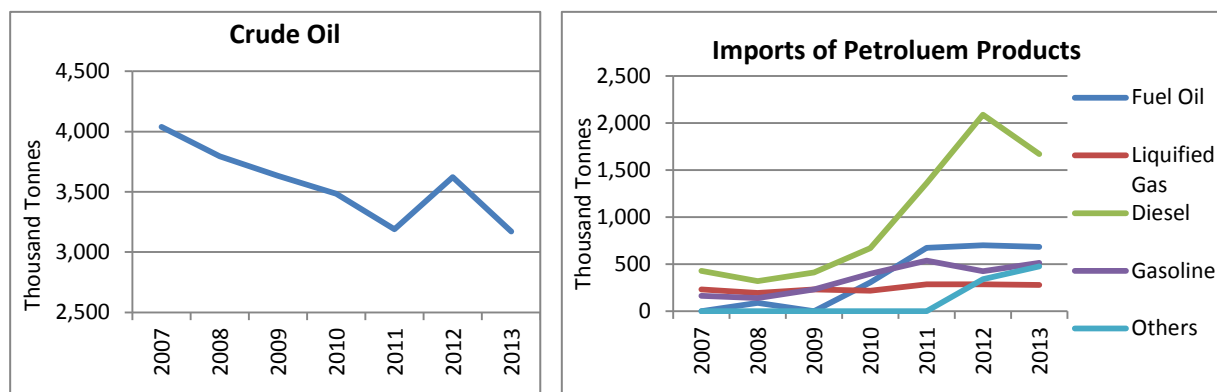
The other major insight provided by the chart above is the changes in the volume of imports of the different petroleum products, as can be seen in the charts below. The imports of crude oil actually fell significantly over this period dropping by 21.5% from 2007 to 2013, despite the increasing energy demand witnessed in this period. Annual levels of crude oil imports fell consistently with the exception of 2012, the year in which crude oil imports increased on an annual basis. This is a surprising development given the urgent energy needs of Jordan throughout this period, especially with the halt in Egyptian gas imports. On the other hand, imports of other petroleum products surged in this period, growing by around 338% from 2007 to 2013. This was specially driven by a 289% increase in diesel imports as well as the rise in the imports of other petroleum products.

Source: Ministry of Energy

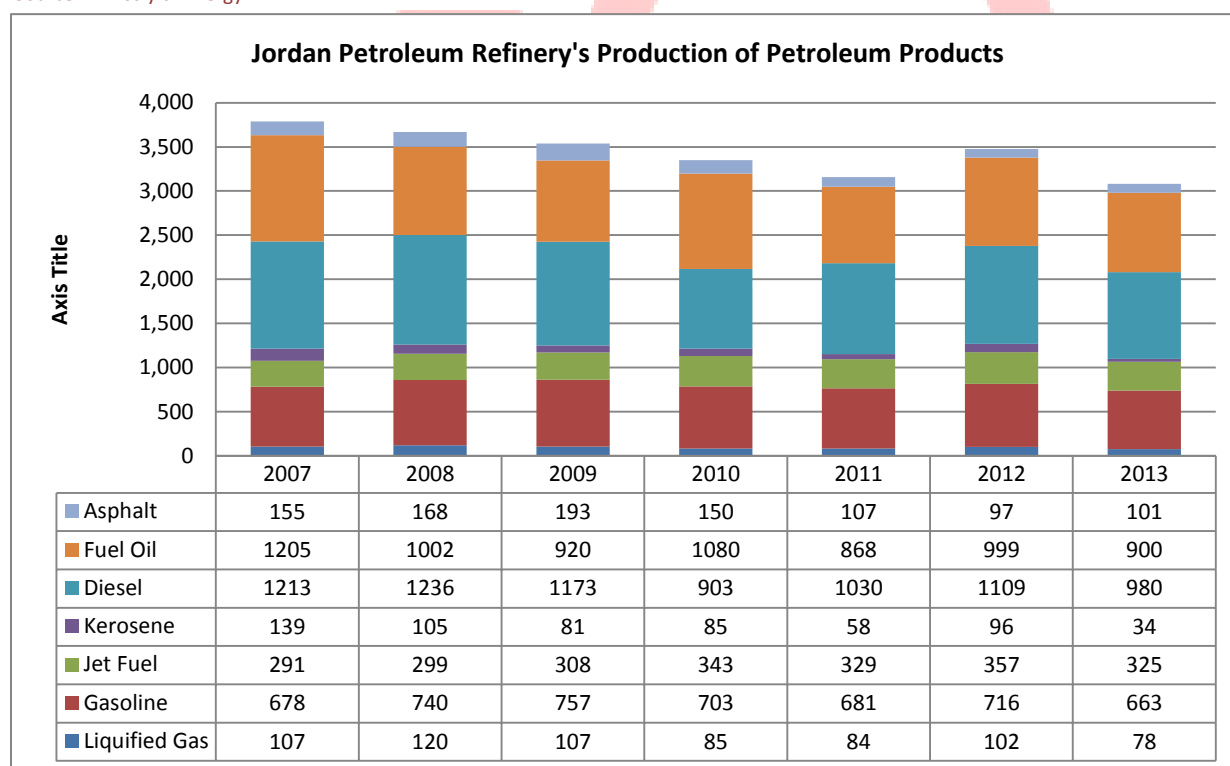
Source: Ministry of Energy

Source: Ministry of Energy





Source: Ministry of Energy



## Jordan Petroleum Refinery

The above analysis points towards a decreased capacity of the Jordan Petroleum Refinery in refining crude oil into petroleum products, especially in light of rising demand. According to the annual reports of the Jordan Petroleum Refinery, the last expansion project was completed in the early eighties, when energy consumption was less than half the level it is today. The decreased capacity is confirmed when looking at the below chart which illustrates the production level of the refinery over the past period.

As can be seen, total production declined consistently throughout the period with the exception of 2012 which witnessed a slight rise in production. In fact, this trend closely follows the trend of crude oil imports, since the imported crude oil is refined into different petroleum products by the Jordan Petroleum Refinery. The refinery's total production of petroleum products from crude oil dropped by 18.7% from 2007 to 2013, with a significant drop in the production of diesel and fuel oil, the two main products that are currently used to generate electricity instead of natural gas.

Therefore, it can be concluded that the inability of the refinery to attract investment for its expansion project has significantly contributed to the deterioration witnessed in the domestic energy sector and the associated expansion of losses witnessed in the domestic energy sector. A recent IMF paper<sup>2</sup> stressed on the need to have "complementary infrastructure improvements" including the upgrade of the refinery to make investments in the traditional energy sector in Jordan commercially feasible. It also added that Jordan's refinery needs to be upgraded before any oil project is completed, including the highly anticipated oil pipeline that is projected to run from Iraq to the port city of Aqaba.

According to the IMF report, the refinery currently can process around 24,000 barrels/day, while the country's oil demand is above 100,000 barrels/day. Once this projected pipeline is completed, Jordan would have the potential to import 150,000 barrels/day through the pipeline. But this would require a significant expansion of the existing refinery or additional refineries might be needed, in order to absorb the higher level of crude oil imports. This means that the refinery's 4th expansion project, which has been discussed for over a decade, is one of the current priorities for Jordan's energy sector.

One of the main reasons why the refinery has been unable to attract strategic investors for its expansion project is due to the troubled financial situation of the company, which stems from debts owed from a number of different stakeholders, most importantly public sector entities (e.g. NEPCO). However, the refinery has worked hard since the beginning of 2015 to reduce the large debt owed to it from the different government entities from a peak of JD1.2 billion to JD685 million by the end of the first half of 2015. Ernest & Young the global financial advisory firm has been selected to advise the JPRC on the best options to finance the expansion project, which is expected to cost somewhere between \$1 billion and \$1.5 billion. However, no strategic partner has yet been determined, but the expansion work is set to start by end of 2015 to beginning of 2016, as the government earlier provided a grace period for the refinery to complete the expansion work by May 2019.

## Shale Oil

Jordan has an estimated 40-70 billion tonnes of shale oil, making the Kingdom the 6th richest country in terms of oil shale deposits<sup>3</sup>. According to the Ministry of Energy, oil shale surface

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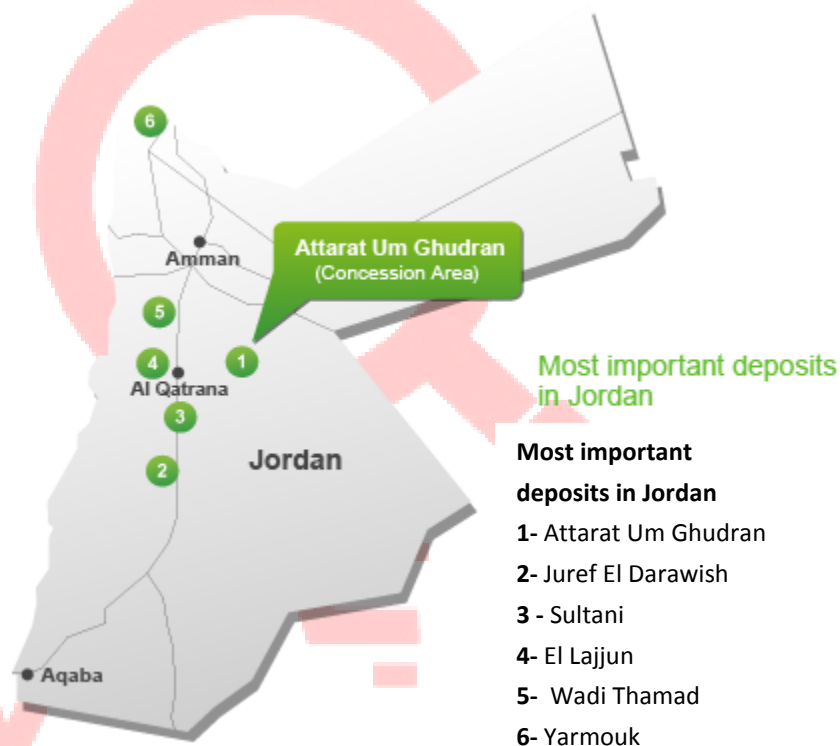
<sup>2</sup> Gamba, A. (2015) "New Energy Sources for Jordan: Macroeconomic Impact and Policy Considerations" IMF Working Paper, WP/15/115

<sup>3</sup> Enefit: <https://www.enefit.jo/en/oilshale/in-jordan>

reserves are estimated at more than 70 billion tonnes containing more than 7 billion tons of oil shale thereby putting Jordan as the fourth richest country in oil shale sources, after the US, China and Brazil. Jordanian shale oil is considered to be of very high quality, with the majority of deposits being shallow making them suitable for open cast mining.

However, shale oil was not recently discovered the energy strategy had already highlighted the large availability of reserves back in 2004 and highlighted the importance in exploiting these reserves<sup>4</sup>. It even prepared a scenario revealing that the best way to compensate for a limited availability of natural gas is using oil shale for electricity production. In other words, the Energy Strategy concluded that the option of using shale oil for electricity generation is the most economically feasible. It took almost a decade for Jordanian authorities to sign a deal with a company to begin implementation.

In 2013 and 2014, the government awarded several local and global companies concession areas for investing in the shale oil by surface, deep distillation or direct combustion. The government also signed memorandums of understandings with several other companies. One of the largest shale oil projects will be implemented by the Attarat Power Company (consortium under the Estonian 'Enefit') and is expected to have a total capacity of 470MW, accounting for around 14-15% of Jordan's current overall electricity capacity. The project consists of two steam units utilising the technology of direct burning oil shale fuel (FCB), and will be operated in two stages; the first will be completed during the second half of 2018 and the second during the first half of 2019. The project costs an estimated \$2.2 billion, to be financed by the Bank of China and the Industrial and Commercial Bank of China with the support of the China Export and Credit Insurance Corporation. The project will result in the first shale oil-fuelled power plant in Jordan to start operations in 2018.



Implementation will be conducted via build, own, operate basis according to the 30-year power purchase agreement signed with the government. Under the agreement, each kilowatt will be sold at about \$0.107, 46% lower than the average cost of 1KW purchased in 2014, which amounted to \$0.197. This means that the government will save over \$370 million (JD263 million) annually<sup>5</sup>. This

<sup>4</sup> Updated Energy Strategy 2007-2020

<sup>5</sup> Assuming the plant remains running at the full capacity of 470MWh. Calculated based on cost difference of one KW (i.e. \$0.09), assuming average KW prices charged to government in 2014

is lower than the company's estimate of JD350 million per year in savings<sup>6</sup>. Moreover, the agreement entails that the company pays the government JD1.5 for each tonne of oil shale, where the plant is expected to consume around 10 million tonnes of oil shale annually. This means that the government will generate some JD15 million in concession fees once the plant becomes fully operational.

The other main project of Enefit's engagement in Jordan is the construction of a shale oil production plan, which is expected to have a capacity of 40,000 barrels of daily oil output covering around 40% of Jordan's energy needs and resulting in savings of approximately JD700 million in energy costs<sup>7</sup>.

Jordanian Government Agreement with ENEFIT	
<b>Type of agreement</b>	30-year BOO Purchase power agreement
<b>Concession area</b>	37km <sup>2</sup> in Attarat Um Ghudran
<b>Cost</b>	\$2.2 billion, financed by Chinese banks
<b>Total Capacity</b>	470MW (accounting for 14-15% of current electricity capacity) + potential 40,000 barrels of oil
<b>Technology</b>	Direct incineration/combustion - Fluidized bed combustion technology
<b>Expected Completion Date</b>	2018
<b>Cost of KW to be Sold to Government</b>	\$0.107
<b>Expected Annual Savings</b>	JD263 million
<b>Expected Annual Revenues</b>	JD15 million
<b>Total expected annual Savings/revenues from Project (excluding oil production)</b>	JD278 million
<b>Total expected annual Savings/revenues from Project (including oil production)</b>	JD978 million JD278 million + savings from oil production (JD700 million <sup>8</sup> )

Regarding the feasibility of this project in light of low oil prices, Enefit recently stated that the company is moving forward with its project despite the plunge in international oil prices, highlighting that the project will remain feasible so long as oil prices remain above \$35/barrel. Recent feasibility studies carried out by NEPCO revealed that using shale oil for electricity generation is expected to bring down the company's losses and decrease its debt by around 20% to 30%, due to its low cost compared to other sources of fuel such as diesel.

The other main investments in the shale oil sector in Jordan include:

- A \$2 billion project to be implemented by the Saudi Arabian Corporation for Oil Shale (SACOS) to produce oil from shale oil using the Galoter process, a surface retorting technology. The

<sup>6</sup> Enefit Jo. "Facts & Figures". Available at: <https://www.enefit.jo/en/oilshale/facts-and-figures>

<sup>7</sup> These are based on Enefit's estimations as no detailed information is yet available to make own calculation. For more information, see: [www.enefit.jo](http://www.enefit.jo)

<sup>8</sup> Based on estimates by Enefit

company signed an agreement with the Jordanian government under which it will have the concession to extract and develop shale oil in its 11 km<sup>2</sup> concession area, also located in the Attarat Um Ghadran area. The project will consist of two main phases; the first will last four years in which geological studies and drilling activities are undertaken, and the second is the production phase where it is anticipated that the shale oil produced will generate up to 600MW of electrical energy and produce up to 30,000 barrels of oil, but this will be determined by findings of the first phase of the project.

SACOS has recently obtained the necessary license to begin the first phase of the project, and is expected to begin implementation in the third quarter of 2015. Oil production is expected to start in 2019. The signed agreement carries more favourable conditions than agreements signed with other investors, with a number of exemptions granted to the project. Under the agreement, a royalty fee reaching up to 4% of production will be paid to the government in addition to a 'Petrol Tax' reaching up to 65% of profits, and a lump sum of \$250 thousand after the first four years and \$10 million after commercial production begins.

Jordanian Government Agreement with SACOS	
<b>Concession area</b>	11km <sup>2</sup> in Attarat Um Ghudran
<b>Cost</b>	\$2billion Total cost of production \$4 billion
<b>Total Capacity</b>	600MW electricity 2,650 oil barrels/day reaching up to 30,000
<b>Technology</b>	Galoter process - Surface retorting
<b>Expected Completion Date</b>	2019
<b>Cost of KW to be Sold to Government</b>	N/A
<b>Expected Return for Government</b>	Royalty fee 4% of production Petrol tax reaching up to 65% of profits \$250,000 award after first four years \$10 million after commercial production begins

- A \$1.8 billion project to be implemented by Karak International Oil (KIO), to produce oil from shale oil using Alberta Taciuk Process (ATP), a dry surface thermal retorting technology (direct incineration/combustion). Similar to the other agreements, the first phase of the project consists of studies and drilling for 5-7 years in the company's 35km<sup>2</sup> concession area located in Al Lajjun area, while production of 2,650 begins in the next phase, reaching up to 60,000 oil barrel per day. The project will also produce up to 30MW of electricity. Under the agreement, the government will obtain a 65% tax on the project's net profits.

Jordanian Government Agreement with KIO	
<b>Concession area</b>	35km <sup>2</sup> in Al Lajjun
<b>Cost</b>	\$1.8billion
<b>Total Capacity</b>	60,000 oil barrels/day 30MW electricity

<b>Technology</b>	Alberta Taciuk Process (ATP), a dry surface thermal retorting technology
<b>Cost of KW to be Sold to Government</b>	N/A
<b>Expected Return for Government</b>	Royalty fee Petrol tax reaching up to 65% of profits Estimated at \$60 million/year through tax and royalties

- A project implemented by the Jordan Oil Shale Company (JOSCO) which is wholly owned by Royal Dutch Shell. The company is currently in its first 'assessment' phase, which was recently extended for another year until mid 2016. The company has still not been decided whether it will proceed to the next 'production' phase, as it will depend on the more specific assessment activities planned for the next year. JOSCO uses a novel technology developed by Shell called In-Situ Conversion Process (ICP), where oil is produced through heating the oil shale in its place and then extracted using conventional oil field extraction technology. ICP is designed for deep and thick oil shale, on the contrary to near-surface oil shale beds. Therefore, it is expected that the company will decide to move forward in production only if large commercial quantities that can be extracted are found.

According to the estimates provided above, the four agreements signed with the government are supposed to begin producing in their first phases around 83,000 oil barrels per day, making up 53% of Jordan's oil needs, in addition to over 1,000 MW of electrical energy. Production is expected to begin climbing gradually in 2017-8. The total value of these projects' investments is around \$6 billion (Enefit-\$2.2b, SACOS-\$2b, KIO-\$1.8b), while JOSCO is still in the assessment phase and no estimated investment was declared.

Finally, it is worth mentioning that the exploitation of shale oil carry a number of disadvantages which have to be considered prior to actual production. A major caveat is the large amounts of water required for the exploitation of shale oil which should be carefully studied given the scarcity of water resources in Jordan. The other major caveat is the environmental impact of shale oil exploitation which also has to be carefully studied as environmental issues could lead to potentially large public liabilities. However, despite these drawbacks, shale oil remains to be one of the largest unexploited resources that Jordan possesses in large commercial quantities.

### III. Jordan's Nuclear Programme

The use of nuclear fuel to generate energy requires the enrichment of uranium, a heavy radioactive element that is extracted from uranium-bearing minerals such as uraninite (uranium oxide). The enrichment process takes place in nuclear reactors established for this purpose, and usually requires substantial amounts of water for cooling. Using nuclear fuel for energy purposes requires a 5% to 7% enrichment of uranium, and up to 20% for research reactors. Enrichment of up to 90% to 95% would be needed to develop nuclear weaponry.



In Jordan, uraninite (i.e. uranium oxide) is estimated to cover large parts of Jordan's area, with a heavy concentration in the central region of the Kingdom. Recent technical studies and studies on the availability of uranium reserves estimated the presence of around 65,000 tonnes of uranium oxide in the central region of Jordan, with around half of this amount estimated to be easily mined, according to the latest studies. This has pointed to the large potential for the feasibility of developing nuclear energy.

Surprisingly however, earlier exploration activities and studies regarding the commercialisation of uranium in Jordan proved to be unfeasible. The French company specialised in nuclear energy 'Areva' withdrew from Jordan in 2012 after years of exploration activities. The company's report prepared in mid 2011 revealed that extraction of Jordanian uranium sources is not economically feasible and its concentration in soil is low. According to a member of parliament, four international companies working in the field of uranium exploration and mining have previously proved that uranium reserves in the central and southern regions of Jordan are not available in commercial quantities.

Nevertheless, the new amounts that were recently estimated by the Jordan Uranium Mining Company are large and significant, which helped push for commencing with Jordan's peaceful nuclear programme and pave the way for more detailed studies and assessments. The Jordan Atomic Energy Commission (JAEC), the main advocate for this programme, has consistently described nuclear power in Jordan as a 'strategic choice' given the high costs of importing energy and the detrimental impact on public finances.

Jordan's nuclear energy programme is a comprehensive programme championed by the JAEC, and consists of a number of components and complementary sub-projects, including the mining of uranium, the establishment of a nuclear power plant, and the establishment of a nuclear research reactor for peaceful applications. The programme also consists of a component that aims to build the human capacities in this sector.

### **Uranium Mining**

The Jordanian Uranium Mining Company was established in the beginning of 2013 and has been since then conducting uranium mining and exploration activities in central Jordan. Currently, the company is constructing a JD100,000 'pilot' facility in the project's area near Amman, in order to carry out advanced studies on uranium concentrations and produce modest quantities of uranium to prove that the Jordanian uranium is extractable. In other words, this pilot facility is being established for experimental purposes only.

In May 2014, the company announced plans to build a second uranium extraction plant at an estimated cost of JD100 million. This announcement came after the technical teams of the company submitted their report regarding their exploration activities, which revealed that Jordan's central area is home to 36,389 metric tonnes of uranium oxide which can be easily mined. The plant will be constructed over a period of four to five years and will have a capacity of producing 300-400 metric tonnes per year which can be expanded to 1,500 metric tonnes per year at a later stage. The company is now working on attracting strategic investors for the construction of the plant. This

investment opportunity was announced at the World Economic Forum (WEF) in the form of a public private partnership (PPP) project at a total investment cost of \$550 million (\$150m for the extraction plant and \$400 million for full-scale production).

The major risk behind this project is the unfeasibility of uranium extraction as was confirmed by a number of preceding international companies, due to either a lack of sufficient amounts of ore uranium or to their low concentration in soils. This was highlighted recently by a statement made by an international expert. The other major risk is the fluctuating price of uranium, which has fell over the past few years due to decreasing global demand for nuclear energy. This was mainly a result of a number of developed countries deciding to phase out of nuclear energy, due to the Fukushima nuclear plant disaster that happened in Japan in 2011.

### **Nuclear Power Plant**

The Russian state-owned 'Rosatom' company, specialised in nuclear energy and applications, was selected in 2013 as the best bidder to establish and operate Jordan's first nuclear power plant, which will consist of two nuclear reactors with a combined capacity of 2,000MW. Government officials estimate that nuclear power will provide 30% of the state's electricity needs by 2030. The total cost of investment is estimated at \$10 billion, where the government of Jordan will bear 50.1% of the cost and the Russian Rosatom will bear the remaining 49.9%. The nuclear plant will be of the third generation, to be constructed in the Amra area near Azraq, around 75km north east of Amman. The first nuclear reactors is expected to become operational by 2023, and the second in 2025, each with an age of 60 years.

The nuclear power plant requires the signing and implementation of two agreements. The first agreement was already endorsed by government and subsequently signed between JAEC and Rosatom in 2014. The agreement consists of two stages, the first stage extends to two years and consists of a comprehensive set of studies and assessments valued at \$46 million. These studies are on issues that include but not limited to the following:

- Plant size and construction costs,
- Cost of electricity production
- Cost of energy sold to NEPCO.
- Utilities needed for the plant such as cooling water and transmission grid.

The second stage of the first agreement consists of signing a final agreement to begin the implementation and physical construction of the nuclear power plant.

The second agreement is a framework agreement signed between the government of Jordan and Russia in March, 2015 to form the legal and political framework for Jordan's nuclear programme. But in order to come into effect in Jordan, this agreement will have to pass through parliament in the form of a draft law to ratify it. Under the agreement Russia will provide enriched nuclear fuel for the reactors for the first 10 years, after which Jordan will have the option of purchasing nuclear fuel oil either from Russia or from any other market offering the most suitable price. However, the agreement also provides the option for Jordan to send the nuclear fuel waste back to Russia. This



means that Jordan will not be enriching its own uranium resources, but it will rather import the nuclear fuel from Russia.

### **Nuclear Research Reactor**

A third component of Jordan's peaceful nuclear programme is the establishment of a 5MW nuclear research reactor inside the campus of the Jordan University of Science & Technology at a total cost of \$130 million, \$70 million has been financed by a soft loan provided by Korea. According to a statement by the JAEC in April 2015, the research reactor is 85% completed and will become operational by June 2016, after experimental operations planned in the first quarter of 2016. The research reactor is expected to be supplied with nuclear fuel by the of 2015. According to official statements, the plant will be one of its kind in the Middle East region to be specialised in research including the production of radioactive samples and the training of Jordanian human capital which will work in the nuclear programme.

### **Feasibility & Disadvantages**

To sum up, all the developments in the nuclear energy programme and the contents of signed agreements described above, point towards the absence of any information regarding the economic feasibility of establishing the nuclear power plants. Despite the absences of all this information, hundreds of millions Jordanian Dinar (estimated at over JD400 million) have been spent so far on the programme, with no concrete results to date. This information includes:

- The price charged on Jordan for the purchase of nuclear fuel from Russia
- The cost of generating electricity from nuclear fuel
- The price charged on NEPCO for the purchase of electrical energy generated from nuclear fuel
- The costs of utilities involved, including the large amounts of water needed to cool the plant
- The feasibility of extracting commercial amounts of uranium of commercial levels, which will depend on the findings of the pilot experimental extraction plant and also on the global price of uranium which has recently been on a declining trend.
- A breakdown of the \$5.1 billion to be invested from the Jordanian government and the means by which the government will obtain this large amount (half of 2013's budget).

Other than financial matters, there are also a large number of disadvantages and risks involved in the Jordan Nuclear Programme, included but not limited to the following:

#### **Safety Risks**

The number one disadvantage of generating or using nuclear fuel is the risks on human health, where the Fukushima nuclear plant disaster in Japan that unfolded during 2011 revealed the severe dangers of radiation exposure and other health hazards associated with nuclear fuels. Since that time, there has been a drive away from nuclear energy where several developed countries are now phasing out from using nuclear energy due to the high health risks involved. Such a risk is especially

relevant when considering the highly and increasingly unstable geopolitical environment neighbouring Jordan.

#### **Water Needs**

Another disadvantage is the large amounts of water needed usually required to cool nuclear reactors, with official estimates reaching as much as 60 million cubic metres of water per day, an amount that Jordan cannot afford as it one of the world's poorest countries in water resources. The JAEC had originally planned to use wastewater from the nearby khirbat al samra sewage treatment plant to cool the reactor. But due to use of this water as source of irrigation water, the water plan received heavy opposition from farmers and other stakeholders in the agriculture sector. Nevertheless, the Water Ministry said that it developed an alternative plan which is to obtain wastewater from a number of different locations, to be purify, and then used to cool the reactor. No further information was provided.

#### **High Investment Costs**

A major disadvantage of the nuclear agreement signed with Russia is the high investment cost to be borne by Jordan, which stands at \$5.1 billion or 51% of the total \$10 billion of required investment. This amount is equal to half of Jordan's budget in 2013, and significant portion will have to be spent upfront. It is unclear how the government plans to raise these funds, especially that it is already engaged in a fiscal consolidation programme, under which taxes and fees are being raised, subsidies lifted, and expenditures reduced. Total spending so far on the nuclear programme is estimated to be well over JD400 million, with no proof of economic feasibility.

#### **Uranium Price**

This major disadvantage concerns the programme's uranium extraction component. The price of uranium plummeted by around half from 2011 to 2014 mainly due to the Fukushima disaster that occurred in Japan. The currently low price of uranium is experiencing wide fluctuations as more and more developed countries phase out of nuclear energy and banning the development of new nuclear plants. This means that future demand is expected to decline as advanced economies begin to use alternative energy sources, which translates into a drop in prices given that supply stays the same. In other words, the outlook for uranium is negative with further declines expected in prices in the near future. This will strongly impact the feasibility of developing a uranium mining industry in Jordan.

#### **Non-Renewable Energy Source; and Limited lifespan of Nuclear Reactors**

Nuclear energy is not considered to be a renewable energy source since uranium deposits will eventually be depleted. Therefore, it is considered to be a non-renewable energy source. Furthermore, nuclear reactors usually have a limited lifespan, estimated to be for around 90 years

in the case of Jordan's nuclear programme. In other words, the investment will have a life-cycle that will end in 90 years time, which means that the returns to investment have be high enough to cover the high investment cost and any associated cost of infrastructure upgrades.

Despite garnering international support from the International Atomic Energy Agency (IAEA), there is a high level of domestic opposition to the programme by a number of various stakeholders. Most of the opposition is based on the above mentioned disadvantages and risks and to the lack of crucial information on strategic issues surrounding the programme such as pricing and infrastructure requirements. This has cast doubt among all stakeholders regarding the project's actual feasibility.

The majority of the former Lower House of Parliament were against this programme where a binding motion was passed in 2012 requiring all work regarding the nuclear energy programme to be halted pending the completion of all the various feasibility studies. This motion was not respected by the concerned authorities. The energy committee of the lower house at that time described the figures provided by the JAEC as misleading, accusing officials of underestimating the costs involved and overestimated the expected benefits. After more than two years, work on the nuclear programme is still moving forward with agreements signed in 2014 and 2015.

## **Conclusion**

In conclusion, this report aimed to describe the developments of the petroleum, shale oil and nuclear subsectors as well as highlighting the main associated challenges with developing these energy sources, taking the updated energy strategy as the main reference point. The report showed how there are various regions in the kingdom on which studies indicated the existence of large amounts of crude oil reserves. Currently, a number of international companies are carrying out exploration and development activities, with increased engagement and involvement from the energy committee at the Lower House of Parliament, due to the failure of previous efforts of other international companies to discover commercial quantities.

The report also revealed that while the volume of imports of crude oil have been declining over the past period, the imports of refined petroleum products surged in the same period, raising the overall value of energy imports to unprecedented levels. This finding pointed towards a deceased production and refining capacity of the Jordan Petroleum Refinery Company, which saw its production plummet over the past period. This as well as other factors underline the dire need to upgrade and develop Jordan's only refinery, which is currently looking for a strategic partner to implement its highly needed 4th expansion project.

The report tackled the developments of Jordanian shale oil, where large amounts of high quality and easily mined shale oil exists across a large part of the Kingdom, especially in the middle region. The report found four major investments currently operating in this subsector, with estimates pointing towards a combined production of around 83,000 oil barrels per day, representing over half of Jordan's energy needs, as well as the production of over 1,000MW of electrical energy. While there are some disadvantages that accompany the utilisation of shale (i.e. high water needs, environmental impact), Jordan will largely benefit from exploiting this resource, as the updated energy strategy found that using shale oil is the best economic option for the generation of electricity. Estimated savings from producing electric energy and oil from shale oil are high and significant.

With regards to nuclear energy, the latest estimates point towards the presence of large ore uranium reserves exceeding 60,000 metric tonnes of uranium oxide present in the central region of Jordan. While this stands in contrast to earlier estimates developed by international companies, it has paved the way for the development of a nuclear energy programme in Jordan, composed of three main components: uranium extraction, nuclear power plant (containing two nuclear reactors), nuclear research reactor. Statements from government officials and from the Russian firm 'Rosatom' are indicating that the programme will provide huge savings for the Jordanian treasury and will cover a large part of electricity needs, but this report found no currently available information to verify such estimates. Most of the pricing and costing issues have not yet been determined under any agreement, to enable an estimation process.

The report actually found a considerable number of disadvantages and risks associated with the nuclear programme including safety risks, large water needs, very high investment costs, and unstable price of uranium resulting from a deterioration in the uranium global market which will

impact the feasibility of developing the uranium mining sector in Jordan. Moreover, nuclear energy is not renewable and the life of nuclear reactors remains limited. The programme has so far received a lot of domestic opposition from various stakeholders, including parliament.

This report concludes that the development of both shale oil and nuclear resources in Jordan and their feasibility in being used as energy sources will remain highly dependent on the global price of crude oil. In other words, the lower the price of oil, the less feasible these projects will be, and the more disadvantageous any potential agreement will be for Jordan. It is worth pointing that the current price of oil is around half the level it was one year ago, before which the terms of all these agreements were negotiated. This means that the government will have to fiercely negotiate upcoming agreements.

The report also concludes that the development & upgrade of the Jordan Refinery's production capacity is currently the most pressing need and priority in the whole of the Jordanian energy sector. This is because the last upgrade of the refinery took place in the 1980s, and because traditional crude oil will remain the main source of energy for many years to come. Moreover, if any of the strategic oil projects or oil shale projects come online, the demand for petroleum products domestically refined from crude oil will surge to unprecedented levels. Closely associated with this priority is the need to develop Jordan's electricity grid to enable it to handle all the energy stemming from projects expected to come online in the coming five years.



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