



Hashemite Kingdom of Jordan

Summary

Updated Master Strategy of Energy Sector in Jordan for the period (2007-2020)

First Part

December 2007

Summary

Updated Master Strategy of Energy Sector in Jordan

First: Introduction

His Majesty King Abdullah Ibn Al Hussein II has charged His Royal Highness Prince Hamza Ibn Al Hussein with the presidency of a Royal Commission to review and update the national master strategy of energy sector, sanctioned by the Cabinet on 7/12/2004 with the aim to confront the challenges that impede implementation of several projects, which meet the Kingdom's energy needs during the next stage in a way that would contribute to improving the level of availability and openness of energy market before investments and achieving the energy supply security.

The Royal Commission has formed subcommittees within three hubs (oil, electricity and natural gas, renewable energy sector and energy conservation sector and alternative and local energy sector) in addition to necessary legislations and prudent governance hub. Moreover, a technical committee was formed under chairmanship of His Excellency secretary general of the Ministry of Energy & Mineral Resources, which comprises as members representatives from the Ministry of Energy & Mineral Resources and other bodies concerned with energy sector in order to assist the Royal subcommittees in completing the required work.

For the purposes of preparing updated strategy for the energy sector, a sequential action methodology has been developed including:

- Study the most important conclusions of the current strategy, and its most important recommendations and what has already been achieved; identify the obstacles that faced the implementation process and the recent developments that had taken place following its ratification at the end of 2004.
- Review and update demand forecasts on oil, natural gas and electricity up to the year 2020.
- Study the available alternatives to meet such demand and choose the best alternative.
- Develop a plan and a timeline program to implement necessary projects to meet needs within the suitable alternatives and

identify technical, financial and legislative requirements to implement such projects.

- Develop recommendations necessary in this respect.

Second: Obstacles and updates

The most important obstacles and updates that emerged during implementation of the strategy projects and programs for the sectors (downstream oil sector, electricity sector, natural gas, renewable energy, energy efficiency and alternative and local energy, can be summarized as follows:

In downstream oil sector domain

- Jordan Petroleum Refinery Company failed to expedite its measures to attract a strategic partner for expanding the refinery.
- Delay in taking the decision to replace the crude oil pipeline from Aqaba to the Refining site in Zarqa due to delay in attracting the new strategic partner for the expansion project.
- Impossibility to reach any understanding with the Saudi side on evaluating the status of the Tapeline and studying the possibility of rehabilitating it.
- Impossibility to follow up the measures for implementing the Jordanian – Iraqi crude oil pipeline despite the signing of a minutes of a meeting on 4/10/2004 regarding tendering the pipeline on the basis of laying a pipeline from Iraq to the Jordan Petroleum Refinery Company site in Zarqa.
- Impossibility of executing the memorandum of understanding between Jordan and Iraq on 15/8/2006 concerning the supply of crude oil (Kirkuk oil) to Jordan Petroleum Refinery Company with the required standard due to failure of the Iraqi side to maintain operation of its oil facilities (loading and pipeline facilities).
- Prolongation of time periods needed for completing downstream oil sector restructuring program and market liberalization.

Recent updates involving this sector include the following:

- The need to build ground storage capacities for crude oil in Aqaba to be appropriate for oil byproducts storage to replace the oil tanker Jerash with a minimum capacity of 230000 tons.
- The need for studying the issue of reinforcing the strategic reserve of crude oil and oil byproducts.

In Electricity Sector Domain

- To face the accelerating growth in the unexpected demand for electricity, and the great challenge represented in securing necessary investments to meet such demand.
- Unavailability of natural gas quantities required for future compound circuit electricity generation projects, something which affects the time schedule for execution and increases the power generation cost. In this regard, the strategy presumed the use of compound circuit system in electrical expansion which is more efficient and less costly than the steam circuit.
- Develop a mechanism for having a substitute for nuclear technology in electricity generation expansion programs.
- To use oil shale for electricity generation in electricity generation expansion programs.

In Natural Gas Domain

- There is a high demand for natural gas in the Kingdom to meet the existing and new power generation stations, existing industries and new industries to be set up and natural gas distribution projects.
- Increasing natural gas use inside Egypt to avoid import of certain byproducts from foreign markets at high prices as a result of clear drop in the Egyptian crude oil production at the expense of export gas quantities.
- The Egyptian request for increasing the prices of natural gas in respect any additional quantities for Jordan due to high rise of oil byproducts prices.
- There is an exclusive gas source currently available from Egypt, in addition to the fact that the Arab gas pipeline is a regional project that services more than one country and is not earmarked only for meeting the demand for gas in the Jordanian market.

In the renewable energy and energy efficiency domain

- High in investment cost for renewable energy systems compared with the cost of traditional generation systems and consequently the rise of the cost of generating electricity from renewable energy.
- Renewable energy projects need wide areas of land which are often hard to secure.
- Lack of special legislations concerning renewable energy projects covering facilities, customs exemptions and necessary tax.

- Government decisions on implementation of electricity generation projects to adopt the BOO system by private sector and not on EPC basis, which will lead to a rise in the cost of such projects due to argumentation of risk factors and finance costs.
- Recent developments in solar energy field provided that a technical committee from electricity sector institutions has to study a preliminary offer from NAANAVA Company to define the capacity of a project for generating electricity from solar energy. This project to be implemented by the company and a proper mechanism shall be determined to proceed with the implementation measures.

In Local Energy Domain

- The current Natural Resources Authority law is not keeping with the current investment requirements (an old law issued in 1968) and the dire need for updating and restructuring the Natural Resources Authority legislations.
- Decline of financial allocation for Natural Resources Authority to enable it complete the production sharing agreements in oil and gas exploration projects.
- Emigration of technical qualified personnel with broad experience in oil domain due to poor local salaries and alluring financial offers from petroleum companies outside Jordan.
- Nonexistence of approved rules and sharing conditions to be relied upon when negotiating with companies willing to invest in field of minerals and oil shale, represented in the following:
 - There is no certain rate of royalty imposed on these companies as there are no legislations to impose.
 - There are no percentages for sharing profits upon negotiation.
 - There is no unified agreements form to facilitate dealing equally with all companies. This in turn leads to a difference in the concluded agreements thereby creating future problems with investors.
- Delay of Natural Petroleum Company in implementing Risha field development program to scale up production of local gas because of poor financial potentials of the company and the delay in attracting a strategic partner.
- There are obstacles impeding investment in oil shale facing investor companies, most important of these obstacles are:
 - Necessity to develop technology and great risk in proving it and making it a success.

- Necessary treatment of oil extracted from oil shale to enable petroleum refineries to refine it, especially regarding sulfur.
- The need for large quantities of water.
- Magnitude of required investments.

Figure (1) shows the percentage of contribution of fuel types in total energy mix for the years (2007, 2012, 2015 and 2020) respectively for medium demand scenario.

Table (5) shows results of primary energy demand forecast as per fuel type for (2007-2020) and for medium scenario:

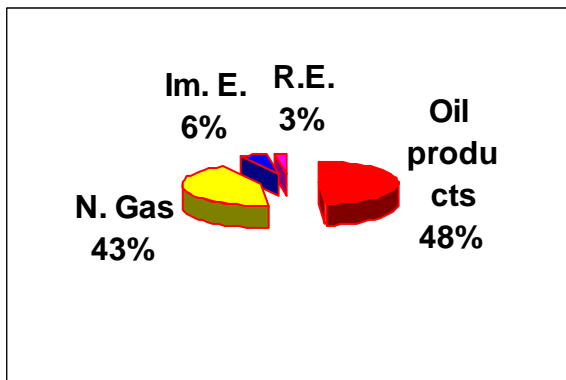
(Quantities in thousand TOE)

	2007	2010	2015	2020
Fuel oil	679	637	765	928
Diesel	1889	2174	2652	3203
Gasoline	806	928	1115	1321
LPG	364	418	510	619
Kerosene	163	186	227	274
Aircraft fuel (Avtur)	260	298	356	423
Asphalt	163	175	190	205
Natural gas (imported)	2469	3761	4335	3778
Natural gas (local)	143	65	68	0
Oil shale	0	0	976	2436
Renewable energy	107	122	745	1362
Imported electricity	533	533	533	533
Total	7577	9298	1247	15084

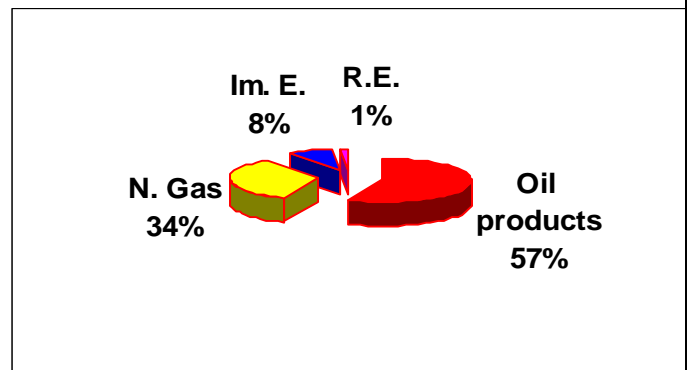
In light of availability of quantities of natural gas, quantities of natural gas can be subrogated in the commercial and domestic sectors and transport industries by 63 thousand TOE in 2007 and by 4318 thousand TOE in 2020 instead of diesel, kerosene and LPG.

Figure (1) percentage of contribution of fuel types in total energy mix for the years (2007, 2012, 2015 and 2020) respectively for medium demand scenario

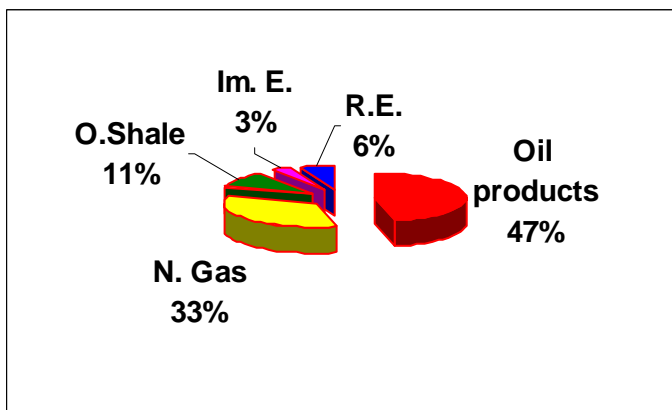
2012



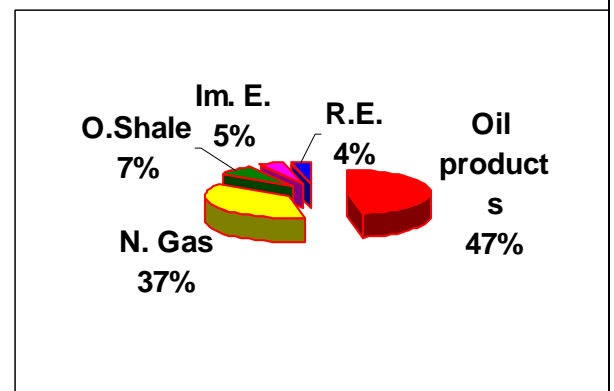
2007



2020



2015



- It is expected that the quantity of demand for primary energy for the year 2007 shall be about 7858 thousand TOE for the high demand scenario and 17108 thousand TOE in the year 2020 i.e. an expected growth rate of 6.2% during the period (2007-2020).

However, demand for primary energy according to the low scenario in the year 2007 will be about 7450 thousand TOE to rise in the year 2020 to 13057 thousand TOE at an annual growth rate of 4.5% for the period (2007-2020).

Correspondingly, demand for primary energy according to the high scenario in the year 2007 will be about 7858 thousand TOE to rise in the year 2020 to 17108 thousand TOE at an annual growth rate of 6.2% for the period (2007-2020).

Fourth: Alternatives to meet the demand for primary energy

In order to meet the demand for primary energy in light of diversity of supply sources, several alternatives for meeting the demand for primary energy and choosing the best alternatives were studied as follow:

Alternatives for crude oil and oil byproducts supply

The Kingdom can be supplied with crude oil and its byproducts through developing the refining industry by maintaining Jordan Petroleum Refinery Company, proceeding with expansion and modernization project and boosting its refining capacity on the strength that it is the best choice for the national economy. The expansion project involves increasing the refining capacity to (17) thousand tons, producing oil byproducts conforming to International specifications EURO IV and converting the greater portion of heavy fuel oil into light byproducts. The investment cost for such project was estimated at 1275 million US\$ approximately.

Security of crude oil supply and diversification of its sources can also be achieved by laying a pipeline from Aqaba to the Refinery site in Zarqa to supply it with oil and also by restructuring of the downstream oil sector and opening the market for competition by establishing logistic and marketing companies and liquefied petroleum gas, which will pave the way for import from the world markets to meet the local market needs, in addition to the possibility for exploiting any local discoveries of crude oil or producing crude oil from oil shale.

In electrical power domain

All alternatives available for electricity generation have been studied and a study was conducted showing the Jordanian electrical system's needs for generation powers for the period (2007-2030) taking into consideration the different alternatives for primary power sources available for electricity generation, whether they are traditional, new or renewable, which include (oil byproducts, natural gas, wind energy, solar energy and oil shale). A study was conducted for such purpose up to the year 2030 in view of the fact that the capital cost of generation units are very high and its life cycle is very long (25-40) years. In order that the economic comparison can be more accurate among all alternatives, the study was conducted for the aid period in addition to studying the nuclear alternative within the alternative of expansion in electrical power generation taking into account all variables occurred to the electricity sector.

Two case studies were approved on the availability of natural gas and limited quantities of natural gas, in addition to studying several cases in each alternative. Table (3) shows a summary of the results of case studies of generation expansion alternatives.

Table (3): Summary of case studies results

Case Study	Alternative	Additional Capacity					Total MW	Total Cost Million US\$
		CC 380 MW	ST 300 MW	OSPP 300 MW	NuPP 400 MW	GT 100 MW		
Natural Gas Availability	HFO	13	-	-	-	11	6040	9 248
	Nuclear Fuel	13	-	-	-	11	6040	9 248
	Oil Shale	6	-	9	-	12	6180	9 131
Limit of Gas Quantities	HFO	2	16	-	-	5	6060	15 049
	Nuclear Fuel	2	9	-	6	4	6260	13 863
	Oil Shale	2	3	14	-	3	6160	11 057

- 1- The above table (3) shows that the alternative of using oil shale for electricity generation is the most economically feasible for expansion in electricity generation, whether in case of availability or unavailability of additional quantities of natural gas.

Several sensitivity tests were conducted on the expansion plan in the optimal generation as follows:

- a- New quantities of gas were discovered in Risha field where a study was conducted on the possibility of producing 100, 170 and 350 million cubic feet daily from Risha gas.
- b- Use of renewable energy: In this case, a study was conducted on the sources of renewable energy and its effect on the expansion plan in optimal generation so that the wind energy and solar energy were considered.
- c- Consumption rationalization and loads management:
In this case a study was conducted as the effect of rationalization of electricity and loads management on generation expansion plan: It was presumed that the measures for electricity rationalization and loads management would save 5% of total electrical power consumed by the year 2015.
- d- The effect of realization of high loads forecast on the optimal generation expansion plan.
- e- The effect of realization of low loads forecast on the electricity generation plan.
- f- Nuclear alternative: In this alternative it was preserved to add two generation units by using nuclear energy with a capacity of 400 MW per each unit so that the first unit shall be in service in the year 2020 and the second unit by the year 2024 and to study the effect of this alternative on the optimal generation expansion plan.

- 2- Table (4) below shown a summary of the results of sensitivity tests applied to optimal generation expansion plan.

Case Study	Additional Capacity					Total MW	Total cost Million US\$
	CC 380 MW	ST 300 MW	Added capacity OSPP 300 MW	NuPP 400 MW	GT 100 MW		
Optimal expansion plan	6	-	9	-	12	6180	9131
Production of 100 million cubic feet daily from Risha field	7	-	8	-	10	6060	9010

Production of 170 million cubic feet daily from Risha field	8	-	7	-	10	6140	8896
Production of 350 million cubic feet daily from Risha	9	-	5	-	11	6020	8789
Renewable energy*	6	-	9	-	12	6180	9129
Consumption rationalization and loads management	5	-	9	-	12	5800	8699
High loads forecast	7	-	10	-	15	7160	10457
Low loads forecast	5	-	7	-	11	5100	7899
Use of nuclear energy	6	-	6	2	12	6080	9241
Cost of un-served energy 2\$/Kwh	6	-	9	-	12	6180	9189
Drop of oil prices by 5%	6	-	9	-	12	6180	9122
Oil shale extract cost 15\$/ton	13	-	-	-	11	6040	9248

*600MW wind+130 solar

Table (8): Summary of sensitivity tests results

- 3- It is apparent from the table (4) that it is possible to realize a considerable saving in overall costs of the generation expansion plan through availability of additional quantities at Risha field and through consumption rationalization programs and loads management.
- 4- The option for using renewable energy realizes a saving from the economic aspect in the costs involving generation expansion plan but it leads to an increase of financial costs. To achieve this option, it is necessary to have a mechanism for supporting renewable energy projects in order to nullify the adverse effect of this option.
- 5- In case of resorting to the case of nuclear option for generation electricity and after ascertaining the feasibility of exploiting oil shale to generate electricity through direct combustion, then this will lead to an increase in the generation expansion plan by about 112 million US\$ during the study period.
- 6- There is a need to increasing the generation capacity of the Jordanian electricity system during the period (2007-2020) ranging

between (4020-4140) MW at a total cost between (4254-5245) million US\$.

Plan of expansion in electrical transmission network

Facing the increasing growth in electrical loads requires expansion of several substations operating in the national network, especially in the central areas of the Kingdom. It also requires setting up of numerous substations to feed the new loading centers that emerge and are hard to feed from the existing substations and in order to connect the new generation stations intended to be added to the electrical system with the national transmission network. This will entail necessity to lay new transmission lines and ground cables to connect these stations with the national network. This is in addition to the need for supporting the transmission lines in the national network as a result of the remarkable increase in loading and the appearance of bottlenecks in certain transmission lines at a cost of about 653 million US\$ during the period (2000-2007).

Alternatives for supply of natural gas

The study should that the alternatives for natural gas supply are:

1- To import natural gas from Egypt through the Arab gas pipeline project

- The current agreement for selling natural gas to electricity generation station (annual contractual quantities reaching 2.615 billion M³/ yearly as of 2011 and there is a flexibility to specify the daily needs by an increase of (15%).
- The current agreement for selling natural gas to industries (gas quantities amounting 2 billion M³/ yearly and to supply about (0.54) billion M³ directly through the main pipeline to the major industries existing in the Kingdom. The approval of the Egyptian government is currently pending in this regard.
- Quantities of gas from Egypt to natural gas distribution projects (negotiations is currently under way with the Egyptian side to supply quantities of gas amounting to 500 million M³/ yearly to meet the need of natural gas distribution projects in Amman, Zarqa and Aqaba).
- Additional quantities of gas from Egypt (1billion M³/ yearly) to meet the needs of electricity generation station.

2- Local gas produced from Risha field

3-

- Potential gas quantities from Risha gas field in current production about (25 million M³/ daily) supplied to electricity generation stations at Risha gas field site.
- It is likely to transport quantities of gas to Amman reaching up to (300) million M³/ daily as of the beginning of 2015 in light of development of Risha gas field and attracting a strategic partner.

4- Natural gas imported from foreign sources which could be available by the year 2015

In view of the limited quantities of natural gas currently imported from Egypt, and in order to meet the future demand for natural gas it is inevitable to look for other foreign sources for supplying gas by importing gas from other countries like Saudi Arabia and Iraq.

Fifth: Primary Energy Mix until 2020

In light of the evaluative studies conducted on energy types and sources of supply thereof, and which could contribute in meeting the demand for primary energy during the period (2007-2020) so that is shall achieve energy supply security and diminish dependence on import eight possible options or scenarios have been reached to achieve the referred to objective at variant achievement percentages as evident from table (5). These scenarios were developed in accordance with basic prospective variables as follow:

- Quantities of natural gas imported from Egypt through the Arab gas pipeline and specified in the present contract signed between the two countries.
- Probability of increasing the quantities of natural gas imported from Egypt.
- Increasing the quantities of natural gas produced at Risha gas field as a result of the efforts exerted for developing this field.
- Introducing an alternative for nuclear energy for electricity generation.
- Exploiting oil shale for generating electricity.

The most probable and factual scenario was given preponderance, namely the sixth scenario, which provides for introducing an alternative for nuclear energy for the purposes of electricity generation by adding a

nuclear generation plant with capacity of 60 MW in the year 2020 to contribute by about 6% in the total energy mix for the year 2020.

In light of this scenario contribution of the local sources in the primary energy mix will increase from 4% in the year 2007 to reach up to 25% and 39% during the years 2015 and 2020 respectively.

In contrast, contribution of foreign sources in the primary energy mix will decrease from 96% in 2007 to 75% and 61% in the years 2015 and 2020 respectively as shown in figure (2), which shows the types of energy that will take part in meeting the demand for primary energy for the years 2007, 2015 and 2020 and the percentage of this sharing according to the referred to sixth scenario.

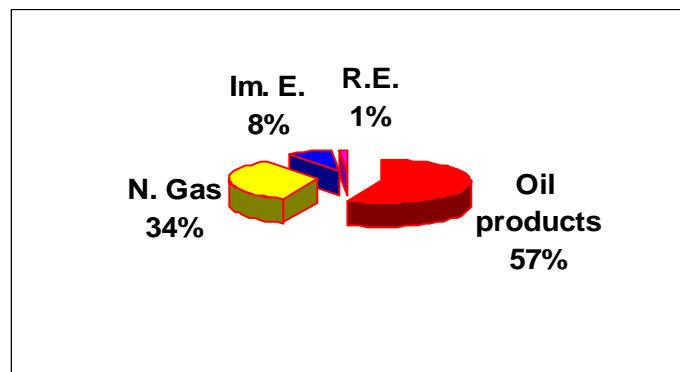
Table (5) Potential scenario to meet the demand for primary energy in the year 2020

Energy source	1 st scenario	2 nd scenario	3 rd scenario	4 th scenario	5 th scenario	6 th scenario	7 th scenario	8 th scenario
Natural gas								
3 billion m3/year-contract	20%	20%						
3 billion m3/year as per contract + additional gas from Egypt (2) billion m3/year			41%	41%				
3 billion m3/year as per contract + 1 billion m3 from development of Risha gaseous field					29%	29%		
3 billion m3/year-contract + additional gas from Egypt (1) billion m3/year + (1) billion m3 from development of Risha field							45%	45%

Nuclear energy (generation station 600 MW)	6%	6%	6%	6%	6%		6%	6%
Wind energy (60) MW + solar energy (60) MW and others	10%	10%	10%	10%	10%	10%	10%	10%
Oil shale	8%	14%	8%	14%	8%	14%	8%	14%
Oil Byproducts	59	53%	47%	41%	42%	40%	31%	25%
Imported electricity	1%	1%	1%	1%	1%	1%	1%	1%

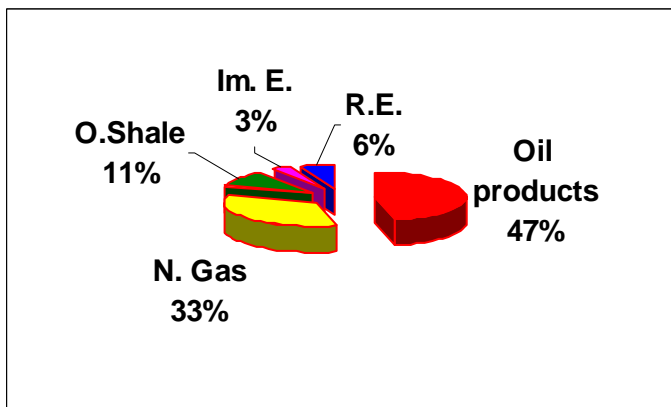
Figure (2): Energy types and rates of sharing in meeting the demand for primary energy during the period (2007-2020).

2007



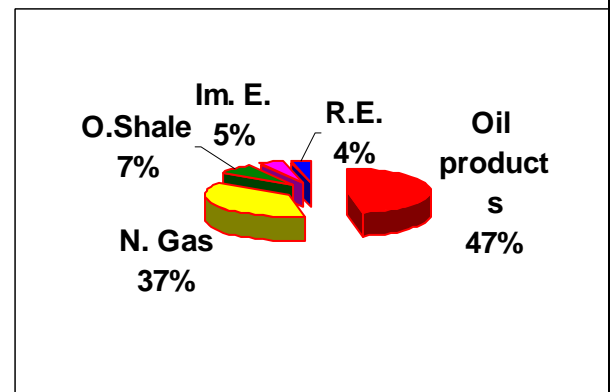
Local sources 4% & Foreign sources 96%

2020



Local sources 39% & Foreign sources 61%

2015



Local sources 25% & Foreign sources 75%

Sixth: Recommendations

The study of updated master strategy for energy sector concluded the outcomes and recommendations, most notably:

First: In the downstream oil sector domain:

The next period (2007-2020) will witness a growing demand for primary energy by a growth rate of about 5.6%. Volume of required investments in this sector will be about 3397 million US\$ at the 2007 prices. It can be summarized in proceeding with implementation of the fourth expansion project for the Petroleum Refinery, which provides for increasing the productive capacity, building conversion units and units for improving the specifications of oil byproducts at a cost of about 260 million US\$ and increasing the volume of storage capacity of crude oil and oil byproducts at a cost of about 1550 million US\$ in addition to completing the downstream oil sector restructuring program estimated at an investment cost of about 312 million US\$.

The most important recommendations in this regard were as follows:

- 1- Maintain the continuation of the current refinery in the refining activities on commercial basis.
- 2- Instruct Jordan Petroleum Refinery Company to speed up its actions to attract a strategic partner and carry out its fourth expansion project which involves increase the refinery capacity and improve quality of byproducts.
- 3- Both the JPRC and the strategic partner shall construct crude oil pipeline from Aqaba to the Petroleum Refinery in Zarqa in conjunction with the fourth expansion project. The pipeline project can be carried out by the private sector and under the supervision of the Government on BOO basis.
- 4- Accelerate completion of the government plan to restructure the downstream oil sector and liberalize oil market, open it for competition especially what is regarded with the legislations to be completed by 1/2/2008.

- 5- Study all alternatives to the refinery industry in case the Refinery Company was unable to attract the strategic partner and the expansion project was not in progress.
- 6- Speed up in completing the implementation of the privatization programs provided establishment of the Logistic Company, distribution companies and liquefied gas, privatization and finalize the concession of Jordan Petroleum Refinery Company max on 1/3/2008.
- 7- Liberalize fuel prices and apply the established pricing policy by the Cabinet for such byproducts so that prices are amended periodically to reflect international prices.
- 8- The need to issue the minerals and oil law to restructure downstream oil sector.
- 9- Adopt the efficiency of storage capacity for crude oil and byproducts by (90) days at the daily consumption in the year and increase storage capacity of the oil byproducts for the strategic reserve in the Kingdom owned by the government by 735 thousand tons out of which 51 thousand tons of liquefied gas to cover current expected needs of the storage capacities in the medium run and carry on increasing the storage capacities as needed in the future in the long run provided this strategic reserve is managed and run by the Government represented by the Ministry of Energy & Mineral Resources. Such capacities are increased through entrusting the logistic company that will be founded and licensed in light of oil market liberalization or through assigning a government body like the Ministry of Energy & Mineral Resources or the regulator of the downstream oil sector.

In electrical power domain

During the last period the electrical power sector witnessed accelerated development and growth and the demand for electricity is expected to continue during the period (2007-2020) at a percentage of 7.4% on the basis of average demand scenario, which requires an addition of (4140-4020) MW as electricity generation units for the electrical system at an estimated cost of about (4254-5245) million US\$ at the rates of 2007 prices to meet the growing demand and replace the existing generation stations. This is in addition to reinforcing the national transmission network by adding substations and high and medium voltage tension lines at a cost of about 563 million US\$ during the same period to enable it

bring the electricity into the regional interconnection network, maintain stability of electrical system and deliver electrical power to all consumers in the Kingdom.

The study was concluded by the following recommendations:

- 1- Carry out expansion projects on the electrical power generation based on IPP in a manner of building – ownership – Operation (BOO).
- 2- Turn to the use of oil shale for electricity generation using the direct combustion mechanism and have a look at international experience in this aspect and complete trends procedures of direct negotiations with the Estonian side to construct 300 MW station operating on combusting oil shale on the way to diversify primary fuel sources necessary to generate electricity. Introduction of new technology is also important in this aspect in addition to heading for the use of renewable energy and nuclear one to generate electricity.
- 3- Provide the necessary capacity of gaseous generation units to face peak loads either through the generation companies operating in the sector or through including this matter in Requests for Proposal documents for the private generation projects in the future or request the same in proposals for single gaseous generation unit projects by the private sector.
- 4- Electricity Sector Regulatory Commission shall control the market and provide necessary studies to the Ministry of Energy & Mineral Resources to file to the Cabinet to ratify transformation of the sector to competitive electrical power market under the provisions of the current electricity law in force.
- 5- Electricity sector regulatory commission shall permanently review the electricity tariff among all concerned bodies to reflect the actual cost of generating and transferring and distributing the electrical power.
- 6- Issue the general electricity law permanently.

In natural gas domain:

The Kingdom is currently being supplied by natural gas from Risha gas field at a daily average of 22 million cubic feet in addition to the natural gas imported from Egypt for electricity generation. Volume of investment needed for developing this sector during the period (2007-2020) is estimated at about 2461 million US\$ to be used for implementing the project of setting up natural gas distribution networks in Aqaba, Zarqa

and Amman by the private sector at a cost of about 400 million US\$ (during the first ten years of the project lifetime), and to supplying existing industries in the Kingdom and electricity stations with natural gas at a cost of about 71 million US\$. This is in addition to completing the Arab Gas Pipeline from Rehab northward to the Jordanian Syrian borders at 30 km length through the Jordanian Fajr Company at a cost of 30 million US\$ and to develop Risha gas field at an estimated cost of 1960 million US\$ through the strategic partner. It is expected the quantities of natural gas will be discovered reaching up to (340) million cubic feet/ daily as of the beginning of 2015 to be transferred from Risha gas field to Amman.

The study recommendations in this domain were:

Regarding the imported natural gas

- 1- Follow up with the Egyptian side to obtain its consent on the additional quantities that have been discussed to meet natural gas demand amounting to 2 billion m³/year distributed as follows:
 - 1 billion m³/year to electricity generation stations.
 - 0.5 billion m³/year to the existing large industries.
 - 0.5 m³/year to the natural gas distribution in Amman, Zarqa and Aqaba.
- 2- NEPCO shall develop a plan to administer the available gas quantities from the Egyptian side to be used in the electricity stations in a way to guarantee the greatest benefit to the National economy.
- 3- It is imperative to search for alternative natural gas sources from other countries like Saudi Arabia and Iraq and other potential countries to meet local demand in the long run.

Regarding local natural gas:

- 1- Speed up plans for the development of Risha gas field to maximize local gas production and thus meet the Kingdom needs of natural gas which might be an alternative to have the natural gas supply in the medium and long run.
- 2- Finalize negotiations with ANADARCO Company on its proposal to take part in the Risha field development before the end of the first quarter of 2008.

- 3- International bidding to attract a strategic partner to develop Risha field in case of failure to reach an agreement with ANADARCO Company.

In the domain of exploiting oil shale for producing oil:

The strategy study estimated the volume of investments required for exploitation of oil shale existing in large quantities at about (1400-3800) million US\$. The surface or superficial or deep oil shale shall be exploited and used for producing oil or electrical power.

The study was concluded by the following recommendations:

- 1- Complete the bankable feasibility studies by the concerned companies to exploit superficial oil shale in the different areas where oil shale is available. So many memoranda of understanding have been signed with companies having adopted technologies on the way to proceed with the investments on the commercial level and pave the way for other companies in this domain.
- 2- Cease negotiations with Shell Company on the concession agreement related to the deep oil shale exploitation for oil production before the end of the first quarter of 2008.
- 3- Direct negotiations with the Estonian side to construct electricity generation plant with the direct combustion of oil shale at 600-900 MW based on BOO and operation of the station before end of 2015.
- 4- Emphasis on detailed studies of the environment impact of the oil shale projects to make sure they comply with the environmental requirements.
- 5- Establish a specialized unit of the oil shale within the Ministry of Energy or Royal Scientific Society/National Energy Research Center.

In renewable energy domain:

Energy sector strategy has provided for reaching a contribution percentage for renewable energy in total energy mix of about 7% by the year 2015 and 10% by the year 2020 where the volume of required investment was estimated at about (1415-2115) million US\$.

The most important recommendations in this regard were as follows:

- 1- Proceed with the issuance of renewable energy law to stimulate the private sector to increase its investments in this domain.
- 2- Proceed with the implementation of the wind energy projects for electricity generation based on BOO represented by 600 MW at the end of 2020 as follows:
 - Proposed wind project in Kamsha (30-40) MW during 2007-2009.
 - Proposed wind project in Fujaij (grant submitted by GEF) – 60-70 MW during 2007-2010.
 - Proposed wind project in Harir – 100-200 MW (on phases) during 2008-2012.
 - Proposed wind project in Wadi Araba at 40-50 MW during 2009-2013.
 - Wind projects – 300 MW in other places in light of the necessary studies by 2020.
- 3- Complete the studies necessary for the thermal solar energy projects (300-600) MW.
- 4- Expand in the use of the solar cells systems to lighting remote areas and in domestic, industrial and commercial uses and electricity generation.
- 5- Carry out electricity generation project from the municipal wastes in coordination with GAM and concerned bodies.
- 6- Focus search and study on the biogas fuel (Brazilian experience) to be used in covering industrial needs and transport sector.
- 7- Create a fund to aid renewable energy projects (and energy rationalization) so that resources of the fund are through:
 - Treasury allocations.
 - Environment fund (CDM).
 - Amounts from Jordan country project fund and within available potential.
 - External aids from donors (French agency, German construction bank, Japanese agency...etc).
 - GEF through World Bank.
 - Any other sources that can be proposed.

In energy consumption rationalization and efficiency domain:

By reviewing the strategy focus was made on implementing a number of programs and projects that will save energy consumption in all sectors (domestic, industrial, commercial, governmental, transportation and water

pumping) at a percentage of about 20% where the volume of investments (expenditure) required in this domain was estimated at about (76-155) million US\$ at 2007 rate.

The strategy recommended the following:

- 1- Create a clear binding mechanism to apply programs and procedures of energy use rationalization as prescribed in the national strategy to improve energy use efficiency in all sectors (domestic, industrial, commercial, transport, services and water pumping), represented by:
 - Prepare broad awareness campaigns on the energy consumption rationalization targeting all sectors as of outset of 2008.
 - Establish audience service offices on purpose to reach all citizens classes and introduce them to the energy consumption rationalization and improve its efficiency as of mid 2008.
 - Exempt equipment – energy savers from the sales tax and customs duties and set suitable mechanisms to facilitate access to them like (solar water heaters, energy-saving lamps) on purpose to encourage citizens to rationalize and conserve energy consumption.
 - Carry out procedures related to the energy consumption rationalization as stated in the transport sector strategy. The consumption of this sector represents 37% of total overall final energy consumption, most notably:
 - Rationalize fuel consumption in the transport sector through adoption of specialized workshops to caliber engines and wheels and other maintenance issues.
 - Reduce customs duties and sales tax and other fees on vehicles of small engines or hybrid vehicles.
 - Use of light electrical systems.
 - (Amman – Zarqa project will lead to reducing average energy consumption by 4 million JD annually).
 - Retrofit replacement of transport modes where saving in fuel is estimated at 18 million JD for 2008-2011.
 - Promote replacement of old vehicles by modern ones in light of the Cabinet's resolution regarding exemptions granted to the public buses so that the exemption will apply to private vehicles.

- Create proper mechanisms to encourage people to use public transport modes rather than private cars especially downtown and in the traffic jam areas so that such modes are provided free of charge.
- The need to enlighten people on the eco-driving subject and car-pooling and use of cars in urgent cases only.
- Reduce the mix speed on the highways to 90 km/hour and create proper mechanisms to control speed.
- Reduce days of working days per week while increasing working daily hours and promote telecommuting.
- Set operative mechanism to apply the National Building Codes related to the thermal insulation through the following procedures:
 - Prepare special codes for energy-saving buildings, for gas installations in the buildings, update thermal insulation codes and general technical specifications to the buildings as of the first quarter of 2008.
 - Bind the engineering offices supervising the application of the energy saving-codes as of 2008.
 - Issue instructions to make quality assurance certificates in the residential flats as of 2008 to ensure application of procedures set forth in the national building law.
 - Amend Jordan national building law and give it priority.
- Create a national award in the energy consumption rationalization domain and improve efficiency to encourage and stimulate rationalization of energy consumption in the Kingdom.

In oil and gas exploration and discovery domain:

The Kingdom was divided into eight exploration areas according to geological nature. All areas of the Kingdom are linked with production sharing agreements or memoranda of understanding with local and foreign companies save for Jafr area.

The most important recommendations in this regard were as follows:

- NRA shall develop a proper mechanism to market and promote Jafr area among companies concerned in oil and gas exploration through signing a memorandum of understanding with an interested company or sign production sharing agreement.

- Complete study on restructuring NRA on the Authority division basis to Mineral and oil commission, geological survey commission, and study the possible privatization of drilling activities, labs and supporting services.
- NRA reconsiders terms of reference for the production sharing agreements or memoranda of understanding with local and foreign companies if no oil discoveries achieved and reconsider the zoning of the open explorative areas.
- Issue law of Jordan geological survey commission.

In the field of Country policies coordination related to the sector, sector regulation and control its performance

To coordinate Country policies related to the energy in all development sectors, energy sector regulation and control its performance,

- Establish supreme body for energy to coordinate Country policies related to energy in all development sectors, carry out programs and projects of the strategy different hubs to ensure good performance.
- Establish uniform commission to regulate energy sector.

Seventh: Volume of Required Investments

The strategy estimated the volume of required investment in million dollars, at the 2007 rates in energy sector for the period (2008-2020) in accordance with the different programs and projects for the sector between (13268-17335) million US\$ i.e. one million dollars annually distributed as follows:

Summary of Investments Volume according to Sectors	Required Investment Volume (MUS\$)
1- In the Domain of Downstream Oil Sector	
- Completing liberalization of downstream oil sector and opening it for competition	2.2
- JRPC fourth expansion project, which includes increasing productive capacity and building conversion units and units for improving oil byproducts specifications.	1275
- Building a pipeline to transport crude oil from Aqaba to Zarqa.	260

- Separating five Aqaba Thermal Power Station Fuel Oil storage tanks and converting 3 of them for storing crude oil instead of heavy fuel oil.	66
- Building storage capacities required for meeting crude oil and oil byproducts demand.	1482
- Establishing Marketing, Logistic, and Liquefied Petroleum Gas Companies.	312
- Preparing draft law for a unified commission for regulating energy sector. - Developing regulations, instructions and mechanisms for the implementation of the energy sector regulation commission in addition to incorporation and operating the commission.	0.7
- Completing Natural Resources Authority Restructuring	1
- Marketing open un-marketed exploration areas in oil and gas exploration domain.	-
2. In the Domain of Electrical Power Sector	
- Building electrical power generation units with a capacity ranging between (4020-4140) MW during the period (2007-2020).	4254-5245
- Enhancing Electrical national network (building substations 400/132/33 KV)	563
3. In the Domain of Natural Gas	
- Supplying the new Samra Power Plant with natural gas for with a capacity of 200 MW for converting into compound circuit with a capacity of 300 MW, and East Amman substation with a capacity of 370 MW through Fajr Company.	6
- Supplying a number of existing industries in the Kingdom with natural gas by the Jordanian- Egyptian Fajr Company.	65
- Implementing natural gas distribution networks project in Aqaba, Amman and Zarqa by the private sector.	400
- Completion of the Arab Gas Pipeline from Rehab to the north to the Jordanian Syrian borders with a total length of about 30 km through Fajr Company.	30
- Developing Al Risha Gas Field through a Strategic Partner.	1960*
4. In the Domain of Renewable Energy	
- Issuing the draft law of renewable energy and establishing energy efficiency fund (financing the fund).	20
- Al-Kamshah proposed wind power project with a capacity about (30-40) MW on BOO system.	50-60
- Al-Fujaj proposed wind project (the grant provided by GEF) with a capacity of about (60-70) MW on BOO system.	90
- Al-Hareer proposed wind project with a capacity of (30-40) MW (in stages).	150-300

- Wadi Arabah proposed wind project with a capacity of about (30-50) MW.	45-75
- Utilization of Solar Energy for electrical power generation with a capacity of (300-600) MW	530-830
- Municipal waste exploitation project for electrical power generation project with a capacity of about (20-30) MW	30-40
- Utilization of agricultural products project to produce biogas fuel (Ethanol).	50-100
- Projects of building units for electrical power generation using wind energy with a capacity of 300 MW during the period (2015-2020).	450-600
5. In the Domain of Improving Energy Consumption Efficiency	
- Implementing Energy Consumption Efficiency Programs in different sectors	
- Governmental	2-5
- Industrial	50-100
- Commercial	10-20
- Domestic	10-20
- Water pumping	1-2
- Transportation	3-5
6. In the Domain of Exploitation of Oil Shale in Electrical Power Generation and Oil Production	
- Deep In-situ Oil Shale /Shell International Company	300-400
- Surface Retorting Oil Shale	1100-3400
Total	13268-17335

* This value according to the offer submitted from Andarko Company of Expected Case, which includes producing 340 million cubic feet daily from Risha Field.

In case all energy sources alternatives are available, including nuclear energy, the volume of investments required for different projects in energy sector for the period (2008-2020) is estimated at an amount ranging between 14-18 billion US\$, about 1.2 billion US\$ annually.

NB: Finance source for the volume of investment needed for energy sector comes from private sector save for electricity transmission grid reinforcement projects which are financed by NEPCO, self-finance, commercial loans or loans guaranteed by the Government.