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Energy Security; the Lebanese Case

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1 Introduction

In our modern age, energy has become an expected right of the world population that underpins economic growth and social development.

Development and cost efficient investment in energy systems has a proven correlation to GDP growth. When electricity supply experiences frequent interruption or is prohibitively expensive, economic growth tends to slow down, stagnate or even contract (WEC Lebanon, 2008).

Originally, energy security was a straightforward strategic objective aimed at ensuring fuel for national defense. Energy security still relates nowadays to the uninterrupted availability of energy sources at an affordable price (IEA, 2014).

Strong growth in energy demand, rising oil prices, and uncertain supply from key energy exporters has led to continued concerns about energy security. Also there are a number of concerns and fears such as: oil and other fossil fuel depletion.

The challenges of the energy industry in every country to provide electricity supply that is secure, affordable and sustainable have migrated with time into the concept of Energy security. Energy security must be delivered alongside achievement of the legally binding targets on carbon emissions and renewable energy that many countries have committed for.

When assessing the challenges of energy security, there are short-term challenges, such as the potential for disruption arising from volatile

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energy sources market prices or technical failures in infrastructure, industrial action or severe weather conditions. An economy is vulnerable to such challenges when its energy supply system lacks resilience to technical failures or is dependent on a narrow range of energy sources along with the inability to switch away from the energy source whose price is increasing (IEA, 2014).

Longer-term challenges arise from changes to market structure, geopolitical patterns and climate change. To such challenges an economy is vulnerable if it is unable to improve its ability to broaden the range of energy sources or is unable to increase its ability to generate and implement new forms of energy. Long-term energy security is thereby mainly linked to timely investments to supply energy in line with economic developments and environmental needs (IEA, 2014).

Facts about Global Energy Security

Since 1990, the world global energy consumption has been increasing nearly 2% per year or 50% in total and is expected to increase further by 56% by 2040 (EIA, 2013).

The efficiency improvements & energy saving measures being undertaken in many countries will only moderate this demand growth by a small percentage ranging between1.3% to 2.6% by 2030 (IEA, 2013).

The renewable energies share of the global energy consumption mix is not expected to be more than 18% to 30% of the total global demand by 2030 (IRENA, 2013).

With the Nuclear energy global share being on the decline by dropping from 13% in 2010 to 7% in 2035, the most sustainable option for the deployment of scale of power generation capacity to meet the global energy demand growth till 2030 will remain that of fossil fuels which will keep on covering around 70% of the total market demand by 2030 (worldbank, 2013).

Energy security is thereby still largely dependent on the physical availability of primary energy sources in sufficient quantities in particular coal, oil, fuel and gas combined with the affordability of these energy sources.

Renewable energies, energy savings measures and demand side responsiveness will play an increasingly important role in providing Energy security in line with their technological maturity and development, and subject to their price competitiveness.

How to achieve Energy Security

There are four key characteristics of an energy supply system that constitute the pillars of Energy security:

1- Adequate capacity:

Proper dimensioning for adequate capacity addresses the difference between the expected likely volumes that can be supplied within a country, against the likely maximum demand. Ensuring adequate capacity for the energy system allows the system to absorb sudden fluctuation in demand and to buffer supply outages and reduce the likelihood of price spikes (GOV UK, 2014).

The interconnection of energy systems - particularly electricity, must also be considered in terms of capacity. A limited market or connection increases the risk of supply disruption by reducing the options available to meet demand.

2- Diversity:

Diversity covers the mix of fuel types, their place of origin, the amount and nature of the energy supply infrastructure, and the number of companies involved and their market shares. Diversity reduces the system's exposure to any one particular risk, and so reduces the impact on the system if any one risk is realized (IEA, 2014).

A well-balanced energy system, comprises various power generation technologies covering a large range of fuel types and renewable energies and with suitable capacity, enables the advantages of each to be maximized. This balanced system allows prices to remain reasonably stable, and ensures a continuing supply to the consumer.

3- Reliability:

Reliability is the ability of a system to perform and maintain its function in routine circumstances, as well as under certain contingent conditions. Reliability

relates to the certainty with which an aspect of the supply chain will fulfill its function, taking account of the reliability of sources, infrastructure and delivery networks. Reliability indicates the risk that an aspect of the system will fail to deliver. An important aspect of reliability is how flexible components of supply are (Australian Gov, 2009).

Measures to improve Reliability are the following:

Resilience measures - to reduce the likelihood of "sudden shock" events affecting energy supplies and reduce the impact of any event that might occur.

Ease of transport – energy must be readily available, and thus the ease and safety with which fuels and electricity can be transported is a key driver for reliability of energy supply.

Availability of infrastructure expertise – to achieve a diverse energy mix, countries must have access to different energy sources, requiring both infrastructure and expertise, whether in generation technologies, fuel handling, access to delivery systems such as pipelines, ports or electricity interconnections and transmission lines (worldcoal, 2014).

Competitive markets incentivize companies to provide reliable supplies to attract and retain customers. Governments can set the framework for the delivery of energy supply through competitive markets, providing transparency, stability and an attractive fiscal regime which encourages businesses to invest, as well as by regulation to ensure effective competition (theaustralian).

Sufficient Investment - Investments are needed in a timely manner to maintain a secure, affordable and sustainable energy system in a country. It is the responsibility of the Government to establish strategic goals within the electricity and gas markets, and to ensure that an appropriate framework is in place to enable delivery (Yergin, D. 2011).

Hold emergency stocks – Emergency stocks of fuels increase the reliability of the energy supply chain by allowing for the necessary time for the system to adapt to a sudden chock in fuel supplies (APERC, 2002).

4- Demand side responsiveness:

The DSR is the degree to which demand can adjust to accommodate any changes in supply. The availability of demand side response indicates the ability of the system to absorb any supply shortages.

Demand side response (DSR) is an active, short-term reduction/shifting in consumption of energy demand at a particular time (OFGEM, 2014).

The achievement of energy security can be reached through addressing each of the above stated characteristics in a timely manner & in such a way that is most adapted to the situation of each country.

Lebanon in terms of Energy Security

Anyone living in Lebanon can tell that the electricity supply during the last decades has been of poor quality, sporadic & unreliable. Electricity rationing & reliance on back-up private generators is commonplace in all areas.

In 2009 the supply of energy averaged 21.22 hours for greater Beirut area and 15.79 hours for the South with an average of 18 hours (75%) for the whole country (MEW, 2010).

What are the reasons for this situation?

A review of Lebanon's rating on the four key characteristics of an energy supply system that constitute the pillars of Energy security shows the following:

1- Lebanon in terms of Adequate capacity:

In 2009, the total production from thermal power plants was (88% of delivered energy), that from hydro plants was (4.5 % of delivered energy) & the imported energy was (7.5% of delivered energy), which resulted in energy not supplied (deficit) of (23% of demand) (MEW, 2010).

In accordance with the Energy Policy Paper, future demand corresponding to an annual load growth of 7%, and ~15% of peak load reserve is estimated up to 2015. Demand growth is estimated to be 5% from 2016 till 2020 and 3% from 2021 till 2025 (MEW, 2010).

In parallel, the renewable energies share of the Lebanon energy consumption mix is expected to be

Figure 1: Map of Existing Power Plants in Lebanon

around 12% of the total demand by 2020.

The planned deployment of scale of power generation capacity to meet the global energy demand growth till 2014 is mainly composed of 200-300 MW tri-fuel Reciprocating Engines & 400-500 MW of tri-fuel Combined Cycle Power Plant all of which have been contracted in 2013 with delivery times ranging between mid-2015 & end-2016.

The rental of 280 MW of Power Barges already implemented in 2013, the planned wheeling of additional 150 MW from regional countries still under negotiations & the restoring of 245 MW from the rehabilitation & upgrade of existing plants already under procurement are expected to complement the production side in the energy balance (MEW, 2010).

Further 1,500 MW are foreseen after 2014 based on NG fueled Combined Cycle Power Plants to be developed within the framework of the IPP scheme. These are however subject to the issuance & coming into effect of an IPP/PPP Law that is currently unavailable due to unfavorable political conditions.

Even though the main initiatives decided for in the Energy Policy Paper for meeting the energy balance within 2014 have been already launched, some of these started later than the policy planned dates and many initiatives have faced administrative obstacles in their implementation phase; This situation coupled with the stagnation in the IPP/PPP legal framework setup may lead to the inability to reach & maintain the energy balance as planned if not promptly resolved.

Finally the interconnection of energy systems via the regional power grid, will surely have an increasingly important role in the future in terms of the energy security of Lebanon as this latter is currently negotiating agreements to purchase electricity from Iran in addition to Syria & Egypt (Photius, 2004).

As a conclusion for the adequate capacity item, even though Lebanon is currently not meeting yet the energy balance requirement, the Lebanese government has launched a series of initiatives to meet the same starting from 2015 & secure it further during the next period.

These plans can however be jeopardized in case of political stagnation that can delay the projects implementation, the setting up of an appropriate legal framework that is necessary for the future IPP projects & the possibility to secure further the energy supply system via the interconnection of regional energy systems.

The overall score on this item is thereby currently still

negative & will gradually improve to positive within 2015 – 2016 in case all of the launched initiatives are executed in a timely manner.

2- Lebanon in terms of Diversity:

The economies of scale do not play in favor of Lebanon's diversity in fuel supplies as most suppliers tend only to commit volumes to strong creditworthy buyers with advanced import plans & the feasibility of using some types of fuels depends largely on the imported volumes.

Lebanon by virtue of its small size has modest primary energy requirements, when compared to other buyers in the market. This small demand becomes even less appealing for the suppliers if split on many types of fuel & more than one source for each type of fuel as it would be required to consolidate its energy security status. This situation could be partly mitigated by integrating the country's needs in larger schemes of energy supply.

Until 1998, the main fuel supplying the electricity plants was Heavy Fuel Oil - HFO. In the same year the Natural Gas - NG Combined Cycle Plants of Zahrani & Deir Ammar were commissioned along with the Open Cycle Gas Turbines of Tyr & Baalbek. The decision to procure 1,040 MW of gas turbines combined cycle & open cycle plants was based on plans to import NG from Syria & Egypt (republic of Lebanon).

In reality the Diesel Oil – DO, which was a back-up fuel for these plants, was inadvertently introduced in the fuel mix as a replacement for NG which was not readily available in 1998 as planned & became partially so only in 2009.

This shortcoming illustrates the challenges faced by the decision makers in the field of energy security as when the decision to build the plants was taken in 1993, the plans were to have the NG available by 1998. But the difficulties faced by the regional stakeholders in reaching an agreement on the pipeline routing & other commercial matters significantly delayed the NG pipeline implementation which was finally connected to Deir Ammar power plant only 11 years later.

In 2009 the used fuels were still HFO for 998 MW or 49% of the fossils fuels share & DO for 1,040 MW or 51% of the fossil fuels share.

To summarize Lebanon's status in terms of maintaining the HFO & DO in the fuel mix, Lebanon has already the necessary infrastructures for the unloading & storage of HFO & DO. On the distribution side, Lebanon lacks the infrastructure to divert the fuel oils from one site to another unless by truck tankers & has considered the possibility of having a centralized HFO treatment facility that will connect all the plants via pipelines to be incorporated on the same right ways of the planned NG distribution pipeline. Finally Lebanon has single sourcing agreements from state to state for the procurement of the fuel oils which leaves little flexibility to cover for eventual supply disruptions from the source.

Thereby Lebanon remained actively seeking to diversify his energy mix during the last decades by introducing the use of NG in the electricity supply system.

In 2005, the Gasyle pipeline was constructed. In practice however the Syrian gas was not available in sufficient quantities for domestic use & even less for export to Lebanon.

In 2006 Egypt, Syria, Jordan, Turkey, Lebanon, and Romania reached an agreement to build the AGP pipeline's extension through Syria to the Turkish border (wikipedia).

In 2009, a gas supply deal with Egypt was entered. The NG was supplied to the Deir Ammar combined cycle power plant though the AGP. This source of supply has been however verified to be unreliable to date as it has been subject to the whims of the unstable political relations between Jordan, Syria & Egypt and has been completely cut off after the revolution in Egypt.

This shortcoming illustrates the pitfalls of the decision making process when it comes to the security of primary energy sourcing as the benefits of a more feasible scheme as the AGP development through Egypt, Jordan & Syria, when assessed against the more expensive underwater pipeline alternative to Lebanon as it was initially planned in 2001, & the security risks of a high dependence on this one-source of gas through a long pipeline and two transit countries shows that achieving simultaneously reasonable levels of security & cost is a most complex task especially when the decision is shared among many countries (Decon, MVV 2009).

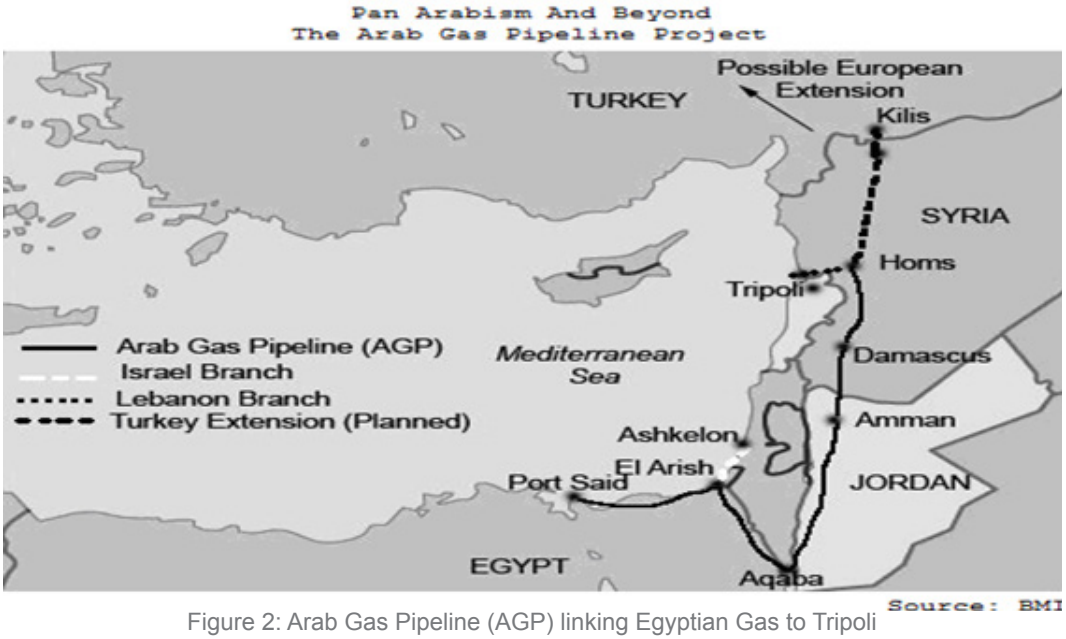

Figure 2: Arab Gas Pipeline (AGP) linking Egyptian Gas to Tripoli

In 2010, the electricity policy paper opted for a fuel sourcing strategy based on 2/3 of the fuel mix from NG with multiple sources of supply; more than 12% are renewable energies; and the remaining from other sources of fuel while selecting technologies that work on both natural gas and fuel oil.

The policy paper decided to develop an infrastructure to supply and distribute NG based on the land pipeline in Deir Ammar and LNG marine terminal station(s) and interconnect them with the plants; The prospected domestic pipeline is expected to be completed by 2016 to 2017.

In practice however, having interconnected pipelines & a dedicated Floating Storage and Regasification Unit - FSRU, even though physically sufficient to secure the supply of NG itself, doesn't solve alone Lebanon's challenge to supply the same in sufficient quantities at a competitive price as the country has also to face market challenges in economies of scale, solvency and suitability of legal framework to achieve this target.

Lebanon needs also to finalize a gas/LNG import law to clarify the regulatory and fiscal regimes governing the import terminal and the various participants including EDL, terminal developer and LNG supplier.

To summarize Lebanon's status in terms of introduction of the NG in the fuel mix, Lebanon has already secured a source of gas supply from Syria & Egypt as it is already connected to the AGP & Gasyle pipelines at Deir Ammar & has entered agreements for the further development of regional pipelines interconnections. In parallel, Lebanon has launched the procurement for an internal pipeline infrastructure along the coast for distributing the NG to the various plants. Finally the procurement of an offshore FSRU as an additional source to feed in the internal distribution pipeline is also undergoing.

Thereby in terms of infrastructure, Lebanon will be properly fit for the large scale supply of NG within 3 to 4 years (Decon, MVV 2009).

Finally Lebanon has started the process for the exploration of Oil & Gas resources that lies in the deep offshore of the Lebanese Exclusive Economic Zone & is expected to have its own domestic NG available within 5 to 7 years which would resolve completely the security of supply of NG in the long term.

In terms of Renewable Energies, Lebanon has plans to reach the 12% renewables share despite the foreseen increases in the conventional plants installed capacity (MEW, 2010).

As a general conclusion for this item, Lebanon has decided & is making significant efforts to diversify its energy mix to become 2/3 on NG & 1/3 on other fuels. Having an installed capacity of 1,040 MW that can run on either NG or DO, currently installing an additional capacity of 797 MW that can run on either HFO or NG with DO as a back-up fuel, and developing its potential in the related infrastructures and various renewable energy technologies, Lebanon scores

satisfactorily on the diversity scale in terms of available technologies.

The competitive sourcing of the fuels will remain however a challenging task unless Lebanon enters into larger energy supply schemes which are difficult to implement given the current regional geopolitical context. Lebanon will however have its own domestic fuels available within the next decade & should definitely be able to resolve the fuel sourcing issue from the roots.

The overall score on this item is thereby still negative & may improve to positive within 2017 in case the internal pipeline infrastructure & the FSRU projects are executed in a timely manner. Further improvements will occur within 2019 to 2021 when the domestic NG & fuel oils will be available.

3- Reliability:

The reliability of Lebanon's energy supply system is probably the aspect of its energy security that requires the most attention as it is the most fragile of all & constitutes its Achilles heel.

An energy supply system cannot be reliable if it generates deficit & lacks the capacity to manage its own infrastructures.

Today Lebanon has an existing tariff that is noticeably below the actual cost of production and the energy supply system has relatively high levels of losses all resulting in yearly substantial deficits.

The utility administration is lacking both the necessary funds & human resources for the management of existing infrastructure or for handling future investments.

According to the policy, the success of any future project requires the administrative upgrading of EDL because it is the core entity of the sector. To achieve this goal, corporatization as the ideal solution was recommended by many stakeholders.

Meanwhile, Lebanon's energy supply system is unable to perform and maintain its function in routine circumstances, as well as under certain contingent conditions. The lack of confidence in the electricity supplied by the utility led most users to rely largely on their own private generators.

The main reasons for the low reliability performance are the following:

Poor Resilience – Due to the negative energy balance, the fragility of the power plants as well as the transmission & distribution grids, the likelihood of "sudden shock" events caused by equipment failures is high. Overloading of equipment & nodes regularly cause system failure & the limited capacity to intervene & restore back the service often lead to long interruption times while the possibility to rely on energy imports in case of sudden shock is also limited.

Improvements on this item can be expected only when sufficient & timely investments will be made on the plants & the grids.

Difficulties of transport - HFO & DO fuels are supplied by ship tankers directly to the main plants & oil facilities to be distributed by truck tankers to secondary facilities. In the absence of the planned domestic coastal pipeline & the FSRU, NG supply has been limited since 2009 to Deir Ammar plant only via the AGP.

Fuel transport is thereby generally non-reliable & affecting negatively the reliability of the energy supply system.

The transmission system in Lebanon has high technical losses reaching 3.5% & the current status of the transmission grid cannot accommodate the evacuation of the additional energy that will be delivered by the new plants (MEW, 2010).

Electrical energy transport is thereby generally non-reliable & affecting negatively the reliability of the energy supply system. The existing infrastructures can barely handle the current generation capacity & need substantial upgrades to cope with the planned developments.

Availability of infrastructure expertise - Lebanon has expert resources in most fields spread around the world but is unable to attract these back to their home country under the prevailing economic & political context.

The already scarce expert human resources of EDL & other public establishments that have expertise in the existing infrastructures are being drained by the inadequate pay scale & working conditions. Most Lebanese companies having infrastructure expertise

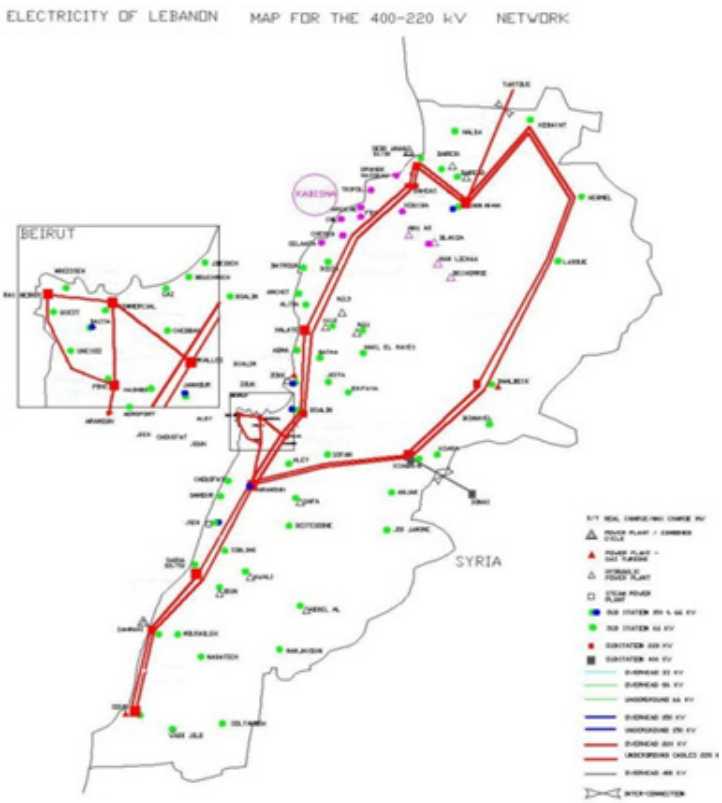

Figure 3: Map of 220 KV Transmission Grid and 400 KV Interconnection (for a clearer image, please refer to: file:///C:/Users/User/Downloads/2-synthesis-transmission.pdf

also operate outside Lebanon & are not attracted by the home market under the current conditions.

Foreign companies having expertise in specific types of infrastructure rarely consider moving in Lebanon due both to the unattractive market conditions & the small scale of the domestic market. Lebanon is thereby exposed to failures in supplies due to the limited number of suppliers & lack of domestic expertise.

Expertise in new types of planed infrastructure as the NG pipeline, FSRU & oil exploration can however be easily developed provided the proper conditions are met.

As a conclusion for this item, even though Lebanon is currently unable to attract the necessary infrastructure expertise into its domestic market, the situation can be gradually reversed in case the market conditions are improved.

Competitive markets - Lebanon is plagued by low levels of political stability, control of corruption, and rule of law (world energy) coupled with incoherent laws making the attraction and retention of customers a difficult task. The market is thereby governed by a limited number of suppliers in the absence of genuine competition.

Sufficient Investment – Lebanon's macroeconomic stability is poor (worldenergy) & the regulation of the energy market is pending the political consensus on the modalities of implementation of Law 462 & the IPP Law. The appropriate framework to attract investments & enable the delivery of the services is still lacking.

Hold emergency stocks – Lebanon has emergency stocks of fuel oil in the oil installations & has launched the procurement of further storage capacity to improve its energy security.

As a general conclusion for this item, the reliability of Lebanon's energy supply system cannot be significantly improved by scattered punctual investments on this or that part of the system but rather needs a general restructuring of the core entity EDL in a climate of political stability, rule of law, transparency, solvency, proper regulations, attractive laws & fiscal regime in view of creating a competitive market that will ensure a high quality of services at reasonable prices. This item thereby rates poorly in the energy security scale & will not significantly improve under the prevailing climate of political instability in Lebanon despite the significant investments that are being made.

4- Demand side responsiveness:

In accordance with the policy paper, on the DSR & Energy Efficiency fronts, the MoEW is committed

to the preparation and spreading of the culture for proper electricity use and adoption of national programs focused on demand side management as the basis for effective energy and demand growth control in order to save a minimum of 5% of the total demand.

The policy paper calls for the establishment of a smart grid using meters with remote disconnects from control centers that will be operated with specialized service providers for the transitional period to modulate consumption and reduce non-technical losses (MEW, 2010). This will also allow for the introduction of new services for consumers, and payment facilities and adopt new tariff structures and mechanisms (feed-in tariff, prepaid cards, net metering, etc.) (MEW, 2010).

On the front of Energy Efficiency, the LCEC has been working towards institutionalizing all national efforts to improve and raise awareness in the main sectors of the economy, encourage the use of renewable energy technologies through technical and policy support & provide reliable data on energy demand patterns and distribution.

Lebanon has also been the first country in the Arab world to develop its National Energy Efficiency Action Plan (NEEAP) in 2011which was considered a strategic document to pave the way for Lebanon's overall national objective of 12% of renewable energy by 2020.

As a conclusion for this item, even though Lebanon has no DSR for the time being, it has already launched the necessary initiatives for developing an effective DSR that should become operational within 2 to 4 years. Moreover on the Energy Efficiency front, Lebanon has been a pioneer in the region, has already achieved outstanding results in the water heaters sector & other renewable energies technologies & is currently undertaking many similar initiatives. The overall energy security rating for this item is thereby positive & will be further consolidated in the years to come.

Lebanon Short Term energy security

As a conclusion, Lebanon scores badly on most short term energy security criteria. The core of the Lebanese energy supply system EDL is fragile & the system is largely exposed to potential disruptions. Moreover the system lacks resilience to technical failures & is unable to switch away from the fuel whose price is increasing. Finally the system has no ability to meet the energy demand, nor to react promptly to sudden changes in the supply-demand balance.

Most short term energy security indicators are expected to improve within the next three years in case of timely implementation of the related policy paper initiatives but the short term energy security will not become solid enough if EDL corporate structure is not consolidated.

Lebanon Long Term energy security

Having initiated infrastructure projects aiming to reduce dependence on any one source of imported energy, increasing the number of suppliers, exploiting native fossil fuel and renewable energy resources, and reducing overall demand through energy conservation measures, Lebanon doesn't score badly on the Long Term energy security scale.

Lebanon is still however vulnerable as it is unable to ensure timely investments to supply energy in line with economic developments and environmental needs & fails to meet challenges arising from changes to market structure, geopolitical patterns and climate change.

Conclusion for Lebanon Energy Security

Infrastructure development taking many years from preparation, studies, planning, procurement, till implementation & the related policies covering usually long periods of time during which government are prone to change many times, the evolution of energy systems requires stable institutional frameworks that are not pray to the ups & downs of political turmoil.

The global integrated vision of the energy sector that was set by the electricity policy paper, has addressed many of the most critical issues that relate to the security shortcomings of the Lebanese energy system & has set an adequate plan for the timely resolution of these. However, its implementation being done in the absence of an appropriate institutional body leaves it exposed to the high political risks that prevail in Lebanon.

The noted energy security shortcomings are mostly related to the low levels of political stability which is hindering the elaboration of adequate legal & administrative frameworks that can quickly boost the energy supply sector in case properly designed especially in view of the large potential of exploiting native fossil fuel.

Lebanon needs to have at the earliest an independent regulatory authority that holds a clear long term vision of the energy sector development, sets the policies & monitors the plans execution far from the political turmoil & changes which have prevented in the past the execution of many infrastructure projects.

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