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EGYPT'S NUCLEAR POWER PROGRAM: SECURITY AND ECONOMIC RISKS

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This policy brief is part of the Energy Policy and Security Program's work on examining the prospects and challenges of the deployment of nuclear power in the Middle East.

Summary

Egypt is embarking on an ambitious plan to build four Russian nuclear power reactors with total capacity of 4800 megawatts. The introduction of nuclear power in Egypt's energy mix, however, entails security and economic risks and faces serious institutional challenges. Nuclear reactors, during or after construction, can be vulnerable targets by state and non-state actors. In recent years, the rate, impact and sophistication of jihadi attacks in Egypt increased significantly and it is not unthinkable for Egypt's nuclear facilities to be targeted. On the economic side, Egypt's new offshore gas discoveries, coupled with prospects of low gas prices and mega-investments in renewables, render the Egyptian nuclear project uneconomic.

MAIN RECOMMENDATIONS

- The Egyptian government should rethink its commitment to nuclear power considering the risk of insider threats as well as the empowerment of Egypt's terrorist groups in terms of (potentially) accessing better missile systems with improved payloads.

- The recent and enormous offshore gas discoveries provide an added economic incentive to walk away from the nuclear deal with Russia. Even in high prices environment, which favors the export of natural gas, Egypt is better off investing in cost-competitive renewables.

Overview of Egypt's Nuclear Program

The Egyptian government's promise of energy self-sufficiency, and its professed ambition of joining the list of countries producing nuclear energy, touches on a sensitive chord of the traditional nationalist spirit among the Egyptian people. A wide range of the public associates nuclear energy with national prestige and pride. However, in attempting to wield public and political support, the government seems to prioritize publicity, rather than pertinent questions on the security, safety and economic worthiness of the nuclear project.

Egypt's peaceful nuclear program began in 1955 when President Gamal Abd el Nasser established the Egyptian Atomic Energy Commission, which is currently known as the Atomic Energy Authority (AEA). Since 1955 Egypt managed to develop nuclear infrastructure by establishing two research reactors (a 1961 2-MWt Russian reactor that is in a longterm shutdown, in addition to a 22-MWt Argentinian research reactor of the model ETRR-2 that began in 1997), and facilities for mining, milling, fuel fabrication, waste management, and small-scale reprocessing. Plans for the construction of nuclear power plants in the Dabaa region are not recent. In 1981, former President el Sadat announced his intentions to establish two nuclear power plants in Dabaa, however, such plans failed to materialize, to a large extent, due to the impact of the Chernobyl disaster, in 1986.

Nonetheless, renewed interest in the construction of the Dabaa nuclear power plants resurfaced, in 2006, as the Minister of Energy announced that a 1000 MWe reactor would be built at Dabaa by 2015. Almost a decade later, Egypt signed a bilateral agreement with Russia, in 2015, for the construction and operation of four reactors, including fuel supply, shipping out of used fuel, training and development of regulatory infrastructure. During Putin's visit to Egypt, in December 2017, Egypt and Rosatom - Russia's state-owned nuclear supplier - signed the construction agreement.

According to the agreement, the project entails the construction of four 1,200MW reactor units, with a total cost of $30bn; $25bn through Russian loans, while the remaining cost is provided by Egypt. It is worth noting that the total cost of energy contracts between Russia and Egypt has reached about $60bn. Construction is planned to begin in the next two years, while test-runs on the first reactor are expected by 2022, and the full project is expected to be completed by late 2030's.

Egypt's Electricity Sector

Egypt's demand of electricity has tripled over the past 20 years. In 2017, power generation was about 186 TWh with 72 percent generated by natural gas, 20 percent by oil, and 7 percent from hydropower. Solar and wind power covered the remaining small balance with 126 GWh came from wind energy, and 0.16 GWh from solar energy. Attempting to increase the share of renewables, Egypt announced the construction of the $2.8 billion Benban complex, the world's largest solar park, generating about 1.8 GW of electricity. On 24 July, 2017, Egypt's President Abdel Fattah el-Sisi inaugurated a $670 million wind farm that has 290 turbines with an output of 580 MW.

According to the recent data published by the Ministry of Electricity and Renewable Energy and its affiliated bodies, the peak electricity load increased by 10 percent over the last two years as it reached 30.8 GW in 2017, compared to 28 GW in 2014/2015. Meanwhile, installed capacity of electricity increased from 35.22 GW in 2014/15, to 50 GW in 2018, at a rate of 30% increase.

The gaps between the installed capacities and actual electricity generation are due to several factors, such as the aging of certain units, and the quality of used fuel. In Cairo and Alexandria, Egypt's largest two cities, electricity demand is expected to grow at 5 to 7 percent per year, creating an approximate 5GW in supply-demand gap, leading to power-cuts and challenges for different sectors.

Egypt's strategy of renewable energy, in 2020 and 2035 are shown in Figure 1.

Insider Threat: Egypt's Major Nuclear Security Challenge

In recent years, the rate, impact and sophistication of jihadi attacks increased significantly. Despite recent counter-terrorism campaigns, Jihadi activities are unlikely to be fully eradicated in the coming years. Several reasons demonstrate why the Egyptian government, on the short and medium terms, may find ensuring the reactors' security a challenging task. The events surrounding the downing of the Russian MetroJet flight, in October 2015, raise serious questions on the level of security in Egypt. Shortly after its crash, Western and Russian investigators concluded that the cause of the crash was a bomb planted by ISIS' affiliate, *Wilayet Sinai* (Sinai Province).

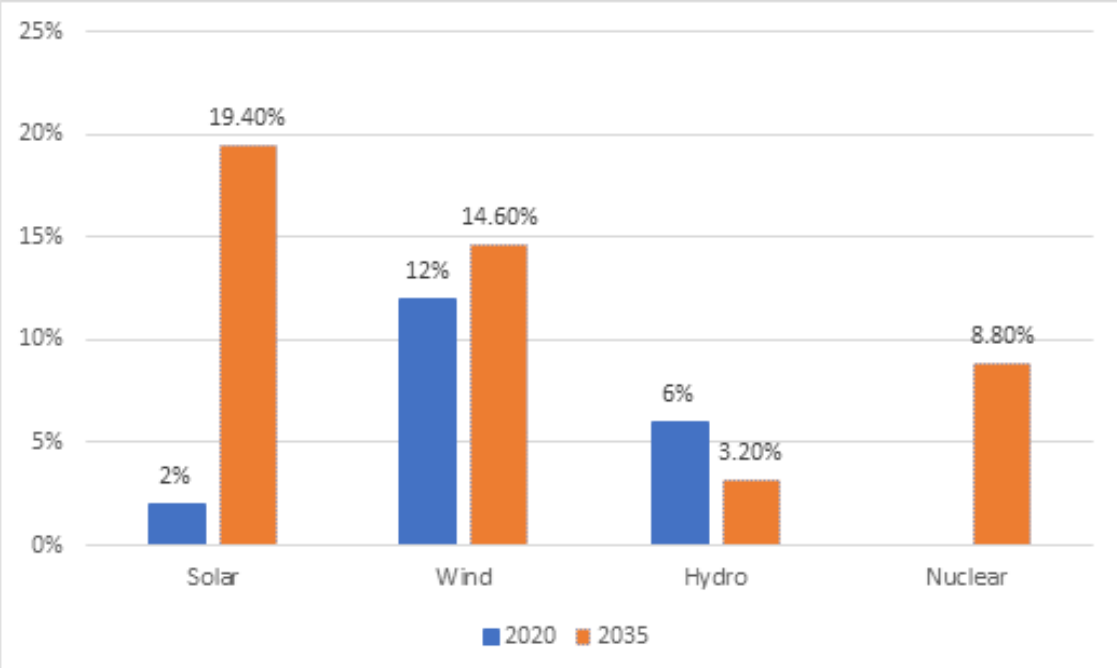

Figure 1: The government's strategy of renewable and nuclear energy in 2020 and 2035

However, Egypt strongly rejected that conclusion, and in its preliminary report, the aviation ministry stressed that it has "so far not found anything indicating any illegal intervention or terrorist action", which even contradicts the statement of Egyptian investigators which said that "they were '90 percent' certain audio recovered from black box caught the sound of a bomb prior to the crash."

This example, among many, shows that the possibility of infiltration and recruitment among official employees is not unthinkable. Moreover, the State's official response is quite worrisome, as it clearly lacks transparency and professionalism.

In December 2017, ISIS' affiliate, *Wilayet Sinai*, claimed responsibility for firing a missile that badly damaged the helicopter of the Defense and Interior Ministers, during their supposedly 'unannounced' visit to North Sinai, killing two military personnel. This situation, once again, highlights the potential serious dangers of recruitment and infiltration of government or security personnel; a threat that certainly cannot be overstressed enough when planning for the construction of Egypt's first a nuclear power plant.

The claim by Yemen's Houthi group that they have fired a ballistic missile on Al-Barakah nuclear power plant in December 2017, regardless if it was true or not, is an alarming sign that nuclear reactors are being considered as targets. The threat emerging from the empowerment of Egypt's terrorist groups, in terms of (potentially) accessing better missile systems with improved payloads, should not be dismissed.

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Is Egypt's Offshore Gas a Game Changer?

The recent discoveries of enormous natural gas fields in Egypt's territorial waters in the Mediterranean could potentially derail the nuclear project and render it uneconomic. In the past decade, Egypt have swung from being net gas exporter to Jordan and Israel to a net gas importer due to shortage of supply and the need to cover domestic demand.

"Natural gas is a good fuel for energy transition in Egypt because of its relatively low cost and flexibility to operate in different load requirements."

However, the discovery of Zohr, the largest gas field in the Mediterranean with estimated reserves of 30 trillion cubic feet and, more recently, the discovery of the promising Noor field have the potential to cover all of Egypt's domestic demand of natural and export the extra volumes.

As mentioned above, Egypt's electricity demand in 2017 was 186 TWh. Assuming a growth rate of 3 percent per year, the total demand of natural gas for electricity production between 2018 and 2030 would be around 2.6 trillion cubic feet, if Egypt is to generate its electric power using gas-fired power plants. Natural gas power generation will continue to be a major component of Egypt's energy mix, but renewable sources, particularly wind and solar, will continue to expand their share.

Natural gas is a good fuel for energy transition in Egypt because of its relatively low cost and flexibility to operate in different load requirements. Consequently, and economically speaking, abundance of cheap domestic natural gas is a major threat to the Egyptian nuclear power project.

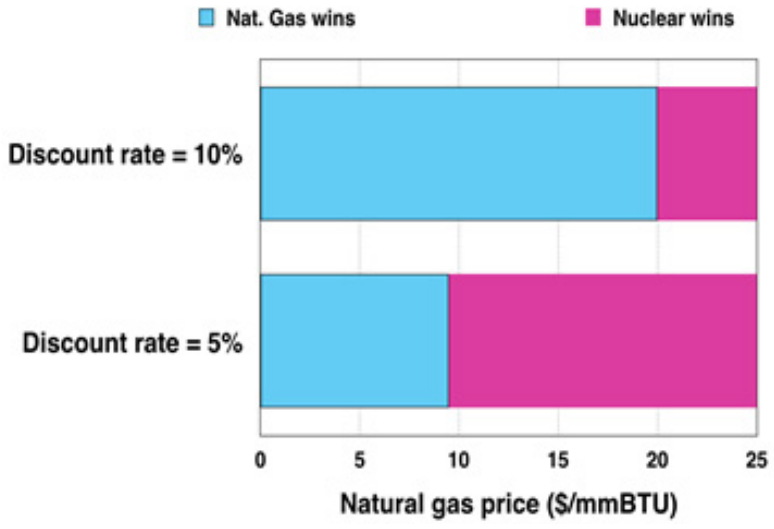

Figure 2: Nuclear power versus natural gas cost competitiveness

Cost Analysis

Unlike renewables that have zero fueling costs, the cost of natural gas is the dominant, component of the cost of generating electricity in a natural gas plant. Therefore, the cost comparison between nuclear and natural gas could vary from country to country. For Egypt, where natural gas is domestically produced, natural gas prices would be significantly lower than countries that import natural gas at international prices.

The difference in the cost of electricity generation between nuclear reactors and natural gas plants decreases as the prices of natural gas increase. One can define a cross-over price of natural gas above which nuclear power becomes economically competitive vis-à-vis natural gas. For Egypt, a country with existing export infrastructure, the cross-over value ranges from $9.5 per mmBTU at 5 percent discount rate to $20 per mmBTU at 10 percent discount rate. Based on Egypt's current credit rating (B), Egypt will have to sell its natural gas at elevated prices between 15 and $20 per mmBTU for its nuclear venture to become economically competitive (see Figure 2)

Additionally, even if the construction of the nuclear power plant starts today, it will take between 8 to 10 years to be connected to the grid. In the meantime, Egypt will still need to cover its increasing energy demand by continuing to build gas-fired plants and develop renewables projects. By the time the first reactor is connected to the Egyptian grid, costs of renewable energy and storage would have likely reached an unprecedented level of cost-effectiveness.

"Egypt will still need to cover its increasing energy demand by continuing to build gas-fired plants and develop renewables projects, since building nuclear reactors takes a long time."

Acknowledgement

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The Energy Policy and Security Program

The Energy Policy and Security Program at the Issam Fares Institute for Public Policy and International Affairs at AUB was launched in 2016 as a Middle East-based, interdisciplinary platform to examine, inform and impact energy and security policies, regionally and globally. The Program closely monitors the challenges and opportunities of the shift towards alternative energy sources with focus on nuclear power and the Middle East. The Program has been established with a seed grant support from the John D. and Catherine T. MacArthur Foundation to investigate the prospects of nuclear power in the Middle East and its potential to promote regional cooperation as a way to address the security concerns associated with the spread of nuclear power.

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