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The Politics of Egypt's Nuclear Energy Program

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Abstract*:*
Egypt is the third largest population after Nigeria and Ethiopia as well as the third-highest gross national income (GNI) in Africa (USEIA, 2015). For a longer period of time, Israel has argued that Iran's nuclear program would cause a regional nuclear race in Middle East and African continent. Indeed, several countries in the Middle East and North Africa (MENA) have announced their intentions to build nuclear power plants. More precisely, in Middle East the first Arab nuclear power plant will be built by United Arab Emirates (UAE) which is scheduled to be fully operational in 2020, Saudi Arabia's nuclear plan consisting sixteen nuclear reactors is scheduled to be fully operational by the end of 2023 as well as Jordan's nuclear power plant which is planned to be operational by 2023, too(Shay, 2016). In North Africa, the most ambitious program is the Egypt's nuclear power plan. In November 2015, in Cairo, Egypt's Minister of energy Mohamed Shaker signed an intergovernmental agreement with Russian state-owned nuclear corporation ROSATOM to build a nuclear power plant equipped with four 1200 MWe units in El-Dabaa (WNN, 2015). To date, few studies have been made to examine the energy security of Egypt, where mostly are focusing on short term. Thus, the main objectives of this research are examining the impact of nuclear energy over Egypt's economic growth as well as examining the geo-strategic implications in MENA region. This paper argues that, from one side the nuclear energy enhances the economic growth and energy security of Egypt, whereas on the other side shifts the balance of powers in MENA region which could trigger another armed conflict in that region. Also, nuclear energy is pushing the need for higher regional cooperation among African countries in assessing regional capacities in building efficient electricity infrastructure.

1. Background Information's

Egypt is the third largest population after Nigeria and Ethiopia as well as the third-highest gross national income (GNI) in Africa (USEIA, 2015). For a longer period of time, Israel has argued that Iran's nuclear program would cause a regional nuclear race in Middle East and African continent. Indeed, several countries in the Middle East and North Africa (MENA) have announced their intentions to build nuclear power plants. More precisely, in Middle East the first Arab nuclear power plant will be built by United Arab Emirates (UAE) which is scheduled to be fully operational in 2020, Saudi Arabia's nuclear plan consisting sixteen nuclear reactors is scheduled to be fully operational by the end of 2023 as well as Jordan's nuclear power plant which is planned to be operational by 2023, too(Shay, 2016). Additionally, other Gulf States such as Qatar, Kuwait, Oman, have canceled their nuclear plans following the Fukushima nuclear accident in Japan in 2011(Nakhle, 2016). On the other side, Tunisia, Libya, Algeria, Morocco, Sudan and Egypt in North Africa[1] are the states who have announced their plans to embark upon nuclear power programs(World Nuclear Association, 2017a). In North Africa, the most ambitious program is the Egypt's nuclear power plan. In November 2015, in Cairo, Egypt's Minister of energy Mohamed Shaker signed an intergovernmental agreement with Russian state-owned nuclear corporation ROSATOM to build a nuclear power plant equipped with four 1200 MWe units in El-Dabaa(WNN, 2015). This contract includes agreements on the main establishment of nuclear power plant, agreement on the supply of fuel, agreement for technical support during operation and agreement for establishing storage for consumer fuel(Daily News Egypt, 2017). In the next following pages, I will provide discussion on the politics of Egypt's nuclear power program and what kind of implications would have over Egypt's economic growth as well as the geo-strategic implications in MENA region. Nonetheless, states go nuclear for political, economic and military(security) reasons (Epstein, 1977). The current energy mix in Egypt is not appropriately developed because it mainly depends on oil and natural gas, or estimated by 94% of the total primary consumption in 2014 (USEIA, 2015). Furthermore, Egypt's ratio of supply to demand of oil is less than 100%, or estimated at nearly 52.7% in 2014 (Ibid). In order to satisfy the demand side, Egypt has imported oil dominantly from Oman, Iraq and Kuwait, which exposes Egypt on geopolitical risks(Atlam & Rapiea, 2016). However, Egypt as the whole North Africa "is predictably running out of its fossil fuel sources of oil, gas, and coal"(Marktanner & Salman, 2011). To date, few studies have been made to examine the energy security of Egypt, where mostly are focusing on short term. Thus, the main objectives of this research are examining the impact of nuclear energy over Egypt's economic

[1] From West, Central and Southern Africa: Nigeria, Ghana, Senegal, Kenya, Uganda, Tanzania, Zambia and Namibia have also announced their plans to build nuclear power programs. But, this paper will focus more on MENA region.

growth as well as examining the geo-strategic implications in MENA region. This paper argues that, from one side the nuclear energy enhances the economic growth and energy security of Egypt, whereas on the other side shifts the balance of powers in MENA region which could trigger another armed conflict in that region. Also, nuclear energy is pushing the need for higher regional cooperation among African countries in assessing regional capacities in building efficient electricity infrastructure.

2. Academic Debate

There is widespread debate among academia and policymakers regarding the motivations of Egypt to start ambitious nuclear power program, as well as, what kind of geo-strategic implications would have in MENA region. At the beginning, based on the time frame, the energy security can be divided in two categories. The first is the so-called "short term energy security" which aim is for a certain period of time to supply energy resources needed for economic development of the state, whereas the second is the so-called "long-term energy security" which aim is by stabilizing imbalances between supply and demand side to enhance the efficacy of the whole energy system of the state(Atlam & Rapiea, 2016). The one side of the debate is whether or not nuclear power is economic viable option for North African states. Rogner & Abdel-Hamid argue that the population and economic growth are increasing the demand for electricity and freshwater in West Asia and North African region(Rogner & Abdel-Hamid, 2008). In addition, they argue that in order to maintain energy supply security, as well as to improve their economies, many countries in WANA region are considering nuclear energy as a most economic viable option(Ibid). On the other hand, Marktanner and Salman argue that "the future course of meeting North Africa's energy needs is subject to a complex political and economic interplay between domestic and geopolitical development interests"(Marktanner & Salman, 2011). In addition, they argue that "the focus is mostly on production of renewable vs nuclear energy," where the nature of the regime plays the crucial role because "nuclear energy is much more compatible with the presence of democratic rule, as nuclear energy in the hands of shaky regimes is likely to create international tensions" (Ibid). They underscored that if North-Africa makes substantial efforts to maintain intra-North African cooperation, the renewable energy such as solar power is, has the potential to shift the energy power balance from the Gulf to North Africa (Ibid). In this regard, Meisen & Hunter argue that solar energy has the potential to satisfy the energy demand as well as to reduce the electricity costs without depending on depleting resources(Meisen & Hunter, 2007).

The other side of debate is the geopolitical and security implications of Egypt's nuclear power program. Patricia Lewis argues that even though all countries of MENA region [except Israel] are state parties of Nuclear Non-proliferation treaty (NPT), nuclear civilian programs "do enable military options later on, should political calculations alter"(Lewis, 2013, p. 435). In April 2013, "in protest of the lack of progress on convening the conference on ridding the Middle East of Weapons of Mass Destruction (WMD)" Egypt withdrew from an important Preparatory Committee meeting of the NPT state parties held in Geneva. However, Egypt did not leave NPT treaty (Ibid). Further still, Shay argues that even though Egypt has experienced electricity crises in the recent years, the "growing need for energy is not the only motivation behind Egypt's interest in a nuclear power program"(Shay, 2016). In addition, Shay argues that Egypt considers itself as a leader of Arab world and its desire for civilian nuclear program could be considered as a "Sunni reaction to Iran's program and what they fear will be a Shia nuclear bomb" (Shay, 2016). However, the presence of nuclear power plants in political instable countries ruled by nondemocratic regime is not safe option at all (Meisen & Hunter, 2007 and Meisen & Hunter, 2007, p. 3). On the other side, Trager and Bahgat argue that till now there are no indications that Egyptian leaders have ever made strong commitments to pursue nuclear weapons program. Hence, there are no indications that the future Egypt's nuclear project is intended for military purposes(Trager, 2016). Besides that, Trager argues that Egypt's nuclear power plant is important for its government from other reasons: to bolster domestic support for the Egypt's incumbent leadership and to spread Egypt's foreign cooperation beyond the traditional bilateral-relationship with Washington(Trager, 2016). In addition, Bahgat argues that "building nuclear weapons programme takes a long period of time and requires substantial financial and human resources," but, most importantly "these investments have to be backed by a determinant political will"(Bahgat, 2007). Also, Bahgat argues that it is evident in the Egyptian case that "this necessary strong political determination was lacking," because intentionally or not Egyptian leaders "have never been convinced that acquiring nuclear weapons would serve Egypt's national interests"(Bahgat, 2007). In contrary, Egyptian leaders were champions in advocating for making Middle East a nuclear-weapons-free zone(Bahgat b., 2011). As a matter of fact, Egypt has nuclear research reactor since 1960's when has acquired its first nuclear research reactor from the Soviet Union(Grimmitt, 2011). To date, there are no records to indicate that Egypt has violated its obligations of NPT treaty ever(Bahgat b., 2011, p. 33).

In order to examine the impact of nuclear energy on Egypt's economic and geo-strategic relations in MENA region I divided this paper in five parts. In the first part I provide short overview of the Egypt's energy profile. In the second part, I elaborate on the Egypt's economic necessities and energy shortages to start nuclear energy program, i.e. economic costs and benefits analysis of the Egypt's nuclear energy program. In the third part, I analyze the geopolitical implication in MENA region of the Egypt-Russian nuclear deal whereas in the fourth part I examine the security necessities of Egypt to build nuclear energy program. Finally, I draw conclusion based on the data and debate provided in this article.

3. Egypt's Energy Profile

Egypt is significant oil non-OPEC and liquefied natural gas (LNG) producer. Its geo-strategic location, especially the Suez Canal and Sumed pipeline, makes Egypt an important transit corridor for oil shipments in the Persian Gulf(Fayzeh, 2006).

According the Trading Economic statistics based on the World Bank data, Egypt's GDP per capita in 2013 was estimated to $2,608.04 which is equivalent to 22% of the world's average(Trading Economics, n.d.). However, Egypt is still trying to recover its economy which was affected by the revolution in 2011. Consequently, Egypt's economy is faced with persistently low growth, a high budget deficit and external vulnerabilities, drop in tourism and foreign direct investment(IMF, 2014, p. 10). Also, as a most affected were oil and liquefied natural gas businesses (LNG). Nevertheless, the fluctuation of oil prices on the market led to budget deficits and reduced flow of revenues in the budget fund. According the U.S Energy Administration, Egypt used 20% of petroleum and other liquids and 40% of dry natural gas of the total consumption in Africa in 2013, which led to "rising energy demand and a high budget deficit"(USEIA, 2015).

3.1. Electricity Consumption, Production and Capacity of Egypt

Nowadays, Egypt suffers from natural gas shortages, an old infrastructure and increased demand for electric power (USEIA, 2015). Egypt's oil production is already exhausted and slowly declining. Even though some recent analysis have shown that Egypt still has considerable reserves, the rising consumption has forced Egypt to balance the export of oil in order to reduce the budget deficit and satisfy its domestic demand (Bahgat c., 2013). Until December 2013, Egypt's total electric consumption was based on roughly 89% from thermal, 9% from hydro and 2% from wind sources. The total installed capacity of Egypt in 2000 was 15.286 MW which by 2013 increased to 30.803 MW, having an average annual growth of 5.54%. The thermal electric capacity has increased as well, from 12.478MW in 2000 to 27.316 MW in 2013, and having an annual growth rate of 6.21%. More precisely, 165TW per hour were generated to satisfy the needs of its customers. On the other side, the total consumption of electricity from 2000 to 2013 has increased drastically. In 2000 the total electric consumption was 64TW per hour which have increased to 141TWper hour in 2013, and having an annual growth rate of 6.2%. From the data represented bellow it is evident that Egypt is looking for renewable sources which sector experienced annual growth rate of 19.9% (wind-generated-electricity).

3.2. Natural Gas Exports of Egypt

Egypt's natural gas exports started in 2003, after completing the first stage of Arab Gas pipeline (AGP) linking Egypt with Jordan(USEIA, 2015). The 1,200 km-long pipeline system has connected Egypt with Syria and Jordan as well and represents a unique example of Arab energy cooperation in MENA region(Hydrocarbons Technology, n.d.-a). Egypt's natural gas export reached its peak in 2009 which was estimated to 645 billion cubic feet's. After 2010, Egypt suffered decline in natural gas exports which in 2013 was estimated to 172 billion cubic feet. The decline of Egypt's natural gas exports is due to the sabotage attacks on the pipeline systems occurred in 2011 and 2012, which have affected the amount of natural gas distributed to Jordan and Israel(USEIA, 2015). Also, in 2012 Egypt has canceled the bilateral agreement and stopped the supply of natural gas to Israel due to a payment dispute(USEIA, 2015). Ironically, from major exporter of natural gas in the region, due to the economic and geo-political consequences, Egypt is forced to import gas for domestic needs. In August 2017, the President of Egypt Mr. Abdel Fattah al-Sissi signed the Resolution No.196/2017 to import natural gas from Israel in order to satisfy domestic demands for natural gas.

3.3. Liquefied Natural Gas (LNG) Exports of Egypt

Currently in Egypt are operating two LNG power plants. The one is the Egyptian LNG located at Idku, a joint venture comprised of Egyptian General Petroleum Corporation (EGPC), the Egyptian Natural Gas Holding Company (EGAS), Royal Dutch-Shell (RDS) Group, Malaysia's state owned petroleum company PETRONAS and ENGIE group(Egyptian LNG, n.d.). The other LNG plant is the Spanish-Egyptian Gas Company (SEGAS)[2] complex located at Damietta, Egypt on a distance of nearly 60km west of Port Said(Hydrocarbons Technology, n.d.-b). The Idku plant has two trains with total capacity of 7.2 million tons per year, whereas Damietta plant has only one train with total capacity of 5.0 million tons per year(Songhurst, 2014, p. 30). The gas exported from SEGAS liquefied natural gas complex is dominantly used to supply the Spanish market and other European countries. Based on the available data, it is evident that LNG export from 497 billion cubic feet in 2008 has drastically fallen to 130 billion cubic feet in 2013.

4. Nuclear Energy and Economic growth

The energy consumption in Egypt is increasing faster than the expansion of its electric power plant capacities. Meanwhile, the Middle East Economic Survey study found that the total generating electric capacity in Egypt was around 31.45 gig watts whereas the peak demand for electricity consumption was 30 gig watts(MEES, 2015). Egypt's goal is by 2022 to develop a specific energy-mix capable to generate 13,500 megawatts from renewable sources, 6,000 megawatts of nuclear power capacity, and additionally 20MW from the thermal electricity capacity from gas and coal(Figueras, 2016). Nuclear generating electricity is the most suitable option for Egypt because it operates nonstop and does not depends from climate variability. Also, the uranium quantities needed to run nuclear power plant are considerably lesser comparing to coal and oil; 1kg uranium can yield 20,000 times more energy than 1kg coal(WNA, 2017). Moreover, the Suez Canal allows Egypt easily to transport uranium to and out of their country if is needed. According the World Nuclear Association, nuclear power plants are

[2] Union Fenosa Gas in conjunction with ENI of Italy (80%) and two state-owned Egyptian companies – Egyptian Natural Gas Holding Company (EGAS – ten percent) and Egyptian General Petroleum Corporation (EGPC – ten percent)

"expensive to build but relatively cheap to run"(WNA, 2017). Even though nuclear power programs suffer from high initial costs, in Egypt's example that is not the case. According the Russian-Egyptian nuclear deal, Egypt will receive loan in amount of $25 billion from Russia (85% of the total costs) with obligation to repay over 22 years with annual interest rate of 3% starting from 2029, whereas private investors from Egypt will contribute in covering the rest 15% of the total costs(NEI Magazine, 2017). Russian state-owned nuclear corporation ROSATOM will be responsible for the construction of the nuclear power plant equipped with four 1200 MWe units in El-Dabaa within a 12-years-period(WNN, 2015). More precisely, ROSATOM is responsible "for the construction of four power units, the supply of nuclear fuel for 60 years, the provision of services as well as waste and used fuel management"(WNN, 2017). The total electricity generated capacity of El-Dabaa nuclear power plants will be 4,760Mwe gross or 1,190Mwe per unit. So, let's do the math. I will analyze all costs and benefits related with operating nuclear power plant *(see table 1 & 2)*. I will examine the following costs provided by WNA: capital (investment) costs, plant operating costs, external costs and other related costs. Firstly, in order to avoid confusion, I will explain what means energy and what means power. According the Energy Lens energy is a measure of how much fuel is contained within something, or used by something over a specific period of time expressed as kWh[3], whereas power is the rate at which energy is generated or used expressed as kW[4](Energy Lens, n.d.). Simplified, energy[5] = power * hour. According the U.S Energy Information Administration data Egypt's consumers pay from $0.1 to $0.7 per kw/h electricity, where the average would be $0.4 per kw/h. Hence, the total income of the El-Dabaa nuclear power plant per year would vary from $10,771,880,000 (realistic) to $16,679,040,000 (idealistic). In order to reduce the deficit in the budget and cut subsidy spending, in the following fiscal year Egypt plans to hike electricity prices from 18% up to 42% depending on consumption levels by households and companies, and hence, the income is expected to grow up for the following fiscal years(Noureldin, 2017). However, there are a lot of costs as well:

- Capital Costs - $25 billion loan from Russia with annual interest rate of 3% and installments of payments would be over 22 year's period. Hence, the total interest paid for 22-years-period is $16.5 billion. Thus, Egypt's ***capital costs*** would be $41.5 billion in total.
- Operation & Maintenance costs- in this category fall labor[6] and overheads,[7] expendable materials[8] and local property taxes.
- Fuel Costs- [9] The approximate nuclear fuel needed for 1000MWe reactor is 165tonnes of fuel, or about 100tonnes of enriched uranium which is equal to 113tonnes of uranium dioxide(Nuclear Power, n.d.). In order to calculate the fuel costs, I will use the WISE Uranium Project calculator, which estimates that for 1,190t of natural uranium Egypt's government, would need to allocate nearly $ 334,299,600 per year.
- Waste–Related Costs - Because precise terms of the agreement [to date of drafting this paper] were unavailable, this amount is still questionable whether or not should be paid additionally by Egypt or ROSATOM, since ROSATOM is responsible for the nuclear waste management too. However, at later period this amount of $163,937,900 should be allocated once the terms of the nuclear agreement expire (*see table 2, column III*).
- Labor costs - according the agreement, around 20,000 people will be hired for throughout the whole process of construction and around 4,000 people will be employed when El-Dabaa power plant will start with work(NNBS, 2017). Even though the salary range for each job position respectively is highly classified, we can still use some average values per job[10] position to calculate labor costs. The average salary per month in Egypt is 6,860EGP or $390. Thus, the median is nearly $500. The usual practice in all other countries in the world is, those employees who on work are exposed on high risk towards their life towards its life to get at least 30% higher income per month than the average monthly salary. Hence, the annual labor costs for El-Dabaa nuclear power plant would vary between $30 million to $40 million. Also, including medical and health benefits this would reach between $55 million to $60 million.
- Expendable materials, it is not expected to have high costs because it will be new power plant. The expendable materials related costs have yet to be determined.

In short, there are no doubts that nuclear energy program is economically viable solution for Egypt on long term. In overall, El-Dabaa nuclear power plant would be able to satisfy 15% of the total electricity consumption in Egypt, which

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[3] Unit of KWh is Kilo Joules per hour

[4] Unit for KW is Kilo Joules/sec.

[5] According Dr. Bill Robinson,[5] 1 MW means 1 million joules per second, or 1MW plant can generate 1000 kilowatt-hours of energy (Robinson, 2017). According the formula $P_{(KW)} = 1000 \times P_{(MW)}$, the total producing capacity of El-Dabaa nuclear power plant would be $P_{(KW)} = 1{,}000 \times 4{,}760 = 4{,}760{,}000_{(KW)}$. In addition, I will show two possible scenarios: best-idealistic and possible-realistic case of production and consumption of electricity.

[6] operators, maintenance personnel (electrical, mechanical, instrument and controls), health physics technicians, engineering personnel (mechanical, electrical, nuclear, chemical, radiological, computer)

[7] medical and pension benefits

[8] Expendable items are usually considered to be consumed when issued and are not recorded as returnable inventory (Business Dictionary)

[9] In addition, NuclearPower.net provides data that annual consumption of 1000MW reactor is 250tonnes of natural uranium or 25tonnes of 5% enriched uranium. In Egypt's case that would be 250t x 4.76 = 1.190t of natural uranium or 119t of 5% enriched uranium.

[10] Oil/Gas/Energy/Mining position is roughly 18,600 EGP or $1,050; Executive and Management position is roughly 15,755 EGP or $895; Factory and Manufacturing 10,998 EGP $625; Engineering position is roughly 10,500 EGP or $600; Construction / Building/ Installation 10,000 EGP or $560; Government and Defense 7,000 EGP or $400 ; Banking 5,756 EGP or $325; Architecture 5,500 EGP or $310; Driver/Courier 1,938EGP or $110; Cleaning and Housekeeping 1,500 EGP or $95 - Middlebury Institute of International Studies at Monterey (MIIS, n.d.).

additionally reduces 15% on import costs on fossil fuels to satisfy energy demand of its nation. On the one hand, it reduces the dependability on foreign states from the region such as Israel, Kuwait, Oman and Iraq, whereas on the other hand, allows Egypt to increase its exports of energy resources for higher price comparing with the consuming domestic prices.

5. Regional and Geostrategic Implications of Nuclear Egypt

There are no doubts that nuclear energy has a positive impact on the national states economies. Nonetheless, nuclear energy brings many geopolitical implications as well. Firstly, it has a negative impact on the process of democratization in the non-democratic states. The major concern related with nuclear energy is nuclear energy programs do not be launched in states with nondemocratic regimes such as Egypt's because "nuclear energy in the hands of shaky regimes is likely to create international tensions"(Marktanner & Salman, 2011). In addition, if nondemocratic regimes justify the implementation of nuclear technology based on national identity and prestige, it is more likely that that will weaken the role of opposition in the subsequent periods of democratization(H. O'neil, 1999). For example, like in North Korea, acquiring nuclear technology has strengthened the political power of the regime. Furthermore, if the nuclear aspirations of such as regime are not opposed, then it will have dramatic effect towards the democracy as well as will generate regional and international tensions. In this regard, the former Secretary of State John Kerry said that Egypt is far from "restoring democracy" (Kerry, 2016), and accordingly, Egypt's nuclear energy program could generate such as tensions in the region and wider. Therefore, Egypt's nuclear energy program needs to be subject to higher safeguard monitoring by IAEA. Secondly, nuclear energy attracts foreign direct investments in the region. One of the biggest problems for most African countries is funding nuclear power plant projects(Gambrah, 2017). In this regard, attracting foreign investors in nuclear energy field is the most viable solution for realization of NPP projects. For example, Chinese companies will build nuclear power plants in Kenya,[11] Sudan[12] and are in negotiations with Niger,[13] whereas Russia will build nuclear power plants in Egypt, Nigeria,[14] and in negotiations with Algeria.[15] What is indicative is that Russia and China are leaders in the African nuclear market. Thirdly, nuclear energy involves many trade-offs on socio-economic and geopolitical plan which could shift the geo-strategic balance in the region. Nowadays, Egypt's regime is seeing United States as a "unreliable ally due to the country's initial support for the Muslim Brotherhood"(Neubauer & Guzansky, 2015). Thus, Egypt's nuclear and military cooperation with Russia could drastically shift the geostrategic balance in MENA region. On the one hand, in order to get better funding terms, Egyptian nuclear program "would help Cairo to redefine its relationship with Russia, Saudi Arabia, and the United Arab Emirates" by acting as a buffer between Moscow, Riyadh and Abu Dabi(Neubauer & Guzansky, 2015). On the other hand, the "sweetheart nuclear deal" offered to Egypt to build nuclear power plant makes sense only if is seen through geopolitical lens. As a fact of illustration, if we compare the costs of 12.53¢kw/h that Turkey should pay to ROSATOM with the price of 5.3¢kw/h[16] that Egypt should pay to ROSATOM as well(Teoman, 2017), we will see that Egypt will pay almost two and a half times more of the price per kw/h than Turkey will pay, which also [the Egypt's price] is two and a half times bellow the world average price of electricity per kw/h(Statista, 2017). Egypt's geostrategic location, especially the control of Suez Canal and the access to Mediterranean Sea, is very attractive for Russia who seeks to get access to the Mediterranean Sea. In the past, Soviet's maintained a "Cold War-era naval base[17] in Sidi Barrani"(Hanna, 2017) for what some U.S officials have recently accused Russia for re-deploying its troops again(Stewart, Ali, & Noueihed, 2017). In addition, both Russia and Egypt are close ally of Libyan general Khalifa, thus, Egypt's territory is the most viable solution for delivering support for general Khalifa in Libya. Finally, it is obvious that in MENA region currently is happening nuclear renaissance period(Grimmitt, 2011). In this regard, the possibility of Egypt to implement dual strategy it is not excluded, which means to work with Russia on enriching weapons-grade uranium under the cover of its nuclear non-proliferation advocacy(Neubauer & Guzansky, 2015). History reminds us that such as cases have already occurred in the past. For example, India was working on nuclear weapons program while calling for nuclear disarmament(Weiss, 2010). It is apparent that there is some trade-off of socio-economic with geostrategic interests between Russia and Egypt. However, Russia's support for autocratic regimes such as al-Sisi's, general Khalifa's as well as Asad's regime, could generate further armed disputes in MENA region. Besides that, the support for autocratic regimes disables the democratization process of Africa. Last but not least, nuclear energy is pushing the need for regional cooperation in eradicating the energy poverty in Africa. As one of the most developed country in Africa with more than fifty years of experience in operating research reactors and founder of "African Nuclear Weapon-Free Zone," Egypt could take the leadership in facilitating regional nuclear energy cooperation in order to eradicate energy poverty in Africa on long term. Nevertheless, one of the major challenges of nuclear energy in African continent is the lack of physical electricity infrastructure"(Barnard, 2014). Thus, expanding nuclear energy in Africa will have positive impact on regional energy security and building the necessarily energy infrastructure. For example, the more developed countries in Africa to export electricity to

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11 http://www.world-nuclear-news.org/C-Chinas-CGN-extends-its-cooperation-with-Kenya-2303174.html
12 https://www.reuters.com/article/us-china-nuclearpower-sudan/china-signs-deal-with-sudan-to-build-nuclear-reactor-xinhua-idUSKCN0YF04Q
13 http://www.businessinsider.com/niger-uranium-mine-and-nuclear-china-2015-10
14 http://www.worldaffairsjournal.org/content/russia-build-nuclear-power-plants-nigeria
15 http://www.globalconstructionreview.com/news/rosatom-help-algeria-race-b7uild-afric7as-fir7st/
16 This price is the among the global average price for electricity by kw/h
17 The naval base is located close to Libyan border which gives Russia leverage to intervene in Libya as well as get access to Mediterranean Sea. Stabilizing the situation in Libya is in interest of Egypt as well.

less developed countries by affordable prices in order to generate economic development in those countries. In this regard, regional legal and regulatory framework is needed, in terms of eliminating all legal obstacles in setting appropriate physical energy infrastructure in the less developed countries. Finally, the nuclear energy enables Egypt to satisfy the demand for drinking water of its nation. Other major problem for Egypt besides electricity shortages is lack of sources for drinking water. According the deal, in El-Dabaa will be built nuclear reactors with desalination facilities. According the estimates of the World Nuclear Association, each nuclear reactor in El-Dabaa will have a capacity to produce 170,000 m^3/d, at a cost less than $\$1/m^3$. Comparing with the costs for desalination with gas turbines, nuclear desalination costs are almost half of the gas plant costs (World Nuclear Association, 2017b). Hence, Egypt will save half of the costs needed to supply gas turbines with fossil fuels, i.e. for the same costs needed to run gas turbines, nuclear energy enables Egypt to double the production capacities of drinking water. Additionally, it decreases the tensions between Egypt and Ethiopia on River Nile issue which I will elaborate more in the next section.

6. Egypt's Security Necessities

6.1. Water (in) Security

As a main source of drinking water, river Nile has also given Egypt and all other countries where it extends the opportunity to build hydroelectric centrals to produce electric power. Accordingly, in Ethiopia where three quarters of its population has lack of access to electricity, its national government is building $5 billion worth hydroelectric dam(Grand Ethiopian Renaissance Dam GERD) with 6.000 megawatt power in order to satisfy the demand for electricity of its citizens and to profit from the sale of electricity to other countries which is estimated to roughly $1 billion in revenues(Conniff, 2017). River Nile is the main source of drinking water for Egyptians, thus, official Cairo has for many years threaten Ethiopia with war if they barricade the river. However, this threat was effective till the breakout of Arab Spring in 2011 when Egypt was preoccupied with its survival, Ethiopia without any warning has started the construction of GERD which is considered as the eight largest hydroelectric dam(Pearce, 2015). Therefore, the Renaissance Dam in Ethiopia and the Sudan's own dam on Blue Nile can significantly slow and limit the flow of water downstream to Egypt which relies on Nile's water for irrigation, producing electric power and as a source of drinking water. Hence, Ethiopia's dam is "the most dangerous flashpoint yet on a lawless river" which can complicated the already sensitive and unstable security situation in Africa(Pearce, 2015).

6.2. Military Strength and Budget Expenditures

The size of Egypt's combined army varies between 450,000 – 470,000 troops, whereas above 350,000 troops represents the army(Bender, 2016). From 2002 to 2014 the military expenditures in Egypt has increased twofold, from $2,380,000,000 in 2002 to $5,080,000,000 in 2014(U.S Department of State, 2017). According the Business Monitor International (BMI) report, Egypt will increase its military expenditure till 2019 at an annual rate of nearly 9.5% or around $8,500,000,000(Business Monitor International, 2017). The reason for this military expenditure is the increased threat of various terrorist groups that operate inside and around Egypt.

6.3. Egypt's Missile Arsenal and Air Defense

Egypt was among the first most developed countries in the world which expressed their willingness to pursue a ballistic missile capability by the mid-20th century. Nowadays, Egypt has a very limited production capability and deployed Soviet-era arsenal. Current Egypt's ballistic missiles arsenal is consisted of Scud-C ballistic missiles,[18] R-300 Elbrus[19] (Formerly R-17; NATO: SS-1-C Scud B) and Project T[20] (Scud-B-100) short range ballistic missiles, as well as R-70[21] Luna-M (NATO: Frog 7B) and Sakr-80[22] artillery rockets(NTI, 2015). To date, there are no evidences whether or not Egypt posses middle-range ballistic missiles or intercontinental ballistic missiles (ICBM). Furthermore, in its arsenal Egypt possess 12 batteries MIM-23 Improved Hawk[23] surface-to-air missiles and 32 batteries of Patriot-3 (MIM-104-F/PAC-3) missile systems all purchased from U.S; 2K12 Kub (SA-6 Gainful), S-75M (SA-2 Guideline) known as Tayer el-Sabah and roughly 50 upgraded S-125 Pechora-M (SA-3) missile systems all purchased from Soviet Union[24](NTI, 2015). However, this year Egypt has also made another deal with Russia to purchase in total 50 MiG-29 jet fighters which delivery is already underway (Fahmy, 2017). Besides the jet fighters, Egypt has also purchased the most sophisticated Russian attack helicopter Kamov Ka-52 Alligator(MF, n.d.) and 24 Rafale jet fighters from France[25] which deliveries are underway as well(Arkin, 2016). What is noticeable is that Rafale[26] jet fighter are one of the rarest aircrafts in the world capable of carrying nuclear warheads (Beckhusen, 2016).

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[18] North Korean production, purchased in late 1990s and early 2000s with range of 550 km (Ramani, 2017)
[19] Guided missiles with a range of 250 to 500km.
[20] North Korean production, with a range of 450km.
[21] Range of 70km
[22] Range of 80km.
[23] Range from 45 to 50 km and 83% accuracy to hit the target.
[24] None of the Soviet-era missiles have ranges more than 45km
[25] Including air-to-air missiles, cruise missiles and naval arsenal.
[26] For more details regarding the aircraft's capabilities visit http://www.airforce-technology.com/projects/rafale/

7. Conclusion

It is very difficult to say with any degree of precision what kind of implications would have the Egypt's nuclear energy program in future. However, from the discussion above, with certain degree of confidence several conclusions can be drawn. Firstly, it is more likely that nuclear energy program would generate economic growth and energy security in Egypt on long term. Also, it enables Egypt to reduce the costs on imports of fossil fuels as well as to meet the demand for drinking water of its nation. On the other side, it is obvious that Egypt's nuclear deal is not in compliance with the national energy security rhetoric. More precisely, even though the nuclear energy generates economic growth, it is not making Egypt more energy independent on foreign influence, but, in contrary, it makes Egypt more dependent on Russia and subject to political influence from Russia. Additionally, Russian support for autocratic regimes in Africa, such as al-Sisi's regime is complicates the process of democratization in Africa, thus, is more likely to generate more armed disputes in near future. Finally, no matter whether or not the program would ever lead to a nuclear arsenal, it is more likely that Egypt will use this program as a bargaining chip to disturb the balances in the region and set them as a leader in the MENA region. However, the possibility that Egypt would implement dual strategy it is not excluded. Thus, more control and monitoring are needed by IAEA in order to prevent Egypt of becoming nuclear weapons state. Additionally, it is more likely that United State and Israel would diplomatically and militarily intervene if any fact or information indicates of existence of a latent nuclear weapons program in Egypt. Thus, more researches are needed in assessing the regional cooperation capacities and in the energy field in Africa. Moreover, this paper considered nuclear energy as a one sources; thus, future studies should assess the role of other energy resources in achieving efficient energy mix which would decrease the energy poverty in Africa on lowest possible levels.

8. Appendixes

Time period	Power	Energy	Income (per day)	Total Income per year	Total income per year (85%) for Egypt govt.
Idealistic (24h daily consumption)	4,760,000 (kw)	114,240,000 (kWh / per day)	$45,696,000	$16,679,040,000	$14,177,184,000
Realistic (65% of daily consumption or 15.5 hours)	4,760,000 (kw)	73,780,000 (kWh/ per day)	$29,512,000	$10,771,880,000	$9,156,098,000

Table 1: Total income per year of El-Dabaa nuclear power plant

Calculation of costs based on 1,190t of uranium needed for the operation of El-Dabaa per year.

Cost Summary (in Thousand US$)			
	Nominal Cost(s)	Future Waste Mgmt Cost	TOTAL
Natural Uranium	71156.52	30937.62	102094.1
Conversion	5355	0	5355
Enrichment	26693.25	10362.82	37059.07
Fuel Fabrication	67156.95	0	67156.95
Subtotal (front end)	170361.7	41303.44	211665.2
Spent Fuel	N/A	122634.4	122634.4
Total	170361.7	163937.9	334299.6

Table 2: Cost Summary for fuel cycle

	Income	Fuel Costs	Waste Management costs	Labor Costs	Other costs[27]	Annual loan repayment	Annual rate + 3% interest rate	Total Profit
Idealistic	$14,177,184,000	$170,361,700	$163,937,900	$55,000,000	$19,464,980	$1,136,363,636	$1,170,454,545	**$12,597,964,875**
Realistic	$9,156,098,000	$170,361,700	$163,937,900	$55,000,000	$19,464,980	$1,136,363,636	$1,170,454,545	**$7,576,878,875**

Table 3: Approximate costs and profit per year of El-Dabaa nuclear power plant

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