AL HABTOOR RESEARCH CENTRE

SECURING FUTURE GENERATIONS

A Road Map for Arab Nuclear Cooperation

December 2022

AL HABTOOR RESEARCH CENTRE

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EXECUTIVE SUMMARY

Nuclear cooperation attracts international and regional attention, many Arab countries have aspired to produce clean nuclear energy and have either begun or are seeking to join the nuclear energy club. The United Arab Emirates, the Arab Republic of Egypt, the Kingdom of Saudi Arabia, and the Hashemite Kingdom of Jordan, are the frontrunners in the Middle East and therefore will be the focus of this paper.

Nuclear power is an international industry in terms of operation, supply chains, and vendors, as well as nuclear safety, non-proliferation and waste management, therefore, there is an ongoing need for cooperation and collaboration between states. This cooperation can include sharing technical expertise and nuclear technology, establishing agreements that facilitate nuclear exports, agreements on nuclear safety and standards, and collaboration with regulatory frameworks.

The paper employs horizontal or environmental scanning to analyse the current position of nuclear energy in each country and their preparedness for nuclear cooperation, as well as existing models of nuclear cooperation in other regions. Thereafter, the paper explores the different incentives countries may have for engaging in nuclear cooperation, including the potential benefits to be gained. A SWOT analysis is used to structure the environmental scanning, evaluating the strengths, weaknesses, opportunities, and threats within each country with regards to their potential role and contribution to nuclear cooperation in addition to an overall SWOT analysis of the countries as a whole with regards to the prospect of ongoing collaboration.

The paper is divided into three chapters; the first chapter provides an overview of nuclear energy in each of the selected countries, the second chapter examines existing models of nuclear cooperation and analyses the different enabling factors which will later be used to identify opportunities for Arab nuclear collaboration, and the third chapter analyses the various economic, political, and security incentives that would drive countries to seek cooperation or that can be used to advocate for greater collaboration among policymakers.

A cooperation model is produced as a result of this analysis, highlighting key characteristics of the ideal regional partnership. Three scenarios for Arab nuclear cooperation are evaluated to demonstrate what could occur if this proposed cooperation occurs, how it would happen, and the scenarios of no collaboration or limited cooperation.

INTRODUCTION

Energy security is a global priority that is a critical component of any governmental agenda, especially in recent years with growing concerns over the impact of climate change and population growth on energy needs as well as the impact of geopolitical conflicts, such as the Russia-Ukraine war, on global energy supplies. In 2021, an IAEA report estimated that global energy consumption would increase by 30%, doubling the electricity increase. The projections for 2050 reflect a rising acknowledgment of climate change issues and the importance of immediately transforming to nuclear power to reduce the emissions from electricity generation.

The longstanding tensions in the Middle East make the region particularly vulnerable to energy security issues considering that many states are not only energy consumers but also energy suppliers. Recognizing the importance of energy diversification for security and sustainability, many Arab countries have either begun the path or are seeking to join the nuclear energy club, including the United Arab Emirates (UAE), the Arab Republic of Egypt, the Kingdom of Saudi Arabia (KSA), and the Hashemite Kingdom of Jordan, which will be the focus of this paper. However, because nuclear power is essentially an international industry in terms of operation, supply chains, and vendors, as well as in terms of nuclear safety, non-proliferation, and waste management, there is an ongoing need for cooperation and collaboration between states. This cooperation can include sharing technical expertise and nuclear technology, establishing agreements that facilitate nuclear exports, agreements on nuclear safety and standards, and collaboration with regulatory frameworks.

All countries with well-established nuclear energy programs, for example, the United States, China, and France have many bilateral and multilateral nuclear cooperation agreements and memberships in regional networks or organizations that create strategic opportunities for their atomic development. Taking this into consideration, this paper assesses the potential of Arab nuclear cooperation to drive the expansion of the atomic energy industry in the region, promote greater self-reliance and sustainability, as well as increase energy security and regional stability. The paper employs horizontal or environmental scanning to analyse the current position of nuclear energy in each country and their preparedness for nuclear cooperation, as well as analyse existing models of nuclear cooperation in other regions. Then, the paper explores the different

incentives the countries may have for engaging in nuclear cooperation, which also includes the potential benefits to be gained. A SWOT analysis is used to structure the environmental scanning, evaluating the strengths, weaknesses, opportunities, and threats within each country with regards to their potential role and contribution to nuclear cooperation in addition to an overall SWOT analysis of all the countries as a whole with regards to the prospect of ongoing collaboration.

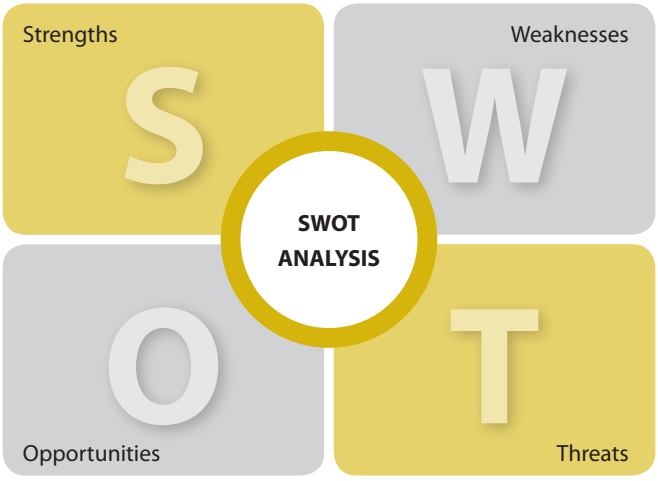
The paper is divided into three chapters; the first chapter provides an overview of nuclear energy in each of the selected countries, the second chapter examines existing models of nuclear cooperation and analyses the different enabling factors which will later be used to identify opportunities for Arab nuclear collaboration and the third chapter analyses the various economic, political and security incentives that would drive countries to seek cooperation or that can be used to advocate for greater collaboration among policymakers. A cooperation model is produced as a result of the analysis, highlighting key characteristics of the ideal regional partnership. Three scenarios for Arab nuclear cooperation are evaluated to demonstrate what could occur if this proposed cooperation occurs, how it would happen, and the scenarios of no collaboration or limited cooperation.

The purpose of the analysis and scenarios presented here is to improve policy and decision-making and to highlight and put into perspective the wide range of factors and elements of the issue of energy security and the potential of nuclear cooperation. To do this, the paper creates space for different potentially changing dynamics, and the recommendations can be tailored to different scenarios.

METHODOLOGY OF THE STUDY

The study will apply the **Environmental Scanning** method which systematically depends on screening the current situation analysing it into the internal and external factor of the actors to understand the status each actor and its strengths and weakness in the present also, the opportunities and threats in the future.[1]

The paper applies **Environmental Scanning** on four countries in the MENA region **(the UAE, Egypt, KSA, and Jordan)** where they stand in obtaining civilian nuclear power plants (NPPs) for generating the electricity and use it in other peaceful uses. The methodology is also going to explore the internal factors (strengths and weaknesses) and the external factors (opportunity and threats) environments of each country to have a better understanding of the capabilities of each country and the challenges facing the nuclear energy programs of each country to identify and explore new innovative ideas for building successful regional collaboration with the mentioned countries in the field of nuclear energy. The methodology will apply a SWOT analysis which will contribute to the development of the cooperation model while identifying the path for future cooperation.



1. Bengston, David N. 2013. Horizon scanning for environmental foresight: a review of issues and approaches. Gen. Tech. Rep. NRS-121. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 20 p.

OBJECTIVES OF THE STUDY

1. Identifying the enabling factors for future cooperation among Arab countries in nuclear energy.
2. Discover the best practices and the enabling factors for successful regional cooperation in nuclear energy.
3. Maximizing the benefits and overcoming the challenges in the cooperation.
4. Suggests a model that depends on the successful experience of the current regional cooperation.

RESEARCH QUESTIONS

1. Where does nuclear energy currently stand in the UAE, Egypt, the KSA, and Jordan?
2. What are the factors of successful nuclear cooperation?
3. What incentives would each country need to enter the collaboration?
4. What is the potential of the collaboration and its benefits?
5. What conditions would influence the prospect of an Arab Nuclear Cooperation and how?

NUCLEAR ENERGY IN ARAB COUNTRIES: WHERE DO ARAB COUNTRIES STAND?

This chapter analyses the current standing of Arab countries regarding the status of nuclear energy planning and implementation

The IAEA's report 2021 on "Energy, electricity, and nuclear power estimates for the period up to 2050" shows that nuclear power will continue to play an indispensable role in low-carbon energy production. The report estimates global energy consumption will increase by 30%; the projections for 2050 reflect a rising acknowledgment of climate change issues and the importance of immediately transforming to nuclear power to reduce the emissions from electricity generation. Commitments under the Paris Agreement could support nuclear power development if the necessary energy policies and market designs facilitate investments in dispatch able, low-carbon technologies.[2]

The expectations of the IAEA's projections of a doubling of nuclear capacity by 2050 are like the International Energy Agency's projections in the publication "Net Zero by 2050 – A Roadmap for the Global Energy Sector". As global electricity generation is expected to double over the next three decades, nuclear power generating capacity would need to expand significantly to maintain its current share of the mix.[3] According to the IAEA's high-case projection, nuclear energy could contribute about 12% of global electricity by 2050, up from 11% in high-case points. According to the available data, nuclear power generated around 10% of the world's electricity in 2020. The low-case scenario was unchanged, with a projected share of 6% for nuclear in the total electricity generation. Coal remains the dominant energy source for electricity production at about 37% for 2020, changing little since 1980.[4]

Many Arab countries hope to join the nuclear energy club, including the UAE, Egypt, the KSA, and Jordan. At the same time, other states have halted developing their civil nuclear plans following the Tohoku earthquake, tsunamis, and meltdown at the Fukushima reactor in Japan in 2011, like Kuwait, Oman, and Qatar.[5]

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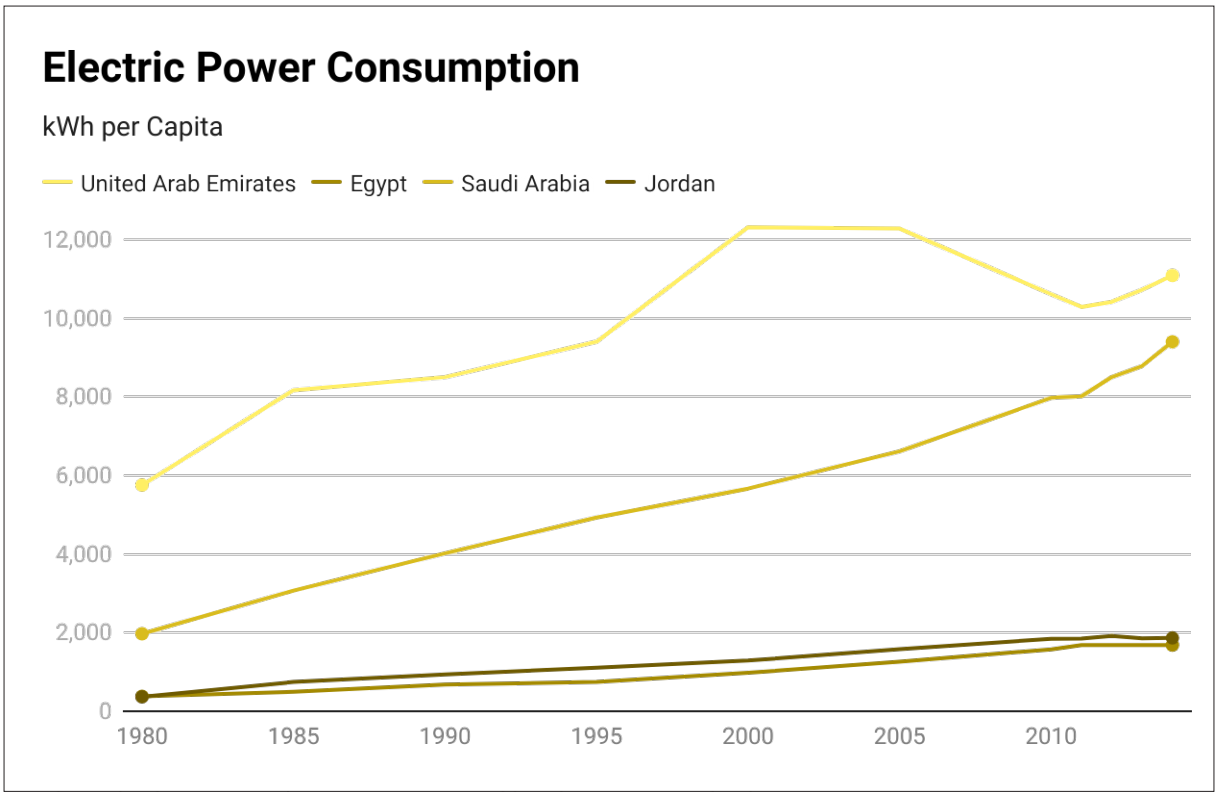
2. IAEA. (2021, September 16). IAEA increases projections for nuclear power use in 2050. IAEA. Retrieved November 16, 2022, from https://www.iaea.org/newscenter/pressreleases/iaea-increases-projections-for-nuclear-power-use-in-2050

3. Bouckaert, Stéphanie, Araceli Fernandez Pales, Christophe McGlade, Uwe Remme, Brent Wanner, Laszlo Varro, Davide D'Ambrosio, and Thomas Spencer. "Net Zero by 2050: A Roadmap for the Global Energy Sector." (2021).

4. IAEA. (2021, September 16). IAEA increases projections for nuclear power use in 2050. IAEA. Retrieved November 16, 2022, from https://www.iaea.org/newscenter/pressreleases/iaea-increases-projections-for-nuclear-power-use-in-2050

5. Nakhle, C. (n.d.). Nuclear energy's future in the Middle East and North Africa. Carnegie Middle East Center. Retrieved November 16, 2022, from https://carnegie-mec.org/2016/01/28/nuclear-energy-s-future-in-middle-east-and-north-africa-pub-62562

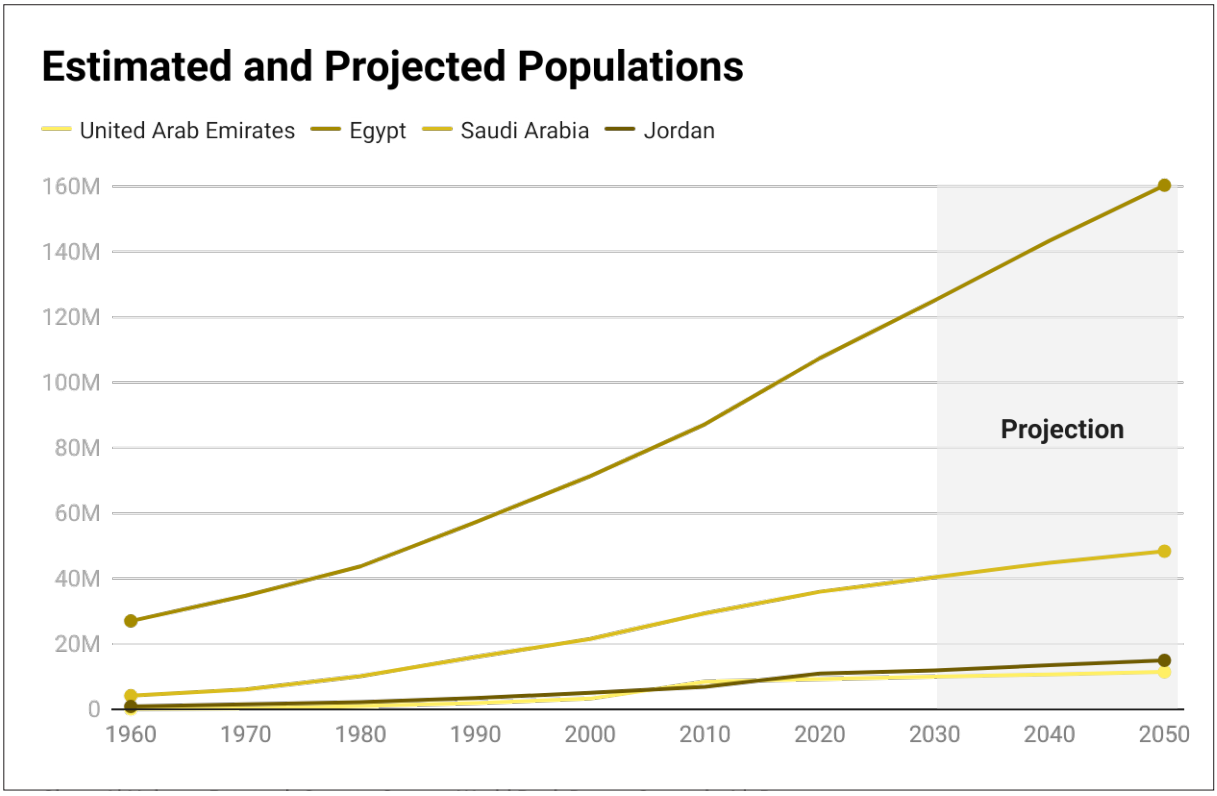
From an economic perspective, the primary concerns are addressed in each country's rising population growth and energy consumption, in addition to enhancing energy security and maximizing foreign income.



Source: Electric Power Consumption (kWh per capita) - Jordan, Saudi Arabia, Egypt, Arab Rep., United Arab Emirates. Data. (n.d.). Retrieved November 16, 2022, from https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?end=2014&locations=JO-SA-EG-AE&start=1985

The above figure shows the increase of electricity consumption per capita in both the UAE and KSA by 2010 due to the rapid growth in demand for electrical energy in UAE and KSA due to the region's rapid economic large-scale infrastructural development, heavy industry, and petrochemicals, all requiring substantial electrical power. High population growth due to labour migration and the high birth rate, coupled with improving living standards, led to a rise in residential and commercial energy consumption. Furthermore, the low price of electricity in the two countries plays a vital role in increasing electrical power demand. Electrical energy is subsidized, which has resulted in the GCC energy prices being amongst the lowest in the world. Moreover, waste due to inefficient buildings and equipment has contributed to an increase in power demand.[6]

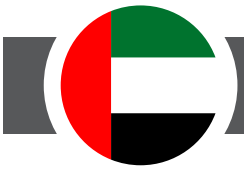
6. Abdullah Al-Badi & Imtenan AlMubarak (2019) Growing energy demand in the GCC countries, Arab Journal of Basic and Applied Sciences, 26:1, 488-496.



Source: Population Estimates and projections, World Bank Group, Last Updated: 07/01/2022 https://databank.worldbank.org/source/population-estimates-and-projections#

The figure shows that Egypt will experience the most significant population increase in absolute terms, with 60 million added people between 2020 and 2050 (20 million up to 2030). Followed by KSA increased (12 million up to 2030).[7]

7. Population Estimates and projections, World Bank Group, Last Updated: 07/01/2022 https://databank.worldbank.org/source/population-estimates-and-projections#



NUCLEAR POWER STATUS IN THE UNITED ARAB EMIRATES

Facing rapidly rising demand in its power sector, the UAE turned to civil nuclear power as a means of electricity generation. While the UAE has been engaged in technical cooperation projects with IAEA for many years (the agency advised the UAE on the formation of a nuclear energy administration in 1977), the country's current drive toward a nuclear power program began with the findings of a national energy study by an interagency working group established by the Economic and Energy Affairs Unit of the country's Executive Affairs Authority (**EAA**). The EAA working group recommended a portfolio approach to electricity generation in which it projected that Abu Dhabi could generate 30% of its electricity from alternative sources, including nuclear power.[8]

The findings of the national-level energy study informed the 2008 "Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy." The white paper was an attempt by the government to outline the issues and steps needed to develop a civil nuclear power program. Policymakers in the UAE acknowledged a degree of sensitivity in producing a document that would serve as the first indication to the international community that the UAE was considering civil nuclear power as an option.[9]

The UAE is ahead of other countries in building the first Arab nuclear power plant and became the first country in 27 years to begin constructing its first reactor. The UAE's Baraka project will have a total installed capacity of 5.6 gigawatts (GW), providing nearly 25% of the nation's electricity needs.[10]

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8. Ebinger, C., Banks, J., Massy, K., & Avasarala, G. (2011). Models for aspirant civil nuclear energy nations in the Middle East. Policy Brief, Brookings Energy Security Initiative.

9. Ibid.

10. Emirates Nuclear Energy Corporation. (n.d.). Retrieved November 16, 2022, from https://www.enec.gov.ae/

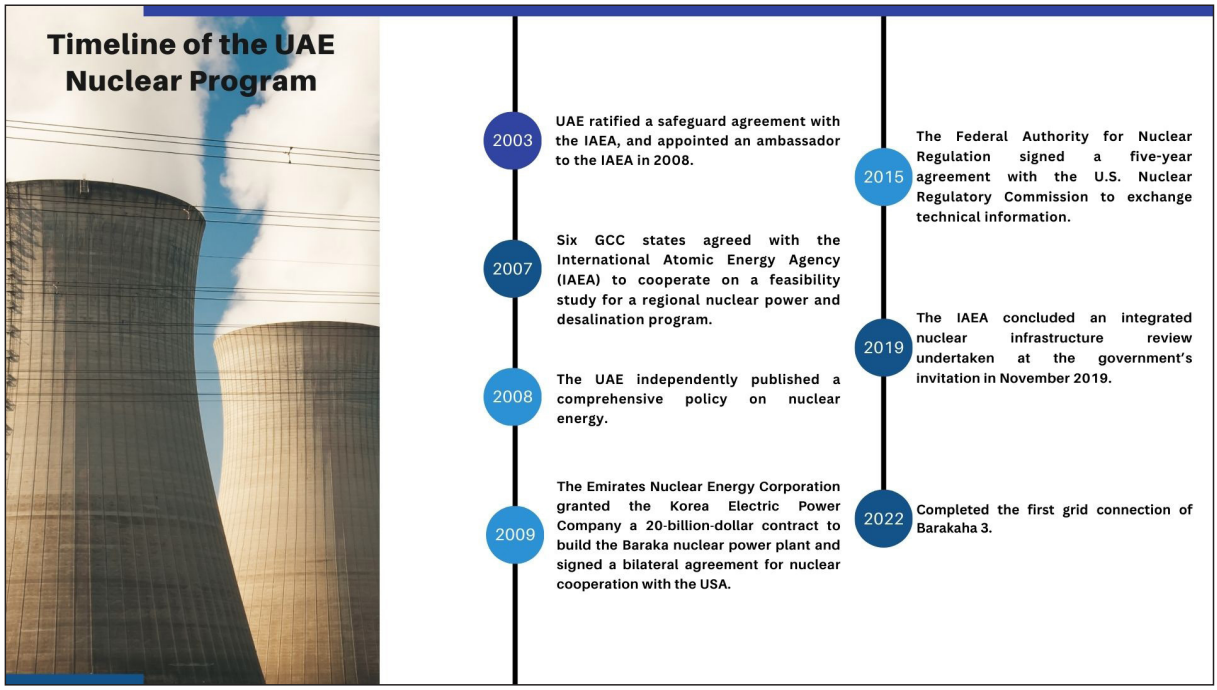
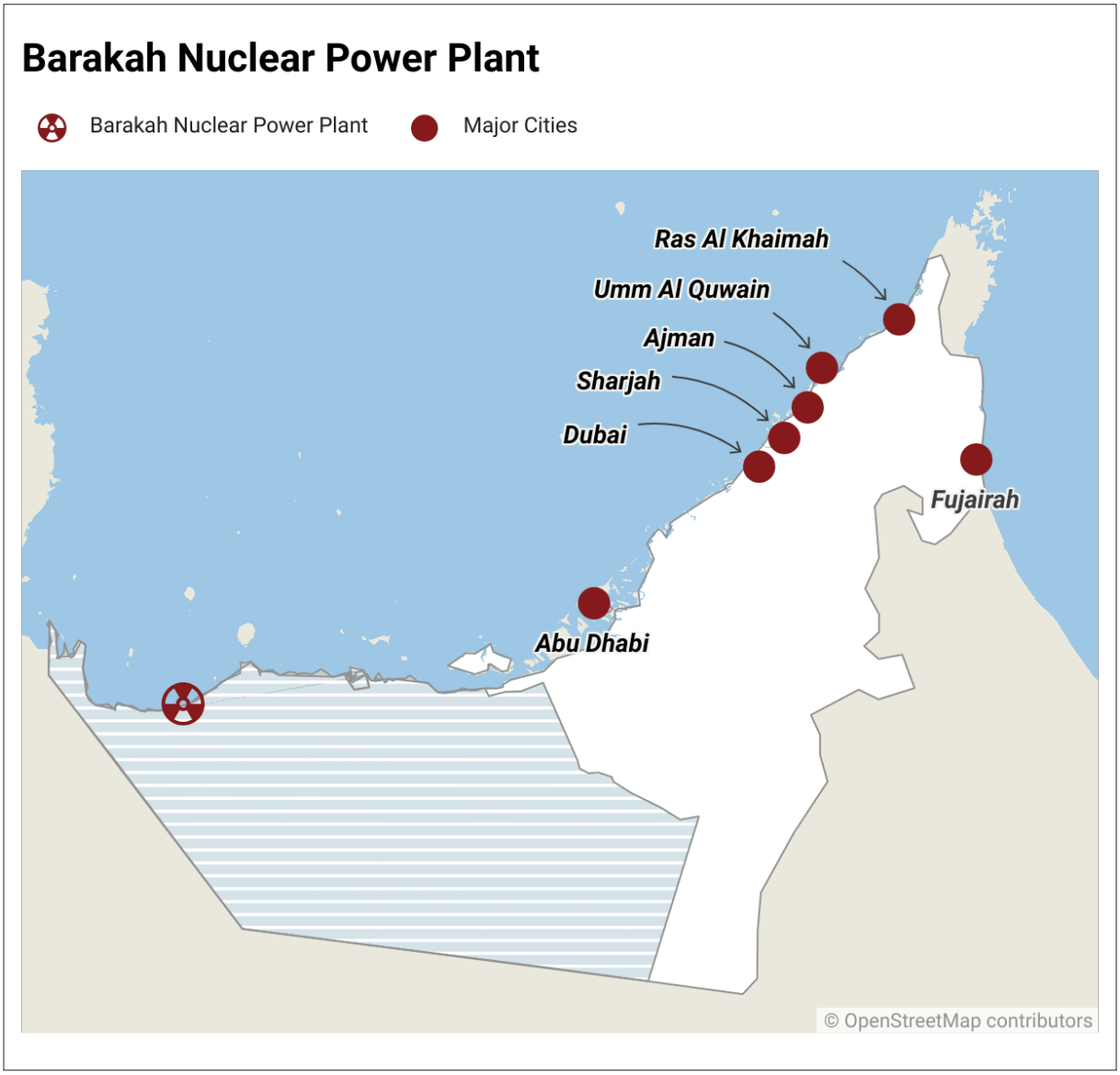


Table (1) Nuclear Power Reactors in the UAE

Reactor Name	Model/Reactor Type	MWe	Construction Start	Grid Connection
Barakah 1	APR- 1400/ PWR	1417	07-2012	08-2020
Barakah 2		1345	04-2013	09-2021
Barakah 3			09-2014	10-2022
Barakah 4			07-2015	N/A

Source: Country energy overview- United Arab Emirates 2022. IAEA. (n.d.). Retrieved November 23, 2022, from https://cnpp.iaea.org/countryprofiles/UnitedArabEmirates/UnitedArabEmirates.htm



Source: Emirates Water and Electricity Company (EWEC), available on: https://www.ewec.ae/en/power-plant/barakah-nuclear-energy-plant

The UAE civil nuclear program has been built by Korea Electric Power Corporation and costs $25 billion. The first UAE plant was ready to fuel in May 2018 and operate in 2021. Four reactors are expected to contribute 25% of the country's electricity. Although the UAE has the seventh largest natural gas reserves in the world, due to the rising demand created by rapid economic growth, it has become a net importer of natural gas, relying on states such as Qatar to supply most of the shortfall,[11] therefore, shifting to alternative energy sources would lead to fewer natural gas imports.

11. Charles Ebinger et al., "Civil Nuclear Power in the United Arab Emirates," in Models for Aspirant Civil Nuclear Energy Nations in the Middle East, Brookings Policy Brief 11 (September 2011).

INSTITUTIONS AND LEGAL FRAMEWORK

The 2008 white paper called for the formation of the Emirates Nuclear Energy Corporation (**ENEC**). ENEC was established in 2008 and had two principal missions: to serve as the entity responsible for deployment, ownership, and operation of NPPs in Abu Dhabi and serve as an investment arm of the government of Abu Dhabi responsible for investments and collaboration with foreign partners in the nuclear sector, both domestically and internationally.

To codify the goals of the 2008 Policy Document and the Road Map document, the government of the UAE instituted the "Federal Law No. 6 of 2009 Regarding the Peaceful Uses of Nuclear Energy" in October 2009. The law, which was produced with input from the international community, established the Federal Authority of Nuclear Regulation (**FANR**) and institutionalized the "prohibition of the development, construction or operation of uranium enrichment or spent fuel reprocessing facilities within the borders of the UAE"; institutionalized the development of a robust system for the licensing and control of nuclear material, and criminalized activities in violation of the law, including the unauthorized use, theft, transport or trade in nuclear materials.[12] As an independent regulator, FANR oversees the UAE's nuclear safety, security, radiation protection, and safeguards.

R&D IN THE FIELD OF NUCLEAR POWER

The UAE coordinated with the IAEA. This all elicited a positive international response. The UAE has preferred a third-generation light-water reactor technology based on building, owning, and operating the model. Contrary to the objectives of Iran, for example, the UAE has renounced any intention to develop a domestic enrichment and reprocessing capability and has undertaken to source fuel from reliable foreign suppliers.[13]

The UAE recognizes the importance of human resource development in building a civilian energy program; the UAE works closely with its Korean nuclear supplier to

12. "UAE President issues law on peaceful uses of nuclear energy," Federal Agency for Nuclear Regulation News Release, October 9, 2009 (http://fanr.gov.ae/en/pressrelease/media-center/press-releases/uae-president-issues-law-on-peaceful-uses-of-nuclear-energy.html). (FANR, 2009).

13. "Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy," United Arab Emirates.

develop a new cadre of Emirati senior reactor operators. Furthermore, to address the demand for skilled nuclear technicians and other plant personnel, the UAE's Institute of Applied Technology is developing a postsecondary vocational training program called a Higher Diploma in Nuclear Technology (**HDNT**).

However, as a government program intent on Emiratization and an increasing workforce nationalization. Generally, the UAE's efforts will likely set the benchmark for best practice or the "gold standard" on civil nuclear power in the Middle East.[14]

INTERNATIONAL AGREEMENTS

Multilateral Commitments and Memberships the UAE has entered into a range of international agreements, including:[15]

- UN Treaty on the Non-proliferation of Nuclear Weapons (NPT)(1995).
- IAEA Comprehensive Safeguards Agreement (2003).
- IAEA Small Quantities Protocol (2003).
- IAEA Additional Protocol to its Safeguards Agreement (signed 2009, ratified 2010).
- IAEA Convention on the Physical Protection of Nuclear Material (2003, Amendments to the Convention ratified in 2009).
- UN Comprehensive Test Ban Treaty (2000).
- UN International Convention for the Suppression of Acts of Nuclear Terrorism (2005).
- Convention on Early Notification of a Nuclear Accident (1987).
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1987).
- Convention on Nuclear Safety (2009).
- Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management (2009).
- U.S. 123 Agreement.

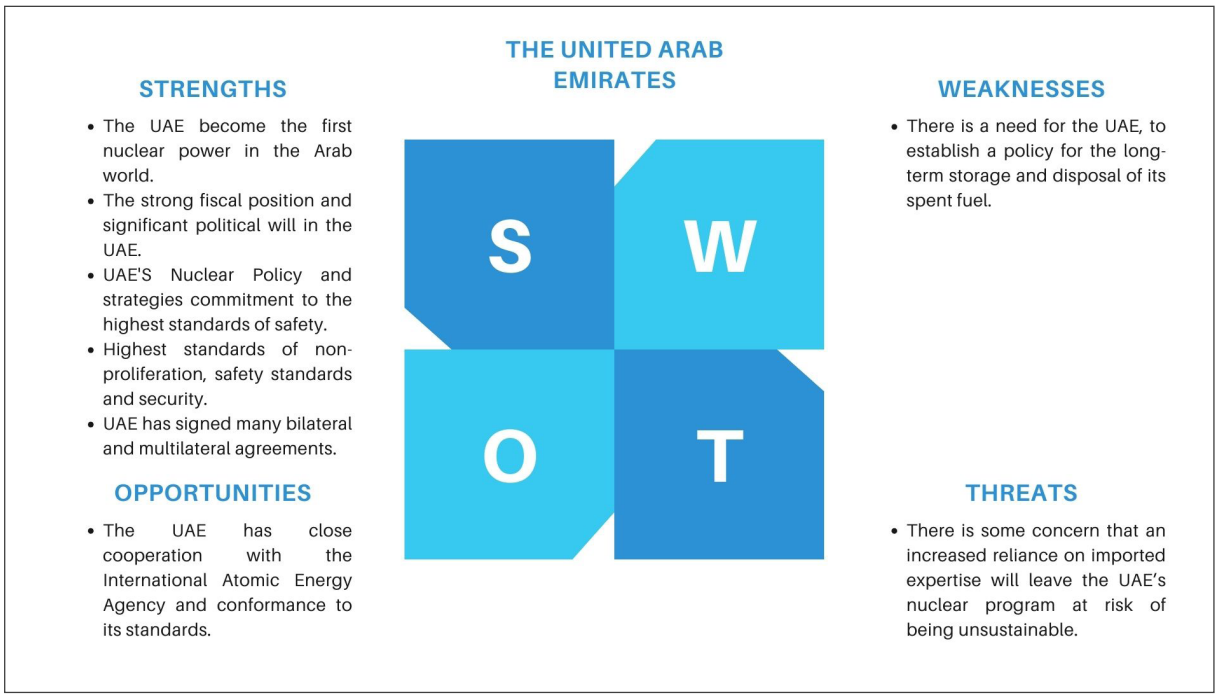
14. John Banks, Kevin Massy, and Charles Ebinger, eds., "Human Resource Development in New Nuclear Energy States: Case Studies from the Middle East," Brookings Energy Security Initiative Policy Brief 12, no. 2 (November 2012): 10-12.

15. Country energy overview- United Arab Emirates 2022. IAEA. (n.d.). Retrieved November 23, 2022, from https://cnpp.iaea.org/countryprofiles/UnitedArabEmirates/UnitedArabEmirates.htm

BILATERAL AGREEMENTS

- The UAE is a signatory of the NPT, ratifying a safeguards agreement with IAEA in 2003. In 2009 it signed the Additional Protocol.
- The USA signed a bilateral nuclear energy cooperation agreement with the UAE in January 2009, and South Korea signed one in June 2009.
- In August and September 2012, Australia and Canada signed bilateral safeguards agreements with the UAE in, with the Australian agreement coming into force in April 2014.
- In October 2012, the UAE passed legislation in line with the revised Vienna Convention so that civil liability lies solely and exclusively with the plant operator.
- France and Canada have nuclear cooperation agreements with the UAE, the latter signed in September 2012, Russia in December 2012, Argentina signed in January 2013, then another in April 2014.
- Japan signed a nuclear cooperation and technology transfer agreement with the UAE in May 2013.
- In July 2014, the UAE ratified the Convention on Supplementary Compensation of Nuclear Damage (CSC), though it has yet to be in force.
- The UK has signed a Memorandum of Understanding on nuclear energy cooperation with the UAE.

SWOT ANALYSIS OF EMIRATI NUCLEAR ENERGY



SUMMARY

The UAE is the Arab world's first nuclear power. Three of the four water reactors that South Korea's KEPCO have been completed at the country's Barakah site, three hundred kilometres west of Abu Dhabi, at a total cost of $20 billion. About a quarter of the Emirates' energy production will be nuclear when its Barakah site is fully operational.[16]

The UAE has engaged the international community in its program from an early stage and has to date made the most progress toward developing a civil nuclear program in the Middle East. UAE's program is supported by the country's sovereign wealth, enabling it to purchase an initial group of reactors and engage the services of the world's leading consultants and personnel.

16. Carvalho, S. (2017, September 25). UAE's first nuclear reactor to operate in 2018: minister. Reuters. Retrieved November 22, 2022, from https://www.reuters.com/article/us-emirates-nuclear-idUSKCN1C0126.

The UAE has shown an awareness for the need of a systematic approach to building indigenous technical capacity for its program. The UAE's development of a regulatory and operational framework for its nuclear program is progressing well in human resource development. The UAE's timetable for implementing its program is ambitious and unprecedented.

NUCLEAR POWER STATUS IN THE ARAB REPUBLIC OF EGYPT

While it has no operational power reactors, Egypt has a long history pursuing a nuclear energy program. Egypt is a regional leader in nuclear matters; it aspired to develop a nuclear program in the mid-1950s when President Gamal Abdel Nasser created the Egyptian Atomic Energy Authority (**EAEA**) as the leading regional institution in promoting the peaceful application of nuclear science and technology. Since then, the EAEA has established three scientific centres: the Nuclear Research Centre (**NRC**), the National Centre for Radiation Research and Technology (**NCRRT**), and the Hot Laboratories and Waste Management Centre (**HLWMC**).[17]

Demographic increases in Egypt —where the population exceeds 100 million— have pressured energy demand, proliferating at a rate between 4-7% per year. Egypt's primary electricity source relies on natural gas, with an annual domestic production of 59 billion cubic meters in 2020. The country's share of the world's proven oil reserves is only 0.2%, and natural gas is 0.9%.[18] Despite these limited reserves, Egypt is Africa's largest non-OPEC oil producer and the third-largest natural gas producer, following Algeria and Nigeria. However, Egypt is Africa's largest oil and natural gas consumer, accounting for about 22% of petroleum and other liquids and 37% of natural gas consumption. An examination of Egypt's energy outlook suggests that the country's growing demand and declining production are the main economic-related drivers for diversifying the energy mix and acquiring nuclear power.

The Egyptian strategy includes the diversification of the energy mix, higher energy efficiency, reform of the electricity and the oil and natural gas markets, and reduction of energy subsidies. It is based on meeting the ever-increasing demand for electricity with a high degree of reliability and sustainability. The Egyptian strategy further aims to reduce the consumption of fossil fuels, therefore reducing the production of greenhouse gases while increasing the share of renewable energy sources and giving a new impetus to start its nuclear energy program, which was suspended in the 1980s.

17. About Us," Egyptian Atomic Energy Authority, accessed March 28, 2019.
18. "BP Statistical Review of World Energy," British Petroleum, June 2018.

President Abdel Fatah Al-Sisi signed a contract with the federal atomic energy agency (**Rosatom**) in 2015 for a power plant comprising four reactors, each with a capacity of 1,200 megawatts. The Russian firm will also ensure its operation for 60 years and provide fuel. As for the spent nuclear fuel, it is to be sent back to Russia to be processed. The agreement also includes the definition of safety norms, the provision of expertise, and the construction of factories to manufacture spare parts for the nuclear power plant. The project's cost is estimated at $32 billion, most of which is financed by Russia via a $25 billion loan, repayable over 25 years, starting in 2029.

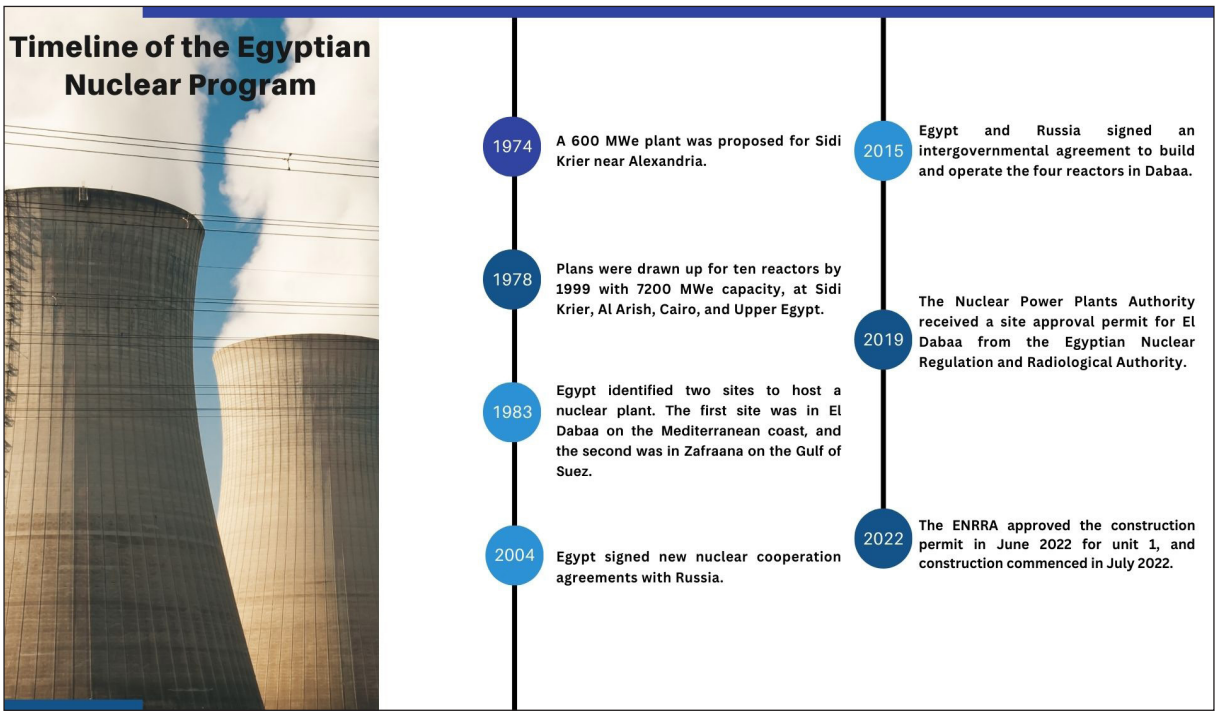
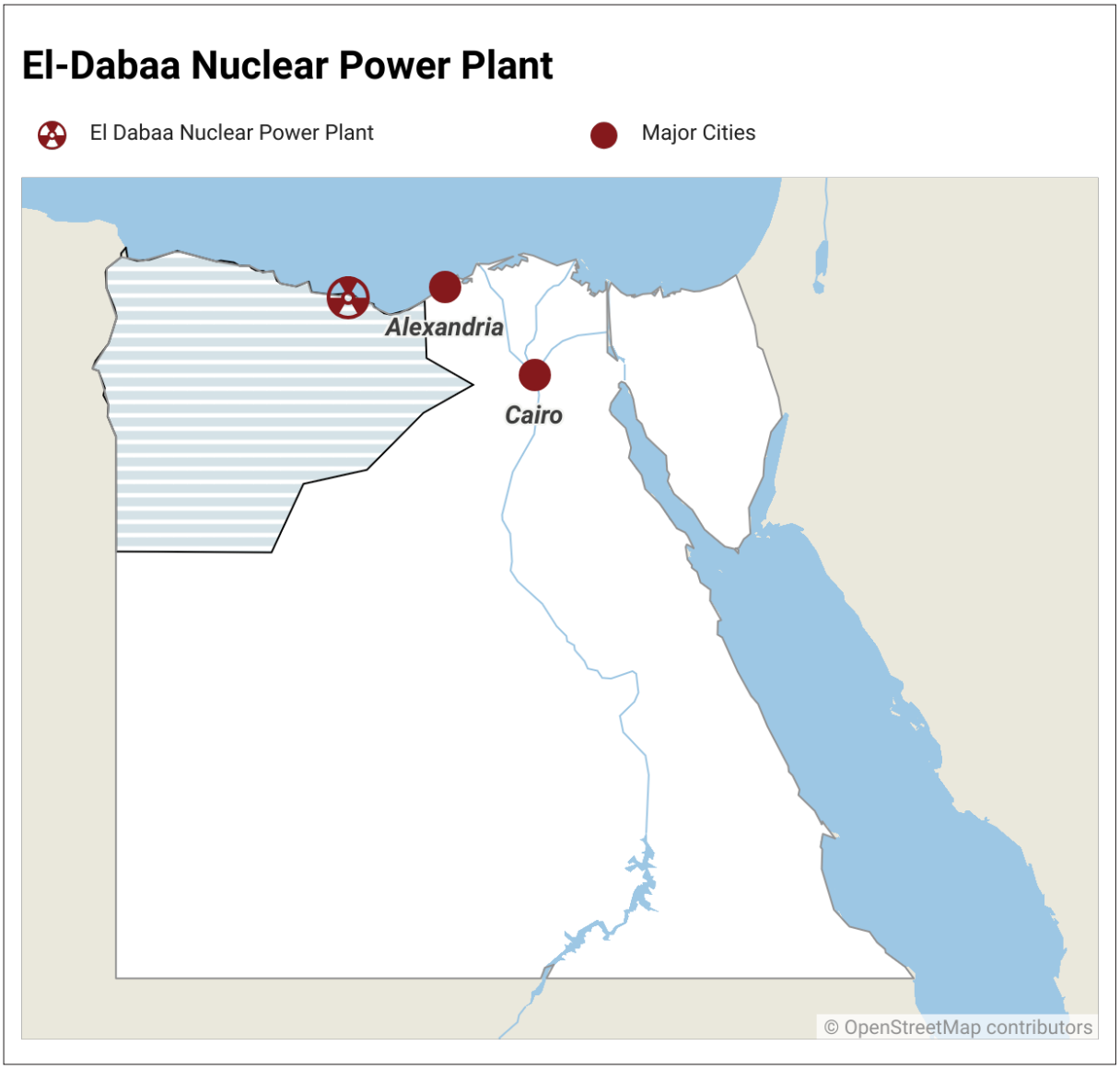


Table (2) Nuclear Power Reactors in Egypt

Reactor Name	Model/Reactor Type	MWe	Construction Start
El Dabaa 1	VVER-1200/ V-529	1200	2022
El Dabaa 2			2022
El Dabaa 3			2023
El Dabaa 4			2023

Source: Egypt - Country Nuclear Power Profiles 2022 Edition. IAEA. (n.d.). Retrieved November 23, 2022, from https://cnpp.iaea.org/countryprofiles/Egypt/Egypt.htm

Egypt signed a deal with Rosatom to build four reactors in El Dabaa, each with a capacity of 1,200 MW, over the next twelve years.[19]



Source: Nuclear Power Plants Authority, Available on: https://nppa.gov.eg/Default#gsc.tab=0

19. Nuclear street - nuclear power plant news, jobs, and Careers. Rosatom Signs Deals to Build First Nuclear Power Plant in Egypt - News - Nuclear Power News - Nuclear Street - Nuclear Power Plant News, Jobs, and Careers. (n.d.). Retrieved November 16, 2022, from http://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2015/11/23/rosatom-signs-deals-to-build-first-nuclear-power-plant-in-egypt-112301#.Y3S-R8dBxD-

INSTITUTIONS AND LEGAL FRAMEWORK

The principal entity for nuclear research has historically been the AEA. On March 29, 2010, Law No. 7 of 2010, The Law on Regulating Nuclear and Radiation Activities (LRNRA), was ratified by then-President Hosni Mubarak after having been approved by Parliament. The law established the Nuclear and Radiation Control Authority (NRCA), a legally independent institution. Under the law, all AEA's functions and employees will be transferred to the NRCA.[20]

INTERNATIONAL AGREEMENTS

Multilateral Commitments and Agreements Egypt has entered into several multilateral agreements, including:

- UN Treaty on the Non-proliferation of Nuclear Weapons (1981).
- IAEA Comprehensive Safeguards Agreement (1982).
- UN Convention on the Suppression of Acts of Nuclear Terrorism (2005), signed, not in force.
- IAEA Convention on Early Notification of a Nuclear Accident (1988).
- IAEA Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1988).
- IAEA Convention on Nuclear Safety (1994), signed, not in force.

Despite Egypt being a signatory of multiple major international agreements, there remain several international agreements that Egypt still needs to sign that are important for an internationally supported nuclear energy program. For instance, Egypt has yet to sign the Additional Protocol to the Comprehensive Safeguards Agreement, the Convention on the Physical Protection of Nuclear Material, the Joint Convention on the Safety of Spent Fuel Management, and the Convention on Supplementary Compensation for Nuclear Damage.[21]

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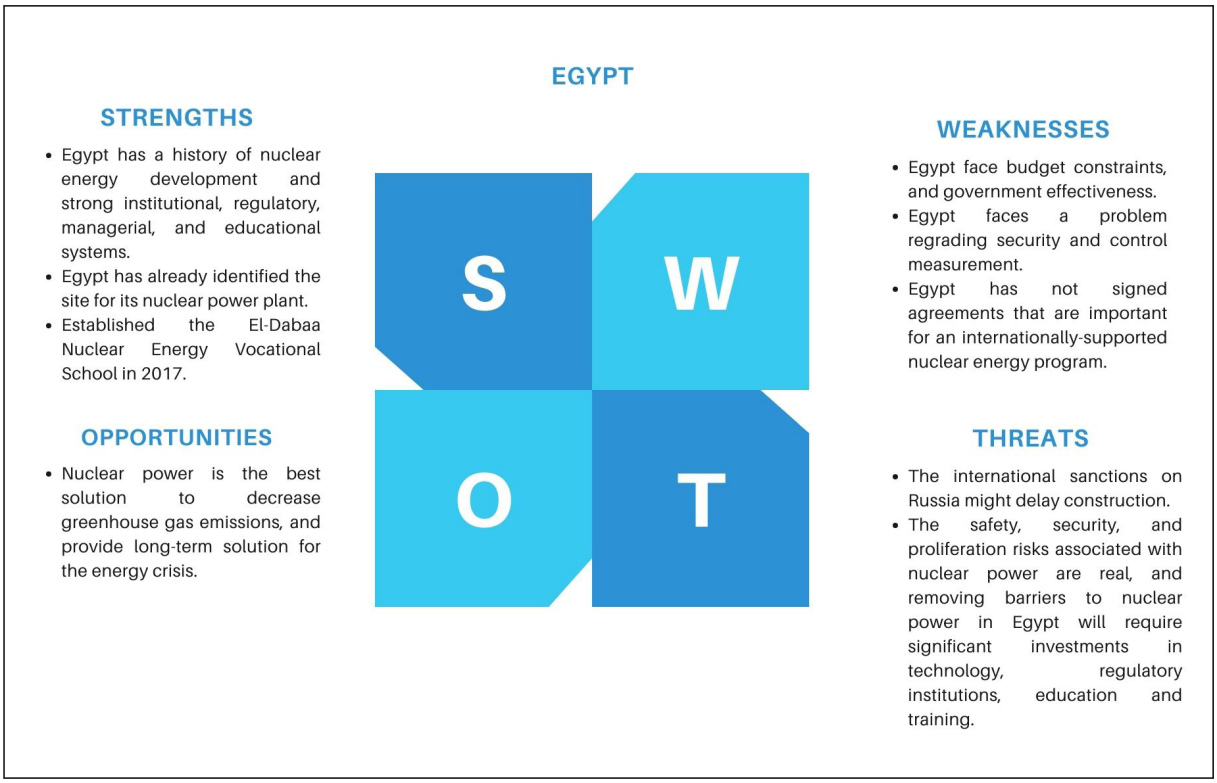
20. Act no. 7 of 2010 on the regulations of nuclear and radioactive activities. The gateway to environmental law. (1970, January 1). Retrieved November 23, 2022, from https://www.ecolex.org/details/legislation/act-no-7-of-2010-on-the-regulations-of-nuclear-and-radioactive-activities-lex-faoc121760/

21. Ebinger, C., Banks, J., Massy, K., & Avasarala, G. (2011). Models for aspirant civil nuclear energy nations in the Middle East. Policy Brief, Brookings Energy Security Initiative.

BILATERAL AGREEMENTS

Egypt has a long and active history of bilateral cooperation in the nuclear energy sphere, dating back to 1961 when Egypt signed a cooperation agreement with the Norwegian Atomic Energy Institute. Egypt also has bilateral agreements in place with India (1962), France (1981), the United States (1981), Germany (1982), Canada (1982), South Korea (1986), Australia (1988), China (2002), and Russia (2008).[22]

SWOT ANALYSIS FOR EGYPTIAN NUCLEAR ENERGY



22. Egypt - Country Nuclear Power Profiles 2022 Edition. IAEA. (n.d.). Retrieved November 23, 2022, from https://cnpp.iaea.org/countryprofiles/Egypt/Egypt.htm

SUMMARY

Egypt's growing reliance on imported energy sources, coupled with its increasing electricity demand from population growth, urbanization, and industrialization, is driving its pursuit of nuclear power. Egypt's legal framework has been revised to accommodate the most recent push toward nuclear power development. Its long-awaited nuclear law, produced with input from the IAEA and others in the international community, was passed in early 2010 and addressed all aspects of plant licensing, safety and security, civil liability, spent fuel management, and the creation of a new regulatory body.

NUCLEAR POWER STATUS IN THE KINGDOM OF SAUDI ARABIA

The KSA's interest in nuclear energy increased as oil prices were low and decreased as prices rose. Saudi Arabia will follow an ambitious nuclear energy plan involving sixteen nuclear reactors to be built by 2030 with a total capacity of more than 17 GWe (expected to meet 15% of the country's electricity needs).[23] Saudi Arabia's population has grown from 4 million in 1960 to over 34 million in 2020, it consumes over 25% of its oil production, and while energy demand is projected to increase substantially, oil production is not. Generating capacity was 83.0 GWe in 2021, up from 25.8 GWe in 2000. Since 1978, the KSA has conducted several feasibility studies on utilizing nuclear power to desalinate seawater. The Saudis are world leaders in seawater desalination, but all facilities are powered by petroleum and gas-generated electricity. Saudi Arabia's only known previous involvement in nuclear applications is limited to experiments to produce radioisotopes using a Standerton accelerator and a cyclotron.[24]

The shift to clean and renewable energy forms part of Saudi Arabia's Vision 2030, which calls for economic diversification before it's oil and natural gas supply runs out. The kingdom expects to get 40 gigawatts of electricity from solar capacity.[25]

The Saudi civil nuclear strategy emphasizes the development of its human capital. For example, Areva Saudi Arabia and Electricité de France have agreed to train workers. However, Saudi Arabia differs from others because it intends to develop an indigenous supply chain and build new industries to compete with Iranian enrichment activities.[26]

Through the King Abdullah City for Atomic and Renewable Energy (KA-CARE), Saudi Arabia looks set to develop nuclear cooperation with third parties such as Hungary and Kazakhstan focused on fuel supply.[27] That is because small modular reactors can desalinate water and generate electricity, address both needs simultaneously, require

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23. مدينة الملك عبد الله للطاقة الذرية والمتجددة. (n.d.). Retrieved November 16, 2022, from https://www.kacare.gov.sa/ar/pages/default.aspx

24. Dan Drollette Jr., "View from the Inside: Prince Turki al-Faisal on Saudi Arabia, Nuclear Energy and Weapons, and Middle East Politics," Bulletin of the Atomic Scientists 72, no. 1 (January 2, 2016): 19.

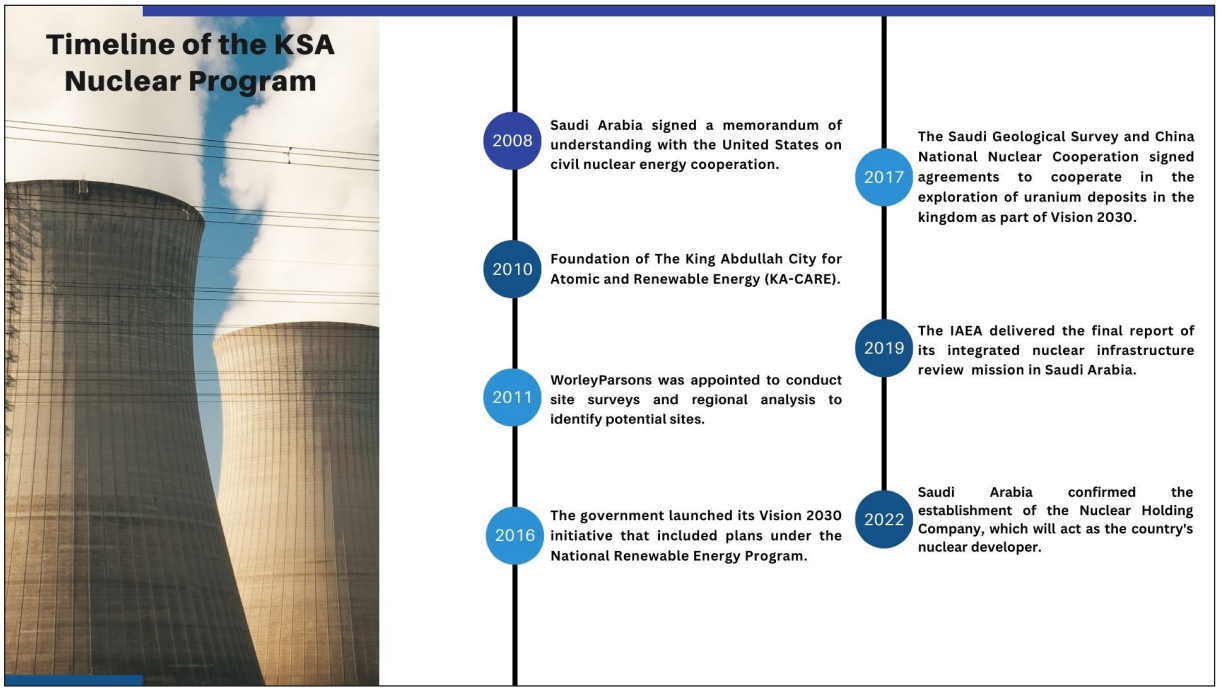
25. Ibid.

26. Nuclear Power in Saudi Arabia," World Nuclear Association, accessed May 2018.

27. Ibid.

a lower capital commitment, and serve both urban and remote areas.[28]

Saudi Arabia has had a safeguard agreement with the IAEA since 2009 but departs from the UAE's best practice by not having signed an Additional Protocol yet.[29]



INTERNATIONAL AGREEMENTS

Multilateral Commitments and Memberships Saudi Arabia has entered into several international agreements, including:

- UN Treaty on the Non-proliferation of Nuclear Weapons (1988)
- IAEA Comprehensive Safeguards Agreement (2009)
- IAEA Convention on Physical Protection of Nuclear Material (2009)
- UN Convention on the Suppression of Acts of Nuclear Terrorism (2007)[30]

28. Nabegh Al Sabbagh, "The Case for Developing Nuclear Energy in the Middle East," Atlantic Council, April 6, 2016.

29. Mark Hibbs, "Safeguards for Saudi Arabia," Carnegie Endowment for International Peace, November 27, 2018.

30. Saudi Arabia signed the Convention on the Suppression of Acts of Nuclear Terrorism, but also declared to the United Nations that it does not consider itself bound by Article 23, Paragraph 1 of the Convention.

- IAEA Convention on Early Notification of a Nuclear Accident (1987)
- IAEA Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1989)
- IAEA Convention on Nuclear Safety (2010)

BILATERAL AGREEMENTS

- Saudi Arabia has signed additional agreements to enhance its capacities: A nuclear cooperation agreement with France in early 2011 seemed likely to advance French interests in the KSA. In June 2015, France signed an agreement to undertake a feasibility study for building two EPR nuclear power reactors. Additional contracts were signed on nuclear safety training and waste disposal.

- A mid-2011 nuclear cooperation agreement with Argentina was related to smaller plants for desalination and the subsequent Invania joint venture.

- A November 2011 agreement with South Korea called for cooperation in nuclear R&D, including building NPPs and research reactors and training, safety, and waste management. In June 2013, KEPCO offered support for the localization of nuclear technology, along with joint research and development of atomic technologies if Saudi Arabia purchases South Korean reactors. In September 2015, further contracts were signed, which aim at building a partnership to establish knowledge infrastructure in SMART technology fields.

- January 2012 agreement with China relates to nuclear plant development and maintenance, research reactors, and the provision of fabricated nuclear fuel. A further agreement with CNNC was signed in August 2014, and in August 2016, KA-CARE signed a contract with CNNC for human resource development.[31]

- A June 2015 agreement with Rosatom provided for cooperation in the field of nuclear energy, including the design, construction, operation, and decommissioning of nuclear power and research reactors, including desalination plants and particle

31. Shalash, M. (2022, April 20). Nuclear power in the Middle East between energy needs and military temptation. Orient XXI. Retrieved November 20, 2022, from https://orientxxi.info/magazine/nuclear-power-in-the-middle-east-between-energy-needs-and-military-temptation,5542

accelerators; the provision of nuclear fuel cycle services, including NPPs and research reactors; the management of used nuclear fuel and radioactive waste management; the production of radioisotopes and their application in industry, medicine, and agriculture; and the education and training of specialists in the field of nuclear energy.

- In October 2015, KA-CARE signed a nuclear cooperation agreement with Hungary. In October 2016, it signed a nuclear cooperation agreement with Kazakhstan, focused on fuel supply.
- In March 2017, an agreement between KA-CARE and Jordan Atomic Energy Commission (**JAEC**) was signed for a feasibility study on the construction of two small modular reactors (**SMRs**) in Jordan for the production of electricity and desalinated water.
- KA-CARE said it was negotiating with the Czech Republic, the UK, and the USA regarding "**further cooperation**." A complete nuclear cooperation agreement with the USA is vital to proceeding with Saudi NPPs.

R&D IN THE FIELD OF NUCLEAR POWER

A 30 kWt low-power research reactor is under construction at King Abdul-Aziz City for Science & Technology (**KACST**) in Riyadh by Argentina's INVAP. The project was officially launched in November 2018, and the structure is reportedly well underway.[32]

INSTITUTIONS AND LEGAL FRAMEWORK

Royal Decree A/35 established KA-CARE in April 2010. Under the oversight of a 15-member Supreme Council, KA-CARE will most likely operate as a stand-alone, vertically integrated institution.[33]

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32. World Nuclear Association. (n.d.). Nuclear Power in Saudi Arabia. Retrieved November 16, 2022, from https://world-nuclear.org/information-library/country-profiles/countries-o-s/saudi-arabia.aspx

33. الأمر الملكي التأسيسي لمدينة الملك عبد الله للطاقة الذرية والمتجددة، متاح على الرابط الاتي: https://www.energy.gov.sa/ar/about/Pages/royalorder.aspx

The main objective behind the establishment of the city is to be the site of the first NPPs in the KSA. However, opinions differed as to whether Riyadh is the best location for such stops. Opponents of NPPs in Riyadh argue that they are best located near coastal areas, and the Fukushima disaster also highlighted the dangers of building reactors near densely populated areas. Several reports have recommended three cities that are technically suitable to host a nuclear power plant.[34]

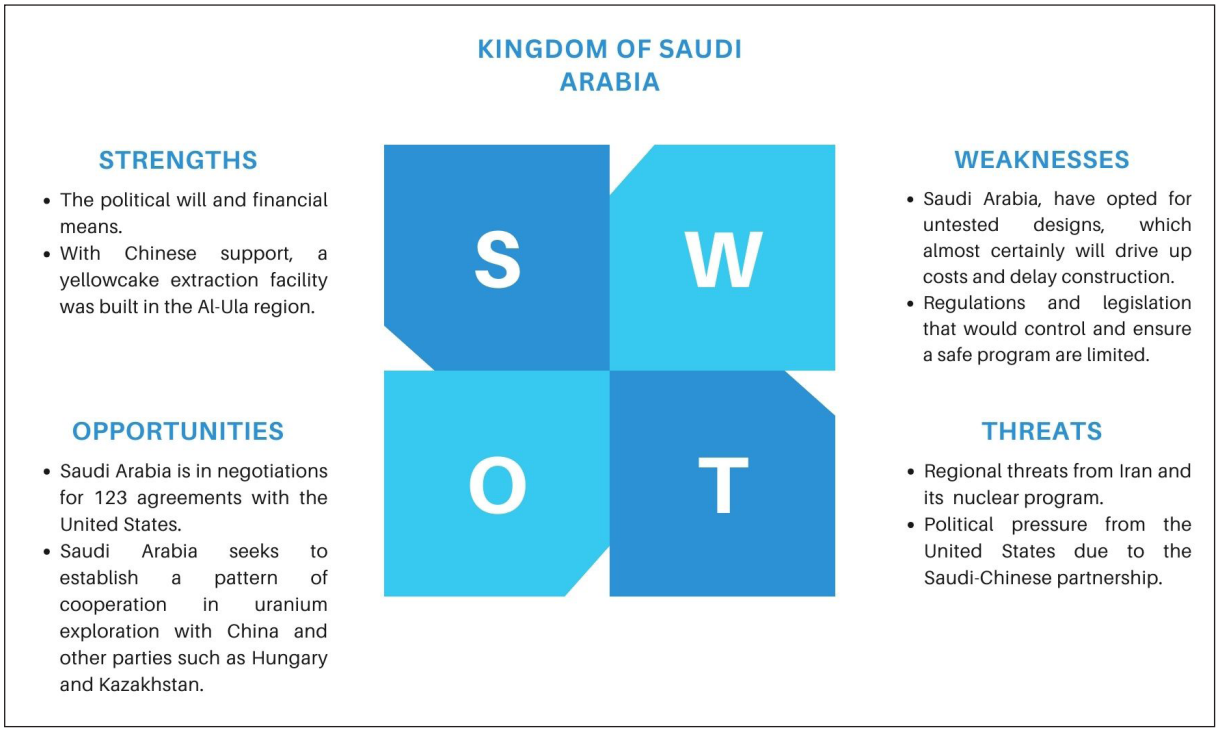
Suggested Sites for Saudi Nuclear Power Plants

Illustrative map

Source: Ebinger, C., Banks, J., Massy, K., & Avasarala, G. (2011). Models for aspirant civil nuclear energy nations in the Middle East. Policy Brief, Brookings Energy Security Initiative.

34. Charles Ebinger et al., "Civil Nuclear Power in Saudi Arabia", in Models for Aspirant Civil Nuclear Energy Nations in the Middle East, Brookings Policy Brief 11 (September 2011).

SWOT ANALYSIS OF SAUDI NUCLEAR ENERGY



SUMMARY

Saudi Arabia has shown an increasingly proactive interest for nuclear power in recent years; however, it has opted for untested designs, which will drive up costs and delay construction. Population and economic growth have increased electricity demand, which is projected to nearly double over the next two decades. Since 2006, when the GCC overtly declared interest in nuclear energy, Saudi Arabia has made gradual progress toward a domestic nuclear program. Establishing KA-CARE as a well-funded, centralized entity is a significant step. There is still much to do before Saudi Arabia can be considered to have launched a formal nuclear power program, the government has yet to announce a long-term strategy for developing its public nuclear sector.

NUCLEAR POWER STATUS IN THE HASHEMITE KINGDOM OF JORDAN

Jordan is confronted with severe challenges in its energy sector. Rising energy demand and a lack of domestic resources hinder economic development and growth, saddling the country with high energy costs. Water scarcity is also a significant factor in Jordan's energy future. Water access is incredibly scarce in the summer, with supplies sometimes available only one day per week, according to the Water Authority of Jordan.[35] Given its worsening energy security situation, Jordan is seriously considering nuclear power. It has an advanced program with committed plans and is developing a legal and regulatory infrastructure to support it.

Jordan is seriously interested in nuclear power and has signed several nuclear cooperation agreements with potential suppliers. It is also investing in uranium exploration and its extraction from phosphates. Jordan imports over 95% of its energy need at the cost of about one-fifth of its GDP. It has about 5200 MWe of generating capacity, and electricity consumption grow at about 3% yearly. Jordan has regional grid connections of 500 MWe with Egypt and 300 MWe with Syria, and it is increasing links with Israel and Palestine. Also, it has a "water deficit" of about 600 million cubic meters per year. Jordan's 2007 national energy strategy envisaged 29% of primary energy from natural gas, 14% from oil, 10% from renewables, and 6% from nuclear by 2020.[36]

In 2015 Jordan signed a deal with Russia's state nuclear corporation (Rosatom) to build Jordan's two NPPs in Amra, with a capacity of 2,000 megawatts worth $10 billion.[37] However, in 2017, Jordan announced that it had cancelled the agreement. It was deemed too costly due to Rosatom wanting to secure finance through commercial loans, the two units would have provided about half of Jordan's electricity and enabled exports to Syria and Iraq.[38]

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35. "Private Sector Participation," Water Authority of Jordan, Hashemite Kingdom of Jordan (http://www.waj.gov.jo/sites/en-us/SitePages/About%20WAJ/Privatization.aspx).

36. World Nuclear Association. (n.d.). Nuclear Power in Jordan. Retrieved November 16, 2022, from https://world-nuclear.org/information-library/country-profiles/countries-g-n/jordan.aspx

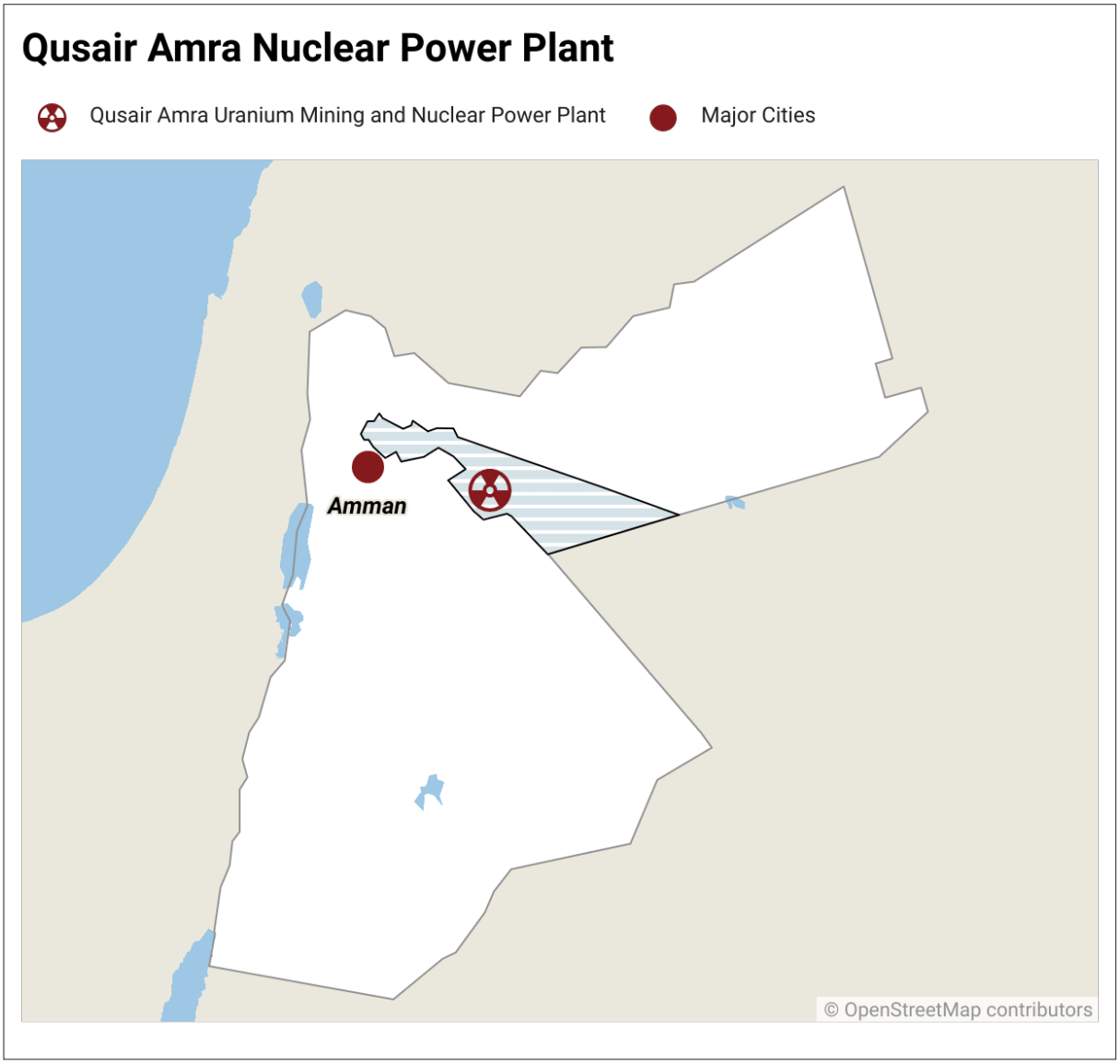
37. Al-Khalidi, S. (2015, March 24). Jordan signs $10 billion nuclear power plant deal with Russia. Reuters. Retrieved November 16, 2022, from https://www.reuters.com/article/us-jordan-nuclear-russia-idUSKBN0MK2QD20150324

38. Nuclear Power in Jordan. World Nuclear Association. (n.d.). Retrieved November 16, 2022, from https://world-nuclear.org/information-library/country-profiles/countries-g-n/jordan.aspx

Table (3) Nuclear Power Reactors in Jordan

Reactor Name	Model/Reactor Type	MWe	Construction Start
Qasr Amra1	VVR-1000/V-392	1060	Cancelled
Qasr Amra2			

Source: Nuclear Power in Jordan. World Nuclear Association. (n.d.). Retrieved November 16, 2022, from https://world-nuclear.org/information-library/country-profiles/countries-g-n/jordan.aspx



Source: Jordan Atomic Energy Commission

INSTITUTIONS AND LEGAL FRAMEWORK

The Jordan Atomic Energy Commission (**JAEC**) was established in July 2007; JAEC is responsible for overall nuclear policy and strategy and for managing the development and implementation of the civil nuclear power program. JAEC aims to transfer peaceful uses of nuclear energy and radiation technology to Jordan and develop its use in electricity generation, water desalination, and other nuclear fields and applications. To achieve these goals, the JAEC's strategy includes establishing nuclear reactors and exploiting Jordanian uranium to provide alternative energy and water sources.

The Jordan Nuclear Regulatory Commission (**JNRC**) is the independent government body responsible for regulating all nuclear activity and facilities in Jordan. As stated in JNRC's Strategic Plan 2010-2014, its primary goal is "to regulate the safe use of nuclear materials and technologies and radioactive sources and nuclear installations (in the future) for peaceful purposes to ensure the protection of public health and safety, workers and the environment." JNRC's principal responsibilities are licensing facilities, preparing the legislative framework, and establishing a system for inventory and accounting for nuclear materials.[39]

R&D IN THE FIELD OF NUCLEAR ENERGY

In 2010, JAEC contracted with South Korea to design and implement the Jordanian nuclear reactor for research and training with a capacity of 5 MWe and the capability of increasing its capacity to 10 megawatts. The contract included the reactor facility and the service building that contained hot cell units to produce radioactive isotopes and pharmaceuticals for medical uses. This project and its activities were completed and put into service for various nuclear research applications and were inaugurated in December 2016.[40]

In May 2017, the new synchrotron light for Experimental Science and Applications in the Middle East was commissioned at Allan. This is the first synchrotron in the Middle East and was used for advanced research projects by scientists from across the region**.** It is closely linked to the European Organization for Nuclear Research (**CERN**) and uses some components from Germany's decommissioned BESSY II synchrotron. It was developed under the auspices of UNESCO with support from the IAEA.[41]

Jordan announced that its extraction plant had produced 20 kilos of yellowcake from 160 tons of uranium ore. Jordan discovered that it had large uranium reserves and a deposit about 80 km south of Amman, containing around 42,000 metric tons of uranium oxide.[42]

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39. According to Jordan Nuclear Regulatory Commission's Strategic Plan.

40. البرنامج النووي الأردني. هيئة الطاقة الذرية الاردنية. (n.d.). Retrieved November 20, 2022, from https://jaec.gov.jo

41. What is sesame? SESAME. (n.d.). Retrieved November 20, 2022, from https://www.sesame.org.jo/about-us/what-is-sesame

42. Omari, R. (Ed.). (2022, May 14). Jordan announces uranium production. Arab News. Retrieved November 20, 2022, from https://www.arabnews.com/node/2082031/amp

INTERNATIONAL AGREEMENTS

Jordan is a signatory to numerous international treaties and bilateral agreements:

- UN Treaty on the Non-proliferation of Nuclear Weapons (1970)
- IAEA Convention on the Physical Protection of Nuclear Material (2009, Amendment accepted 2009)
- IAEA Convention on Early Notification of a Nuclear Accident (1988)
- IAEA Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1998).
- IAEA Convention on Nuclear Safety (2009)
- IAEA Application of Safeguards in Connection with the Treaty on the Non-proliferation of nuclear weapons (with protocol) (1978)
- IAEA Additional Protocol to the Agreement between the Hashemite Kingdom of Jordan and the IAEA for the Application (1998)

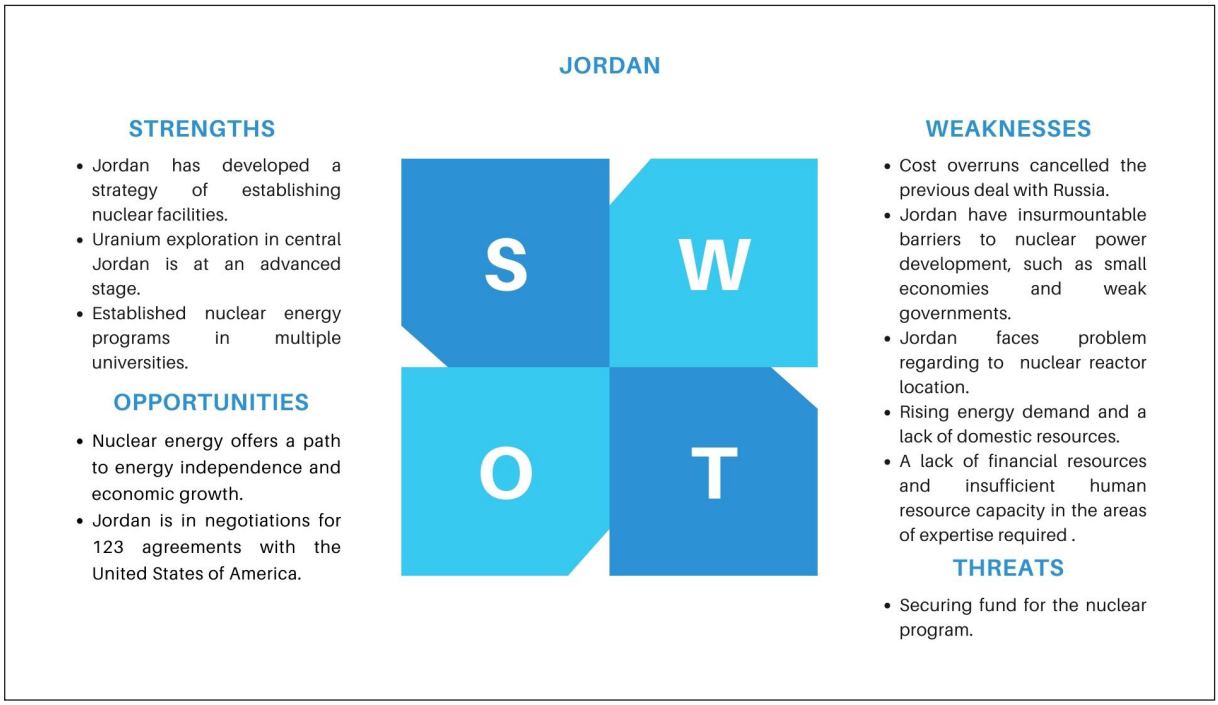
BILATERAL AGREEMENTS

As part of securing external assistance for the development of its civil nuclear energy program, Jordan has entered into a variety of bilateral nuclear cooperation agreements with many countries: France (2008), China (2008), South Korea (2008), Canada (2009), Russia (2009), United Kingdom (2009), Argentina (2009), Japan (2010), Romania (2011), Spain (2011), and Turkey (2011).[43]

Jordan does not have a formal nuclear cooperation agreement with the United States to sign Agreement 123. It has ongoing negotiations with the United States, Italy, and the Czech Republic.

43. Jordon Overview 2018. (n.d.). https://www-pub.iaea.org/MTCD/Publications/PDF/cnpp2018/countryprofiles/Jordan/Jordan.htm

SWOT ANALYSIS FOR JORDANIAN NUCLEAR ENERGY



SUMMARY

Jordan also has nuclear ambitions and has declared its intention to get 30% of its electricity from nuclear sources and to become a net electricity exporter by 2030.[44] Jordan, too, faces similar difficulties. Its prospective nuclear reactor location, Qasr Amra, is a UNESCO World Heritage site and home to the powerful Beni Sakher tribe, who oppose the project.[45] Additionally, the nearest water source is seventy kilometres away.

The central factor in Jordan's decision to consider nuclear energy is its unsustainable domestic energy situation, especially in the power sector. Jordan imports more than

44. Ramana, M. V., & Ahmad, A. (2016). Wishful thinking and real problems: Small modular reactors, planning constraints, and nuclear power in Jordan. Energy Policy, 93, 236-245.

45. Abuqudairi, A. (2014, April 14). Jordan Nuclear Battle Heats up. News | Al Jazeera. Retrieved November 22, 2022, from https://www.aljazeera.com/news/2014/4/14/jordan-nuclear-battle-heats-up

95% of its energy needs at a cost of about one-fifth of its GDP.[46] Nuclear energy offers a path to energy independence and economic growth.

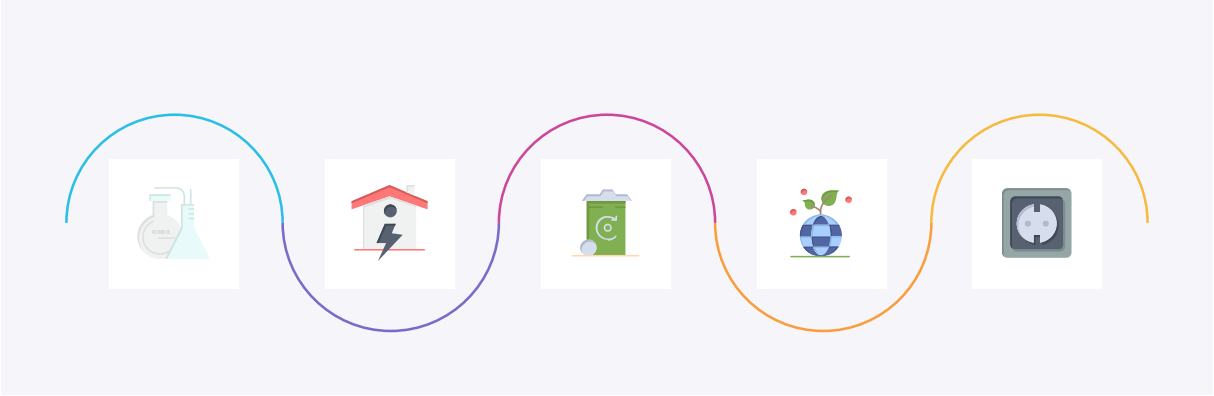
Jordan has worked closely with the IAEA, seeking technical assistance for a nuclear energy program, and has followed IAEA's recommended framework and guidelines for establishing nuclear infrastructure. Jordan has also worked to meet the King's pledge to pursue a peaceful program by international norms; Amman has signed the NPT, an Additional Protocol, and other numerous international treaties and IAEA agreements. However, development in Jordan faces two major challenges. The first is the lack of financial resources, while the second lies in the lack of capabilities and human resources in the required areas of expertise, as well as the difficulty of seeking foreign expertise due to weak financial capabilities. In general, Jordan will need to continue developing its long-term strategy regarding related to the nuclear fuel cycle and waste management.[47]

46. WorleyParsons. (2011, September). White paper on nuclear energy in Jordan. Jordan Atomic Energy Commission. Retrieved November 22, 2022, from https://www.laka.org/docu/catalogue/publication/5.05.0.00/01_white-paper-on-nuclear-energy-in-jordan-final-rep

47. Ebinger, C., Banks, J., Massy, K., & Avasarala, G. (2011). Models for aspirant civil nuclear energy nations in the Middle East. Policy Brief, Brookings Energy Security Initiative.

THE INCENTIVES AND INTERESTS OF THE MEMBERS

ENERGY SECURITY AND REGIONAL STABILITY



Countries in the Arab region are all facing challenges to the sustainability of their energy systems especially with rising levels of extreme heat and water shortages, alongside high rates of population growth and rapid industrial development.[48] Jordan, for example, is one of the world's 10 driest territories so the need to find alternative solutions for the potential water shortages it will face is increasingly urgent.[49] Egypt also has an urgent need for energy diversification which became increasingly pressing around 2013-2014 when the country experienced more frequent electricity blackouts, many of which became a source of public discontent.[50] While many countries in the region have already begun investing in the expansion of nuclear energy as part of their efforts to diversify energy sources, the levels of development vary and the economic and political challenges to the full realization of these projects also differ between countries. The potential regional conflicts that may arise because of a collective energy crisis or even independent crises in some of the countries provides some justification for an integrated regional collaboration focusing on nuclear energy development.

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48. International Atomic Agency. (2022). (tech.). Climate Change and Nuclear Power: Securing Clean Energy for Climate Resilience. IAEA. Retrieved from https://www.iaea.org/sites/default/files/iaea-ccnp2022-body-web.pdf

49. https://www.wise-uranium.org/upjo.html

50. M.Hickey, Samuel, Salaheddin Malkawi, and Ayman Khalil. 2021. "Nuclear power in the Middle East: Financing and geopolitics in the state nuclear power programs of Turkey, Egypt, Jordan and the United Arab Emirates." Energy Research & Social Science. doi:https://doi.org/10.1016/j.erss.2021.101961.

However, this type of collective action often requires a high level of coordination, trust, and potential surrender of certain elements of sovereignty which demands a strong foundation of mutual interests and objectives. Whether the regional nuclear cooperation is to be achieved through a series of cooperative agreements, a form of nuclear energy community with agreed guiding principles and rules, or through the formation of a regional organization that becomes responsible for the collective management of nuclear energy development in the region, having shared perceptions is a prerequisite for all the above. Although the type of cooperation in question is not primarily a security cooperation, the objectives of sustainability and energy self-sufficiency cannot be fully divorced from security as well as political objectives.[51]

Therefore, it is imperative that countries agree on what they expect from the cooperation, what constitutes a violation of the community, what constitutes an emergency and what measures should be taken, if any, collectively to maintain the agreed upon order or to support a member/partner in fulfilling their role. This can provide the indirect benefit of a certain level of political cooperation, revolving around the mutual interest of energy security, which is something that many Arab leaders have attempted to do in the past. Managing this could, in both the short run and long run, give Arab countries political leverage and a collective bargaining power.

NUCLEAR FINANCING

One of the most important factors that governments consider before investing in the development of a nuclear power plant (NPP) is the cost. Nuclear power projects have a very high capital cost in addition to long construction periods and long periods of return on investment compared to other energy sources. Excluding owner and regulatory costs, the engineering, procurement, and construction costs of one new large capacity nuclear power unit could exceed several billion dollars. Although fuel costs for NPPs are relatively low and their cost of production is more predictable than that of gas and coal, the initial capital investment could be risky for some countries especially if they plan to depend solely on return of investment (which can take up to 10-20 years of

51. Ragab, Eman. 2020. An Alternative Approach to Regional Security in the Middle East. https://www.thecairoreview.com/essays/an-alternative-approach-to-regional-security-in-the-middle-east/.

operation) to pay back capital plus interest.[52] This was the main obstacle to Jordan's plans to build a nuclear power plant as their disagreements with Rosatom about how the project should be financed reached a standstill that ended with a decision to put the project on hold as they explore the feasibility of building a small reactor.[53] It could also be an obstacle to other Arab countries aiming to build additional reactors or maintain existing ones.

There are various risks involved in building new power plants. These include factors which may delay the construction of the plant or increase its capital cost before operation starts as well as factors which could affect the plant during operation, which therefore affects its capacity to earn a return on investment. Most NPPs are funded through a mixture of debt and equity financing, with equity investments typically being more expensive than debt financing. Indeed, Egypt, Saudi Arabia and the UAE are using loans to finance the bulk of their NPP costs. However, as building can take up to 5 years and debt repayment occurs over a span of 15-20 years, there are continuous financial risks involved in the investment. These risks include changes in interest rates and tasks which may lead to difficulties in refinancing loans on favorable terms. There are also risks associated with foreign exchange as well as the costs and availability of nuclear liability. These risks can be mitigated with financial instruments as well as through establishing a legal framework for liability.

ENRICHING LOCAL TECHNICAL EXPERTISE

Another key factor determining the successful deployment and operation of a nuclear power project is the availability of technical and human resources to support conception, construction, operation and potentially decommissioning. This requires strong national commitment to education and training most likely in combination with technology transfer such as the example of Egypt with Russia and the UAE and Saudi Arabia with South Korea. In general, the most common approach to new nuclear construction is usually through the adoption of third generation reactor designs as these have been proven effective and come with a higher measure of cost predictability.

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52. International Atomic Agency. (2009). (tech.). Issues to Improve the Prospects of Financing Nuclear Power Plants. IAEA. Retrieved from https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1408_web.pdf.

53. Clercq, G. D. (2018, July 11). Rosatom looks to nuclear newcomers to cement dominance; in talks with Jordan. ZAWYA. Retrieved November 9, 2022, from https://www.zawya.com/en/business/rosatom-looks-to-nuclear-newcomers-to-cement-dominance-in-talks-with-jordan-vxvkfnc8

Even then, to improve the transportability of designs across borders requires a degree of knowledge sharing regarding safety approaches, codes, and standards. Therefore, a certain level of cooperation is necessary for the effectiveness of any nuclear program, not only with regards to sharing technology and know-how but also with regards to nuclear supplies.[54] This is precisely the role of formations such as the Nuclear Suppliers Group, a voluntary multilateral regime composed of states with the capacity to produce nuclear technologies, which aims to ensure that the technology transfers and exports of its members do not contribute to the spread of nuclear weapons.[55]

However, the expertise needed to develop NPPs and ensure compliance with international standards often leads nuclear newcomers to depend on foreign expertise, which may not be the most sustainable approach in the long run. It also requires a significant amount of diplomacy before any level of cooperation takes place due to the sensitive nature of the technologies being shared. The UAE for example faced numerous challenges to obtaining foreign nuclear assistance due to it being perceived as a major proliferation threat because of its close trading ties with Iran as well as its weak export control system. Through extensive consultation and negotiation with supplier states, as well as domestic political lobbying and the decision to forsake a full nuclear cycle, the UAE was able to emerge with a significant number of nuclear cooperation agreements in just two years.[56]

The UAE's strategy is, arguably, replicable by other Arab states but it also points to the potential benefits of Arab nuclear cooperation with regards to negotiation and bargaining power as well as improving public image. More importantly, the fact that dependence on foreign assistance for nuclear technology can pose a challenge to nuclear development is perhaps an opportunity to consider the benefits of greater nuclear cooperation in this area. This cooperation, which is also known as technological synergy, could entail a wide range of agreements or mechanisms that allow Arab countries to share technology and expertise in a way that creates synergy between their technologies and creates complementarity between fuel cycles or different reactors on a technical level.[57]

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54. International Atomic Agency. (2009). (tech.). Issues to Improve the Prospects of Financing Nuclear Power Plants. IAEA. Retrieved from https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1408_web.pdf.

55. Early, B. R. (2010). Acquiring foreign nuclear assistance in the Middle East. The Nonproliferation Review, 17(2), 259–280. https://doi.org/10.1080/10736700.2010.485427

56. Ibid.

57. International Atomic Agency. (2018). (tech.). Enhancing Benefits of Nuclear Energy Technology Innovation through Cooperation among Countries: Final Report of the INPRO Collaborative Project SYNERGIES. IAEA. Retrieved from https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1807_web.pdf

It is also important to note that nuclear energy constitutes a country's hard power, particularly with regards to a country's scientific and technological strength in the field. At the moment, Arab countries are relatively behind in terms of local nuclear energy expertise however the UAE's expanding program and Egypt's power plant development show that there is a clear opportunity to build local capacities and nurture local human capital.[58] which has been damaged due to delays and the discontinuation of various respective nuclear programs, and provide incentives to scientists and experts who aim to pursue careers in nuclear research and engineering in order to lessen dependence on foreign expertise and overall costs. An Arab nuclear cooperation that prioritizes local technical expertise could represent collective hard power and a strong political standing.

NUCLEAR POLITICS AND DIPLOMACY

For countries located in conflict zones or unstable regions such as the Middle East, initiating and expanding nuclear development can be particularly challenging and can warrant unwanted international attention that could have negative economic and political impacts on a country. Iran is an excellent example of how a lack of international support and diplomatic ties can make the cost of nuclear development extremely high. The example also demonstrates the extent to which a domestic nuclear program can lead to foreign involvement. Through regional cooperation, Arab states could benefit from having an established framework and common regulations can give legitimacy to members' nuclear programs and make it more difficult for dominant powers, particularly the United States, to use their own standards to expand their involvement in Arab country's nuclear development under the pretenses of assuring nonproliferation.[59]

Considering that increased cooperation is likely to require a higher level of transparency, this could help promote greater acceptance and trust in the nuclear energy development of Arab countries, especially if building on the progress of countries such as the UAE

58. Sun, D, Xu, H, Tu, Y. In with the New: China's Nuclear-Energy Diplomacy in the Middle East. Middle East Policy. 2022; 29: 41– 60. https://doi.org/10.1111/mepo.12619

59. Crapo, M., Ichord, R. F., Bell, R., Gordon, J. T., & Scholl, E. (2019). WHY THE UNITED STATES MUST LEAD IN CIVILIAN NUCLEAR POWER. In US Nuclear Energy Leadership: Innovation and The Strategic Global Challenge (pp. 14–20). Atlantic Council. http://www.jstor.org/stable/resrep26783.8

with established operational frameworks. This strategy will also be especially critical if the United States begins to perceive Russia's role in nuclear plant financing (in Egypt, Jordan, and potentially other Arab countries in the future) to be a threat and leverages certain institutions, over which it has influence, to pressure Arab countries in other areas. The United States and Russia are in fact competitors in the financing and building of new nuclear plants in other countries, a crucial component of their international influence, so a dominance of Russian nuclear technology in the region could potentially strain relations between the Arab countries and the United States.

There is a lot of evidence indicating that the nuclear energy programs in the Arab countries are facing international warnings, and raises many real concerns about the ability of some Arab countries to extract uranium ore. Some experts believe that some of these concerns may be exaggerated and counterproductive to efforts to prevent the spread of nuclear weapons.[60] The Kingdom of Saudi Arabia has been working diligently and continuously to build the organizational and technical foundations necessary for the peaceful nuclear program for decades, and it has been seeking close cooperation with the International Atomic Energy Agency to ensure the achievement of this goal.[61] While the Kingdom is currently seeking out cooperation on numerous fronts to secure both technical and political support, their position in terms of international approval remains unclear. Saudi Arabia could benefit from expanding cooperation with other Arab countries particularly in regulatory frameworks and safety regulations. The same can be said for Egypt and Jordan.

CLIMATE GOALS AND THE NEW STATUS QUO

At this time, interest in and recognition of the importance of climate change issues is the highest it has ever been in the Arab region with Egypt hosting the COP27 and the UAE expected to host COP28. Most countries internationally and regionally have already set their own climate agendas, policies, and objectives. Among the countries included in this analysis, Saudi Arabia aims to source 50% of its electricity from renewable

60. Ahmad, A. (2020, October 8). Saudi Arabia's nuclear program: Separating real concerns from threat inflation. Belfer Center for Science and International Affairs. Retrieved from https://www.belfercenter.org/publication/saudi-arabias-nuclear-program-separating-real-concerns-threat-inflation

61. Gornall, J. (2022, July 31). How clean nuclear energy will put Saudi Arabia ahead of the climate-change curve. Arab News. Retrieved November 12, 2022, from https://www.arabnews.com/node/2132771/saudi-arabia

energy sources including nuclear power, wind and solar, Egypt aims for renewables to make up 42% of the energy mix by 2035, the UAE aims meet 30% of its power needs using clean energy by 2030 and Jordan aims for renewables to make up 50% of its energy mix by 2030.[62] [63] [64] [65] Since nuclear power is essentially a zero carbon emitter, it offers a double benefit of advancing energy security while also putting countries on the right path towards achieving the climate goals which are becoming an increasingly crucial component of international diplomacy. While there is already consensus that cooperation is necessary for a successful nuclear program on the economic, political and security fronts, from a global sustainability standpoint cooperation also has additional benefits with regards to resource availability and waste management. There are specific elements of nuclear energy, such as the management of radioactive waste, which can be improved through increased cooperation and knowledge sharing between countries.[66]

62. John, O. B., Horvath, M., & Gause, F. G. (2022, October 28). Strong momentum in Saudi Arabia's drive toward renewables and Infrastructure. Middle East Institute. Retrieved November 12, 2022, from https://www.mei.edu/publications/strong-momentum-saudi-arabias-drive-toward-renewables-and-infrastructure

63. Ministry of International Cooperation. (2022). Accelerating the Transition to a Green Economy. Ministry of International Cooperation. Retrieved November 12, 2022, from https://moic.gov.eg/sector/Energy/4#:~:text=increases%2C%20the%20Government%20of%20Egypt,country's%20electricity%20mix%20by%202035.

64. Global Data Energy. (2022, November 17). UAE introduces new methods of renewable energy to meet Clean Energy Target. Power Technology. Retrieved November 11, 2022, from https://www.power-technology.com/comment/uae-renewable-energy/

65. Zawya Projects. (2022, July 6). Jordan aims for 50 percent renewable energy by 2030. Zawya. Retrieved November 10, 2022, from https://www.zawya.com/en/projects/utilities/jordan-aims-for-50-percent-renewable-energy-by-2030-t0gdggz2#:~:text=Jordan%20has%20devised%20plans%20to,quoted%20on%20Wednesday%20as%20saying.

66. Angres, D. (2019, December 2). Advancing International Cooperation on Radioactive Waste Disposal. Nuclear Energy Agency (NEA). Retrieved November 10, 2022, from https://www.oecd-nea.org/jcms/c_12738/advancing-international-co-operation-on-radioactive-waste-disposal

MODELS OF REGIONAL NUCLEAR COOPERATION

Three models were chosen from three different regions for the sake of representation. Those models of cooperation are the Regional Cooperation Agreement for the promotion of Nuclear Science and Technology in Latin America and the Caribbean **(ARCAL)**, ASEAN Network of Regulatory Bodies on Atomic Energy **(ASEANTOM)**, and the European Atomic Energy Community **(EURATOM)**. **Firstly**, they are all based on a geographical aspect, meaning, geographical proximity is the main criteria for membership. **Secondly**, being a sustainable and productive coalition was a crucial factor to be chosen as a model since the availability of implemented projects proves that the enabling factors which were extracted from its experience are legitimate. Additionally, integration into global norms is also considered as an indicator for sustainability. **Thirdly**, three factors were found to be common among the three models. Namely, leadership, experience, and motive. Leadership entails that there was a specific country or individual lobbying for the formation of the cooperative model. Experience means that nuclear cooperation usually comes after a series of prior cooperation or agreements among countries of the region. **Finally**, it is noticeable that motives stem from the existence of a crisis or a threat; this will be shown in the three models. We consider the following nuclear cooperation models as "best practices" or in other words, models through which Arab regional nuclear cooperation should be established.

REGIONAL COOPERATION AGREEMENT FOR THE PROMOTION OF NUCLEAR SCIENCE AND TECHNOLOGY IN LATIN AMERICA AND THE CARIBBEAN (ARCAL)

Productivity and Sustainability

Since its establishment in 1984, ARCAL has executed more than 160 projects. ARCAL was successful in implementing projects in alignment with its aims, such as curbing the fruit fly infestation in Guatemala and Mexico, developing new varieties of food such as quinoa, tomato, and rice in Cuba, and collaborating with the IAEA in helping countries to improve their water resources management and monitoring marine pollution. In 2016, after an earthquake in Ecuador, ARCAL dispatched four mobile digital X-ray units, mobile generators, emergency diagnostic equipment, and personal radiation detectors.[67]

67. IAEA. (2019, May 20). Event marking 35th anniversary of Arcal. IAEA. Retrieved November 20, 2022, from https://

Global Norms

Member states of ARCAL have experience adhering to global norms and cooperative agreements concerned with nuclear energy. All member states are part of the IAEA. They are all signatories of the NPT either by accession or ratification. The Dominican Republic was the last to ratify the CTBT universalizing the treaty in Latin America and the Caribbean. Finally, they are signatories of the Convention on Early Notification of a Nuclear Accident.[68]

Experience

ARCAL members had prior experience in regional cooperation and specifically in the field of nuclear technology. From 1965 to 1967, a preparatory commission took place in Mexico, which included twenty-one Latin American and Caribbean states, except Cuba.[69] The talks promulgated the first drafts of what is known today as the treaty of Tlatelolco, The Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean. The treaty was signed in 1967 and resulted in the creation of OPANAL stands for "Organismo para la Proscripción de las Armas Nucleares en la América Latina y el Caribe" which is responsible for ensuring the implementation of the "Treaty of Tlatelolco" in cooperation with the IAEA. Over time, cooperation between Latin American and Caribbean states began to focus on peaceful uses for nuclear technology. The shift in focus has had the desired effect, with member countries operating more research reactors indicating that nuclear medicine and agricultural research have taken priority over nuclear weapons.

Leadership

Although no specific country was calling for establishing the cooperative agreement, Argentina and Brazil can be regarded as leading the process. In the beginning, Argentina and Brazil rejected the idea of creating a nuclear-weapon-free zone (NWFZ). However, with internal changes taking place in the two countries, they finally agreed, and the

www.iaea.org/newscenter/statements/event-marking-35th-anniversary-of-arcal

68. Dominica ratifies CTBT, universalising treaty in Latin America and the Caribbean. CTBTO. (2022). Retrieved November 20, 2022, from https://www.ctbto.org/news-and-events/news/dominica-ratifies-ctbt-universalising-treaty-latin-america-and-caribbean

69. Convention on early notification of a nuclear accident (Early Notification Convention). Nuclear Energy Agency (NEA). (2022). Retrieved November 20, 2022, from https://www.oecd-nea.org/jcms/pl_29135/convention-on-early-notification-of-a-nuclear-accident-early-notification-convention

culmination of the cooperative process was in 1991 after signing the "Guadalajara Agreement." Argentina and Brazil are currently considered the leading distributors of nuclear technology in the region. Argentina and Brazil own the largest uranium reserves in the area, with Brazil owning 5% of the world's uranium reserves.[70]

Motive

For Latin American states, the catalyst for regional nuclear safety cooperation was the 1962 Cuban Missile Crisis when Bolivia, Brazil, Chile, and Ecuador reiterated a proposal to the UN Assembly, mentioning the crisis in their speeches. Even though the focus was on creating an NWFZ, it paved the way for further nuclear cooperation. On the one hand, the idea of a nuclear agreement started when nuclear technology was not widespread. Accordingly, no interest groups were in the way of implementing the treaty. On the other hand, the Cuban Missile Crisis triggered the region's countries to protect themselves from the risk of becoming a nuclear exchange hub for superpowers.[71]

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70. Ibid.

71. Dawood, L., & Herz, M. (2013). Nuclear Governance in Latin America. Contexto Internacional, 35, 497-535.

ASEAN NETWORK OF REGULATORY BODIES ON ATOMIC ENERGY (ASEANTOM)

Productivity and Sustainability

Since its establishment in 2011, ASEANTOM has executed projects in many areas, such as the enhancing agricultural productivity using mutation breeding and biotechnology from 2013 to 2016, which had an impact on organic farming, the project Development of Sterile Insect Technique for Dengue Mosquito Vector, "**Aedes aegypti**" Using Gamma Irradiation was established between 2012 and 2015 and the ongoing project of Environmental Radioactivity Monitoring in PNRI Grounds and Vicinities.[72]

Global Norms

Most ASEAN countries were already committed to the global regimes on nuclear governance even before the establishment of ASEANTOM. For instance, all member countries are signatories of the NPT. Except for Brunei, all ASEAN countries are members of the IAEA and signatories of the CTBT (The Comprehensive Nuclear-Test-Ban Treaty).[73] Furthermore, ASEAN members are all signatories of the Convention on Early Notification of a Nuclear Accident,[74] except Brunei and Laos. However, they signed the Community Supported Agriculture (CSA) agreement.

Experience

ASEAN country's experience in nuclear development began in the 1960s, with Thailand being the first to develop its nuclear reactor in 1962, followed by Vietnam in 1963, then the Philippines, Indonesia, and Malaysia. The "Bangkok treaty," or SEANWFZ, was

72. Section, N. I. and D. (2017). ASEANTOM for stronger nuclear safety, security and safeguards in Southeast Asia. ASEANTOM for Stronger Nuclear Safety, Security and Safeguards in Southeast Asia. Retrieved November 20, 2022, from https://pnri.dost.gov.ph/index.php/2-uncategorised/508-aseantom-for-stronger-nuclear-safety-security-and-safeguards-in-southeast-asia

73. IAEA. (2016, June 8). List of member states. IAEA. Retrieved November 20, 2022, from https://www.iaea.org/about/governance/list-of-member-states

74. IAEA. (2014, October 17). Convention on early notification of a nuclear accident. IAEA. Retrieved November 20, 2022, from https://www.iaea.org/topics/nuclear-safety-conventions/convention-early-notification-nuclear-accident

signed in 1995 and was the first regional treaty on nuclear governance. However, it focuses more on nuclear weapons. In addition to signing the treaty, the signatories agreed to meet every five years to evaluate its implementation and disseminate further recommendations. ASEAN countries also established the convention on Counter-Terrorism ACCT in 2007 as the only and first convention to prevent nuclear terrorism in ASEAN, which came as a response to the 9/11 attacks; a Pakistani scientist running a network of commercial nuclear exchange in the black market (A.Q Khan Network), and North Korea's withdrawal from the NPT.[75]

Leadership

Thailand assumed the leadership of ASEANTOM. The Prime Minister of Thailand proposed the integration to the 20th ASEAN summit, which received positive responses from other member states. They agreed on establishing a "network or an institution" to engage all the ASEAN member states' nuclear regulatory bodies under one framework. Thailand also worked on seeking international support. Firstly, they intended to establish ASEANTOM during the 55th general conference of the IAEA in 2011. The following year, the PM of Thailand announced his country's desire to proceed with ASEANTOM at the Nuclear Security Summit in Seoul.[76]

Motive

ASEAN members founded their nuclear cooperation strategy based on the three S's (safeguards, safety, and security) after the Fukushima disaster of 2011, which started after an earthquake in Japan caused the release of radiological material. ASEAN countries concurred on establishing a "regional nuclear safety regime" to reinforce regional cooperation, information sharing, technical exchange, and capacity building.[77]

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75. Singh, B. (n.d.). https://sdsc.bellschool.anu.edu.au/experts-publications/publications/3116/asean-southeast-asia-nuclear-weapon-free-zone-and-challenge. Strategic & Defence Studies Centre Coral Bell School of Asia Pacific Affairs ANU College of Asia & the Pacific, 1–2.

76. Anantasirikiat, S. (2019). Designing Regional Institution on Nuclear Energy Governance in ASEAN (Doctoral dissertation)., 18-38.

77. Ibid.

EUROPEAN ATOMIC ENERGY COMMUNITY (EURATOM)

Productivity and Sustainability

EURATOM has already implemented several projects, such as the Safety Assessment of the Molten Salt Fast Reactor (SAMOFAR), to deliver a breakthrough in the management of nuclear waste to make nuclear energy as safe and sustainable as possible. The Molten Salt Fast Reactor (MSFR) has been developed with this aim. Other projects include the Graduate and Executive Nuclear Training and Lifelong Education project, the Severe Accident Modelling and Safety Assessment for Fluid-fuel Energy Reactors project, which is considered a game-changer in the field of nuclear energy for developing the Molten Salt Reactor (MSR).[78]

Global Norms

Member states of EURATOM are the member states of the European Union, making them automatically part of the IAEA; all members are signatories of the NPT,[79] the Comprehensive Nuclear Test Ban Treaty,[80] and the Convention on Early Notification of a Nuclear Accident.[81]

Experience

European countries and their American partner have had an experience favouring European integration. The European Coal and Steel Community (ECSC) began the integration chain. From 1950 to 1952, negotiations were being conducted between French diplomat Jean Monnet and American experts to extend European integration for other areas, including nuclear energy. They first proposed the European Defence

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78. Section, N. I. and D. (2017). ASEANTOM for stronger nuclear safety, security and safeguards in Southeast Asia. ASEANTOM for Stronger Nuclear Safety, Security and Safeguards in Southeast Asia. Retrieved November 20, 2022, from https://pnri.dost.gov.ph/index.php/2-uncategorised/508-aseantom-for-stronger-nuclear-safety-security-and-safeguards-in-southeast-asia

79. Grunert, P. (1997, May 26). II. NUCLEAR NON-PROLIFERATION TREATY (NPT). Nuclear non-proliferation treaty (NPT) (2) - the principal international arms control conventions. Retrieved November 2022, from https://www.europarl.europa.eu/workingpapers/poli/w23/npt_en.html

80. Text of the treaty. CTBTO. (n.d.). Retrieved November 2022, from https://www.ctbto.org/our-mission/the-treaty

81. IAEA. (2014, October 17). Convention on early notification of a nuclear accident. IAEA. Retrieved November 2022, fromhttps://www.iaea.org/topics/nuclear-safety-conventions/convention-early-notification-nuclear-accident

Community (EDC) for organizing R&D, production, and trade of military technologies. However, The EURATOM treaty was a needed attempt to compensate for the regulation of peaceful rather than military nuclear activities covered by the EDC.[82]

Leadership

During the Cold War, U.S. officials considered European nuclear integration as a cornerstone of U.S. nuclear foreign policy. U.S. officials aimed at designing nuclear-sharing arrangements with their European allies to share the costs and responsibilities of building nuclear capabilities and prevent Western Germany from obtaining nuclear weapons on its own. Thus, uniting Western Europe was considered a vital aim. To accomplish this objective, President Eisenhower reformed the Atomic Energy Act of 1946, allowing the United States to transfer its nuclear knowledge to friendly nations.[83] Accordingly, European Atomic integration was, to a reasonable extent, pushed by American foreign policy back then.

Motive

The idea of creating a European society for atomic energy was first lobbied by Jean Monnet, who believed that atomic energy would be the new energy source in the future, given the ability to produce it in Europe while avoiding dependency on other parts of the world. The exhaustion of coal reserves in Europe made using atomic energy necessary. During the Suez Crisis, Europe understood the importance of independence from unstable international situations and its effect on fundamental trade routes.[84] Accordingly, European powers understood that an atomic community would give them leverage and increase their autonomy, paving the way for the signing of the EURATOM treaty in 1957.[85]

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82. Gaudet, M. (1959). Euratom.

83. Lee, S., & Ginting, B. (2016). Nuclear security cooperation in Northeast Asia: Implications from EURATOM. The Journal of Northeast Asian History, 13(2), 93-118.

84. Krige, J. (2008). The peaceful atom as political weapon: Euratom and American foreign policy in the late 1950s. Historical Studies in the Natural Sciences, 38(1), 5-44.

85. Graziatti, L. V. (2017). The Treaty of Rome EEC and EURATOM 1957. ABC Research Alert, 5(3), Peru-Peru.

ENABLING FACTORS FOR ESTABLISHING SUCCESSFUL NUCLEAR COOPERATION

LEGISLATIVE AND REGULATORY FRAMEWORK

It is necessary for nuclear players to have a legal and regulatory framework in the form of a regulatory body for nuclear energy. A regulatory body in each member state is important for the implementation of nuclear safety and security practices, adherence to non-proliferation, and security requirements which are related to controlling material and accounting, waste management, information security, fire safety, emergency preparedness, physical protection, and radiation safety.

If the regulatory body is not fully competent to carry out these tasks, safety, security challenges, and nuclear proliferation risks may arise. It is observed that in the above-mentioned examples of successful regional cooperation, regulatory bodies inside member states are responsible for addressing proliferation concerns verifying and inspecting that the licensees are meeting all requirements.

For instance, the Vietnamese Agency for Radiation and Nuclear Safety (VARNAS) has acted as Vietnam's regulatory body since 2012. On the other hand, Indonesia does not adhere with the prescription of the IAEA where there is no Nuclear Energy Program Implementing Organization (NEPIO), however, institutions such the Ministry of Energy and Mineral Resources, the Ministry of Research and Technology, and the Ministry of Environment all carry out functions to prepare for the establishment of NPPs. This arrangement would cover the absence of an independent regulatory body.[86] In Malaysia, NPP legislation was promulgated in 1984 and entails detailed provision on radioactive materials, and the Nuclear Power Cooperation (MNPC) was established in 2011.[87]

ARCAL member states also adhere to the IAEA norm which establishes the necessity of a national legal framework for the peaceful use of nuclear energy. For example,

86. Siriratana, B., & Pantip, A. (2013). Summary of the first meeting of ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM).

87. Baker, C., & Dall'Arche, F. (2016). Nuclear Governance in Asia after the Nuclear Security Summit Process. CSIS Issues & Insights, 16(9).

Argentina's Nuclear Regulatory Authority (ARN) was created as an autonomous body in 1997 as a successor to the National Nuclear Regulatory Board. The ARN reports directly to the president and is empowered to control and regulate nuclear activities inside Argentina.[88] In Brazil, a 2021 law created the National Authority on Nuclear Safety which has the financial, technical, and administrative autonomy and the authority to impose sanctions on organizations committing any violation to nuclear safety.[89] In 1992, Cuba adopted a new national regulatory infrastructure and as a result, the National Center for Nuclear Safety (CNSN) has received positive internal and external evaluation.[90] Two countries, however, still lack the existence of an independent regulatory body: Colombia and Ecuador. Nevertheless, the Ecuadorian Ministry of Electricity and Renewable Energy and the Colombian Ministry of Mines and Energy carry out work which mitigates the risks that arise from the absence of independent regulatory bodies.[91]

Finally, EURATOM has its own legal framework developed by the European Commission which oversees its implementation in member states. The legal framework of EURATOM is mainly established through the 1957 EURATOM Treaty.[92] Regarding members, each state has its own regulatory body such as the Spanish Consejo de Seguridad Nuclear and the Federal Office for the Safety of Nuclear Waste Management and the Federal Office for Radiation Protection in Germany among others EURATOM.[93] [94]

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88. IAEA. (2017, November 14). Nuclear regulatory authority (ARN) of Argentina. IAEA. Retrieved November 22, 2022, from https://www.iaea.org/resources/catalogue/nuclear-regulatory-authority-arn-of-argentina

89. Nuclear power in Brazil. Nuclear Power in Brazil | Brasil Nuclear Energy - World Nuclear Association. (2022). Retrieved November 2022, from https://world-nuclear.org/information-library/country-profiles/countries-a-f/brazil.aspx

90. IAEA. (2019). Republic of Cuba Convention on Nuclear Safety First National Report. iaea.org. Retrieved 2022, from https://www.iaea.org/sites/default/files/national_report_of_cuba_for_the_8th_review_meeting.pdf

91. Renha, S., de Sá, L., & Estévez, I. (2015). Regulatory Structures and Issues in Latin America. Radiation Protection in Medical Imaging and Radiation Oncology. Series: Series in Medical Physics and Biomedical Engineering, 275-300.

92. Commision, E. (2020). The commission contributes to nuclear safety in the EU, but updates required. Special report: Nuclear safety in the EU, the Commission's role. Retrieved November 2022, from https://op.europa.eu/webpub/eca/special-reports/nuclear-safety-3-2020/en/

93. ENSREG. (n.d.). Nuclear Regulatory Authority. ENSREG. Retrieved November 22, 2022, from https://www.ensreg.eu/country-profile/Germany

94. Bmuv. (n.d.). Constitution and laws. BMUV. Retrieved November 2022, from https://www.bmuv.de/en/topics/nuclear-safety-radiological-protection/nuclear-safety/legal-provisions-technical-rules-and-regulations/constitution-and-laws

CLEARLY DEFINED FINANCIAL RESOURCES

Since the early 1950s, many major governments in the Middle East, Asia, and Europe have retreated from fully realizing their investments in nuclear energy due to financial constraints. Financing has stopped most states from achieving their original plans of pursuing nuclear energy, it is common in many countries to terminate nuclear reactor projects for financial reasons. For instance, in Finland, a reactor project led by a French manufacturer Areva was delayed for more than three years and was at least 80% over budget.[95]

For the members of a regional nuclear cooperation to avoid this fate, financial resources should be established, defined, and decided prior to establishing the coalition.[96] For example, ARCAL activities' financial resources were defined in the agreement to include contributions of states parties to ARCAL, states and institutions associated with ARCAL as strategic partners, the IAEA, donor countries, international organizations, and others.[97]

EURATOM's financial resources are defined as well. EURATOM members budgets are linked to that of the European Commission and accordingly, the Commission finances EURATOM loans by issuing bonds on behalf of the nuclear community.[98] In order for a nuclear community to work efficiently and be able to execute projects on their agendas financial stability is key and stems from a clearly defined source of money.

However, the two examples should be taken with a grain of salt when used as a reference on possible Arab nuclear cooperation; given the income disparity among Egypt, Jordan, UAE, and KSA, member states cannot be the main source of financing.

95. Sokolski, H. (n.d.). The high and hidden costs of nuclear power. Hoover Institution. Retrieved November 22, 2022, from https://www.hoover.org/research/high-and-hidden-costs-nuclear-power

96. Hunziker, B. (2022, May 3). International co-financing of nuclear reactors between the United States and its Allies. Atlantic Council. Retrieved November 22, 2022, from https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/international-co-financing-of-nuclear-reactors-between-the-united-states-and-its-allies/

97. Arcal Regulations - International Atomic Energy Agency. ARCAL. (n.d.). Retrieved November 21, 2022, from https://www.iaea.org/sites/default/files/18/02/arcal-manual.pdf

98. Euratom loans. European Commission - European Commission. (2022, September 26). Retrieved November 21, 2022, from https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/international-economic-relations/euratom-loans_en

There is no supranational organization, such as the EU in the case of EURATOM, which can be relied upon for financing. In this case, a successful co-financing scheme requires turnkey contracts to be employed[99] in which financial risk is either carried by the construction company in case of budget overdraws and mistakes, by the operator in case of late delivery and in some instances, risk can be shared by either by governments and corporations or only corporations. Turnkey agreements will be carried on along with contributions from member states, aid from international organizations, and financing from strategic partners.[100]

NUCLEAR SAFETY AND SECURITY MEASURES

Nuclear programs without adequate safety and security measures pose a huge threat as such it is essential that robust safety and security measures are in place, however, we must first differentiate between nuclear safety and security measures.

Establishing safety measures begins with the regulatory process, which is made up of guidance on nuclear safety, radiation protection, emergency planning and preparedness, radioactive waste management, transporting radioactive materials, and the safety of nuclear fuel cycle facilities. The issue of ensuring nuclear safety is crucial to the extent that it can be argued that out of all threats facing humanity that have caused death and destruction, none is more threatening than the danger of nuclear power.[101] Severity of the issue led to the stoppage of twelve nuclear energy reactors in Japan following the Fukushima reactor leak in 2011, overall installed nuclear generation capacity went down after other countries began shutting down reactors as well.[102]

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99. Park, K. C., & Chevalier, F. (2010). The winning strategy of the late-comer: how Korea was awarded the UAE nuclear power contract. International Review of Business Research Papers, 6(2), 221-238.

100. Shalash, M. (2022, April 20). Nuclear power in the Middle East between energy needs and military temptation. Orient XXI. Retrieved November 21, 2022, from https://orientxxi.info/magazine/nuclear-power-in-the-middle-east-between-energy-needs-and-military-temptation,5542

101. World Nuclear Asociation. (n.d.). Radioactive Wastes- Myths and realities. Radioactive Wastes - Myths and Realities : World Nuclear Association - World Nuclear Association. Retrieved November 22, 2022, from https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-wastes-myths-and-realities.aspx

102. Malin, M. B. (2017). Nuclear Energy in the Middle East? Regional Security Cooperation Needed. Belfer Center for Science and International Affairs, 2–6.

Security measures include the security of the power plants themselves and are less of a technical issue than safety measures.[103] Nuclear reactors constitute a desirable target for terrorist groups and state-initiated attacks which makes ensuring nuclear reactors' security as a specific and prioritized issue in the Middle East. The MENA region is known to be high risk when it comes to political stability and security.[104] Moreover, non-state actors in the region such as the Houthis, Hamas, Hezbollah, and others own a stock of highly accurate drones which may lead to targeted attacks on nuclear reactors.[105] [106]

For instance, in the Nuclear Security Index of NTI in 2020, Egypt received low scores in the Illicit Activities by Non-State Actors, Nuclear Security and Domestic Nuclear Security Legislations (25-100, 0-100 and 0-100 respectively). Jordan also scored poorly in illicit Activities by Non-State Actors Domestic Legislation (15-100 and 33-100). However, the UAE scored very highly in the categories mentioned previously.[107]

Looking on others' experiences, we will find that EURATOM members have acknowledged the necessity of adopting a framework for nuclear safety to ensure greater harmonization of national standards. The European Commission has argued that measures taken by national regulators are not sufficient because nuclear safety measures still vary greatly across member states. Accordingly, the European Nuclear Safety Regulatory Group (ENSRG) reached a legally enforceable agreement which made it an obligation for member states to abide by nuclear safety measures added in the convention.[108]

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103. Ibid.

104. Khlopkov, A. (2011). UNIDIR RESOURCE S IDEAS FOR PEACE AND SECURITY PROSPECTS FOR NUCLEAR POWER IN THE MIDDLE EAST AFTER FUKUSHIMA AND THE ARAB SPRING. Center for Energy and Security Studies (CENESS), 3–5.

105. Vatanka, A., Kaleji, V., Authors, V., Lister, C., & Saab, B. Y. (2022, November). The Middle East's Next Big Challenge: Nuclear Security. Middle East Institute. Retrieved November 2022, from https://www.mei.edu/publications/middle-easts-next-big-challenge-nuclear-security

106. Asculai, E. (2012). Nuclear power in the Middle East: The Nonproliferation Review, 19(3), 391–400. https://doi.org/10.1080/10736700.2012.734187

107. Initiative, N. T. (2020). Losing Focus in a Disordered World. Retrieved November 20, 2022, from https://www.ntiindex.org/

108. Stani, A. (2010). EU Law on Nuclear Safety. Journal of Energy & Natural Resources Law, 28(1), 145–158. https://doi.org/10.1080/02646811.2010.11435240

ASEANTOM has managed to institutionalize and harmonize nuclear safety and security measures in its member states, although some challenges have been identified, ASEANTOM has managed to address them. For instance, Vietnam had no prior experience with the concept of nuclear safety measures which was not explicitly defined within the regulatory body. This led to several Vietnamese stakeholders voicing concerns over nuclear safety. Following IAEA recommendations, Vietnam began implementing nuclear safety measures which included a licensing system under its national regulatory body for the transshipment of radioactive sources and nuclear material.[109] Accordingly, systems of radioactive nuclear waste transformation, interdependence with regard to securing nuclear reactors through sharing costs and expertise, legal reporting obligation, and finally the harmonization of national legal standards of nuclear safety and security are essential for the establishment and sustainability of the cooperation.

SEEKING INTERNATIONAL LEGITIMACY

One of the main enabling factors for a nuclear cooperation to succeed is working with international organization in the form of providing expertise in key areas and co-financing. The IAEA sets the global framework of every nuclear project to make sure that each country seeking nuclear One of the main enabling factors for nuclear cooperation to work is working with international organizations to provide expertise in key areas and co-financing. The IAEA sets the global framework of every nuclear project to make sure that each country seeking nuclear technologies is adhering to non-proliferation standards, by coordinating between the regulatory and political regimes of member states. IAEA is not the only international organization, there are a set of treaties, rules, conventions, regional institutions, and professional associations such as the World Association of Nuclear Operators (WANO) that complement IAEA rules in regulating nuclear activities.

109. Ness, V. P., Gurtov, M., & Suzuki, T. (2017). Enhancing nuclear energy cooperation in ASEAN: Regional norms and challenges. In Learning from fukushima: Nuclear power in East Asia (pp. 198–201). essay, Australian National University Press.

The International Framework for Nuclear Energy Partnership (GNEP) is also a partner to the IAEA which deals with co-financing issues.[110] Additionally, the IAEA helps in coordinating co-financing between relevant entities of countries wishing to cooperate in nuclear projects. Cooperation with internationally recognized bodies will not only provide any cooperation with the scarce expertise and financial resources, but also international recognition.

Cooperating fully with the IAEA, which ensures non-proliferation adherence gives a green light for members of the cooperation to carry on with their projects and eliminate any potential political repercussions from regional and international powers because the threat of proliferating nuclear weapons will no longer exist. The IAEA also provides legal assistance for all members upon request regardless of the stage of their nuclear activities.[111] Legislative assistance covers nuclear safety, nuclear security, safeguards, non-proliferation, and liability for nuclear damage.

ASEANTOM has been able to make use of its partnership with international bodies by implementing projects such as the Joint Nuclear Emergency Preparedness and Response Cooperation in ASEAN which was executed with the assistance of the IAEA as well as the EU. For instance, in 2016, the European Commission completed a feasibility study on methods to enhance regional cooperation within ASEAN on nuclear emergency and radiological preparedness.[112]

ARCAL also undertook several projects under the auspices of the IAEA and implemented cooperation activities in several areas such as training, research, and development.[113] This demonstrates that even for an established nuclear cooperation, assistance from international bodies remains an asset. Furthermore, it is an essential that the international community receives non-proliferation assurance from the MENA region given preexisting issues in the region.

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110. Hunziker, B. (2022, May 3). International co-financing of nuclear reactors between the United States and its Allies. Atlantic Council. Retrieved November 2022, from https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/international-co-financing-of-nuclear-reactors-between-the-united-states-and-its-allies/

111. IAEA. (2016, July 15). Legislative assistance. IAEA. Retrieved November 22, 2022, from https://www.iaea.org/services/legislative-assistance

112. Ness, V. P., Gurtov, M., & Suzuki, T. (2017). In Learning from fukushima: Nuclear power in East Asia (pp. 188–191). essay, Australian National University Press.

113. IAEA. (2016, July 15). Legislative assistance. IAEA. Retrieved November 2022, from https://www.iaea.org/services/legislative-assistance

PROPOSED MODEL FOR ARAB NUCLEAR COOPERATION

Based on what has been discussed in this paper by analysing successful and influential international models and experiences in its regional scope in the field of the use of nuclear energy, and based on the results highlighted by the analysis, a vision was developed for an Arab nuclear cooperation model that achieves maximum benefit from the use of nuclear energy. It maximizes the capabilities available to each of the cooperation countries, meets the needs of cooperation countries in the future, and serves as the nucleus for cooperation between the countries of the region in the long-term. This cooperation would be the first in the Middle East, given the absence of a nuclear model in the region. A summary of what has been studied will be presented as follows:

THE PHILOSOPHY OF THE MODEL

The philosophy of the Arab nuclear cooperation model is based on the trend of launching nuclear energy projects in the Middle East since 2011, especially after the announcement of the connection of the Iranian Bushehr reactor with a capacity of 1,000 megawatts to the local electricity grid. According to the statistics of the IAEA, the KSA announced plans to build 16 nuclear power reactors by 2030, Upon completion of the fourth reactor of the Barakah Nuclear Power Plant, it will be the largest source of electricity production in the Emirates. Egypt and Jordan are also seeking to develop nuclear energy according to their own needs.

For most oil and natural gas exporters in the Middle East, energy security is a serious issue. GCC countries are adopting alternative technologies to prepare for a post-oil future by reducing their dependence on fossil fuels. This is one of the main motives for Saudi Arabia and the United Arab Emirates to develop nuclear energy and alleviate the problem of water scarcity through desalination. Jordan and Egypt also face a rise in energy prices coinciding with the increasing demand for electricity because of the rapid population increase. However, the security logic of nuclear programs in the Middle East cannot be ignored to counter Iran's military nuclear program. Some countries may consider the nuclear option as a deterrent against possible geostrategic changes in the region.

THE OBJECTIVES OF THE MODEL

The objectives of the model are based on three basic principles:

1. **Cooperation:** Building on previous international experiences, individual experiences of each country, transparency in sharing information and exchanging knowledge on nuclear cooperation.
2. **Independence:** Relying on the resources available to the member states and achieving self-sufficiency in the energy and resources required for the continuation of the current programs.
3. **Security:** Achieving energy security in a broader sense to include securing supplies and needs and securing premises.

MOTIVES OF THE MODEL

- Benefit from the geography of the region in which the participating countries are located, especially as it is a region free from any possible natural disasters.
- Benefit from the accumulated experiences of the model countries and achieve the maximum possible benefit from the available resources, whether it is technology, experts, experiments, or radioactive raw materials.
- Achieving balance in the region by countering Iran and other potentially risky nuclear newcomers.
- The ability to produce energy, especially clean energy, considering continued population and industrial growth and the increasing demand for electric energy.
- Setting the foundation for an economic cooperation model that will develop in the future to possibly include military and further political cooperation, such as the European Union, which started with achieving economic cooperation first and then developed to include many aspects. The cooperation would be the first in the region, after the failure of the Arab League to achieve cooperation between its members so far.

- The importance of the existence of an Arab bloc in the region is to act as a pressure card on the international community if hostile countries develop their nuclear capabilities in the region or threaten to use them.
- Achieving reliability through self-sufficiency, localizing the manufacture of basic materials needed for nuclear energy, and providing nuclear materials for ongoing programs instead of relying on them from abroad to avoid long-term problems concerning the supply chain.
- Building an Arab-Arab cadre capable of managing and operating these reactors in the future, thus achieving the sustainability of nuclear energy as an important source of energy.
- The expected economic return for the cooperation countries through achieving self-sufficiency in energy and providing energy for export.
- The bilateral agreements among the countries such as the agreement between KA-CARE and JAEN in 2017 for a feasibility study on the construction of two small modular reactors.

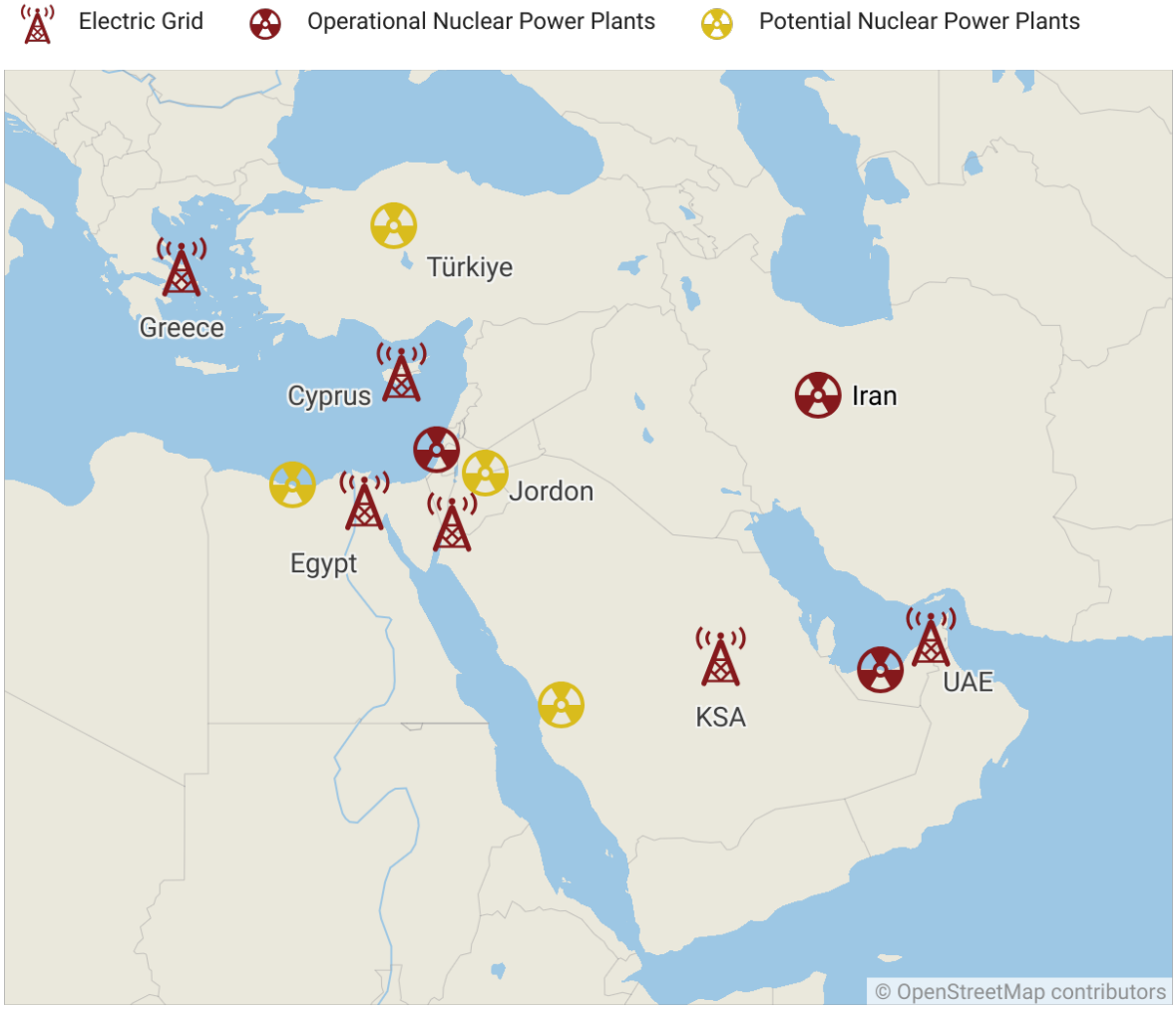
THE FORMS AND PATTERN OF COOPERATION

Regional nuclear cooperation is to be achieved through a series of cooperative agreements, a form of nuclear energy community with agreed guiding principles, transparency, and rules, or through the formation of a regional organization that becomes responsible for the collective management of nuclear energy development in the region, having shared perceptions is a prerequisite for all the above.

The model of cooperation is expected to have 4 countries; the UAE, Egypt, the KSA, and Jordan, as they share several factors that make cooperation and integration among them an urgent need to achieve their goals. Also, they have ambitious programs and accumulative experience, in addition to the need for securing clean energy.

At the beginning and could be expanded in the future according to the level of cooperation to include more countries like Turkey and the rest of the GCC.

Nuclear Energy in the Region



The above map demonstrates the geographical proximity between the participating countries, which allows benefiting from the resources available to some members concerning the transfer and export of energy through a communication network starting from the UAE, passing through Saudi Arabia-Jordan, then Egypt to the European market. In addition to the possibility of benefiting from communication to supply the GCC countries by linking Saudi Arabia and the UAE.

In order to create a form of cooperation, a minimum amount of enabling factors must be present. These are highlighted in the table below:

Factors	UAE	Egypt	KSA	Jordan
Nuclear Experience (Sites - Research - R&D - International Agreements)	X	X	X	X
Leadership (Political Will)	X	X	X	X
Motives (Economic - Political - Security)	X	X	X	X
Legislative and regulatory framework	X	X	X	X
Clear-defined financial resources	X	X	X	
Nuclear safety and security measurements	X			X
Seeking International Legitimacy	X	X	X	X

The table shows that the 4 countries are sharing the majority of the factors but still, the issue of clear funding is not identified yet with Jordan. Most NPPs are funded through a mixture of debt and equity financing, with equity investments typically being more expensive than debt financing. Indeed, Egypt, Saudi Arabia, and the UAE are using loans to finance the bulk of their NPP costs. The factor of **nuclear safety and security measurements** is still an issue in the case of Egypt and Saudi Arabia. And both issues have suggested solutions that can be applied depending on the successful experience of the current models.

THE EXPECTED BENEFITS FROM COOPERATION

- Countries in the Arab region are all facing challenges to the sustainability of their energy systems, especially with rising levels of extreme heat and water shortages, alongside high rates of population growth and rapid industrial development. Although the type of cooperation in question is not primarily security cooperation, sustainability and energy self-sufficiency objectives cannot be entirely divorced from security and political purposes. It is, therefore, imperative that countries agree on what they expect from the cooperation. Managing this could, in both the short

run and long run, give Arab countries political leverage and collective bargaining power.

- Cooperation in the field of nuclear energy provides many economic benefits on several levels, including (the level of industrial, agricultural, medical, technical, and military use). The models that have been studied have proven this as an example. ASEANTOM has executed projects in many areas, such as enhancing agricultural productivity using mutation, and ARCAL has executed more than 160 projects. ARCAL was successful in implementing projects in alignment with its aims, such as curbing the fruit fly infestation in Guatemala and Mexico, developing new varieties of food such as quinoa, tomato, and rice in Cuba, and collaborating with the IAEA in helping countries to improve their water resources management and monitoring marine pollution. In 2016, after an earthquake in Ecuador, ARCAL dispatched four mobile digital X-ray units, mobile generators, emergency diagnostic equipment, and personal radiation detectors. EURATOM include the Graduate and Executive Nuclear Training and Lifelong Education project, and the Severe Accident Modeling and Safety Assessment for Fluid-fuel Energy Reactors project.

- The geographical convergence of the participating countries will be profitable in the event of a network connection through which the surplus electric energy generated by the reactors of each country is exported.

- Cooperation between countries will accelerate the pace of sustainable development since nuclear power is essentially a zero carbon emitter, it offers a double benefit of advancing energy security while also putting countries on the right path towards achieving climate goals, which are becoming an increasingly crucial component of international diplomacy.

- The UAE's strategy in the technological synergy is arguable, and replicable by other Arab states. Still, it also points to the potential benefits of Arab nuclear cooperation in negotiation and bargaining power and improving public image. More importantly, the fact that dependence on foreign assistance for nuclear technology can pose a challenge to nuclear development is perhaps an opportunity to consider the benefits of greater nuclear cooperation in this area.

- Integrating nuclear energy cooperation with other countries can also help solve other problems like water sacristy and security. Also, it could promote agricultural investment, educational mobility, scientific research cooperation, and multilateral resource management.

RECOMMENDATIONS FOR APPLYING THE MODEL

A. The model can start with a multilateral agreement among the countries which can then evolve into an organization after agreements on the basic regulations and the shape of the cooperation take place.

B. The model can also include a financing fund based on the idea of burden-sharing, by providing each country with a financial contribution that reflects its desire for cooperation.

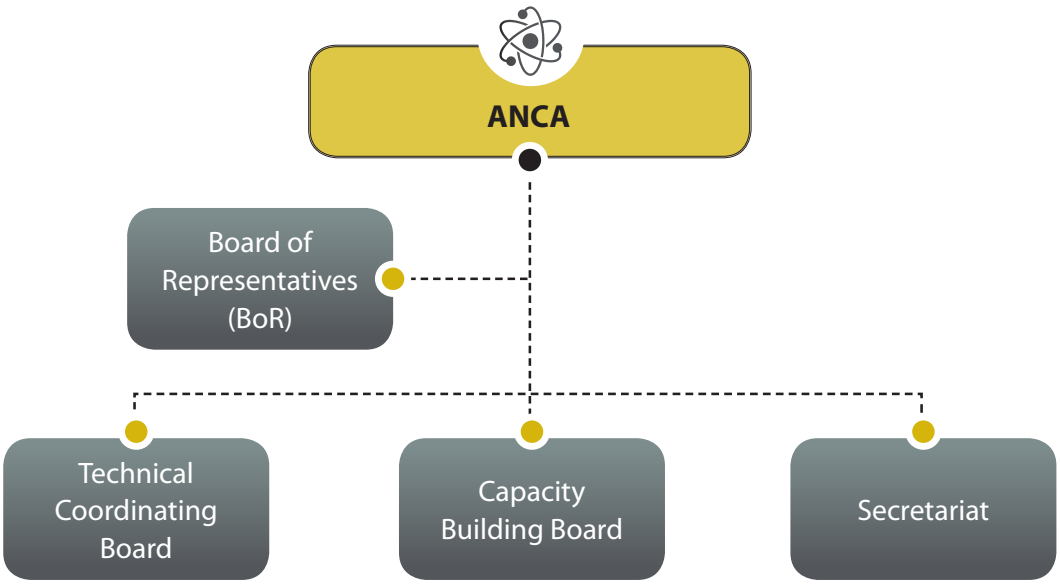
C. Following the UAE model, especially concerning deepening the relationship with IAEA to achieve the maximum degrees of nuclear safety and security measurements.

The proposed regional cooperation organization would follow the model below based on the enabling factors discussed above.

LEGAL FRAMEWORK

Signatories of the agreement are bound to create their legal framework, which will set the boundaries of the cooperation. The framework will decide upon the obligations of member states as well as areas of mutual benefit. In addition, it will include binding legal rules concerned with financial aspects, security, and safety measures, as well as arrangements for the denunciation of the agreement and the accession of new members.

The Arab Nuclear Cooperation Agreement (ANCA) with the Following Organizational Structure



ANCA legal framework will also include the adoption of external conventions such as the IAEA Convention on Physical Protection of Nuclear Material (CPPNM), agreements with IAEA regarding coordination for technical and financial assistance, and bilateral agreements between states within the organization. Finally, it will include arrangements to be implemented on the national level in each member state to achieve legal harmonization regarding the work of regulatory bodies.

ORGANIZATIONAL STRUCTURE

Considering that the signatories of this agreement recognize that within their respective national nuclear development programs exist areas of common interest wherein cooperation can promote atomic technology and its use for peaceful purposes, and acknowledging the role of the IAEA in encouraging and assisting member states, signing parties agree on the following clauses and organizational structure. Accordingly, signatories agree on establishing the "Arab Nuclear Cooperation Agreement."

BOARD OF REPRESENTATIVES

Member states shall designate Permanent Representatives to ANCA. These ANCA representatives will constitute the "Board of ANCA Representatives," the highest decision-making body of the agreement, and shall meet at least once yearly. The Board of Representatives (BoR) will establish policies, guidelines, and strategies. Furthermore, the BoR will be responsible for the necessary legal regulations, including the organizational manual and the financial arrangements, reviewing annual reports concerned with projects' implementation, and defining ANCA relations with other partners from states and non-state actors.

TECHNICAL COORDINATING BOARD

Member states shall designate national coordinators who will constitute the Technical Coordinating Board and meet at least once a year. The Technical Coordinating Board is responsible for implementing BOR decisions, giving technical assistance to the BOR, formulating and submitting an annual report including respective resource allocations and assessing the implementation of yearly projects, and providing recommendations about projects' continuation, modification, or conclusion.

CAPACITY BUILDING BOARD

Member states shall assign experts to coordinate training and capacity-building programs in member countries. Programs include activities, research, development, and exchanging nuclear experience among member states.

SECRETARIAT

The Secretariat shall coordinate activities between member states, allocate contributions collected from member states and other financial sources among ANCA projects, prepare the annual plan of activities, provide administrative support for different bodies of the organization, compile and distribute reports, and prepare annual reports on the implementation of projects to be submitted to the BOR.

FINANCIAL RESOURCES

The financial resources of ANCA would include the following:

- Contributions from member states.
- Aid from strategic partners. (State actors, non-state actors, IAEA, and other international organizations)
- Turnkey agreements are to be conducted after ANCA has given legal consent.

SAFETY AND SECURITY MEASURES

Safety and security measures of ANCA would include:

- Licensing systems.

- System for waste treatment and transshipment of radioactive and nuclear waste for eventual disposal.
- Agreeing on shared measures for the physical protection of nuclear reactors and periodical assessment by the ANCA Board of Members.
- Forming neutral physical protection forces within member states to protect nuclear reactors.

COOPERATION WITH INTERNATIONAL BODIES

ANCA will signing memorandums of understanding with the IAEA, EU, and other international and regional bodies with experience in nuclear energy seeking technical and financial cooperation.

SCENARIOS OF THE STUDY

The purpose of scenarios is to describe and create narratives on how the world might look like in the future. They explore how conditions may change in certain trends to become stronger or less prevalent or if different events were to occur. The scenario analysis is not intended to be a forecast but rather a process of evaluating the potential future pathways under certain conditions and assumptions. The scenarios are essentially a range of hypothetical "what ifs". While they do not predict the most likely pathways, they help policy and decision-makers understand which factors could lead to changes on the nuclear energy cooperation front and what these changes could mean for energy security and stability in the region.[114]

SCENARIO ONE: TECHNICAL AND ECONOMIC NUCLEAR COOPERATION

At the moment, the UAE is the only country in the region with active nuclear reactors. If Egypt and Saudi Arabia's nuclear power plant projects go as planned, a new layer of political and security considerations will be added to the agendas of Western countries and superpowers when dealing with the region, especially as the United States strengthens its approach towards nuclear competitors. With the rapid expansion of Russian and Chinese nuclear power, which has been characterized as "Great Power Competition", the United States is already adapting its strategy to prevent the emergence of what it perceives to be "regional hegemons" to protect its geopolitical interests. This rivalry represents a clear shift in U.S defence concerns from counterterrorism in the Middle East to resource and economic activity in Eurasia. This, combined with Russia's nuclear financing in the region and the expected rise of nuclear agreements with China could pose a threat to Arab nuclear programs.[115]

Therefore, we have here what could be perceived as a repetition of history where the economic and security interests of the Arab countries potentially conflict (at least in certain areas) with American geopolitical interests. In the past and until recently, Arab countries were treated as a playground for the U.S. defence industry and a proxy zone for conflicts. Although the past does not offer a full indication of the future, American decision-makers have explicitly acknowledged the that this is the "era of

114. Rhydderch, A., & Alexander, J. (2009). Scenario Planning (pp. 3–37). Foresight Horizon Scanning Centre.

115. Congressional Research Service. (2022). (rep.). Great Power Competition: Implications for Defense—Issues for Congress. Congressional Research Service.

grand strategy" which essentially means that any actors or industries involved with Russia and China, which the U.S is actively working to counter-balance, could become collateral damage in the grand scheme of policy.[116]

Arab nuclear expansion is particularly vulnerable to this considering the already sensitive nature of nuclear development in the Arab region. It is for this reason that Arab countries must work pre-emptively to avoid being caught in the crossfire of international nuclear competition. If Arab policymakers act in a timely and strategic manner, acknowledging the criticality of this unfolding trend, this could lead to greater nuclear cooperation through multilateral agreements that may lead to a more solid or structured form of cooperation that encompasses knowledge and technology sharing as well as collective strategic decision making to better navigate the new multipolar system.

On the other hand, Great Power Competition may not necessarily be a constant threat to the stability and the nuclear ambitions of Arab countries; there may be some advantages that could also encourage nuclear cooperation. For example, the U.S. may be more eager to share nuclear technology and initiate agreements to balance other competitors' influence. Arab countries may find value in negotiating with the U.S. as a bloc and can leverage this dynamic to further regional cooperation about financing for example.

In addition to growing international competition, increasing regional competition has also been a trend that is expected to continue.[117] If the trend of Gulf investments in the region continues, it is possible that investing in building the nuclear capacity of other Arab countries could become part of Saudi Arabia's and the UAE's strategy for regional influence. Countries like Jordan and Egypt could be potential beneficiaries of this. This could also occur as Gulf countries continue to invest in their local nuclear capacities and opportunities begin to emerge for Arab nuclear scientists and experts, especially if the cost of other foreign experts becomes unsustainable or if Great Power Competition in the region makes reliance on foreign expertise more politically sensitive and potentially unstable. This entire process of course will not show before 10-15 years after nuclear reactors are built and start operating. Policymakers can, however, begin preparing for this transition by investing in local capacities through training programs, exchange programs, grants, and scholarships for scientists.

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116. Ibid.

117. Heistein, A., Rakov, D., & Guzansky, Y. (2021, March 1). What will the Middle East look like in 2030? an Israeli perspective. Middle East Institute. Retrieved November 8, 2022, from https://www.mei.edu/publications/what-will-middle-east-look-2030-israeli-perspective

The expansion of nuclear energy cannot be completely separated from the risk of nuclear weapon proliferation which must also be factored into the equation. As mentioned previously in the second chapter, nuclear energy development in the Arab region is often perceived as a proliferation risk by foreign powers, and countries that receive peaceful nuclear assistance are found to be more likely to initiate weapons programs than others. Considering this, in the future, there could be more serious efforts to thwart Arab nuclear programs by mobilizing the international community and exercising different forms of pressure via international organizations. This could lead Egypt, Jordan, Saudi Arabia, and the UAE to act as a bloc, especially if they continue to expand on existing bilateral and multilateral nuclear agreements. On the other hand, the increasing multi-polarity of the international system is seen by some as a risk to the overall non-proliferation regime. This means that a future where countries are no longer incentivized to abide by the non-proliferation regime is a possibility.[118] While this can lead to many different outcomes, one pathway is that of greater nuclear cooperation that includes more provisions and joint efforts relating to nuclear weapons. It could also mean a period where the pursuit of nuclear weapons by one Arab country for example leads to political tensions and instability that creates momentum for regional non-proliferation agreements such as that which Egypt has attempted to initiate in the past.

SCENARIO TWO: THE NO-COOPERATION SCENARIO

The following is an overview of potential factors that may lead to the inability to initiate Arab nuclear cooperation as well as recommendations for avoiding this scenario.

POLITICAL

Geopolitical competition among China, Russia, and the US will certainly complicate nuclear ambitions. For instance, the Sino-Saudi rapprochement seems to be a source of dissatisfaction in Washington. It further shows the distance that Riyadh has taken in this area with Washington, the old traditional ally. Saudi decisions could be explained by the ongoing dissension between Saudis and Americans, especially regarding policies in the Middle East and the Iranian issue. A Saudi expedition travelled to a nuclear energy project site in Fujian (South-West China) in 2018 where exchanges took place

118. Rebecca Davis Gibbons & Stephen Herzog (2022) Durable institution under fire? The NPT confronts emerging multipolarity, Contemporary Security Policy, 43:1, 50-79, DOI: 10.1080/13523260.2021.1998294

around technologies and engineering works. China is one of only a few countries in the world that mastered that technology but decided to share it only with countries participating in the Road and Belt initiative which Washington decided to undermine whenever it is possible. The Chinese and Russians have been actively pursuing nuclear deals in the Middle East to advance their position in the region most notably in states that are key players in the current geopolitical scape such as Egypt, Turkey, and Saudi Arabia. All this threatens US political and commercial interests in the region in favour of Russia, China, and any other key player which were supported through its nuclear engagement. Accordingly, rivalry and competition among international powers may stand in the face of the continuation of agreements necessary for the integration.[119]

Additionally, political disagreements among Arab countries, whether relating to new events or long-standing tensions, could strain relations and prevent constructive cooperation. This could also include disagreements about the motive or rationale behind the cooperation which means that if one country has the nuclear ambition to extend peaceful usage, this will hamper further cooperation with other states whose motives include only peaceful usage of nuclear energy. An example of this is Saudi Arabia which has already declared in January of this year that the Kingdom has already built a plant to produce "yellow cake" which confirms the point that the country has at its disposal large amounts of Uranium.[120]

SECURITY

The struggle between transparency and nuclear security is another thing that threatens the foundation of a nuclear agreement, even a peaceful one. In the context of emerging interdependence among member states, it is recognized that when one state carries out its mission to protect nuclear materials it is also a concern for others. As a response, a framework is usually the answer to such an issue. States tend then to question themselves, in the light of the intersection between security and the fundamental principle of state sovereignty, which one should be chosen. Transparency in sharing information and technology between the states due to sovereignty concerns could be an obstacle to cooperation considering that many of the mechanisms and

119. Hunziker, B. (2022, May 3). International co-financing of nuclear reactors between the United States and its Allies. Atlantic Council. Retrieved November 2022, from https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/international-co-financing-of-nuclear-reactors-between-the-united-states-and-its-allies/

120. Shalash, M. (2022, April 20). Nuclear power in the Middle East between energy needs and military temptation. Orient XXI. Retrieved November 2022, from https://orientxxi.info/magazine/nuclear-power-in-the-middle-east-between-energy-needs-and-military-temptation,5542

frameworks require transparency to be effective. This is exemplified in the case of the IAEA Convention on Physical Protection of Nuclear Material which aims to disseminate principles of nuclear security among states and its amendment which introduced twelve principles of physical protection "responsibility of the state, responsibilities during international transport, legislative and regulatory framework, competent authority, the responsibility of the license holders, security culture, threat, graded approach, defence in depth, quality assurance, contingency plans, and confidentiality". Egypt and Iran refused to sign such a convention which can be traced to sovereignty and national security concerns. On the level of regional nuclear cooperation, it is usually a concern whether state members would allow for assessment with other countries involved in theprocess.[121][122]

The possibility of terrorist attacks and security breaches in the region is particularly high due to the prevalence and unpredictability of terrorist organizations. Worries about nuclear security in the Middle East are considered high relative to other regions. For example, UAE, Egypt, and Saudi Arabia are worried about possible terrorist attacks on their reactors. There are also questions about measures to deal with theft, sabotage, illegal transfers, and unauthorized possession. There is also the worry of any nuclear leakage in the Gulf which would constitute a severe challenge for those countries given their dependency on the desalination of seawater. As newcomers to the nuclear playing field, countries of the proposed cooperation suffer from a scarcity of qualified experts and a tardy development of needed technologies. This challenge was already mentioned in the above sections by referring to the Nuclear Security Index of NTI in 2020 in which Egypt got low scores, in the illicit activities by Non-State Actor, Nuclear Security, and Domestic Nuclear Security Legislations (25-100, 0-100 and 0-100 respectively). Jordan also scored very low in illicit Activities by the Non-State Actor's Domestic Legislation (15-100 and 33-100). On its side, the UAE scored very high in the aforementioned categories.[123]

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121. Ibid.

122. Membership of the convention on the physical protection of nuclear ... PHYSICAL PROTECTION, 2005 AMENDMENT & NUCLEAR TERRORISM CONVENTIONS. (2015). Retrieved November 2022, from https://www.nti.org/wp-content/uploads/2021/09/cppnm_membership.pdf

123. Source: Initiative, N. T. (2020). Losing Focus in a Disordered World. Retrieved November 20, 2022, from https://www.ntiindex.org/

ECONOMIC

Determining each country's financial contribution to the network or organization as well as deciding on the appropriate allocation of resources could be an obstacle to agreements. In the case of our proposed model of cooperation, financing could be a source of disagreement since the two rich countries in the integration, UAE and Saudi Arabia, may find it unjust to give the highest share of contributions, especially with the other two countries struggling with their financial resources to continue with their nuclear projects. For instance, in 2015 Jordan signed a deal with Russia's Rosatom to build Jordan's two NPPs in Amra, with a capacity of 2000 megawatts worth $10 billion. However, in 2018 Jordan announced that it has cancelled the agreement because it was deemed too costly as a result of a financial disagreement with Rosatom. Jordan's project was halted due to the lack of financial resources. The question remains whether rich countries in the agreement would accept to finance others' projects or their strategic calculations would not give results in favour of the lower income states.

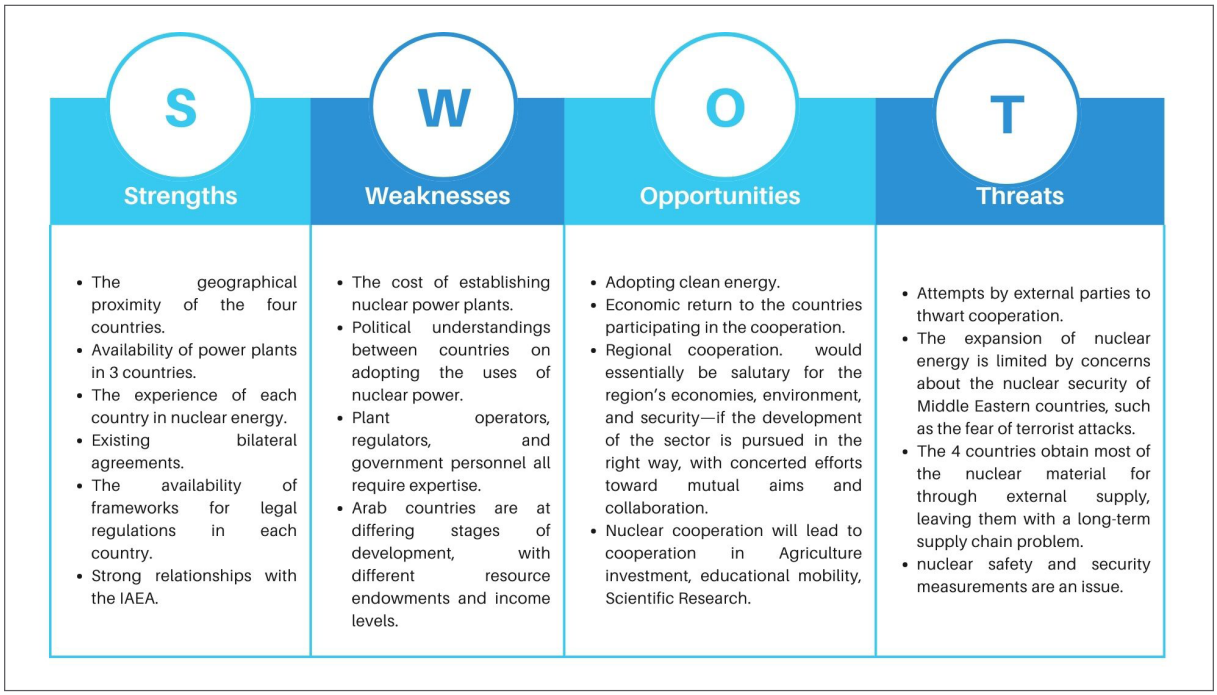
SCENARIO THREE: LIMITED TECHNICAL NUCLEAR COOPERATION

This model is limited to a narrow scope of cooperation and is limited to technical cooperation, and can be through several forms of cooperation:

- Organising scientific conferences among member states.
- Exchange of delegations in the form of missions at the level of experts in the proposed countries.
- The maximum level is the signing of a bilateral agreement between the two parties, and it is limited to limited technical cooperation for studies and results of current programs.
- Signing a joint feasibility study like an agreement between KA-CARE and the JAEC was signed in 2017 for a feasibility study on the construction of two small modular reactors in Jordan for the production of electricity and desalinated water. No particular technology was mentioned.

CONCLUSION

The paper concludes to some significant issues according to SWOT analysis:



The concern of Middle Eastern countries over the availability of nuclear materials to terrorist organizations undermines their desire to develop civilian nuclear energy. The UAE, Egypt, KSA, and Jordan obtain most of the nuclear material for ongoing programs from outside supply, leaving them with a long-term supply chain security problem. In addition to the attempt of some neighbouring countries to undermine any move to cooperate in this field. The cost barrier is still a barrier preventing countries such as Jordan from advancing their program, but through the model this obstacle will be avoided. The Arab countries have many opportunities that can be invested through this cooperation, as it will be the first of its kind in the region and will serve as a nucleus for further cooperation in many fields; benefitting from the accumulated scientific expertise and experience of the member states.

The expansion of nuclear energy is limited by concerns about the nuclear security of Middle Eastern countries, such as the fear of terrorist attacks by Saudi Arabia and the UAE. As a broad concept, nuclear security may mean taking preventive and rapid detective measures to respond against malicious acts such as theft, sabotage, unauthorized possession and illegal transfer, as well as "nuclear safety", i.e. taking

measures to ensure the operation of nuclear facilities, prevent accidents, or minimize the consequences of accidents.

Table (4) Sabotage: Protect Facilities[124]

Factors	Egypt	UAE	KSA	Jordan
Number of Sites	100	100	N/A	100
Security and Control Measures	19	65	N/A	46
Global Norms	29	83	N/A	81
Domestic Commitments and Capacity	67	89	N/A	36
Risk Environment	39	71	N/A	40

Source: Initiative, N. T. (2020). Losing Focus in a Disordered World. Retrieved November 20, 2022, from https://www.ntiindex.org/

According to NTI nuclear security report it shows that Egypt and Jordan have issues related to security and control measures, domestic commitments and capacity, and risk environment and no available data related to Saudi Arabia.

The paper assessed the different incentives and potential benefits Arab countries could gain through regional nuclear cooperation. The paper's findings show that energy security extends beyond the energy and economy in the region and has a clear impact on overall regional stability; therefore, energy diversification is a matter of national security for each state. For this reason, Arab countries are directing more attention toward nuclear energy development and are seeking cooperation with countries that provide financing and technical assistance. However, this creates an unwanted dependence in the short and long term, which poses a risk to the sustainability of their nuclear projects and economies overall. The possibility of nuclear financing through a regional network or organization is, therefore, another incentive for cooperation, as is the opportunity for Arab countries to share nuclear technology and expertise, which can strengthen their hard power. Finally, research shows the importance of international legitimacy for the sustainability of nuclear programs, especially those in sensitive regions. Nuclear cooperation with a unified or collectively recognized

124. The sabotage ranking assesses countries with nuclear facilities based on these five categories. Ranking from 100 in each factor, with 100 being the highest score.

regulatory framework can provide legitimacy. This, in addition to demonstrated alignment and commitment to the climate goals, is a highly recommended strategy for nuclear energy expansion and constructive cooperation.

The paper identifies key factors that drive countries to enter nuclear cooperation as well as the prerequisites that make this possible. What is common among all models is that they began as response to a crisis and were able to continue and expand as each respective country worked on its national regulatory and security frameworks. Cooperation also expanded as countries recognized the benefits of sharing the costs and responsibilities of building nuclear capacities as well as the benefits of sharing technical nuclear knowledge and using cooperation to complete trade initiatives. Financial stability was a big factor and was discussed in the chapter on incentives, as is international legitimacy which can be seen as both enabling factor supporting cooperation as well as an incentive for countries to cooperate.

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