



# Current Energy Systems Policies as One of the Tributaries of Sustainable Development in Egypt

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**Abstract:** The world seeks, in accordance with sustainable development priorities, to impose methodologies that contribute to the maximum benefit from natural resources in obtaining energy; In view of the challenges resulting from the increased need for electric power and the high operational costs of obtaining conventional energy; Which requires an increase in the economic expenditures of the state in addition to the environmental pollution resulting from the use of petroleum materials in power generation and the depletion of oil resources in light of the provision of natural resources at a lower cost that is better for the environment and promotes economic development at the global and national levels. The energy sector has become the target of new national policies attributed to improving generation efficiency and increasing the adoption of non-fossil generation. These policies are: assessment of climate change, fuel resource use, water consumption, pollution risk reduction, and reliability of efficient power generation. Hence, the national policies aimed at increasing the role of the contribution of nuclear energy in the energy mix to mitigate climate change, as it provides a large amount of low-cost electricity. and promote progress towards achieving the Sustainable Development Goals and mitigating climate change in an environmentally efficient and economically efficient manner and encourage support for technologies, institutions, and actors.

**Keywords:** International Treaties, Electricity, Nuclear Energy, Sustainability, Price Liberalization, Egypt

## 1. Introduction

General headings and a summary of the topic should be written in five lines.

The following figure shows the conceptual summary. The number of circles emanating from the figure can be increased.

The following figure shows a summary of the research study and the most important findings and proposals. Egypt has the material and human resources that qualify it to possess nuclear reactors to produce electricity.

### 1.1. The Study Problem

- 1) Increasing the prices of petroleum and various fuels.
- 2) Oil and natural gas resources are not renewable and are threatened with depletion.
- 3) Continuous crises that threaten the economy and national security because of the lack of fuel.
- 4) High prices of fossil fuels and their limitations.

### 1.2. Objectives of the Study

Advancing the Egyptian economy to receive the art of modern technologies and adapting them to serve economic development and working to develop the strategy of the electricity sector in Egypt, which leads to the development of infrastructure as one of the pillars of economic growth.

### 1.3. The Importance of Studying

Allowing the possibility of substituting renewable resources for nuclear energy in improving comprehensive economic development and supporting development needs.

Achieving energy independence and reducing fluctuations in the cost of electricity production.

### 1.4. Study Hypotheses

- 1) Egypt possesses the material and human resources that qualify it to possess nuclear reactors to produce electricity.

2) Egypt can simulate models of generating electricity from nuclear energy in the world to secure the needs of

economic and social development due to the availability of energy supplies on a regular and sustainable basis.

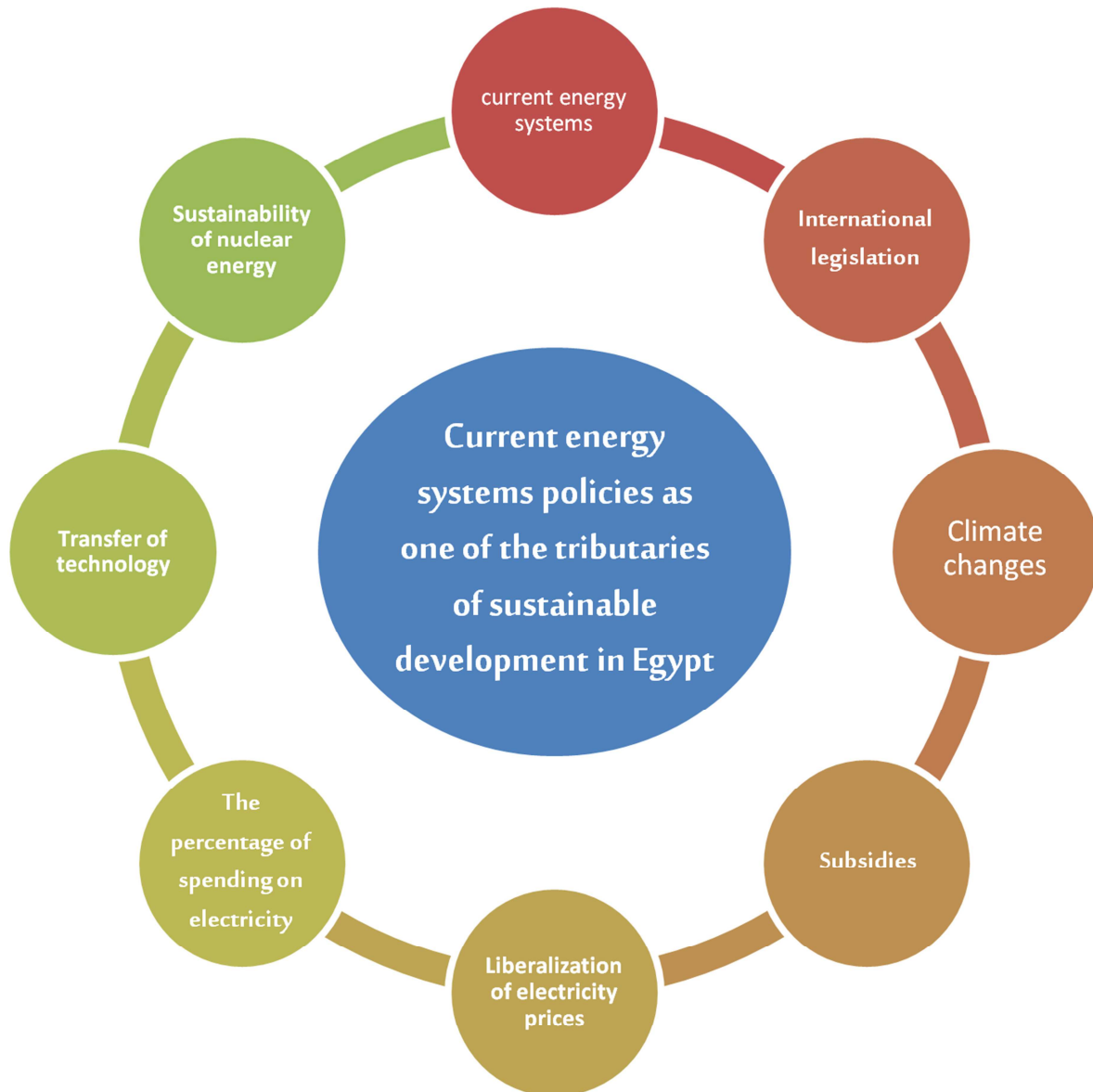


Figure 1. Fram of work.

## 2. International Legislation for the Peaceful Uses of Nuclear Energy

turn the international community has expanded nuclear energy into several peaceful fields, including medicine, electricity production, industry, and agriculture. Several international agreements have been concluded to regulate the peaceful uses of nuclear energy, including the following:

- 1) Convention banning nuclear weapons tests in the atmosphere and outer space.
- 2) Treaty on the Non-Proliferation of nuclear weapons:
- 3) The Special Convention on Early Notification of a Nuclear Accident [1].

### 2.1. Legislation National Peaceful Uses of Nuclear Energy

In 1964 AD, the United States of America issued the Nuclear Energy Law, and this law laid the foundations for regulating nuclear activity within the United States of America, and it was replaced by the 1954 AD Nuclear Energy Law. This law is considered the main source for most of the national nuclear legislation in the world., dealing with all aspects of this activity in terms of licensing, prevention, and liability, to keep pace with the great developments in the fields of nuclear reactors, as it includes the following elements and objectives:

- 1) saving A legislative framework for regulating the uses of nuclear energy to achieve the public interest, considering the international commitments emanating

from the international agreements that countries have undertaken through these agreements.

- 2) put Principles of practicing nuclear activity and leaving the details of this practice to be made by administrative regulations according to the circumstances of each institution and country.
- 3) put the supervisory structure empowered to effectively implement the authority to supervise and effectively control the authorized activities.
- 4) saving Complete financial protection against any damage caused by any nuclear accident in view of the damage that is likely to result from this accident. Accordingly, nuclear legislation consists of the following elements:
- 5) Prevention Radiological and regulatory oversight of the uses of radioactive materials and other sources of ionizing radiation, as well as environmental protection.
- 6) Safety Nuclear power and regulatory oversight of nuclear facilities, including the management of radioactive facilities.

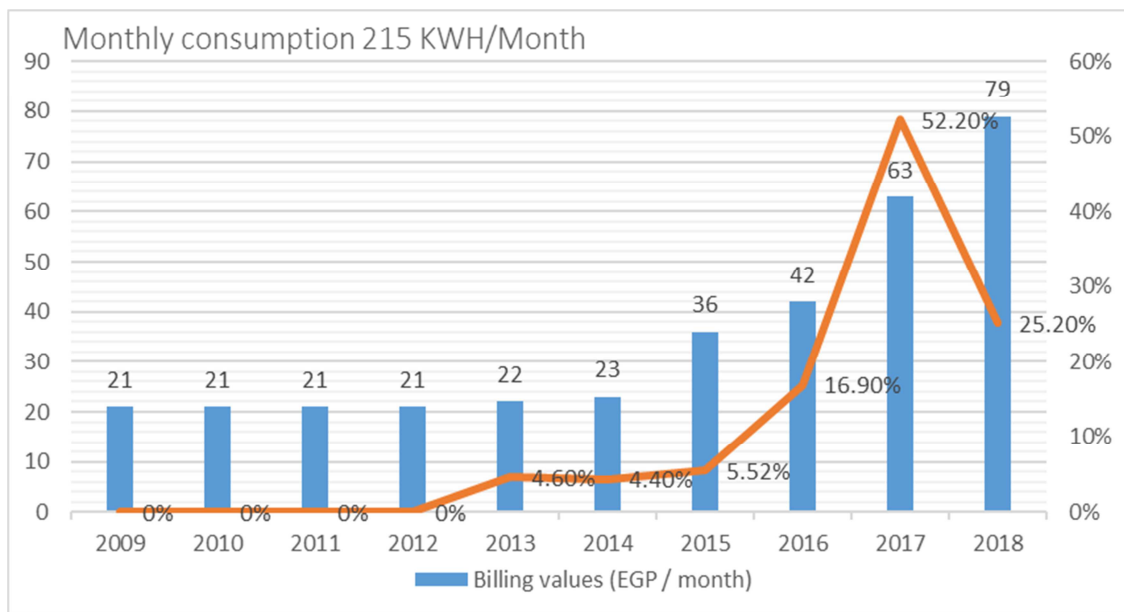
and transportation Safe for Radioactive Materials, Physical Protection of Nuclear Materials and Facilities, Nuclear Material Account Control System.

### 2.1.1. The Policies of the Current Energy Systems in Egypt

*First: liberalizing Electricity Prices in Egypt*

The price of oil affects the price of electricity generated from coal and gas power generation sources. According to the program to restructure the electricity subsidy tariff in Egypt, the government has liberalized fuel prices and lifted subsidies on it. To reduce the negative effects left by the distorted subsidy system on the Egyptian economy, which was severely affected as a result of the petroleum product subsidy system's acquisition of financial resources, which raised the value of the cost of producing electric energy in a way that makes it difficult to free the selling price to the consumer; The reason for raising fuel and electricity prices is more stagnation and pressure on the middle class, which has increased the burdens of the citizen and made him lose the ability to meet his basic needs. Therefore, raising subsidies in general, including electricity subsidies, is a severe blow that increases the discontent of the citizen in a way that is not in the interest of security, home and its stability. [2]

Egypt suffered from shortcomings in the fairness of spending on electricity. The government did not consider the record inflation of living prices for Egyptians during the past years, especially the poor, and insisted on raising electricity prices for all usage segments for the sixth year in a row. The following figure shows the increase in the value of electricity bills by 4.6% from 2013 to 52.2% in 2018. [3]

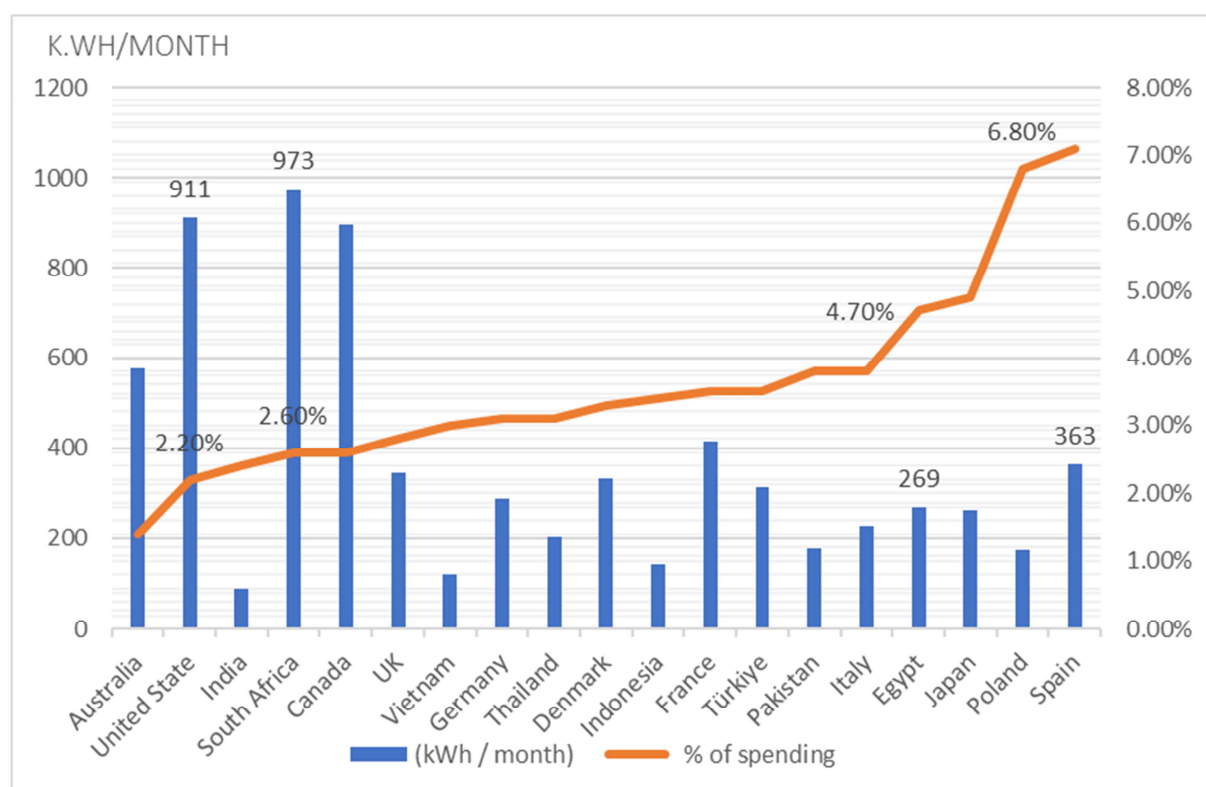


**Figure 2.** Increase in Monthly Bills for Middle-Income People.

Source: The Egyptian Initiative for Personal Rights and Electricity Facts for the fiscal year 2017 from the website [https://eipr.org/sites/default/files/reports/pdf/\\_factreportele17-18\\_.pdf](https://eipr.org/sites/default/files/reports/pdf/_factreportele17-18_.pdf)

And by comparing the rates of spending on electricity in different countries, the increases have raised the burden of energy costs on Egyptian families, as the percentage of spending on electricity bills out of total spending has increased to more than 4.5% for the poorest and middle-income groups; Thus, Egypt suffers from social inequality and inefficiency in the exploitation of public money. What

Egyptians spend - as spending rates - exceeds twice what households spend in countries such as Australia, the United States, South Africa, and Canada, even though these countries use between two and three times the electricity used by households. Egypt, as shown in the following figure: [4]



**Figure 3.** Comparing the Proportion of Spending on Electricity and Domestic Use Among Countries of the World.

Source: Egyptian Initiative for Personal Rights. Electricity facts for the fiscal year 2017 from the website [https://eipr.org/sites/default/files/reports/pdf/\\_factreportele17-18\\_.pdf](https://eipr.org/sites/default/files/reports/pdf/_factreportele17-18_.pdf)

The state's plan to stabilize prices after lifting subsidies depends on the expansion of new and renewable energy projects, in addition to raising the level of efficiency of power generation plants to be less consuming fuel, which called for the trend towards establishing nuclear power plants, and despite their high cost, the future is in favor of this type of energy. Especially considering the government's tendency to liberalize its prices in the next stage.

### 2.1.2. Classification of Subsidies

*Providing Energy Subsidies from Governments Is Classified into the Following Categories*

Energy policies at the national level require technological developments in parallel with the rapid growth of the population, and the government to carry out further energy price reforms. Government support is classified as follows:

- 1) Subsidies: financial aid commensurate with energy production through mechanisms such as import tariffs and production tax credits.
- 2) Financing research and development: It includes public and private investment in the field of research and development in the field of energy.
- 3) Financial support: such as tax exemptions on renewable energy equipment and environmental taxes, such as imposing a carbon tax on consumers of environmentally polluting energy.
- 4) Investment credit: policy that achieves a high success

rate in spreading renewable energy sources.

- 5) External factors: External factors include an estimate of the costs of damage caused by climate change and an assessment of environmental and social impacts, and converting them into funds to give an external cost such as: [5]

(a) Support pathways of impact on human health due to toxic compounds, noise, heat or radiation through air, soil and water pathways. (b) global warming. (c) Major accidents.

## 3. The Effects of Climate Change on the World

Climate change poses more serious threats to sustainable development in poor countries than in rich countries. Because of the fragility of the economies of these countries in the face of the repercussions of the climate; The multiple pressures impair the ability to take mitigation and adaptation measures, as the level of greenhouse gases increases, the climate change intensifies, and then its impact intensifies. Figure 4 shows the distribution of carbon emissions in the world, and it is also clear that China has surpassed the European Union and the United States and has become the largest emitter of carbon in the world.

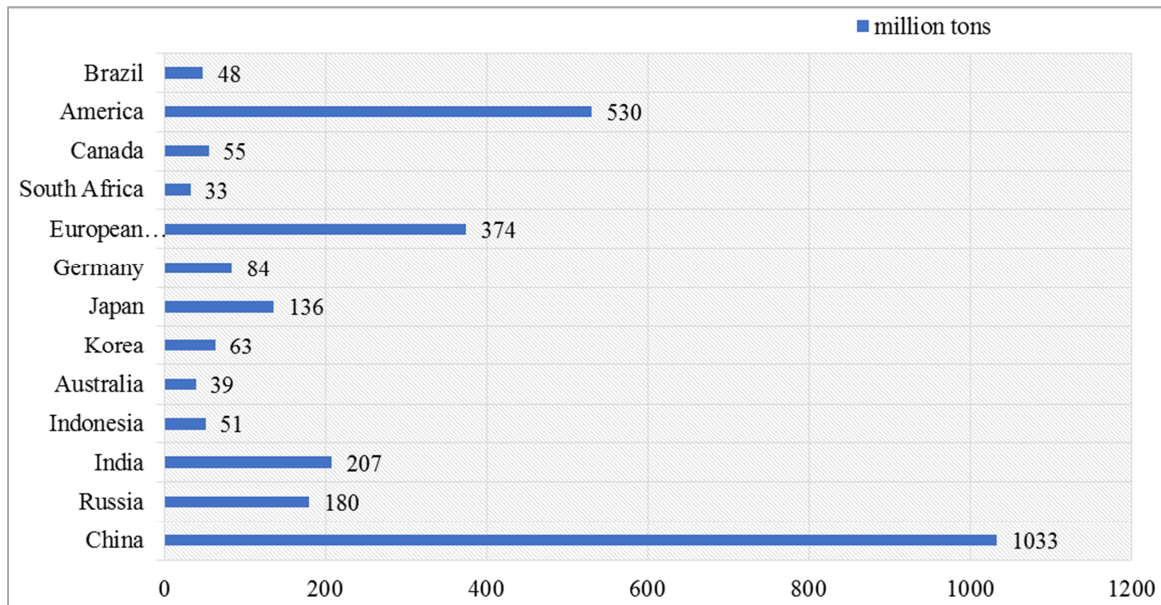


Figure 4. Carbon Emissions of the World's Major Economies in 2015.

Source: Xing, T., Jiang, Q., & Ma, X. (2017). To Facilitate or Curb? The Role of Financial Development in China's Carbon Emissions Reduction Process: A Novel Approach. *International Journal of Environmental Research and Public Health*, 14 (10), 1222.

#### 4. The Position of the Energy Sector in the Structure of the Economy of the Arab Countries

Looking at the degree of dependence on energy in the Arab countries during the period 2000-2018 as shown in the following figure, we note that the general trend for most Arab countries is to increase the percentage of dependence on energy, and this is also the case with net energy-exporting countries. [6]

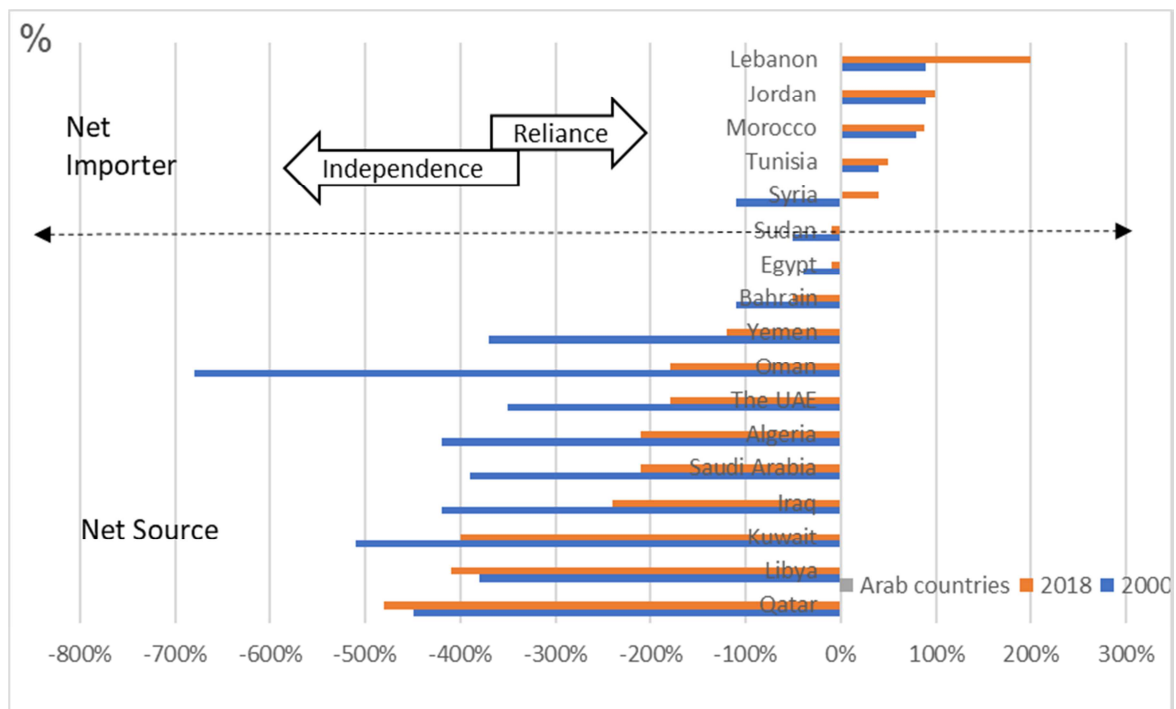


Figure 5. Percentage of Dependence on Energy in the Arab Countries.

Source: It was prepared by the researcher from the available data The Role of Natural Gas in Achieving Sustainable Development in the Arab Countries (October 2015), Organization of Arab Petroleum Exporting Countries (OAPEC), Kuwait, p. 7.

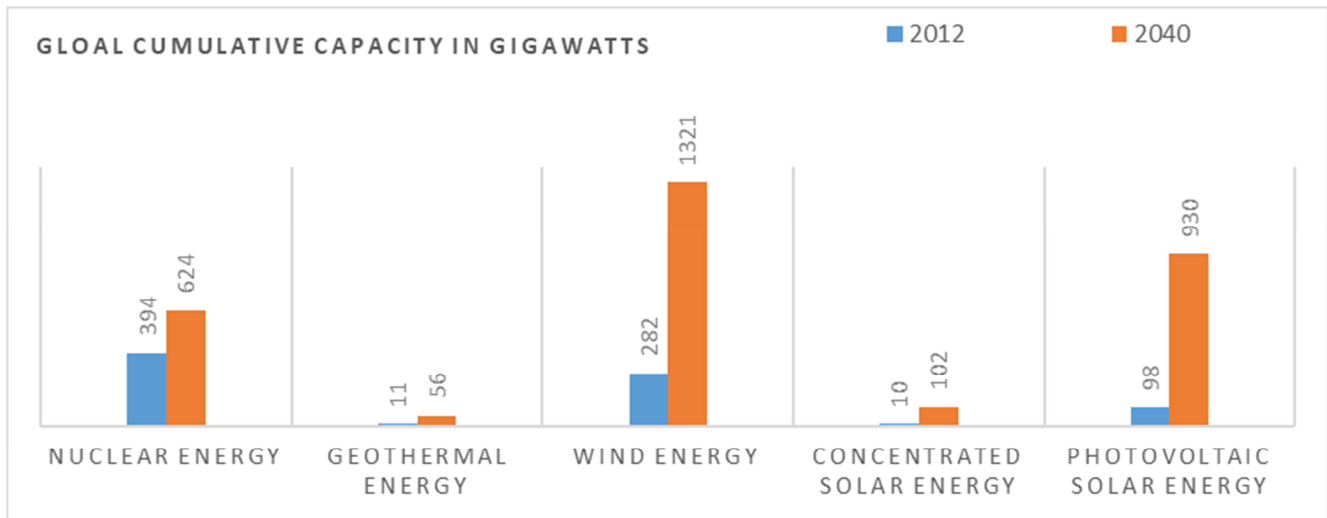


## 5. Prospects for the Growth of Alternative Energies in the World

*First: Expectations global to Increase the Capacity of Alternative Energy*

Solar energy, wind energy, and nuclear energy have the largest rates that indicate the growth of the generated capacity globally, and as shown in the following figure, the capacity generated from solar energy installations will grow

at a rate of 930 gigawatts, and nuclear energy will also reach an increase in capacity at a rate of 230 gigawatts in 2040. It is also an excellent provider of basic loads, as it does not depend on a variable fuel resource. Once the nuclear reactor is charged with nuclear fuel, it can operate around the clock for a period of one to two years. These indicators are useful to Egypt. Because the country's high resource potential in solar and wind energy provides an advantage for the private sector to participate in global markets. [7]



**Figure 6.** Expectations Global on increasing the capacity of alternative and renewable energy by 2040.

Source: Riyadh Economic Forum (2018) Towards Sustainable Economic Development, Seventh Session, Economics of Alternative and Renewable Energy in the Kingdom of Saudi Arabia Challenges and future prospects, supervised by Abdul Aziz bin Muhammad Al-Suwailem, Maher bin Abdullah Al-Awdan, pg. 59.

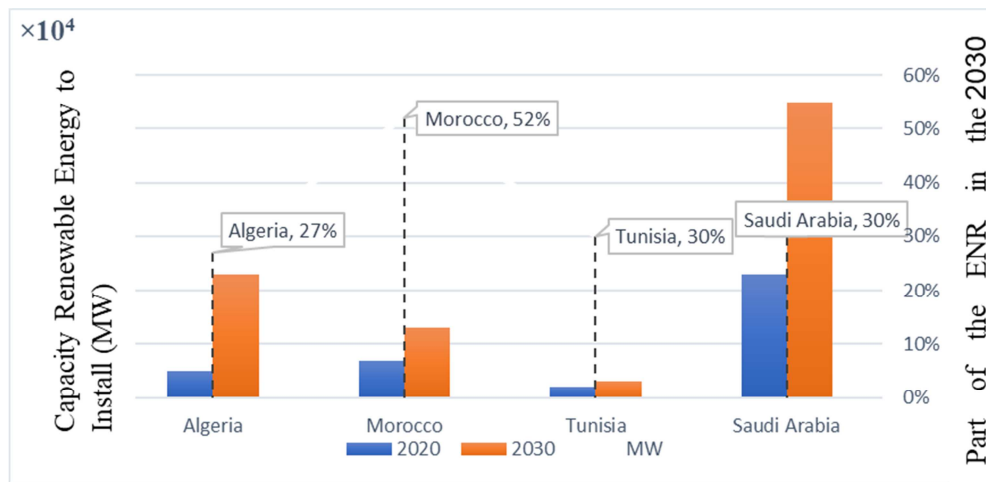
And to achieve economic stability and competitiveness in the international market. Renewable energy sources are an essential component of future energy pathways. And the development of electricity networks as an important element in the process of transitioning towards low-carbon energy systems and developing the technological and institutional basis for a secure, large-scale, economically competitive nuclear power. Nuclear power supplies stable, high-quality electricity while reducing pollution in many developed and developing countries. [8]

The energy sector has become the target of new national policies attributed to improving generation efficiency and increasing the adoption of non-fossil generation. These policies are: assessment of climate change, fuel resource use, water consumption, pollution risk reduction, and reliability of efficient power generation. Hence, the national policies aimed at increasing the role of the contribution of nuclear energy in the energy mix to mitigate climate change, as it provides a large amount of low-cost electricity. and promote progress towards achieving the Sustainable Development Goals and mitigating climate change in an environmentally

efficient and economically efficient manner and encourage support for technologies, institutions and actors.

Among the implications of this are the investment trends in the Arab countries, as the following figure shows the shift of many countries to the use of renewable energy to save the consumption of their fossil resources, such as Morocco, Tunisia and Saudi Arabia, despite their huge reserves of oil and natural gas; It is therefore important to put in place a transformation of an energy system that will allow it to reduce its dependence on fuel and continue to contribute to the financing of national economic development. Like those Arab countries, the achievement of renewable energy goals can be considered as a starting point for achieving reform of the electricity sector in Egypt [9].

All these considerations justify the massive inclusion of new energies in the long-term energy supply strategy, and their adoption an energy policy based on finding actual alternative elements that achieve the preservation, exploitation, and management of its depleted petroleum resources with high efficiency to support the process of sustainable development.

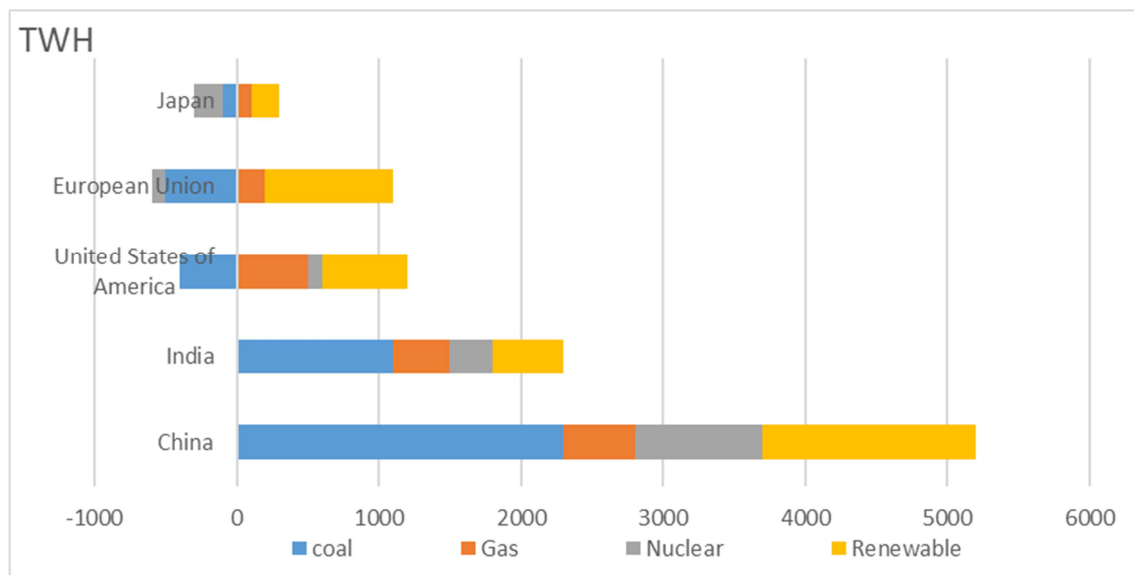


Source: Abada, Z., & Bouharkat, M. (2018). Study of management strategy of energy resources in Algeria. Energy Reports, 4, 1-7

**Figure 7.** The Capacities to Be Installed by 2020 and 2030, and the Share of Capacity in the Energy Mix in Some Arab Countries.

The investment trends in developed countries We can see from the figure that China's investments have exceeded their counterparts in Europe in the fields of renewable energy. The growth of global investment in developed countries has increased at an annual rate of 17%, reaching a new record level. China is also at the forefront of generating electricity from its own sources. Where China is now investing more

heavily in renewable technologies than Germany, the United States, India, and Italy; It is likely to exceed Its investment is 5500 TWh by 2035. The European Union generates 71% of renewable electricity; Investing in it represents an economic, healthy, and environmentally friendly dimension, and thus it has become a great economic solution for developed and developing countries. [10]



**Figure 8.** Investment Trends in a Group of Developed Countries.

Source: Ahmed, S., Islam, MT, Karim, MA, & Karim, NM (2014). Exploitation of renewable energy for sustainable development and overcoming power crisis in Bangladesh. Renewable Energy, 72, 223-235.

To improve the performance of the electric power sector in Egypt, it is necessary to consider the availability of energy policies; Including supporting investments and setting construction standards to promote industrial development based on renewable energy infrastructure to support sustainable initiatives and improve the competitiveness of the state, and Giving priority to continuing efforts to invest in the development of alternative energies as a basic tool for

sustainability, and its growing participation in the energy mix.

The researcher believes that nuclear energy will occupy the main force for improving clean energy, and it is a feasible way to complete the goal of reducing gas emissions in developing countries., Nuclear energy has also been associated with job creation and economic growth, as it contributes to the development of high-quality human resources. Nuclear development provides a new opportunity

for advanced science education. [11]

Decisions and practices of the energy sector play a central role in determining the sustainability of development; Structural changes in the economy. It includes that energy production on a technological basis is better than production based on depleted resources, And that nuclear energy technology is able to compete in the investment market, The government, in cooperation with the private sector, can work to ensure the dissemination of alternative technologies that are efficient in production.

*To clarify this, we refer to the benefits of renewable energy, which are:*

- 1) Social effects1- Creating a workforce. 2- Increasing internal security by providing energy instead of importing it.
- 2) Political effects1- Creating actors in the energy future. 2-Local ownership and decision making. 3- Community building and empowerment.
- 3) Technological effects: 1-Education and training in the field of renewable energy. 2- Developing the renewable energy industry. 3- Energy self-sufficiency.
- 4) Environmental Effects: 1-Reducing greenhouse gas emissions, and the way to the possibility of mitigating carbon emissions is the rapid expansion of nuclear power generation. 2- An increase in environmental values and behaviors.
- 5) Economic effects: 1-income for shareholders. 2- Income for the local community. 3- Local jobs. 4-Community assets, regional development, and income diversification.

The system based on power generation from a variety of renewable sources provides a system that is more robust and less vulnerable to interruptions in the supply of electricity compared to central systems, thus ensuring energy security. Hence, its development is a strategic choice for the structural adjustment of the energy sector. [12]

## 6. Efforts of Sustainability of Nuclear Energy in Egypt

Egypt has set ambitious goals to achieve sustainability related to energy production, and these goals will be achieved by supporting empowerment and capacity building, improving the provision of basic services in health and education, technological innovation, and sustainable management of natural resources, in compliance with the principles of development. And raising the rate of growth in energy use in any country, which depends on its current level of development and strengthening the nuclear security infrastructure.

The transition to a low-carbon energy system depends largely on the pace of technological transformation as well as institutional changes, and the role of technology currently allows choosing environmental impacts in the future, so technology more efficiently harnesses environmental resources to achieve environmental sustainability. And the

development of new technologies and new energies, to improve the structure of energy consumption. [13]

And when external risks and costs are low, nuclear power becomes competitive. With the increasing demand for electricity, nuclear energy is an essential part of energy security in Egypt, managing its electricity needs mainly through nuclear production. The sustainability of energy options depends on their performance in achieving policy objectives such as alleviating energy poverty, improving equity, reducing air pollution, enhancing energy security and ensuring economic well-being. It consists of:

### 1) Principles of Sustainability of Nuclear Energy:

- 1- Institutional change. 2. Optimize the power supply mix.
- 3- Physical protection and infrastructure.
- 4- Redistribution of natural resources in a fair manner. 6- Direction of investments. 7- The trend of technological development.

8- Preserving the ecological resilience of the inclusion environment in the energy system. 9- Energy security (reducing exposure to fluctuations in fuel prices).

### 2) Technology transfer and Technical considerations for developing countries

Building a successful nuclear program must ensure building participatory policies with developed countries in exporting technology to achieve economic integration between the two regions; The transfer of technology to developing countries contributed greatly to energy production, such as Brazil, China, India, Korea, Argentina and South Africa. This continuous transfer of technology is based on building technical capabilities to manage nuclear materials and the ability to regulate, supervise and ensure their safety. As a result, it requires building the scientific basis in the developing world in order to promote the beneficial uses of nuclear science and technology in the future. [14]

As The association of technology transfer with industrialization is a remedy for the problem of underdevelopment and a key factor that allows bridging the existing technological gap between it and developed countries, and The success of industry localization depends on the existence of local capabilities related to the development and production of nuclear technology. Manufacturers need to master continuous technological adaptation and improve cost and performance to compete in the domestic and international market by means of international joint ventures to attract foreign know-how in design and production.

### 3) Technical Cooperation Program to support nuclear projects.

The IAEA uses the Technical Cooperation Program to help countries design, formulate, implement, and evaluate regional cooperative activities. The applied regional cooperative modalities included technical cooperation among developing countries, such as a cooperation agreement for Arab countries in Asia for research, development and training in the field of nuclear science and technology, as the agreement includes providing support for regional projects across national borders and meets the needs of many member



states in various regions, in addition to to increase the number of trained professionals in nuclear applications.

The support provided through the Technical Cooperation Program was effective in enhancing the capabilities of member states to initiate and manage cooperative activities efficiently, with developed countries guiding less developed countries by hosting training activities and field experts and their contribution to building human capacities, and promoting the exchange of information, knowledge, and expertise to facilitate science. technology, sustainable energy planning and development, including the nuclear power option for electricity generation, environmental management, and nuclear safety and security; The global partnership for sustainable development within TCP adds value to the work of technical cooperation through broader strategic communication, technical innovation, and additional financial resources. [15]

#### 4) Sustainability of future electricity sources

Reducing the share of fossil fuels in the electricity mix will not only significantly reduce environmental impacts, but also reduce costs, injuries, and deaths from electricity generation; Therefore, future policies should be directed towards reducing the contribution of fossil fuel technologies and increasing low-carbon options.

Egypt suffers from rapid population growth, and in addition to other environmental challenges, this exhausts the limited energy resources in the region, and therefore an energy policy carefully designed to achieve sustainable development must be implemented. The country adopted plans to establish nuclear power plants that produce electricity through nuclear means. Incorporating nuclear power into the country's power generation portfolio reduces greenhouse gas emissions due to the low share of fossil fuels.

The government should strengthen financial support mechanisms and incentives to encourage renewable energy to become more competitive with fossil fuels, especially for technologies with high capital costs such as nuclear energy. The difficulties faced by a single country in mobilizing the huge capital investment required for energy infrastructure projects justify the need for regional cooperation and integration for technology transfer and capacity building. And encourage the use of renewable technology in industrial applications. [16]

#### 5) The framework of the benefits and productive uses of energy

The importance of energy production efficiency in providing an improved electrical supply in Egypt to support the industry, agriculture, education, and health sectors, as energy management in a country is linked to many policies such as: trade, infrastructure, environment, transportation, and finance. And the effective use of the international energy market to achieve structural diversification and global economic integration to share resources. It depends on attractive incentives, such as an effective pricing policy and an enabling environment that leads to a sustainable market and encourages renewable energy generation in Egypt.

to build new nuclear capabilities, where the nuclear option is a new opportunity to give diversification and more

reliability to the electrical system.

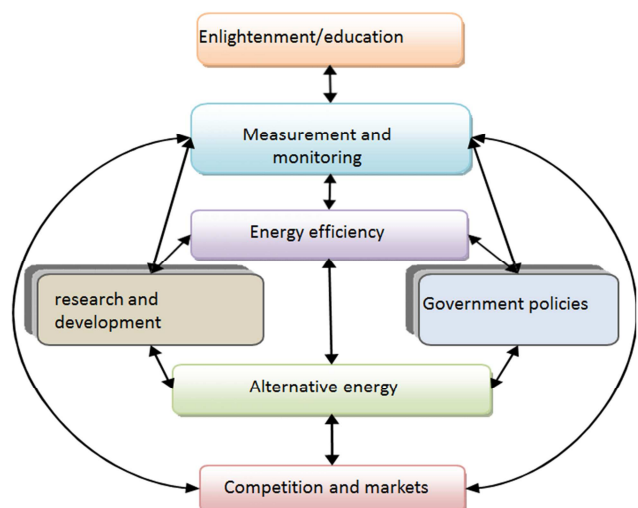
Sustainable development takes into account the activation of modern technology and linking it to the goals of society, so sustainable development relies heavily on modern technology, and always seeks to develop its use in achieving the goals of society, by educating the population on the importance of various technologies in the development field, and how to use the available and new ones in improving the quality of The life of society and the achievement of its desired goals, without this leading to negative environmental risks and effects, and access to sustainable modern energy services contributes to the eradication of poverty, the improvement of health, and helps to meet basic human needs.

*The requirements for achieving sustainable energy are represented in the following figure:*

*Measurement and monitoring:* It means monitoring the implementation and impact of the energy sector. Energy Management and Efficiency: Achieving cost-effective energy efficiency potential is beneficial to the economy.

*Research and development* There should be a development of technology based on the available resources and technological cooperation in the field of nuclear energy.

*Competition and markets:* It is evident in the existence of stable, transparent and participatory patterns in making energy policies and competitive markets, and in promoting trade in energy and fuel technology and achieving a sustainable energy infrastructure, Through the introduction of legislation that supports the initiative and provides funds to support projects that involve saving energy and developing its sources. [17]



Source: Designed by the researcher

**Figure 9.** Methods sustainability.

## 7. Nuclear Energy Policies in Egypt

There is an ongoing global movement towards zero carbon economies. Implementation of renewable energy development strategies. To improve sustainable international development and promote green economy, and increase the efficiency of energy strategy in collaborative work, Until

nuclear power plants became an important part of the energy mix in Egypt. [18]

*The main requirements of the energy supply chain include:*

- 1) Energy security guarantee.
- 2) Restructuring the energy sector.
- 3) Increasing the energy sector's contribution to the GDP.
- 4) Maximize the use of local energy resources.
- 5) Promoting rational and sustainable management of the sector.
- 6) Reduce energy consumption intensity.
- 7) Reducing the environmental impact of emissions in the sector.
- 8) Energy Support Administration.

9) Promote innovation in the energy sector.

10) Rehabilitation of competencies needed by the sector.

11) Reconsider the governing legislative framework.

12) Application of environmental standards and expansion of audited measurements.

13) Construction of the Dabaa nuclear plant.

Considering the objectives of energy security, resource efficiency, and climate change mitigation, nuclear energy: (a) represents a well-established electricity generation technology that does not produce carbon or other climate-related emissions; (b) It is expandable, and therefore can save large amounts of energy. (C) It uses a natural resource such as fuel (uranium). [19]

**Table 1.** Comparing the costs of nuclear energy and other energy sources.

The cost of kilowatt-hours of electricity for stations that entered service in 2018/2016 in the United States (in US cents)	
Cost per kilowatt-hour of electricity for stations	
Charcoal is environmentally friendly	0.1362 cents per kilowatt-hour
Natural gas	0.0893 cents per kilowatt-hour
Nuclear Energy	0.1139 cents per kilowatt-hour
Solar energy (solar generators)	0.2107 cents per kilowatt-hour
solar energy (thermal)	0.3118 cents per kilowatt-hour
waterfalls	0.0864 cents per kilowatt-hour
It turns out that the price per kilowatt-hour of solar energy is about two or three times higher than that of nuclear energy.	
Price per kilowatt-hour of various energy sources in the UK	
Nuclear Energy	80-105 GBP/MWh
Charcoal is environmentally friendly	£100-155/MWh
solar energy	£125-180/MWh
And it turns out that the price per kilowatt-hour of energy Nuclear is cheaper than the corresponding price of solar energy	
Price per kilowatt-hour of various energy sources in France	
Nuclear Energy	50 Euro/MWh
solar energy	293 EUR/MWh
It turns out that the price per kilowatt-hour of solar energy is about six times the corresponding price for nuclear energy.	
The price per kilowatt-hour of various energy sources in Australia	
Nuclear Energy	40-70 Australian dollars/megawatt hour
Charcoal is environmentally friendly	64-107 Australian dollars/MWh
solar energy	85 Australian dollars / megawatt hour
solar power generators	120 Australian dollars / megawatt hour
From it, it turns out that the price of kilowatt-hours of nuclear energy is cheaper than the corresponding price of solar energy.	

Source: El-Osery, IA (2017). The Egyptian Nuclear Power Project and IAEA Technical Assistance in Supporting the Project and its Nuclear Safeguards (No. IAEA-CN-220).

One of the implications of this idea is that the external cost of alternative sources is 50% higher than the cost of nuclear energy. These costs will include those related to impacts on human health and the environment, global warming, long-term waste management, and plant decommissioning. It turns out that it is a clean energy compared to fossil energy, and its economic efficiency is greater, but what is wrong with it is some long-term damage, especially radioactive ones, in addition to the danger of groundwater pollution and the difficulty of predicting nuclear risks.

## 8. Case Study on the Economic Benefits of the Nuclear Plant in America

The nuclear energy industry plays an important role in providing both job opportunities and raising economic growth. The 100 nuclear reactors in the United States generate significant domestic economic value in electricity

sales; It is between 40 and 50 billion dollars annually; More than 100,000 workers also contribute to production; Worldwide, more than 170 new nuclear power plant projects are in the licensing and advanced planning stages; Where 72 stations are currently being constructed, and as a result, the coming years will witness an increase in the demand for materials, components and services for the global nuclear industry. The Ministry of Commerce estimates the global market for nuclear products, services, and fuel at between \$500 and \$740 billion over the next ten years; Nuclear power is the only proven technology that can provide emissions-free and affordable electricity.

It shows analysis of 23 US nuclear power plants represented in 41 reactors; Every dollar spent by the average reactor leads to the creation of \$1.04 in the local community, \$1.18 in the state economy, and \$1.87 in the US national economy. The average nuclear plant pumps about \$16 million in governmental and local taxes annually, and schools, roads, and other facilities benefit from these taxes.

State and local infrastructure, and the average nuclear plant also pays federal taxes of 67 \$ million annually, which are used to build state public facilities.

- 1) The effects of establishing a nuclear plant on the income of the workforce

Nuclear plants create the largest annual income for the workforce based on being a labor-intensive technology, as

the table below shows the number of jobs, average wages, and workforce income from nuclear energy in America. The average electricity production from nuclear power of 1,000 megawatts generates nearly \$470 million in economic output or value added, including more than \$35 million in total labor income.

*Table 2. Benefits of establishing a nuclear plant.*

income of the workforce (\$ million / year)	Average income (hour/\$)	Direct local jobs	average size (mw)	Jobs / MW	technology
\$32.49	\$31	504	1,000	0.5	Nuclear

Source: Nuclear Energy's Economic Benefits, (April 2014) Current and Future, white paper, nuclear energy institute, pag3.

- 2) Implications of manufacturing and services in the United States

US nuclear reactors generate significant domestic economic value in electricity sales; That is, between 40 and 50 billion dollars annually, and from these revenues, nuclear companies purchase more than 14 billion dollars annually in materials, fuel, and services from local suppliers.

- 3) Its effects on Commercial nuclear exports create more US jobs.

Businesses and workers in the United States benefit from the expansion of nuclear power that is underway around the world; American companies have already booked export orders in equipment and services, including generators, reactor coolant pumps, instrumentation, and control systems, and according to the Commerce Department, every 1\$ billion in exports by American companies represents 5,000 to 10,000 jobs in the United States.

has entered into contracts with new nuclear projects being built in the UAE; The Export-Import Bank in the United States approved a loan of two billion dollars to support American exports of goods, and the UAE has contracted with many American companies to provide program management services, regulation, law, design, engineering, environment, control, training and licensing, and the provision of reactor coolant pumps, reactor components, controls, and engineering and training services, and other companies in the United States provide additional engineering, construction management, quality control, materials management, and regulatory services.

- 4) Building and construction time for nuclear power plants

The project construction time affects both its investment attractiveness and financing costs, as the time it takes to build nuclear power plants is from 4 to 7.1 years; As for concentrated solar power plants, the average construction time is 2.0 years. On the other hand, we find that the natural gas-fired stations take a shorter construction period, ranging from 2 to 3 years. As for the coal-fired stations, it takes a construction period of about 5 years. Hence, the ability of this industry to compete is closely linked to the length of construction periods, and any delay in construction operations is due to delays in issuing licenses or legal issues, or facing technical problems due to the difficulty of providing expertise, equipment and components, and all of this leads to the high capital cost of this industry; The

lengthening of the period specified for the completion of construction and start-up has a significant impact on the economics of nuclear energy. However, changes were made to make improvements through the inclusion of organizational changes starting from the design stage until the completion of construction operations, which reflected positively on the time spent on building and construction.

In contrast, nuclear energy does not require large areas for the resettlement of large numbers of people, and therefore its environmental impact on land, forests and water is very small, and the amount of toxic elements arising as waste from burning coal is greater than the amount of nuclear fuel consumed to generate the same amount of electricity from a nuclear power plant.

Accordingly, nuclear reactors provide primary load power that continues over 90% of the time, and thus the consumption of nuclear energy as renewable energy increases dramatically in the United States. [20]

Accordingly, the energy crisis can be dealt with in three ways. 1) Generate energy. 2) Energy rationalization policies. 3) Energy conservation. 4) Strengthening interconnection between energy networks.

*Considering this, the government identified several main areas of action:*

- 1) Creating more competition in the liberalized energy markets. 2) Security of supply. 3) Economic efficiency. 4) Enhancing energy efficiency. In the same context, strengthening the capabilities of the state depends on a) policy and awareness. b) Market promotion. C) development and support. d) Technology.

*The energy policy in Egypt aims to:*

Create a fully integrated internal energy market.

Research and innovation: supporting low-carbon technologies.

Supply security: diversifying energy sources and making them more efficient.

*Second: Nuclear security systems and measures*

Nuclear safety, like nuclear security, aims to protect people, property, society, and the environment from the harmful effects of ionizing radiation. Work to address the risks emanating from radiation during its normal use, and from potential accidents, is considered work aimed at enhancing nuclear safety. Nuclear security work is aimed at preventing, detecting, and responding to malicious acts

involving radioactive materials, or directed against facilities or activities where such materials are used.

**Table 3.** Security requirements and mechanisms for implementing the technical aspects of nuclear safety. Several underlying technical principles are necessary for the successful application of safety technology to nuclear facilities.

- Evaluation of the expected life of the facility. The use of non-combustible and heat-resistant materials, especially in the reactor building and control room.	- Barriers to prevent the release of radioactive materials, reduce the exposure of site employees to radiation, and form a barrier that prevents the release of radioactive materials into the environment.	Appropriate classification of structures, systems, and components. An emergency system for cooling the reactor core and means of containment. Early warning systems and appropriate means of communication.	Design and construction of nuclear facilities
High-quality software and hardware are required. Emergency reactor core cooling system.	The regulatory body shall establish a program for planned and regular inspection.	- Legal infrastructure: The government ensures the provision of a legal infrastructure and regulatory basis for evaluating the safety of a research reactor. It is responsible for adopting the necessary legislation.	Regulatory supervision of nuclear facilities
- Independent evaluations are conducted by employees of the Authority to assess the effectiveness of administrative operations and work performance.	Organizational interface management. Institutional Support Department. Functional responsibilities.	- Quality Assurance: a schedule for the completion of the activities related to the stages, such as the site study - Arrangements for inspections, tests and periodic maintenance.	Security management
-Evaluation of the risks of earthquakes, weather events and floods; It is necessary to prepare a description of the area from the angle of meteorology. External risks resulting from human activity.	Population density, distribution and characteristics of the area surrounding the site, relevant to potential emergency measures and assessment of risks to the population.	The characteristics of the site and its environment that may have an impact on the transfer of releases of radioactive materials to humans are taken into consideration. The containment structure represents the function of containing radioactive materials inside the nuclear reactor to prevent unplanned release and protect the reactor from external events.	Site evaluation and selection
- Monitoring devices to measure the activity of radioactive materials in the atmosphere and at the entrances and exits of the facility to remove the radioactive materials. Monitor, calibrate and test performance periodically. Defining international assistance programs to raise awareness, educate and qualify specialized experts.	Devices for measuring surface contamination with radioactive materials. -heart the reactor maintains where the fuel geometry is on the necessary path for coolant flow.	Fixed dose rate measuring devices showing radiation levels in workplaces where operators are routinely present. -Transparency and credibility of information related to nuclear activities.	Radiation protection systems
Dismantle and dispose of contaminated equipment and devices and reduce any rise in fuel temperature.	- Develop a plan for usage monitoring, system monitoring, and hardware inventory. - Dumping of activated structures and large components and decontamination of remaining structures to allow unrestricted use of the facility.	- Conducting the necessary planning for financial resources to ensure the operational effectiveness of national capabilities. - Preventive storage of the entire reactor after removing all fuel assemblies and all facilitating removal of activated and radioactive components.	sustainability Output out of service

Source: researcher's work, from the content International Atomic Energy Agency safety standards for the protection of people and the environment, safety of research reactors, International Atomic Energy Agency, No. NS-R-4, pp. 1-140.

## 9. Results of Study

After presenting, interpreting, and correcting the facts through realistic phenomena and applying analytical method, the study reached the following results:

1. The construction of nuclear power plants has a significant impact on the country's gross domestic product, not only because of the direct impact of the project on the revenues of local contractors, but also because of the indirect impact, which the plant project ensures the growth of orders in "related industries" such as orders for the supply of materials, construction equipment, utilities and other services, as well as the growth of demand for industries that serve consumer goods, and additional jobs will be created in the construction and engineering industries.
2. Several industries undergo qualitative development;

Nuclear energy is a highly precise and technical industry with increasing requirements for delivery time, composition and quality of materials and equipment, and therefore the participation of local institutions in nuclear projects will inevitably increase their efficiency and competitiveness locally and globally. Such companies are usually in high demand in other countries that sell large infrastructure facilities.

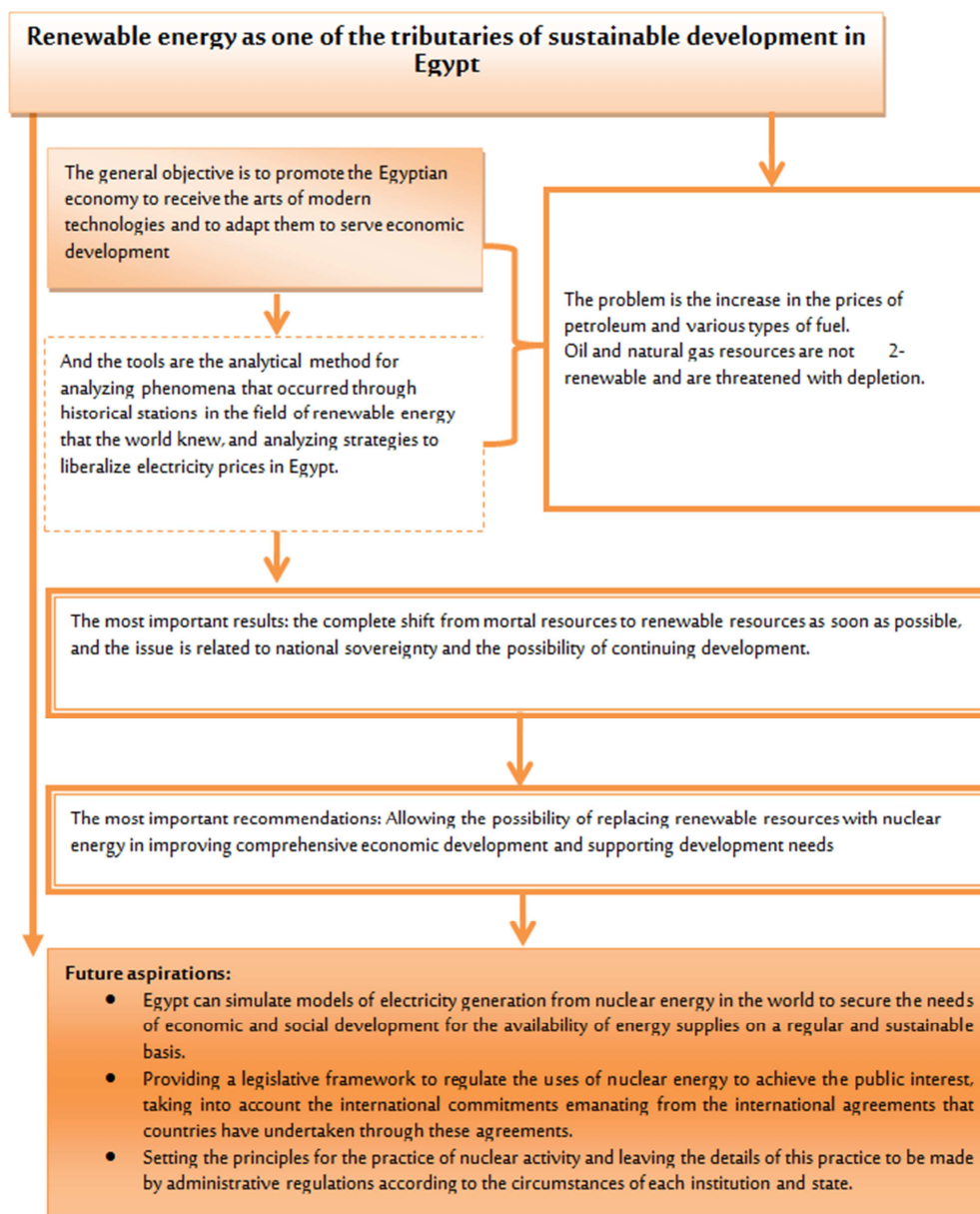
3. Nuclear energy constitutes a complete infrastructure for other fields not related to energy production, in particular, this includes nuclear medicine, the use of research reactors for scientific research, the use of radiation techniques in agriculture, materials science and other fields, and new opportunities to improve the quality of human life.
4. The study confirmed that the presence of nuclear power plants in Egypt gives tremendous impetus to economic and technological development, and becomes a

permanent source of growth, pointing out that every dollar invested in building a nuclear power plant using Russian technologies will generate about 2\$ from the revenues of local companies, and two and a half dollars from tax revenue, and 4 \$ of the national gross domestic product.

## 10. Conclusion

The fossil fuel burning is the main culprit behind global warming which resulted in greenhouse gases (GHG) emissions led by carbon dioxide (CO<sub>2</sub>) emission, key contributor to environmental pollution. The rising CO<sub>2</sub> emissions intensity and global warming complexities have raised the importance to focus on alternative energy generation options. The serious concerns over fossil fuel

consumption, issue of energy security, and GHG emissions challenges have brought attention to clean energy sources among public and policy analysts as well. Clean energy options (nuclear energy and renewable energy) have emerged as alternate energy source and effective tools to combat the hazards of climate change. As a part of the new energy policy strategy, many countries are focusing on increasing the share of nuclear energy supply to diversify energy supply, reduce dependence on imported fossil fuels with volatile prices, increase energy stability and security. Accordingly, The current study contributes to expanding knowledge and starting to improve Egypt's nuclear power infrastructure by investigating the relationship between nuclear power, economic growth and CO<sub>2</sub> emissions in the context of the experiences of the devastated countries such as China and South Korea.



*Figure 10. Renewable energy as one of the tributaries of sustainable development in Egypt.*

## References

- [1] Mustafa Ahmed Abu Al-Khair, The Right of States to the Peaceful Uses of Nuclear Energy in International Law, Chairman of the Advisory Board of the Palestinian Society for Human Rights (Rased), <http://saotaliassar.org/Frei%20Kitabat/01032012Schrift/D-AhmadAbuAlKchair01.htm>
- [2] Salehi-Isfahani, D. (2016). Energy subsidy reform in Iran. In *The Middle East Economies in Times of Transition* (pp. 186-195). Palgrave Macmillan, London.
- [3] The Role of Natural Gas in Achieving Sustainable Development in the Arab Countries (October 2015), Organization of Arab Petroleum Exporting Countries (OAPEC), Kuwait, p. 7.
- [4] Gladkykh, G., Spittler, N., Davíðsdóttir, B., & Diemer, A. (2018). Steady state of energy: Feedback and leverages for promoting or preventing sustainable energy system development. *Energy Policy*, 120, 121-131.
- [5] Al-Mansour, F., Sucic, B., & Pusnik, M. (2014). Challenges and prospects of electricity production from renewable energy sources in Slovenia. *Energy*, 77, 73-81.
- [6] HUSSAIN, N., UQAILI, MA, HARIJAN, K., & VALASAI, G. (2015). 422: Pakistan's energy system: integrated energy modeling and formulation of national energy policies. *SUSTAINABLE ENERGY*, 591. Pp 1-10.
- [7] Maulidia, M., Dargusch, P., Ashworth, P., & Ardiansyah, F. (2019). Rethinking renewable energy targets and electricity sector reform in Indonesia: a private sector perspective. *Renewable and Sustainable Energy Reviews*, 101, 231-247.
- [8] Ahmed, S., Islam, MT, Karim, MA, & Karim, NM (2014). Exploitation of renewable energy for sustainable development and overcoming power crisis in Bangladesh. *Renewable Energy*, 72, 223-235.
- [9] Pietrosevoli, L., & Rodríguez-Monroy, C. (2019). The Venezuelan energy crisis: Renewable energy in the transition towards sustainability. *Renewable and Sustainable Energy Reviews*, 105, 415-426.
- [10] Lindberg, MB, Markard, J, & Andersen, AD (2018). Policies, actors and sustainability transition pathways: A study of the EU's energy policy mix. *Research policy*.
- [11] Ferenc L. Toth, (November 2014) Nuclear energy and sustainable development1, *Energy Policy* 74 pp 1-4.
- [12] Abada, Z., & Bouharkat, M. (2018). Study of management strategy of energy resources in Algeria. *Energy Reports*, 4, 1-7.
- [13] Khurshid, SJ (March 2018), Nuclear Techniques for Sustainable Development Goals—Pakistan's Perspective. pp 1-9.
- [14] Moreira, JM, Cesaretti, MA, Carajilescov, P., & Maiorino, JR (2015). Sustainability deterioration of electricity generation in Brazil. *Energy Policy*, 87, 334-346.
- [15] Peng, L., Zhang, Y., Li, F., Wang, Q., Chen, X., & Yu, A. (2019). Policy implication of nuclear energy's potential for energy optimization and CO2 mitigation: a case study of Fujian, China. *Nuclear Engineering and Technology*.
- [16] Ekaterina Borisova, (January 2018) Development of Saudi Arabia's Nuclear Program: Causes and Consequences, Institute of Oriental Studies, Moscow, Russia. pp. 123-130.
- [17] Ho, SS, Oshita, T., Looi, J., Leong, AD, & Chuah, AS (2019). Exploring public perceptions of benefits and risks, trust, and acceptance of nuclear energy in Thailand and Vietnam: A qualitative approach. *Energy Policy*, 127, 259-268.
- [18] Kutun, AM, Paramati, SR, Ummalla, M., & Zakari, A. (2018). Financing renewable energy projects in major emerging market economies: Evidence in the perspective of sustainable economic development. *Emerging Markets Finance and Trade*, 54 (8), 1762-1778.
- [19] Vezzoni, B., Lomonaco, G., & Forasassi, G. (2009). Preliminary Approach to Sustainable Nuclear Scenario Definition. Case Study: Italy. Pp 1-11.
- [20] Edomah, N., Foulds, C., & Jones, A. (2017). Policy making and energy infrastructure change: A Nigerian case study of energy governance in the electricity sector. *Energy Policy*, 102, 476-485.