

# The Economic and Environmental Importance of Using Nuclear Energy to Generate Electricity

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**Abstract:** The world seeks, in accordance with sustainable development priorities, to impose methodologies that contribute to maximizing the utilization of 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 that are less expensive and better for the environment and promote economic development at the global and national levels. In view of the continued rise in the global demand for energy, especially in economies that have grown rapidly in industrialization and developing economies, he turned the issue of energy availability and security into an important political issue and a major element for all international conferences and forums of the United Nations, which seek energy sustainability at the lowest costs and the use of clean and human-friendly energies and environment. Egypt faces a similar situation with its reliance on the traditional pattern of electric power generation, especially fossil fuels, as a major source of energy, in addition to the increasing consumption considering the large economic and population growth. This puts great pressure on its fossil fuel resources. In addition, the need for alternative energy is of strategic importance for the long-term prosperity and security of the energy supply.

**Keywords:** Nuclear Energy, Fossil Fuels, Fuel Costs, Generate Electricity, Greenhouse Gas Emissions

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## 1. Introduction

Nuclear energy meets all the requirements of the energy future. It is a source of stable and clean energy at an economically attractive price, which together represents the basis for the global energy balance in the future.; One nuclear plant can produce enough electricity to light half a country; It allows strategic independence in the field of energy and reduces fluctuations in the cost of electricity production; Nuclear energy will also provide many benefits to the country. Such as creating millions of jobs that generate billions for citizens annually and maintaining an advanced technological level for the entire national economy, and it can be one of the most important factors for the prosperity of developing countries. [1]

To clarify this, we point out that it is economical in terms of cost compared to the amount of energy it produces. One kilogram of uranium produces two million times more energy

than a kilogram of coal, in order for the vision to be clear, the importance of this energy is represented in creating great opportunities for local, industrial and economic development that support the wheel of progress and scientific research. Accordingly, the nuclear sector relies heavily on government support, which appears through the formulation of a general policy supporting nuclear projects in countries seeking progress. [2]

The study explains the economic and environmental determinants of generating electricity from nuclear energy.

and Evaluation of the main systems of energy sources and their impact on the environment.

### 1.1. Summarize the Main Content of Each Section

Prepare Nuclear power stations are the most economical in generating electricity compared to central power stations operating on fossil fuels; the social return is great and is directly reflected in the life of the citizen [3]; This is in

addition to the fact that there will be a long-term production of electrical energy. The minimum age for using the station is up to sixty years, and it can extend for a longer period of time. Which will be reflected in providing job opportunities [4].

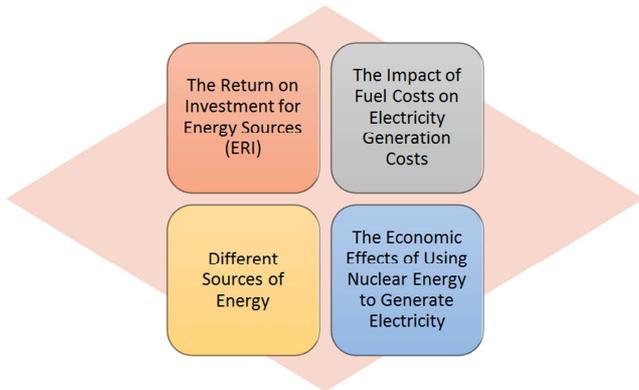


Figure 1. The role of nuclear energy in the sustainability of the electricity sector.

1.2. Future Investments

In addition to the future investments that will be pumped into the region because of the presence of that station, it is also linked to the idea of transferring science and technology that contributes to the development of the infrastructure of society.

Energy security is one of the main criteria for ensuring economic stability, as it is an integral part of national security [5] Where electricity is an essential input for the well-being of society and economic development; Hence, nuclear energy is one of the possible measures to meet the world's needs for electricity, being a promising alternative to traditional energy sources. to expose the cost of producing electricity from it is subject to sharp fluctuations because of fluctuations in the prices of its fossil fuels [6].

2. The Economic and Environmental Dimension of Generating Electricity from Nuclear Energy

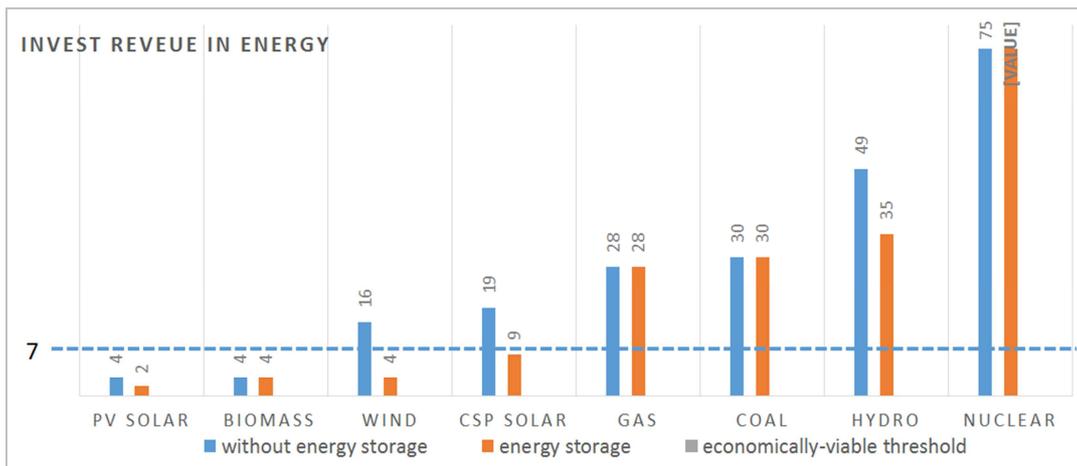
2.1. The Economic and Environmental Determinants of Generating Electricity from Nuclear Energy

2.1.1. The Return on Investment for Energy Sources (ERI)

It means return on investment. It is a performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments; Where the return on investment directly measures the amount of return on a specific investment compared to the cost of the investment; To calculate the return on investment, the interest (or return) of the investment is divided by the cost of the investment, and when the number is small, it is difficult to obtain energy from this source and it is expensive. [7]

We conclude from that when the number is one; There is no return on the energy invested, and the investment is completely wasted; The countervailing figure for the prosperity of our modern society is about 7; As a result of technological advances EROI is higher than 1. Several consumed energy sources were evaluated, where the EROI was determined for efficiency and cost analysis, and this includes different types of energy sources such as oil, biofuels, geothermal energy, nuclear fuel, coal, solar energy, wind energy, and hydroelectric energy. [8]

We point out that energy sources must exceed the economic value of about 7 (the blue line) to obtain the surplus energy needed to support modern society, and the minimum required energy source is EROI greater than 1 in order to be able to support the energy community.



James Conca, (2018), EROI -- A Tool To Predict The Best Energy Mix.

Figure 2. Return on investment from different energy sources.

It is clear from the figure 2 that the yield for each energy source represents 75 for nuclear, which is the highest yield compared to hydro 35, coal 30, closed-cycle gas turbines 28, solar thermal energy 9, wind 4, biomass 4, and solar

photovoltaic energy 2, and this is the reason why Serious environmental advocates, and the team of the United Nations, are strongly urging the world to adopt a combination of nuclear, hydro and renewable energy as the best combination

that can replace fossil fuels, and this combination will reduce carbon emissions by half from the current mix and can be achieved with existing technologies. [9]

From another angle, nuclear energy helps support the prospects for sustainable development. It is a form of energy generation with low carbon emissions, And a solution to the problem of greenhouse gases, and the local social and economic effects are represented in increasing local employment and expenditures and adding to the national economy. By providing job opportunities and strengthening the infrastructure, it will create more than three thousand jobs when a new facility is put into operation. The stations are safe. Safety is the basic principle when designing nuclear construction.

And he confirmed it nuclear fuel supplies are cost-competitive in the long run, and more environmentally friendly and less vulnerable to fuel price changes unlike coal and gas fired stations, which enhances the regional development of the state and enables the provision of current energies, AndIntegration with energy resource systems exported abroad.

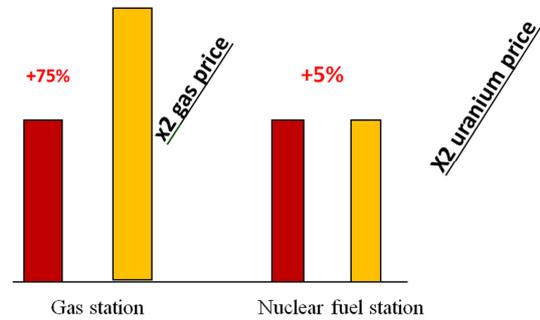
**2.1.2. The Main Features of Nuclear Energy**

Nuclear energy has advantages, the most important of which is a technology with a large production capacity, being a carbon-free source of electricity generation, stable cost and low marginal cost, geopolitical distribution of uranium resources and a local source of energy. Gas-fired electricity is no longer the cheapest form of generation because gas prices are expected to rise in the future.

We note that the most important aspect of nuclear energy is its lack of sensitivity to the cost of uranium fuel compared to energy based on fossil fuels. The following figure shows the cost of electricity after doubling both types of fuel costs; Where it turns out that the cost of nuclear energy does not increase by only 5% compared to 75% for the gas station. According to this vision, nuclear energy is significantly cheaper than coal and gas in all countries, and although the capital costs are greater than the costs incurred by coal-fired facilities, which are much greater than those of gas-fired

plants, the costs of nuclear fuel are very low.

From this standpoint, the effects of uranium price fluctuations on the generation cost are considered electricity through nuclear energy, relatively small compared to other methods used to generate electricity, and As a result, the total costs of nuclear power generation are quite favorable and will remain competitive. [10]

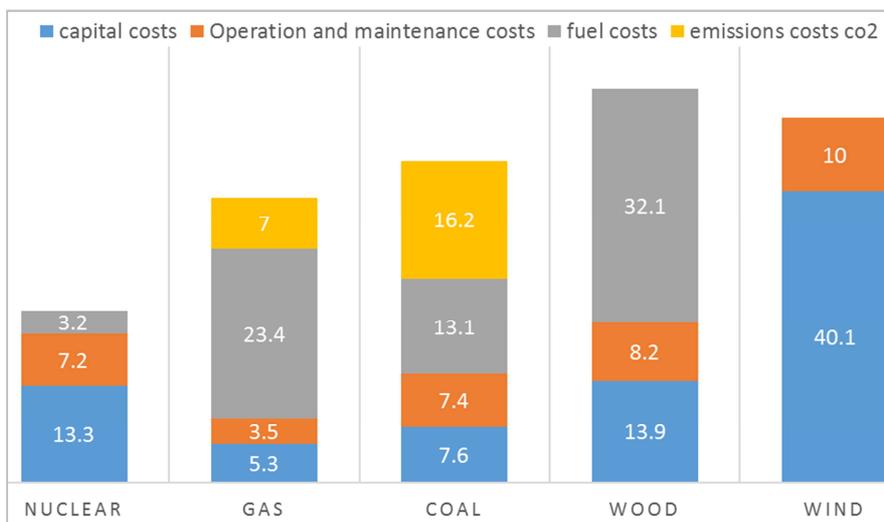


**Figure 3.** Sensitivity of the cost of electricity to fluctuating fuel prices. The effect of fuel cost on electricity generation costs (generation cost Euro/MWh).

Source: The researcher's design from the data available on the following website [www.iaea.org](http://www.iaea.org)

**2.1.3. The Cost-Effectiveness of Nuclear Power Generation**

Nuclear power is a prime example of reliably generating the electrical base load at stable and non-volatile costs; Which justifies the investment of nuclear energy economically; It is effective in terms of the cost of electricity. While fuel and operating costs have little effect on the price of nuclear electricity; They are not subject to any changes in fuel availability as uranium is widely available in various politically stable countries that secure its supplies. Also, nuclear power plants can help the country to diversify energy sources away from imported natural gas to obtain El availability the diversity of its sources contributes to increasing supply security.



Source: The Economics of Nuclear Power, (2008) World Nuclear Association, pp. 7

**Figure 4.** Comparison of the costs of energy sources (Euro/MWh) (working hours 2000 hours / year).

A detailed study on energy economics in Finland indicated that nuclear energy will be the least expensive option in relation to other generation capacities; The study compared nuclear energy with coal and gas turbines, and showed that although nuclear energy has much higher capital costs than other costs, amounting to 1749 euros / kilowatt; Including the initial fuel load, it is about three times the cost of a gas station, but it has much lower fuel costs, with capacity factors of over 64%, and is therefore the cheapest option.

The relative effects of capital and fuel costs are evident from the graph; The relatively high capital cost of nuclear energy means that the cost of financing and the time spent on construction are vital in relation to gas and coal, but the cost of fuel is much lower, and the effect of adding the cost of carbon emissions can also be seen, as the capital cost of nuclear energy is 13.3 euros / MWh and the cost of fuel is 3.2 Euro / megawatt hour, compared to the capital cost of gas 5.3 Euro / megawatt hour and fuel 23.4 euros / megawatt hour, and this indicates that the total costs of building a nuclear plant are cheaper than the costs of building gas, coal and wind plants.

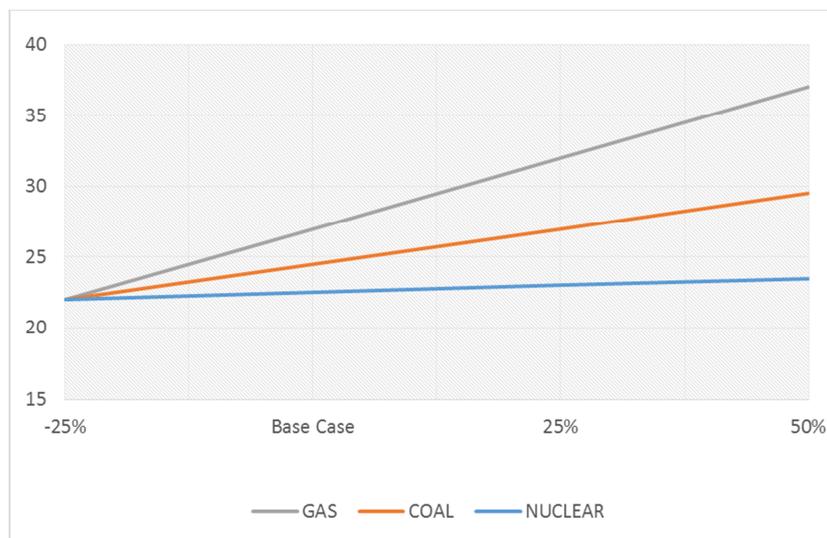
It is likely That the selection of the station depends on the global economic situation of the country; Nuclear power is capital-intensive, while fuel costs are more important for fossil-fuel-based systems; So if a country like Japan or France has to choose between importing large quantities of fuel or spending a lot of capital in setting up a station; Simple costs may be less important than broader economic

considerations, which can be a more serious drain on foreign exchange reserves than with less expensive uranium. Where the factors favoring uranium are as follows:

1. Uranium is characterized by being a highly concentrated source of energy that can be transported easily and at a low cost, and the quantities required are much less than coal or oil, as one kilogram of natural uranium produces about 20 thousand times the energy that coal itself reaches, and therefore it is in essence a portable and interchangeable commodity. to trade.
2. The contribution of fuel to the total cost of electricity produced is relatively small, and therefore the rise in fuel prices will have a relatively small effect; For example, it would double the market price of uranium The cost of LWR fuel should increase by 26%, and the cost of electricity by about 7% (while doubling the price of gas will add 70% to the price of electricity from this source). [11]

#### 2.1.4. The Impact of Fuel Costs on Electricity Generation Costs

The Finnish study indicated the sensitivity of fuel prices to electricity costs, and confirms this data The doubling of fuel prices will lead to an increase in the cost of electricity, for nuclear energy, by about 9%, and an increase in coal by 31%, and gas by 66%. Gas prices have already skyrocketed during the period 2008-2017, and thus nuclear electricity competes with gas, which is highly dependent on the price of fuel.



Source: The researcher worked according to the data from the following content The Economics of Nuclear Power, World Nuclear Association, 2008, pg. 7.

Figure 5. The effect of fuel cost on electricity generation costs (generation cost eur/mwh).

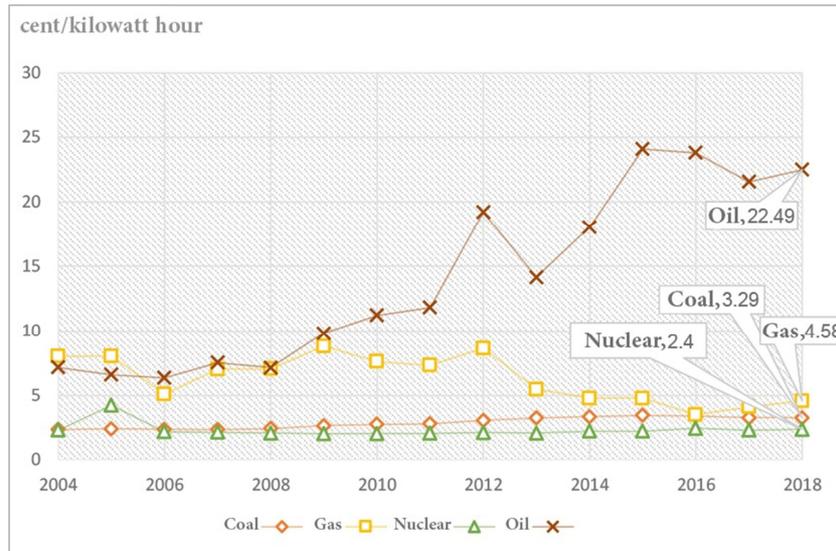
It is worth noting that the costs of transporting fossil fuels are higher, given that the amount of material transported will be large, as it is known The fuel required to produce the same energy is much more in the case of fossil fuels, and the main attraction of nuclear energy is the low cost of fuel compared to other sources and its long-term availability in a sustainable manner.

#### 2.1.5. Comparing the Total Production Costs with Different Sources of Energy

Prepare Nuclear energy is an economic source for generating electricity, as it is clear from the figure that nuclear energy is competitive in terms of cost compared to other sources of electricity generation. As shown in figure 6 Especially if the

social, health and environmental costs of fossil fuels are considered. The cost of producing electricity from nuclear

energy was 2.4 cents/kWh in 2018, compared to coal, gas and oil at 3.29, 4.58 and 22.49 cents/kWh, respectively.



Source: The researcher worked according to the data from the following website [www.statista.com/statistics/184712/US-electricity-production-costs-by-](http://www.statista.com/statistics/184712/US-electricity-production-costs-by-)

Figure 6. The cost of producing electricity in the United States.

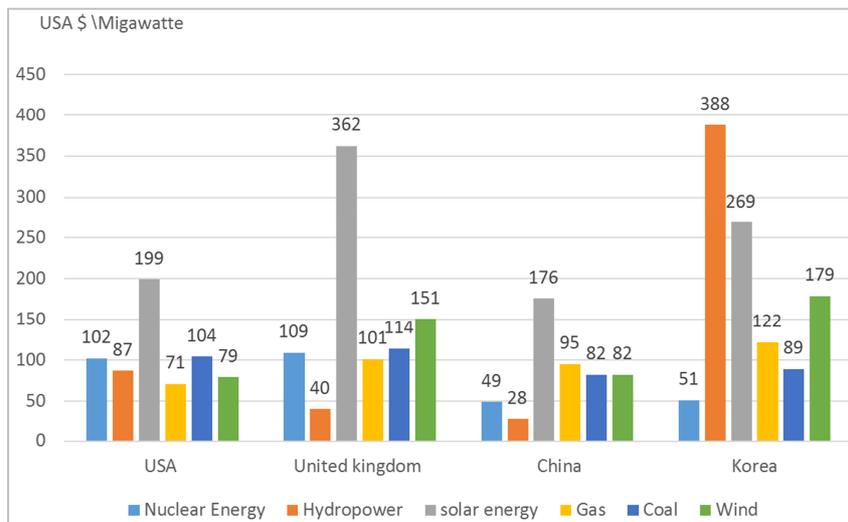
On the other hand, the downward trend of nuclear energy prices and the upward trend of oil prices (because of the increased demand for it) may lead to making the prices of electricity generated by nuclear energy crowd out the prices of electricity generated by fossil fuels, and this matter may turn Arab countries towards importing electric energy from the West.

While adopting the nuclear option helps industrial and technological development, as the plant needs parts and spare parts according to high specifications, a large part of which must be provided locally to reduce the economic cost; Which leads to an effective contribution to advancing the economy, national competitiveness, social justice and preserving the environment, while achieving leadership in the fields of renewable energy and

rational and sustainable management of resources.

In contrast with high fixed costs and low operating costs, the average electricity costs of nuclear plants decrease significantly with the increase in production. Whereas operating and maintenance costs tend to be somewhat higher compared to other thermal modes of generation. [12]

From another angle, the standard costs of a wide range of generation technologies in different countries are evaluated. It evaluates the relative costs of generating electricity for new plants that use various technologies; It highlights the continuing competitiveness of nuclear energy in many countries, generally due to the improvement in the operational performance of nuclear plants and the high expectations of fossil fuel prices.



Source: World Nuclear Association. (2017) Nuclear Power Economics and Project Structuring: Edition. World Nuclear Association, London, Tech. Rep.

Figure 7. Costs of electricity produced from energy sources in different countries at a discount rate of 10%.

Figure 7 shows the low costs of electricity produced from nuclear energy in the United States. It amounted to \$102/MW, compared to solar electricity at \$199/MW and coal at \$104/MW; It is also considered one of the least expensive energies in China, Korea and the United Kingdom. In the same context, the construction of nuclear power plants is a model for major infrastructure projects all over the world. Nuclear energy is characterized by the fact that it meets the needs of basic electrical loads very effectively. The percentage of what is provided by its production capacity is higher than 92%.

From another perspective, the purpose of developing the electric power industry is to create an advanced economic sector, as Egypt can establish an industrial group for local manufacturing of technology that contributes to the diversification of sources of electric power production. The government should also strive to encourage private sector companies to invest in clean technology and renewable energy resources; Egypt has huge natural energy resources such as wind energy and solar energy, but investing in them requires huge funds.

We note that it requires expansion in the infrastructure, there are many efforts and funds that may be difficult for the state to bear, and some countries may refuse to enter the nuclear program because of this investment being very expensive, which exhausts the national economy. One of the visions calling for this is that the burden of establishing the infrastructure of any country can be reduced if a group of countries share the burdens and costs and form a partnership at the regional level.

These include partnership; physical facilities, joint programs and knowledge; which is reflected as direct economic benefits; The information and infrastructure partnership also contributes to the harmonization and standardization of regulatory and legislative standards and frameworks and overcoming most of the problems that may arise during the planning, implementation and operation of the nuclear plant. [13]

**2.1.6. The Economic Effects of Using Nuclear Energy to Generate Electricity**

*1) Benefits of nuclear energy for water desalination:*

Saving water by various desalination techniques in light of the lack of natural water resources has become the preferred option, and accordingly Nuclear energy can play an important role in meeting the growing regional needs for electricity and water. where It is characterized by its ability to produce desalinated water at a lower cost compared to fossil energy.

One of the visions calling for this is that the desalination of sea water using nuclear energy is a practical option to meet the growing global demand for drinking water, and the desalination of sea water is a viable option to meet the increasing demand for it. The rapid growth in population and industrialization in Egypt is a strong incentive to use nuclear energy to meet its needs for water and electricity.

*It consists of the motives of nuclear desalination in:*

Inadequate national primary energy resources known to increase demand for energy and electricity in the medium and long term, and potable water resources are limited; This requires adding new sources of supply, especially in remote areas.

Realizing nuclear energy as an appropriate, economically competitive and viable energy source; Not only will it complement traditional energy sources; Rather, it will also promote technological development and constitute a catalyst for social and economic progress. [14]

*2) Creating job opportunities to operate power stations:*

Nuclear energy is the largest producer of carbon-free electricity and a powerful economic engine through direct and secondary spending, environmental stewardship, and community leadership. It is also a leader in job creation and helps support local and regional economies. The following figure shows the potential jobs that can be created for each type of energy system., as it turns out that it provides 500 job opportunities compared to other energy sources.

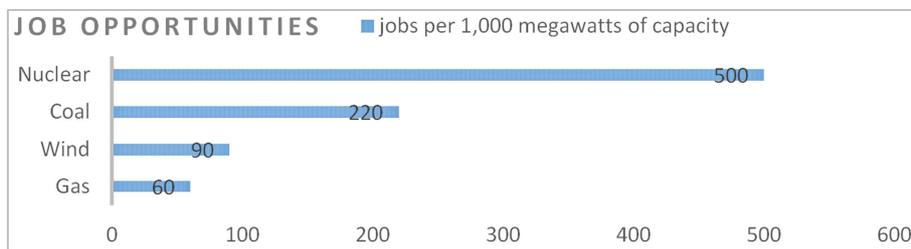


Figure 8. Job creation potential across different technologies.

Source: Nuclear energy supports jobs, (April 11, 2018), clean energy economy, from site: <https://www.seattletimes.com/sponsored/nuclear-energy-supports-jobs-clean-energy-economy>.

Since jobs are created by energy systems, they improve the quality of life of the local community, as many people work either in direct jobs such as manufacturing, installation, operation, and maintenance, or in indirect jobs such as suppliers of equipment, building materials and installation

throughout the life cycle of power plants.

*3) A case study on the economic benefits of the nuclear power plant in the United States of America.*

The nuclear energy industry plays an important role in providing both job opportunities and raising economic

growth. Where the 100 nuclear reactors in the United States generate significant domestic economic value in electricity sales; It is represented in the range 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 energy is the only proven technology that can provide emission-free and affordable electricity. [15]

It shows analyzes 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 a nuclear power plant 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 1. The benefits of establishing a nuclear plant.*

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

Source: Nuclear Energy's Economic Benefits, (April 2014) Current and Future, white paper, nuclear energy institute, pp 3.

#### 2. The effects 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 out of 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 and the creation of 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. According to the Commerce Department, every \$1 billion in exports by American companies represents 5,000 to 10,000 jobs in the United States.

UAE 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. The time of building and construction of 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, the construction period takes about 5 years. Hence, the ability of this industry to compete is closely related to the length of construction periods, and any delay in construction operations is caused by 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 an increase in the 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. [16]

### 2.2. Evaluation of the Main Systems of Energy Sources and Their Impact on the Environment

#### 2.2.1. Land, Fuel and Transportation Requirements for the Various Power Generation Systems

Nuclear power plants and associated fuel cycle facilities do

not require large areas of land to operate, and therefore the environmental impact of nuclear energy on land, forests and water is small, and the burden caused by nuclear energy facilities in the fuel transport infrastructure is very less compared to fossil fuel facilities, due to the different The volume of transported quantities Nuclear power plants require much less space to store fuel on site than fossil fuel plants. of the same capacity. [17]

To illustrate, the following table compares the full fuel cycle system requirements for fuel storage, land area, and

transportation needs for coal and nuclear fuel stations.; Coal power systems require about eight times more land area than nuclear systems for the same annual production of electricity, and the following criteria to focus on comparing these two types of energy production, as coal production has a great impact on the Earth's environment, and its burning produces some worrisome pollutants in the atmosphere. As for nuclear power plants, they do not produce any pollutants in the air, It has a minimal environmental impact on the Earth during normal operation.

**Table 2.** A comparison between coal plants and nuclear power plants.

| Power plants 1300 GW                                       | coal  | nuclear  |
|--|---|--|
| The installed capacity of the fuel annual fuel consumption | 2 x 650 MWe 3.3 million tons  | MWe 1300 uranium 32 tU (170 t nat U)                 |
| Land use for factory site, mining, and waste disposal.     | 415 hectares  | 50 hectares  |
| Space requirements for fuel storage                        | (2 months reserve) 25 hectares  | a few square metres                                  |
| transportation fuel requirements                           | 82,500 wagons per 40 tons annually  | 5 trucks per year                                    |
| CO <sub>2</sub> emissions                                  | CO <sub>2</sub> /yr 10 000 000  | 0  |
| SO <sub>2</sub> emissions with flue gas desulfurization.   | tSO <sub>2</sub> /yr 14 000   | 0  |
| NOx emissions with denitrification                         | t NOx/yr 7000   | 0  |
| Particulate emissions with control                         | t/yr 2300   | 0  |
|  | One coal plant generates the following amounts of air pollutants in a given year: |  |
|  | 37 million tons of carbon dioxide   |  |
|  | 10,000 tons of sulfur dioxide.  |  |
|  | 10,200 tons of nitrogen oxide.  |  |
|  | 500tons of small airborne particles.  |  |
|  | 220 tons of hydrocarbons.   |  |
|  | 720 tons of carbon monoxide.  |  |
| Waste  |   | 1.5 cubic meters of highly radioactive waste volume. |

Source: JA Marques de Souza, (January 2002), current issues in nuclear energy, nuclear power and the international nuclear environment, Published by the American Nuclear Society, pg. 25.

This has been confirmed by the following table for estimating the size of land needs for the site for different types of power stations (not including the fuel cycle requirements). Most energies, especially the sun and wind, require a large use of land, which will be needed in many cases for other purposes such as agriculture. It can be noted that Renewables require much more land than thermal lands.

**Table 3.** Land area required for power plant sites (1000 megawatts).

| type of power plant                   | Land area requirements (hectares) |
|---------------------------------------|-----------------------------------|
| Oil and coal (including fuel storage) | 100                               |
| Nuclear and natural gas               | 50                                |
| hydropower                            | 25,000                            |
| solar energy                          | 5000                              |
| Wind Energy                           | 10,000                            |
| biomass farm                          | 400,000                           |

Source: Aly, A, I, M, & Hussien, R. A. (2000). Environmental impact of nuclear, fossil and renewable energy source: A Review of nuclear energy.

The economic effects of nuclear reactors are that they produce a very large amount of energy. One ton of nuclear fuel produces the same amount of electricity as 100,000 tons of coal; Table 4 also shows the energy contents of the main primary sources of electricity production, which refer to the huge energy content of natural uranium compared to other alternatives.

**Table 4.** Energy content of the main primary energy sources for electricity production.

| (Production of electricity from various sources) |                                 |
|--|---------------------------------|
| Source: 1 kg of fuel                             | Electric power production (kWh) |
| 1kg of wood                                      | ~2 kWh                          |
| 1kg of coal                                      | kWh ~3                          |
| KG1 of oil                                       | kWh~4                           |
| 1KG natural gas                                  | kWh~6                           |
| kg1 of uranium                                   | kWh (FBR) 3 000 000             |
|  | kWh (PWR) 60 000~               |

Source: JA Marques de Souza, (January 2002), current issues in nuclear energy, nuclear power and the international nuclear environment, Published by the American Nuclear Society, pg. 23.

One of the visions calling for this is that nuclear energy has many advantages compared to power plants that use fossil fuels. It is safe, reliable, clean, and moreover a virtually inexhaustible source of low-carbon energy, thus reducing climate change and global warming; Let's investigate the highest safety has always resulted from improving the designs of nuclear facilities. [18]

**2.2.2. Comparison of Carbon Emissions Between Different Energy Systems**

This figure indicates the relative levels of carbon dioxide emissions resulting from the generation of kilowatt-hours of electricity from different sources. In contrast, every 22 tons

of uranium used saves about one million tons of carbon dioxide emissions compared to coal.

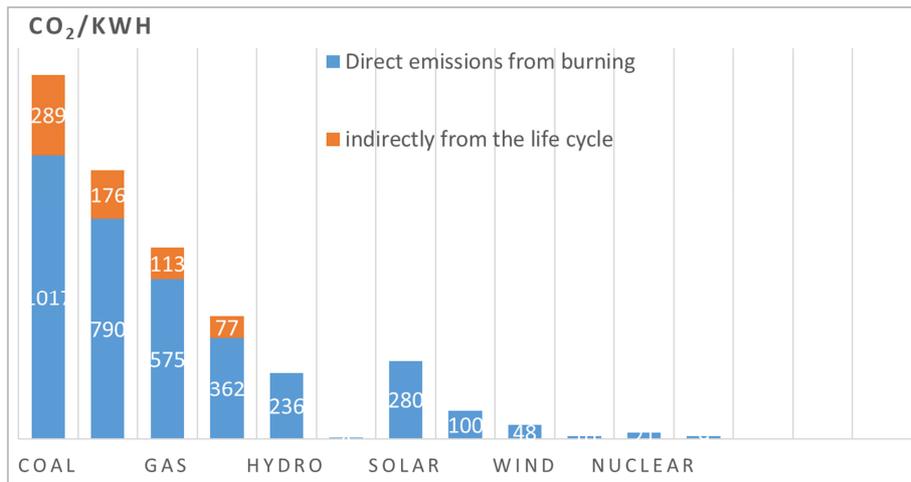


Figure 9. Greenhouse gas emissions from electricity production.

Source: Powers, A., Crouch, G., & Officer, IRS (2012). Nuclear power: The safe and green alternative. Indian. edu. Alternative, Alexander P Powers Environmental Management, Senior SPEA Honors Thesis Presentation pg. 12, 16.

The graph 9 shows that coal and conventional fuels have very large emissions of greenhouse gases; While nuclear energy does not emit any greenhouse gases directly, and only produces greenhouse gases indirectly from uranium mining, it does not leave any trace of carbon on the world, and it will also help combat the main problem of climate change. On the other hand, radioactive waste is About a million times smaller than fossil fuel waste.

2.2.3. Evaluation Health of the Main Energy Production Systems

1) Health effects of different energy systems

The issue of nuclear waste is dealt with according to very strict international standards. The level of radiation in the areas surrounding the nuclear plants is strictly controlled so that it does not exceed the natural radiation; So as not to exceed the global health impact of most risk factors.

Table 5. Evaluate the health effects of different types of energy systems.

| Deaths per terawatt-hour of energy from various energy sources   |                              |  |
|--|------------------------------|--|
| power source   | death rate per terawatt hour | comments   |
| Coal (global average) Coal   | 161                          | It represents 26% of the world's energy            |
| coal (in China)  | 278                          |  |
| Coal (in the US)   | 15                           |  |
| petroleumOil   | 36                           | It represents 36% of the world's energy            |
| Natural gasnatural gas   | 4                            | It represents 21% of the world's energy            |
| live massBiomass   | 12                           | It represents less than 0.1% of the world's energy |
| solar energySolar energy   | 0.44                         | It represents 26% of the world's energy            |
| Wind Energy  | 0.15                         | represent less than 1.0% of the world's energy     |
| waterfalls   | 1.4                          | It represents less than 2.2% of the world's energy |
| Nuclear energy   | 0.04                         | It accounts for about 6% of the world's energy     |
| Radiation in nature (fundamental radiation)  |                              |  |
| The average annual radiation dose to which humans are exposed from nature is approxYR /MSV 2.4, varies with location and altitude above ground level; It ranges between 1-10 YR/MSV and reaches more than 50 YR/MSV in some countries. |                              |  |
| Examples by numbers of radiation exposure  |                              |  |
| Airport x-ray detectors  | 5                            | microSv  |
| Short distance air travel  | 5                            | microSv  |
| Long-distance air travel between continents or across the equator  | 30-90                        | microSv  |
| Average dose to the public from nuclear plants   | 0.2                          | microSv/yr   |
| Hence, it becomes clear that the average dose to the public from nuclear power plants is less than twelve thousand times the average annual dose of radiation in nature).  |                              |  |

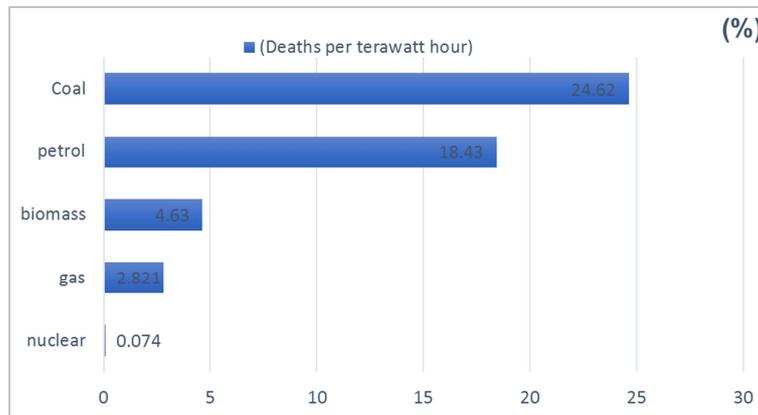
2) Death rates from air pollution and accidents related to energy production.

The comparison is between the dominant energy sources—brown coal, coal, oil and gas, biomass, and nuclear; Where the graph shows the results of analyzing the short-term

mortality rate from accidents and air pollution related to energy production, and since we want to compare the relative safety of energy production from different sources; This data has been standardized with deaths resulting from one hour of energy production in each case. [19]

In light of this, it is important to point out that deaths related to air pollution are dominant in the case of brown coal, coal, oil and gas; As it accounts for more than 99% of deaths; As well as 70% of nuclear-related deaths and all biomass-

related deaths, and therefore nuclear energy is the safest energy source; This results in 442 times fewer deaths than brown coal per unit of energy.



Source: The researcher worked according to the data from the following website <https://ourworldindata.org/what-is-the-safest-form-of-energy>

**Figure 10.** Death rates from energy production per terawatt hour.

The previous figure 10 shows that the death rate in nuclear power plants is 0.074% compared to gas. 2.821% and coal 24.62% per terawatt hour. Based on this principle, energy production not only has short-term health effects related to accidents and air pollution, but also contributes to the long-term impact of global warming, whose effects are likely (such as severe weather conditions, sea level rise, reduced freshwater resources and crop productivity, and, for some, fatal heatstroke).

*It is the reflections of that idea:* 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 to assess climate change, fuel resource use, water consumption, pollution risk reduction, and reliability of efficient power generation. Hence, national policies aimed at increasing the role of nuclear energy in the energy mix to mitigate climate change. It also provides a large amount of low-cost electricity and promote progress towards achieving the goals of sustainable development in an environmentally efficient and economically efficient manner and encourage support for technologies, institutions and actors.

*And we draw from that that:* The competitive advantages of nuclear energy are the stability of electricity prices and the availability of fuel; The use of nuclear fuel to generate electricity allows greater independence in fuel consumption compared to other energy resources. Even for countries with limited domestic resources to manufacture nuclear fuel; Nuclear fuel is loaded at most only once during the year at the plant, and there is ample time to arrange for the supply of new fuel.

*The researcher verifies that it is:* When generating electricity, nuclear energy is cost-competitive compared to generation based on fossil fuels, in addition to the reasonableness and competitiveness of prices. Although it involves relatively high capital costs; In addition to the

requirements for the costs of waste disposal and stopping its operation, considering the social, health and environmental costs of fossil fuels in relation to nuclear costs. [20]

### 3. Conclusion

Considering this, the study provided an assessment based on specific criteria for international models and the extent to which they are used to serve as models for simulation, and to prepare optimal economic frameworks to enhance the effectiveness of cooperative participation and participatory planning between these countries within the framework of energy continuity, by providing directives aimed at developing a diverse mix of sustainable energy. To support and strengthen sustainable economic frameworks that stimulate growth and the participation of the international community in sustaining life and resolving energy crises. After presenting, analyzing, interpreting, and correcting the facts through realistic phenomena and applying the standard side, the study reached the following results:

1. Nuclear energy stimulates the sustainable economic development of countries and provides many new opportunities in the development of education, technology and new sectors of the economy and employment. It will also contribute to preparing and supporting scientific and engineering teams.
2. The study concluded that during the construction of nuclear power plants and before their completion, projects become a constant source of growth. Nuclear reactors prepare plans for the infrastructure and stimulate development in various industries, because they will stimulate the flow of investments and the development of local industries. Also, starting the operation of the station will facilitate the export of electricity, and the potential capable of developing the nuclear industry in the country will appear.

3. The station will support the development of the region's infrastructure, in terms of roads, public buildings and tourist facilities, which will positively affect the future of Egypt as a whole. After the completion of the construction of the Dabaa station, it will play an important role in total energy consumption due to the production of low-carbon electricity.
4. The study confirmed that the nuclear fuel used to operate nuclear power plants compared to hydrocarbon energy sources is practically not subject to fluctuations in global market prices, because the fuel component in the cost of electricity for nuclear power plants ranges between 4-5 percent and about 60-70 percent when raw materials are used. This protects the cost of "atomic kilowatt-hours" from market fluctuations in the commodity market, and thus ensures sustainable development and investment in industrial projects that require stable electricity supplies at predictable and attractive prices for decades to come.
4. Egypt possesses its national nuclear fuel capabilities necessary to operate its nuclear program; In addition to the economic development of Egyptian companies that will participate in the local component, which will contribute to upgrading the local industry, opening international markets, and creating more job opportunities.
5. The construction of a nuclear power plant will become the impetus for industrial development in Egypt, and Egyptian companies will contribute to the construction process at different stages as part of the first energy unit. Egyptian companies are expected to contribute 20%, which is a high percentage. With each subsequent unit, the level of tasks will increase. With the growth of the experience of local companies participating in the implementation of the nuclear project.
6. 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.

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