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## IMPACT OF REPLACEMENT COAL AND FOSSIL ENERGY BY NUCLEAR ENERGY ON GLOBAL GREENHOUSE GASES EMISSION

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**Abstract:** Climate change has become one of the important matters that worry humanity worldwide, until local seminars and international conferences have been held for it at the highest levels, such as the level of heads of state. What is worrying about climate change is the increase in the average global temperature until it soon reaches the age of mankind, which has reached 1.5 degrees Celsius until the year 2033 and 2 degrees Celsius until the year 2059, as an inevitable result of the increase in carbon emissions resulting from electricity generation, industry and vehicle exhaust, which were estimated at about 1000 gigabytes of tons until the year 2060, in which the production of electrical energy contributes by more than 50%. On the other hand, the unjust encroachment on forests, this is the lung of the world. Since electric power generation is responsible for more than half of the global emissions of carbon gases, this research aims to study the carbon emissions resulting from electric power generation with the scenarios of Unfinished Symphony, Modern Jazz and Hard Rock, and trying to reduce the carbon emissions resulting from electric power generation by replacing electricity generation with nuclear energy as an alternative to coal all types, as well as petroleum (fossil fuels), with the stability of the use of natural gas and new and renewable energies according to previous scenarios until the year 2060. The result was, according to the Unfinished Symphony scenario, emissions were about (591.9) Giga tons. In contrast, when using nuclear energy as an alternative, the contribution of electricity production by 65% cancels out the improvement in the amount of carbon emissions by 75.1%, with a carbon dioxide productivity of 146.8 Giga tons. According to the Jazz scenario, emissions were about (632.1) Giga tons. In contrast, when using nuclear energy as an alternative, the contribution of electricity production is 65%, which cancels out the improvement in the amount of carbon emissions by 75.2%, with a carbon dioxide productivity of 156.8 Giga tons. According to the Hard Rock scenario, emissions were about (643.3) Giga tons. In contrast, when using nuclear energy as an alternative, the contribution of electricity production is 65%, which cancels out the improvement in the amount of carbon emissions by 74.87%, with a production of carbon dioxide that amounted to 161.6 Giga tons.

**Keywords:** Climate change – CO<sub>2</sub> emission – Electric demand scenario – Nuclear energy contribution

### 1. INTRODUCTION

Anthropogenic climate change is widely seen as the major threat to humans. It has dominated the global environmental policy agenda over the past two decades [1]. Changes in global and regional temperatures, precipitation patterns and other climate attributes are driven by increasing concentrations of greenhouse gases (GHGs) in the atmosphere [2]. Carbon dioxide (CO<sub>2</sub>) emitted from burning fossil fuels in the energy sector specially at electricity generation and other industrial activities are the principal driver of this process as shown in figs (1, 2) [3]. Energy demand is expected to increase significantly in the coming decades, and well trigger changes in climate with huge risks for human societies and the earth system [4]. All low carbon energy sources and technologies will be required to face the twin challenge of mitigating climate change and meeting global energy needs [5]. An overwhelming majority of parties to the United Nations Framework Convention on Climate Change (UNFCCC) have ratified the Paris agreement and have agreed to make nationally determined contributions (NDCs) to control GHG emissions so that the increase of global mean surface temperature will not exceed 2°C relative to preindustrial levels. Nuclear power can make a significant contribution to achieve the climate change target of the Paris agreement by reducing GHG emissions [6]. Nuclear power plants (NPPs) produce virtually no GHG emissions or air pollutants during their operation and comparatively no emissions over their entire life cycle [9] [10]. Since, the electric power generation is responsible for about half of the global emissions of carbon gases, this research aims to study the carbon emissions resulting from electric power generation with the scenarios of Unfinished Symphony, Jazz and Hard Rock, with trying to reduce the carbon emissions resulting from electric power generation by replacing electricity generation with nuclear energy as an alternative of others which uses fossil fuels with the sustaining of natural gas in line until the year 2060 [11]. Many scientists concerned with the global climate change from all points of view. As a result of the study at 2020 conducted on a statistical approach on the fuel consumption and emissions of the international maritime trade fleet, total global anthropogenic emissions were reported to be 2.7% CO<sub>2</sub>, 11% NO<sub>x</sub>, and 2% SO<sub>x</sub> [12]. Sea transport is responsible for approximately 12–18% of global CO<sub>2</sub> emissions as of 2050 [13]. During the journey of a ship between two harbours, the amount of CO<sub>2</sub>

emissions emitted by the fuel produced by its main machine and auxiliary machines against the sea and air resistance was Approximately 3.17 ton CO<sub>2</sub> is emitted from the burning of one ton of ship fuel [14]. It is assumed that the EU will have to reduce its GHG emissions by at least 80 percent through action within the EU. This will require, in effect, a near-zero-carbon electricity, road and rail transportation industry, and heating and cooling in buildings. Given this zero-carbon target, one can distinguish between the scale of the system, determined by energy efficiency (and population and wealth), and the design of the system (near to zero-carbon technologies) [15]. World total energy supply (WTES) increased by 68.2% from 1990 to 2019, surpassing 600 EJ for the first time. This increase was driven by Asia, responsible for 83.6% of the world growth in the period [16]. Our paper aims to establish the relation between carbon dioxide emissions employing a complex model comprising economic growth, tourism sector, financial development, energy use, trade and agriculture globally, employing GMM models on a panel dataset comprising of 168 countries and 24 years. In doing so, the article has reached a number of findings. Regression results were positive and significant for per capita GDP and negative for per capita squared GDP, confirming the standard EKC hypotheses. A positive role of nuclear energy and renewable energy production were also revealed while energy from coal increased environmental pollution as expected [17]. Climate change is one of the most important issues facing the world today. Nuclear power can make an important contribution to reducing greenhouse gas emissions while delivering energy in the increasingly large quantities needed for global economic development. Nuclear power plants produce virtually no greenhouse gas emissions or air pollutants during their operation and only very low emissions over their full life cycle. The advantages of nuclear power in terms of climate change are an important reason why many countries intend to introduce nuclear power or to expand existing programs in the coming decades. All countries have the right to use nuclear technology for peaceful purposes, as well as the responsibility to do so safely and securely [18].

Table 1: Summary of Lifecycle CO<sub>2</sub> emission intensity

Technology	Mean tonnes CO <sub>2</sub> e/GWh
Lignite	1054
Coal	888
Oil	733
Natural Gas	499
Solar PV	85
Biomass	45
Nuclear	29
Hydroelectric	26
Wind	26

Main assumptions of the three world energy scenarios:

- Unfinished Symphony, the energy efficiency is driven by a country government approach to fulfilling sustainability through international cooperation. It is assumed that stimulant network of fiscal incentives such as green subsidies and influential carbon pricing across the different parts of the world is available
- Modern Jazz, the energy efficiency is driven by a market approach. The world is mostly productive, and its economics grow faster with strong technological upgrading. The technology innovation and new business models have sustainability approach.
- In Hard Rock, the energy efficiency reflects historical trend and national interests restrict countries from elaboration efficiently on a global level, with minor concern to acknowledge and address climate change. Technologies are mandated depending on the availability of local resources. Shielding a country's domestic industries rather than free trade controls the scene.

## 2. RESULTS & DISCUSSIONS

Our estimation model is based on contribution of each energy generation source type to generate CO<sub>2</sub>. This is shown in table (1). The energy production in Figure (1) illustrates each energy source contribution in Unfinished Symphony scenario. The oil contribution is the highest one while the other contribution is the lowest which comes from renewable energy sources. This contribution is the same in all studied scenario but with various values in each scenario. The contribution of oil begins year 2021 with 6.105E+06 GWH and expected to be 7.416E+06 GWH with percentage 21.47% more in 2060. The energy production in Figure (2), illustrates each energy source contribution in Modern Jazz scenario. The oil contribution still represent highest one. The contribution of oil in this scenario begins year 2021 with 6.124E+06 GWH and expected to reach 8.389E+06 GWH with percentage 27% more in 2060. While analyzing the last (HR) scenario in Figure (3), it is found out that oil contribution in energy production is expected to be 8.867E+06 GWH with percentage increase about 30.8%. The global emission related to the present scenarios and their present contributions are shown in figures (7), (8) and (9).

The emitted CO<sub>2</sub> in case of Unfinished Symphony scenario for coal source is 6.867 Giga tonnes and from oil source is 5.377 Giga tonnes in year 2060, while the total accumulated CO<sub>2</sub> emission is 592 Giga tonnes.

Regarding the other scenarios, it is illustrated that it is more in case of Modern Jazz with total accumulated predicted value 632 Giga tonnes and 643 Giga tonnes in case of Hard Rock in year 2060.

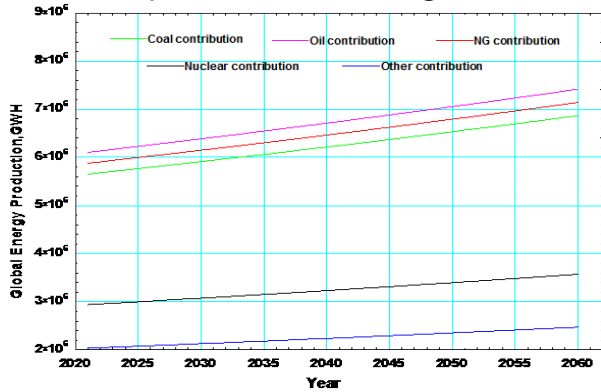


Figure (1). Global electricity demand according to Unfinished Symphony scenario

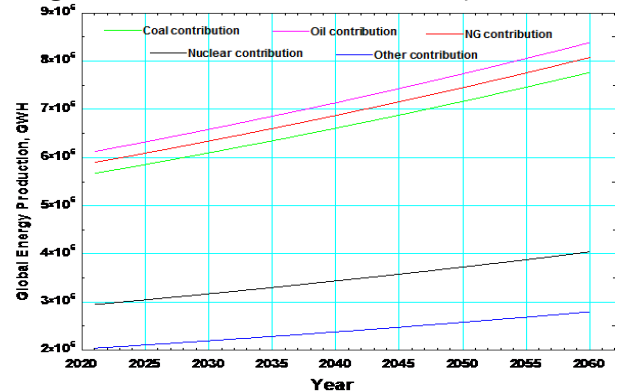


Figure (2). Global electricity demand according to Modern Jazz scenario

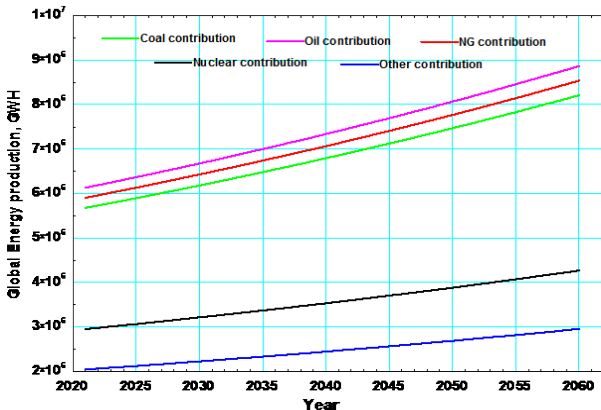


Figure (3) Global electricity demand according to Hard Rock scenario

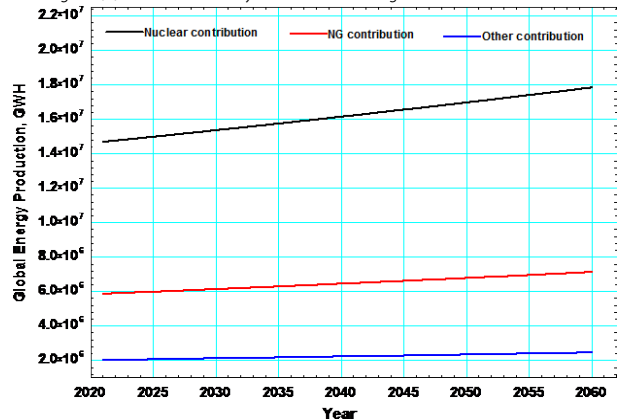


Figure (4). Global electricity demand according to developed Unfinished Symphony scenario

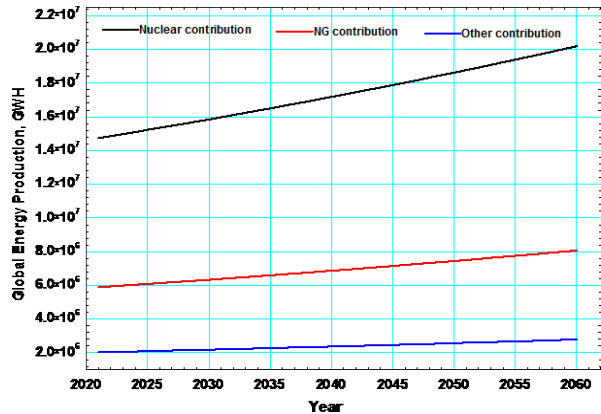


Figure (5). Global electricity demand according to developed Modern Jazz scenario

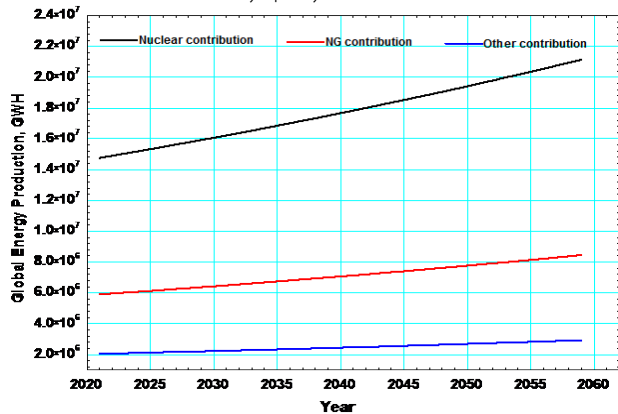


Figure (6). Global electricity demand according to developed Hard Rock scenario

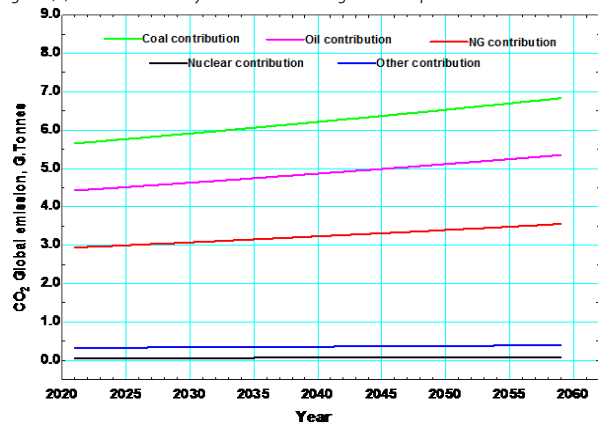


Figure (7). Global CO<sub>2</sub> electricity emission according to Unfinished Symphony scenario

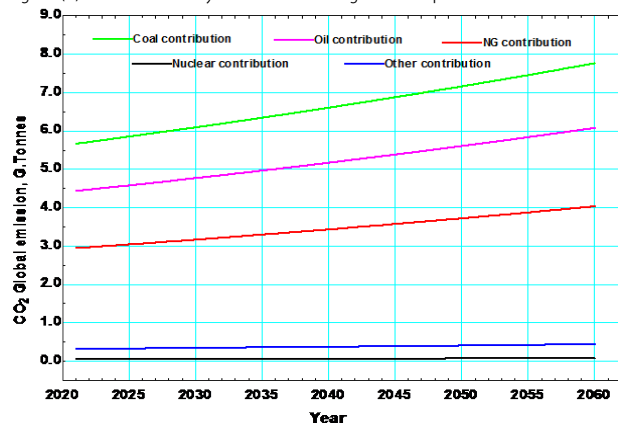


Figure (8). Global Greenhouse electricity emission according to Modern Jazz scenario

Our developed model is based on the above criteria which replaces contribution of oil and coal with nuclear energy generation source. The other sources contributions are kept the same. The energy productions of three scenarios are illustrated in Figs. (4), (5) and (6).

It is shown from these figures that energy produced by nuclear technology source in Unfinished Symphony scenario begins with  $1.470E+07$  GWH in 2021 until reaches  $1.785E+07$  GWH in 2060. In Modern Jazz the production is found in 2021 to be  $1.474E+07$  and  $2.019E+07$  in 2060. In Hard Rock scenario the predicted value are  $2.135E+07$  in year 2060. As shown from previous expected values, the three scenarios are different in energy productions and they are be found increasing from first scenario of Unfinished Symphony passing more to Modern Jazz till the utmost value in Hard Rock as  $1.785E+07$ ,  $2.019E+07$  and  $2.135E+07$  in 2060. Based on developed model, the predicted  $CO_2$  emission will be also developed and predicted. As the proposed nuclear energy used instead of coal and oil sources, the emission of  $CO_2$  will be enhanced and reduced the climate change.

The global emission related to the developed scenarios with nuclear energy source and their predicted contributions are shown in figures (10), (11) and (12). The emitted  $CO_2$  in case of Unfinished Symphony scenario for coal and oil sources are diminished, while the total accumulated  $CO_2$  emission is 0.07142 Giga tonnes from nuclear technology. Regarding the other scenarios, it is illustrated that the nuclear technology contribution is 0.08078 Giga tonnes in case of Modern Jazz and 0.08539 Giga tonnes in case of Hard Rock in year 2060.

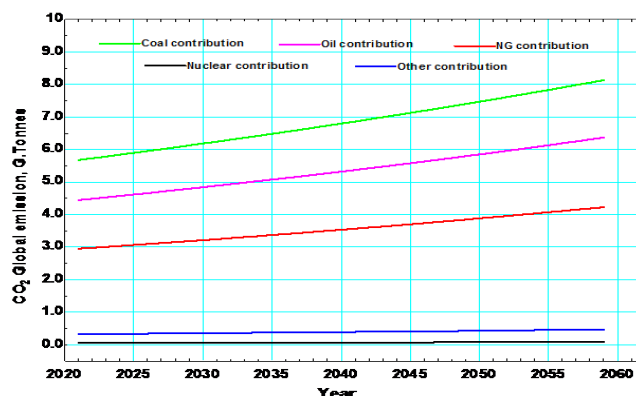


Figure (9). Global  $CO_2$  emission according to Hard Rock scenario

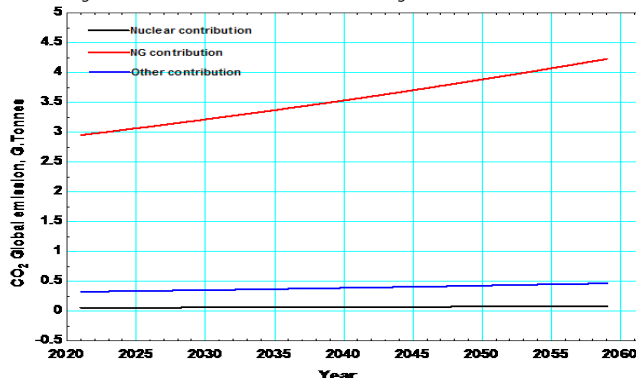


Figure (10). Global  $CO_2$  emission according to developed Unfinished Symphony scenario

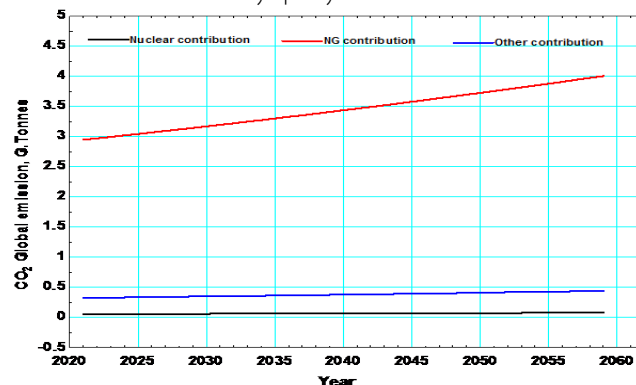


Figure (11). Global  $CO_2$  emission according to developed Modern Jazz scenario

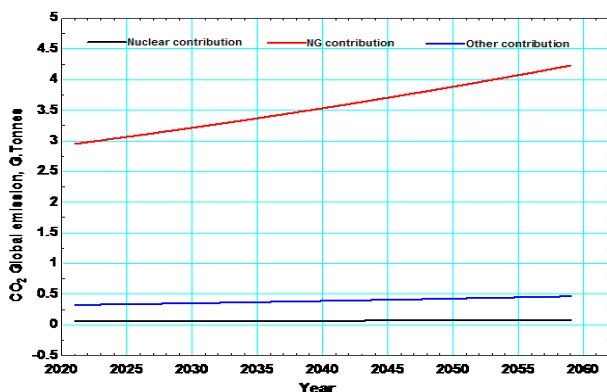


Figure (12). Global  $CO_2$  emission according to developed Hard Rock scenario

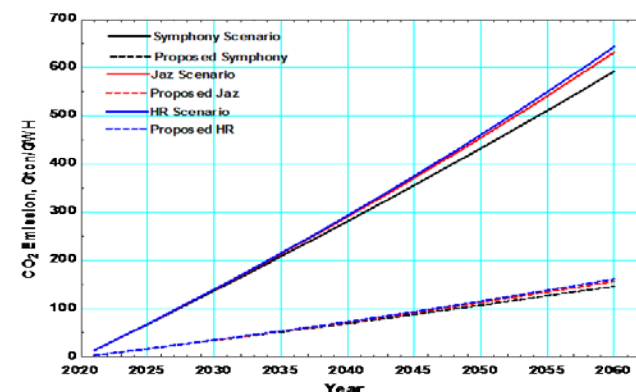


Figure (13). Global  $CO_2$  emission for different present and developed scenarios

As illustrated in Figure (13). The emitted  $CO_2$  in case of Unfinished Symphony scenario of the developed model for coal and oil sources technology diminishes, while the total accumulated  $CO_2$  emission is 147 Giga tonnes. Regarding the other scenarios, it is illustrated that in case of Modern Jazz will have total accumulated predicted value 157 Giga tonnes and 162 Giga tonnes in case of Hard Rock in year 2060.

Prediction model deduces and expects that the global energy consumption in year 2060 will exceed the 2020 level of 790 EJ in average in all scenarios, with 497 EJ in Unfinished Symphony, 839 EJ in Modern Jazz and 1034 EJ in Hard Rock

### 3. FACTOR OF EMISSION

The emission factor of CO<sub>2</sub> for each scenario and each model is predicted according to the following table:

Table (2) emission factor for different scenarios

Factor (KgCO <sub>2</sub> /kWh)	Unfinished Symphony	Modern Jazz	Hard Rock
Previous model	21.55	20.35	19.59
Proposed model	5.344	5.046	4.919

It is noticed, when we compare present model and developed proposed model in the end of year 2060 that the emission factor is 21.55 kgCO<sub>2</sub>/kWh in present unfinished Symphony and reduced to 5.344 kgCO<sub>2</sub>/kWh in developed model. In case of Modern Jazz it reduced from 20.35 in present model to 5.046 in developed model and finally from 19.59 to 4.919 in Hard Rock scenario for two models respectively. Enhancements are noticed and illustrated in table (2) and emission factors indicates great difference in values towards less pollution when replacing fossil fuel energy generation with nuclear energy generation which encourage countries to convert most dirty energy generations to nuclear energy generation in future.

### 4. CONCLUSION

Due to global electricity demand increases gradually and annually about 3% towards 2060, the nuclear, natural gas and renewable energies production is proposed to meet a majority of the increase in energy demand instead of coal and crude oil. The climate change represents main challenge and considered the main incentive factor that leads the world to find out effective solution. Three standard scenarios are applied in our model, Unfinished Symphony, Modern Jazz and Hard rock respectively. Using nuclear power technology source is our choice and proposal to generate energy instead of coal and fossil fuel to reduce CO<sub>2</sub> emissions. This proposed model expects reducing CO<sub>2</sub> emission in 2060 for Unfinished Symphony scheme from 592 to 147 Giga tonnes. For Modern Jazz it is expected to reduce CO<sub>2</sub> emission from 632.1 to 156.8 Giga tonnes finally in Hard rock scheme it is reduced from 643.3 to 161.6 Giga tonnes. So it is concluded that replacing coals and fossil fuel sources with nuclear energy technology is a good solution to reduce global CO<sub>2</sub> emission in the future 2060, which is found out very efficient and effective towards climate changes enhancement, so employing more nuclear power reactors with intensive safe technology will encourage countries converging to this technology and satisfies global world energy demands and also combats global warming.

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