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Reevaluating Nuclear Energy's Challenges and Potentials in Addressing Global Warming Amid Ambiguous Scenarios Shaped by Prior Concerns and Apprehensions

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Abstract

Given the rise in temperatures to more than 1.5C as a result of reliance on fossil energy sources, the world has begun to realize the seriousness of the situation on aspects of life that humans will witness at the end of the twenty-first century if measures are not taken to reduce the rise in temperatures. Hence, in this work, we studied the significance of nuclear energy and analyzed the strengths, weaknesses, and discrepancies (SWOT) with stress on analyzing 47 studies that discuss different aspects. In this work, we focused on the critical of nuclear energy and its sustainable role in diminishing the phenomenon of global warming by investigating nuclear energy scenarios, as it is clear that nuclear energy has distinguished potential in bridging the energy gap that will occur due to the depletion of fossil fuel sources in the next four decades, and that concentrating on sustainable sources such as nuclear energy, which is characterized by an elevated production capacity, can be the vital source that covers different aspects. In addition, the downside of this study spotlighted is the concerns of nuclear energy waste, which is counterproductive and considered by a group of decision-makers and researchers to be a hopeless case, in addition to the historical risks caused by such as Fukushima and Chornobyl, which still have numerous people reconsidering the reliance on nuclear energy as a result of these historical perils.

Keywords: *Nuclear energy, historical risks, waste, global warming, carbon dioxide, SWOT, fossil fuels*

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INTRODUCTION

Global warming is one of the most pressing environmental challenges of the 21st century, with significant implications for climate stability, biodiversity, and human livelihoods [1]. Hence, this phenomenon is not new debate concerning its roots and impact has acquired significant traction in recent years, leading to heightened awareness of the need to enhance the addressing the industrial society produces massive material flows, disrupting natural equilibrium and potentially causing global crises. Such as Biodiversity loss, waste accumulation, pollution, etc. rev global warming effects [2],[3],[4]. Global warming, driven by human-induced greenhouse gas emissions, causes rising temperatures, melting ice caps, sea level rise, ocean acidification, extreme weather, and significant ecological and socioeconomic impacts on society [5]. Ongoing global efforts target limiting temperature rise to below 2 °C, reaching 1.5 °C [6]. On the other hand, this urgent crisis affects health, food security, and safety, despite the efforts made to limit temperature rise to 1.5 degrees Celsius, the effects are becoming increasingly clear, which could cause the death of 250,000 people by 2050.

According to the World Health Organization [7]. Global warming results from high gas emissions, primarily carbon dioxide, which trap heat in the atmosphere, increasing sun exposure effects [8]. The dependency on fossil fuels is one of the standout factors contributing to the increase in carbon dioxide and other gases. Despite the constant growth, initiatives are underway to minimize greenhouse gas emissions over the next four decades Climate change alters weather patterns globally, stressing various sectors from the tropics to the poles [9]. As it greatly affects the agricultural and industrial sectors, finding the necessary measures to solve this crisis requires drawing up effective strategies that ensure the creation of renewable energy sources such as solar energy, nuclear energy, and wind energy to reduce the fossil fuel sources that are widely used. However, climate change is affecting all continents, impacting environments and economies, Governments and businesses are adopting measures to decarbonize, protect resources, and implement innovative solutions in energy, transportation, and construction to mitigate the negative impacts [10],[11],12],[13],[14].

Notwithstanding the significance of solar energy sources and their notable contribution to the enhancement of the energy sector, the obstacles that sectors face involving efficiency issues in solar energy, impede the advancement of solar energy. However, the trend toward nuclear energy is one of the elements affecting the energy industry, and gathering renewable sources with nuclear energy is remarkably efficient, facilitating them is essential to reaching sustainability goals in the energy sector. Due to constraints, a complete conversion to renewables is currently unfeasible without nuclear energy, Desired energy features include sustainability, minimal environmental impact, cost-effectiveness, safety, industrial heat provision, and carbon sequestration to combat greenhouse gas emissions effectively [15],[16].

Nuclear Energy's Role Amid Climate Change

Nuclear energy's potential for future electricity markets gains attention amid decarbonization and reduced fossil fuel usage [17]. It provides a significant portion of energy needs with almost zero emissions of greenhouse gases [18][19]. In general, nuclear energy generation can assist in mitigating climate change by producing low-carbon electricity. It addresses ecological issues while promoting environmental sustainability, making it a suitable energy source for reducing carbon emissions [20],[21],[22],[23]. Furthermore, it is a vital resource for creating long-term alternative

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energy environmental plans. However, nuclear and renewable energy technologies are anticipated to diminish future greenhouse gas emissions [24],[25],[26],[27]. It is expected that by 2050, renewable energy and nuclear energy will be the dominant sources of energy, transportation, and green usage.

Moreover, enhancing the plans made at the current time comprehensively enables them to reduce the phenomenon of global warming and acquire gradual progress in achieving sustainability and reducing the effects of the phenomenon of global warming, which is caused by unsafe energy sources that cause the release of emissions(i.e. oil, gas, and coal). However, reducing them and searching for diversification of energy sources such as nuclear energy and green hydrogen energy can contribute to global warming reduction in 2060. Nuclear energy is characterized by high efficiency in generating energy which makes it a viable option for many countries in their sectors. By 2060, fossil fuel sources may run out [28]. With the confirmations about the depletion of fossil energy sources according to previous studies in the coming decades, there is a push for continuous enhancement in the search for sustainable energy sources with high production capacities such as nuclear energy. This energy is characterized by tremendous production efficiency that can cover energy requirements to a large extent, especially in the industrial sector. This paper explains the comprehensive potential of nuclear energy through its strengths, weaknesses, opportunities, and threats.

SWOT Analysis of Nuclear Energy

Strengths

1. Nuclear energy emits no carbon emissions making it unique in terms of greenhouse gas emissions decline.
2. Nuclear energy provides high rates of energy
3. Nuclear energy does not require large surveys
4. Nuclear energy is a sustainable source that enhances the ecosystem and the energy sector and is inexhaustible compared to fossil fuel sources that are depleted over time.

Weaknesses

1. Weaknesses about previous catastrophic accidents such as Chornobyl, Fukushima, and others, and uses in the manufacture of deadly nuclear weapons and their ongoing concerns at present.
2. The investment cost is very high.
3. Concerns about hazardous waste that can be left behind for long periods
4. The is a stable trend towards alternative renewable sources such as solar photovoltaic and wind energy.

Opportunities

1. Exploiting the use of small nuclear reactors with advanced technology
2. Exploiting the high production efficiency of nuclear reactors in light of the fluctuations in fossil fuel sources and the interruption of renewable energy sources.

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3. Increasing research and development in promoting new technologies that enhance the safety of nuclear energy and its application may lead to the usage of safe energy in the coming years.
4. Integrating nuclear energy with renewable energy sources is an important player at present that contributes to strengthening the energy sectors due to the continuous energy demand.

Threats

1. The volatile political threats using nuclear energy are a result of the fears it has left behind, which calls for finding alternative energy sources that are safer for society.
2. The misuse damages it has left behind and its effects are still fresh and people fear witnessing a recurring scene. There is fear of misuse by terrorist organizations.
3. Less complexities in fossil fuel and renewable energy sources have commanded reliance on them discouraging the adoption of nuclear energy.
4. Investing in nuclear energy projects is huge as it requires international and global licensing and vast experience which poses a complex threat to small-scale companies and investors.

LITERATURE REVIEW

Aspects Impacting Global Warming

Global warming is influenced by several variables such as human activities like burning fossil fuels and deforestation which contribute to greenhouse gas emissions. In addition, volcanic eruptions and changes in solar energy are examples of natural phenomena that contribute to the impact of global warming. This study delves into the major causes of environmental damage, including the damage caused by fossil fuel sources and the impact of their harmful emissions on living organisms.

The climatic change is induced by greenhouse gas emissions from both natural and human sources. Anthropogenic activities have resulted in around 1.0 °C of global warming over pre-industrial levels, which is projected to increase to 1.5 °C by 2030-2052 if present emissions continue [29]. The study reveals fossil fuel pollutants may cause cancer and respiratory problems [30].

Global warming, primarily driven by fossil fuel emissions, has led to temperature increases that directly affect agriculture. Research indicates that rising temperatures have altered planting schedules and reduced crop yields, threatening global food security [31]. The study explores the escalating threats of global warming on sustainable school management and investigates how education, especially through open and distance learning, can raise awareness and promote measures against carbon emissions due to global warming is a current environmental threat to all elements of life such as air, food, shelter, water, well-being, and land[30]. The study confirms that although fossil fuels are depleting, they are the main source of energy supplies, but they may lead to a series of climate change problems [32].

Furthermore, despite their enormous impact, fossil fuels remain the principal source of energy generation worldwide. The study illustrates that global warming, the rise in the earth's average temperature, poses a significant challenge today. It is primarily driven by human activities, including deforestation, fossil fuel combustion, and industrial processes that increase greenhouse gas emissions. This issue has prompted extensive scientific discourse, With emissions on the rise, the impacts of global warming are likely to worsen, leading to more extreme heat events.

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Projections suggest a temperature increase of 1.5 to 2 degrees Celsius by 2050, possibly reaching 3.5 degrees Celsius by 2100[33].

This study highlights how public perceptions of global warming influence environmental policies and discourse which presents a methodology to assess the connection between weather, climate trends, and perceptions in the U.S., controlling for various variables [34]. Research highlights that human-driven environmental changes such as climate change, marine pollution, and urbanization pose increasing risks to human health. To address these challenges, improving health systems is essential [35]. The study highlights natural factors including solar activity, volcanic activity, and thermohaline circulation in the deep seas may impact climate variability over a decadal period [36].

The study outlines the primary cause of rising global temperatures is greenhouse gases from human activities, notably carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). Key sources include fossil fuel combustion, deforestation, and industrial processes. Increased CO2 in the atmosphere traps solar heat leading to higher global temperatures that threaten both the environment and humanity. Coastal flooding intensified by melting polar ice caps, and extreme weather events resulting in loss of life and infrastructure. Furthermore, disrupted habitats and altered migration patterns endanger biodiversity. To mitigate these effects, reducing emissions and advancing alternative energy and sustainable land use is crucial [37].

The study demonstrates that while climate change is increasing the amount of excessively hot days, it may also influence cold patterns leading to more substantial adverse health outcomes when severe cold weather events occur. Besides, climate models predict that as global temperatures rise, the frequency and intensity of extreme hot and cold weather events will increase, thereby increasing the risk of temperature-related harm [38].

The study revealed all fossil fuels are ultimately used for combustion, whether for heating, electricity, or transportation. These fuels primarily consist of carbon and hydrogen with additional substances like sulfur and lead. Burning fossil fuels releases gases (COx, SOx, NOx, CH), soot, ash, tar droplets, and organic compounds into the atmosphere, resulting in air pollution, this pollution includes unnatural particulates and gases or natural constituents at abnormal levels, harming human health, animals, crops, and visibility. On the other hand, the study sees transitioning quickly to cleaner fuels such as natural gas and hydrogen would provide significant economic and eco-benefits [39].

Background: Emerging positive nuclear energy aspects

Nuclear energy is regarded as an effective means of improving environmental sustainability, particularly in light of global warming which is a pressing environmental issue of modern time. This is caused by greenhouse gas emissions from the use of fossil fuels, industrialization, development, deforestation, modernization, and population growth [40].

This study discusses the sustainability of nuclear energy, a sustainable energy source, and its potential investments. It provides a critical review of the costs and benefits of nuclear energy, highlights its unsustainability, and areas of sustainable energy transition that have been overlooked. These areas include decentralization, civic engagement, safety, and renewable energy. It discusses the Polish nuclear program and highlights environmental misinformation and typical problems in the evaluation of nuclear energy projects. The results suggest that commercial use of

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nuclear energy should not be included in sustainable energy transition programs. It states that further research into nuclear technologies is needed due to their long-term consequences since the 1950s[41].

The study elucidates that climate change and energy security are transforming the energy market, leading to the development of integrated energy systems that coordinate multiple energy sources, storage, and industrial loads. Nuclear power plants balance intermittent renewables with reliable energy generation. However, digital interconnections between facilities may introduce unanticipated risks from operational technology. These risks can be eliminated or mitigated during the early design phases of the systems engineering lifecycle. Risk-informed decision-making at the mission, facility, and systems levels is crucial for a small modular reactor and integrated energy system project with multiple interconnections and interdependencies. Including digital risk considerations in the engineering decision analysis process improves communication and integration among engineering teams, resulting in more effective, efficient, safe, secure, and reliable operations[42].

The study examines the global performance of nuclear power reactors and their role in producing low-carbon electricity. It highlights the importance of advanced fuel and modular reactor technologies like fast breeder reactors for safety and waste management. Further, research is needed to enhance safety and ensure long-term nuclear energy viability [43]. This study highlights that the future power system's energy mix can vary based on load modeling methods either historical scaling or new baseload additions. It also examines how nuclear energy's overnight construction costs influence capacity expansion. Hence, transitioning to low-carbon energy sources is crucial to mitigate anthropogenic climate change requires significant systemic changes in the energy sector and a thorough analysis of various pathways to tackle this issue[44]. The study reveals nuclear energy currently provides 10% of global power and plays a vital role in low-carbon production, preventing over 60 gigatons of CO2 emissions in the last 50 years [45].

This study presents a combined-term economic analysis of an upgraded nuclear power plant integrated with thermal energy storage (TES) and secondary power generators. It quantifies the benefits of operating flexible nuclear power plants within a low-carbon UK electricity system and results applicable to similar infrastructures. The thermodynamic modeling and optimization framework identifies optimal operating conditions for primary power generation during nominal and part-load operations while defining technical design constraints for modular TES and secondary steam Rankine cycle units. The overall system model assesses the value of enhanced flexibility for decarbonizing electricity supply amid variable renewables [46]. The study demonstrates that utilizing water electrolysis together with nuclear energy to make pink hydrogen is an effective and viable answer to the global decarbonization strategy, provided that nuclear energy is a clean energy source with minimal emissions [47].

The study points out that nuclear energy is a significant green energy source that is commonly ineffective in increasing CO_2 emissions but does produce radioactive waste, contributing to environmental pollution. Its cost-effectiveness has fueled the global adoption of nuclear power. Recently, demand for nuclear energy has surged as an alternative to fossil fuels, particularly due to reduced natural gas supplies from Russia following the Ukrainian conflict. This makes nuclear energy a potential solution to the ongoing energy crisis in Europe [48]. The study highlights an important aspect of nuclear energy as a vital energy for sustainability due to its low emissions,

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high power generation capacity, and speed of electricity production and it does not require additional space, i.e., it does not consume an enormous area. This aspect distinguishes nuclear energy from wind and solar energy, which require large areas[49],[50].

The study shows wildfires in the Chornobyl Exclusion Zone (CEZ) contaminated by radionuclides from the Chornobyl disaster pose significant health risks due to the spread of radioactive particles. Rapid response to these fires is vital to ensure safety in nearby areas [51]. The study elucidates that nuclear power significantly enhances energy security for numerous countries by stabilizing electricity grids. Given the variability of renewable energy sources, reliable power from nuclear plants is essential to balance seasonal fluctuations and meet peak demands. With high energy density, market stability, a low environmental footprint throughout its life cycle, and long operational lifespans, nuclear energy stands out as a leading low-carbon solution to address the increasing energy needs of nations[52].

The study demonstrates that the designation of nuclear energy as a sustainable source with low carbon emissions has garnered attention amid climate change talks. While some call for a nuclear renaissance to reduce dependency on fossil fuels, opponents express worries about nuclear waste management and health dangers, as emphasized by the current threats to Ukrainian nuclear sites. As the impacts of climate change endanger global security, biodiversity, and human well-being due to growing carbon dioxide emissions, nuclear energy has once again been the subject of fresh scientific investigation [53].

The study shows policymakers globally are pushing for nuclear energy expansion to combat climate change, offering financial and political incentives for new reactors. However, this initiative conflicts with justice considerations, as the nuclear fuel chain causes environmental injustices, particularly affecting indigenous peoples and marginalized communities. The radioactive waste produced remains hazardous for tens of thousands of years and the risk of catastrophic accidents can render land uninhabitable for decades. Current socio-political systems focused on growth and technology often neglect these significant impacts [54]. The study indicates that nuclear power plants face capital costs of USD 4000 to USD 7000 per kW, with significant licensing fees affecting economic viability [55].

This study utilizes Fully Modified Ordinary Least Squares, Common Correlated Effects, and Dumitrescu-Hurlin panel causality techniques to analyze the environmental impacts of nuclear energy in EU countries from 1990 to 2022. It addresses contradictions in literature and the narrow focus on nuclear energy's environmental effects, emphasizing CO2 emissions and ecological footprint. Findings indicate that nuclear energy impacts CO2 emissions with causality flowing from CO2 to nuclear consumption. However, no direct link is found with the ecological footprint. While nuclear energy reduces air pollution, it necessitates significant land use, affecting ecosystems [56]

FRAMEWORK MULTI-NARRATIVE STUDIES IN NUCLEAR ENERGY

This study addressed the multi-faceted aspects of the sustainability aspects that nuclear energy plays by reviewing previous studies. Concentrating on aspects of the role of nuclear energy in different aspects of research such as the role of political stability, energy security, small nuclear reactor technologies, and the role of nuclear energy in promoting green sustainability. The study reveals features and identifies opportunities for global nuclear power development within a

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sustainability framework. It emphasizes necessary national financial measures for energy markets and advocates for clean energy and low-carbon technologies. Addressing socioeconomic and environmental challenges, it underscores expanding nuclear energy to meet sustainable development and rising electricity demand [57]

This study discusses the current status and future growth of nuclear power, highlighting advancements in reactor technology that enhance safety, simplicity, and cost-effectiveness. New reactors aim to mitigate historic public health and safety concerns from past accidents, potentially alleviating opposition and reducing greenhouse gas emissions. However, challenges remain, particularly regarding nuclear safety, waste disposal, and proliferation which must be credibly addressed to gain public support. Interest in nuclear power has surged due to volatile fossil fuel prices, energy security concerns, and climate change [58].

This study explores how sustainability is framed in the national energy strategies of nations adopting nuclear energy. Analyzing 56 sustainability facets across 7 dimensions revealed most strategies acknowledged sustainability but lacked clear definitions, with limited focus on risk, waste management, and social aspects compared to environmental and economic factors. Public consultation processes were also minimal. Energy supply and use are crucial in the transition to a sustainable society. However, nuclear energy is utilized or planned in 40 countries, yet its role in sustainable development is debated [59].

The study shows Paris Agreement (COP21) highlighted the importance of low-carbon energy technologies, like nuclear power, to combat rising global temperatures below 2 °C. The energy sector significantly contributes to carbon pollution affecting global sustainability. Emphasizing alternative nuclear energy and implementing carbon taxes on polluting industries can effectively reduce carbon damages [60]. The study underlines nuclear energy as a viable alternative for global energy safety and a solution for climate change mitigation to meet low-carbon energy transition targets. The effectiveness of nuclear energy in reducing carbon emissions fuels debates on sustainable growth. In this analysis, CO2 emissions were the dependent variable, with nuclear energy, globalization, and technology as independent variables, controlling for economic growth and renewable energy[61].

This study examines the effect of nuclear energy consumption on green growth in major energy-consuming countries using the CS-ARDL framework. Results indicate that nuclear energy significantly supports long-run green growth while environmental technologies and financial development even play roles. These insights are crucial for policy-making in promoting sustainable growth amid climate concerns [62]. This study investigates the role of alternative and nuclear energy in sustainability, analyzing government spending and economic growth in the top three CO2-emitting nations from 1981 to 2016. It finds a long-term positive correlation between expenditure, growth, and emissions, advocating for green fiscal policies to advance environmental sustainability and a green economy[63].

The study aims to analyze the role of alternative and nuclear energy in reducing carbon damage in a panel of five selected island economies for 2001-2020. It outlines how alternative energy and nuclear power play a crucial role in reducing carbon emissions costs and making island economies green and clean [64]. The study analyzed the relationship between renewable and nuclear energy and environmental sustainability in Pakistan, using the load capacity factor as an ecological indicator. Employing the dynamic Autoregressive Distribution Lag (DARDL) technique, it found

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that nuclear and renewable energy foster sustainable development while hydro energy consumption and economic growth impede environmental sustainability by lowering the load capacity factor[65].

The study found that rising demand for nuclear power enables the achievement of a carbon-neutral agenda, but insufficient funding for renewable energy leads to higher carbon emissions despite research suggesting increasing investment in nuclear energy and green financing can improve regional environmental quality [66]. The study explores the impact of nuclear and renewable energy consumption on ecological quality, represented by CO2 emissions, ecological footprint, and load capacity factor while considering financial development and economic growth. It employs a novel approach to causality, going beyond traditional methods to examine non-linear relationships. Results indicate that nuclear and renewable energy, along with financial development, help reduce ecological harm at higher levels, whereas economic growth negatively impacts ecological quality. Besides, the study advocates for policy measures supporting nuclear energy and ecological sustainability[67].

The study emphasizes nuclear energy is safe, reliable, and environmentally friendly, supporting global energy needs in the 21st century. In Bangladesh, it can bridge the demand-production gap, Generation III pressurized water reactors ensure reliable electricity generation through integrated safety features [68]. The study shows that increasing nuclear energy participation in Brazil's electricity grid enhances energy security, ensures a clean combination, improves reliability, and lowers operating costs [69].

The study aimed to systematically assess societal and technical risks of renewable energy and nuclear technologies, especially small modular reactors. While evaluating traditional and emerging systems' potential to meet global energy demands and support climate and carbon reduction goals and the urgency to transition toward sustainable energy sources is underscored by increasing global concerns about climate change, environmental degradation, and the imperative to reduce carbon emissions [70]. The study indicates policymakers globally prioritize ecological sustainability, with nuclear energy seen as a low-carbon option [71].

The study outlines the role of non-political factors such as digital government and political stability fills this gap by estimating the impact of digital government and political stability on nuclear energy investment within the framework of the Paris Agreement using 26 nuclear energy-producing economies from 2003 to 2022. Empirical estimation of the model is done via the use of the fixed effects model (FEM), random effects model (REM), two-stage least squares (2SLS), and generalized methods of moments (GMM) approach. The outcomes of these approaches reveal that digital government and political stability are both helpful in enhancing investment in nuclear energy[72].

Study portrays nuclear energy as crucial for the global transition to sustainable energy due to its carbon-free nature and ability to reduce environmental impacts. This examines the influence of geopolitical risk on nuclear energy production in leading consuming nations from 1996 to 2022, utilizing a cross-sectional autoregressive distributed lag (CS-ARDL) model. Findings indicate that geopolitical risk enhances long-term nuclear energy production in both developed and developing economies. Besides, GDP, financial development, research and development spending, and environmental technologies contribute to this rise. Nonetheless, in the short term, only GDP and

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environmental technologies significantly impact production, underscoring the need for effective policy responses [73].

The study emphasizes nuclear energy plays a crucial role in promoting environmental sustainability, this study aims to explore the impact of nuclear energy, financial globalization, technological innovation, and economic growth on ecological sustainability in the top 10 nuclear energy-consuming economies from 1995 to 2020[74].

The study India encounters significant challenges in economic development due to climate change, as its energy sector heavily relies on fossil fuels. To ensure energy security and sustainable growth, there is an urgent need for clean energy solutions to reduce greenhouse gas emissions. Nuclear energy presents a sustainable option to address environmental issues linked to fossil fuel electricity generation. This examines the implications of nuclear energy integration in India's power sector using MARKAL energy modeling software, projecting that over 50% of electricity could come from nuclear sources by 2045, facilitated by the Indo-US nuclear deal [75].

Another study shows the role of nuclear power in energy security is examined through a vulnerability-based approach, focusing on terms like vulnerability, threat, hazard, and resilience, emphasizing resilience's components robustness, flexibility, redundancy, diversification, adaptability, and interdependency. It analyzes nuclear power's impact on the energy supply system, balancing its strengths against potential hazards. This unique perspective advances the understanding of nuclear power's role in energy security, crucial for future energy policy development[76].

ANALYSIS OF NUCLEAR ENERGY SCENARIO

We shall examine the key causes for the barriers to nuclear energy through an examination of three scenarios, including a brief approach that explains the nature of the expected and historical scope. This aspect will provide us with a common concept in developing the barriers to nuclear energy and its exploitation and employment in the energy sector only. A more significant insight into international concerns and avoiding them, which provides effective and sustainable measures for the usage of nuclear energy

Scenario I: Nuclear Energy

Nuclear energy is one of the most efficient sources of nuclear energy in generating energy, as it can contribute significantly to reducing global warming emissions by replacing fossil energy sources with nuclear energy, given that it is more suitable energy in many aspects, including sustainability, less impact on the phenomenon of global warming, and eco-friendly.

Scenario II: Overcoming Energy Availability Concerns in 2050.

Concerns persist due to the ongoing fluctuations in the energy sectors due to the significant increase in energy demand rates. Finding showes that sources such as nuclear energy, solar energy, wind energy, and nuclear energy in particular, which have very high production rates, can chart a bright path in 2050 in covering a large part of energy demand. Correspondingly, relying on nuclear and renewable energy sources helps reduce carbon dioxide [77].

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Scenario III: Nuclear Energy Waste Concerns

It is one of the most prominent obstacles that hinder progress in moving towards nuclear energy, which makes many countries raise many concerns including safety concerns, resulting from the accidents that they left behind such as Chornobyl and Fukushima. These tragedies left an unforgettable mark of great destruction as a result of problems with nuclear reactors, such as their failure to operate, problems in the reactor, radiation deposits, or other reasons. These effects that they left behind made many reconsider relying on nuclear energy, in addition to fears of exploiting it in aspects of destructive weapons. One of the most dangerous aspects of nuclear energy is its waste, which is a dangerous factor. These aspects will hinder nuclear energy despite the huge amount of energy it provides compared to fossil fuel sources, solar energy, wind energy, and others.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Global warming has witnessed great focus due to the effects of the rise in toxic gases, i.e., greenhouse gases, most of which are produced through fossil fuel sources. In this work, we focused on analyzing studies with various aspects that discussed the main reasons for the increase in the phenomenon of global warming. Thos include identifying carbon dioxide gas, which is one of the gases that constitute approximately 60% of the gases produced from fossil fuel sources that pose great harm to the phenomenon of global warming. We found that nuclear energy does not produce carbon dioxide gas and does not contribute to the escalation of emissions that affect the phenomenon of global warming. Hence, we found that the trend towards nuclear energy is a sustainable trend that enhances green energy and the environment. However, the study showed that nuclear energy, despite its advantages according to literary studies, the previous catastrophic fears it left behind are negative aspects that hinder the world's move towards nuclear energy. This has caused a decline in reliance on nuclear energy sources and most countries are divided into those who support the usage of nuclear energy to reduce emissions and enhance energy demand in 2050. Others believe that relying on sources that do not raise any catastrophic concerns is necessary, such as renewable energy sources that are more promising than nuclear energy.

Recommendations

1. Utilize small nuclear reactors i.e. small modular reactor
2. Utilize renewable energy sources with nuclear energy sources.
3. Heighten research and development sectors in developing technologies that reduce the effects of radioactive emissions left by nuclear energy.
4. Increase ongoing support for researchers and companies working closely to achieve public safety from the risks of nuclear energy.
5. Develop advanced waste management strategies, including using hazardous waste in fission processes, safe geological storage, and recycling to reduce the environmental impact of radioactive emissions.

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