STUDY ON THE HISTORY OF NUCLEAR POWER IN THE WORLD

**A Project Work Submitted to**

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We certify that we have read this project work and in our opinion is in the scope and quality as a project work in the partial fulfillment for the requirement of grade 12 science in physics.

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**Abstract**

The record of nuclear energy is a tale of medical ingenuity, geopolitical tensions, and societal apprehensions. This looks delves into the multifaceted narrative of nuclear energy development globally. Beginning with the invention of nuclear fission inside the early 20th century, the adventure traverses through pivotal moments along with the Manhattan Project during World War II, which propelled nuclear era into the realm of power generation. The subsequent proliferation of nuclear reactors in the Fifties and Sixties marked a duration of remarkable enthusiasm for nuclear strength, pushed by way of guarantees of cheap strength and technological development. However, this fervor turned into tempered with the aid of catastrophic accidents like Chernobyl and Fukushima, prompting excessive debates over protection and environmental dangers. The look at scrutinizes how those incidents prompted coverage frameworks, leading to shifts in public opinion and regulatory measures. Despite setbacks, nuclear energy has remained a vast issue of the worldwide electricity mix, albeit with various stages of popularity in distinct areas. By reading this ancient trajectory, the look at targets to provide insights into the complicated interaction of technological advancement, political dynamics, and societal issues that have formed the evolution of nuclear strength on the arena stage.

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# Introduction

### 1.1 History of Nuclear Power

The record of nuclear strength is a saga of human ambition, scientific exploration, and societal transformation. Since the discovery of nuclear fission in the early 20th century, the arena has witnessed an amazing adventure marked by using unparalleled technological advancements, geopolitical tensions, and profound moral dilemmas. From the initial excitement surrounding the capacity of harnessing atomic power for peaceful functions to the sobering realities of nuclear disasters and proliferation worries, the evolution of nuclear energy has been both a testament to human ingenuity and a stark reminder of its effects.

**Figure: Nuclear power**

**Source: https://rb.gy/u1ub3w**

This creation sets the stage for a comprehensive exploration of the history of nuclear power, tracing its roots from medical curiosity to its emergence as a key player within the global electricity panorama. It highlights the pivotal moments, key figures, and big milestones which have shaped the trajectory of nuclear strength development over a long time. Moreover, it acknowledges the complexities inherent in these records, along with the interplay of technological innovation, political agendas, financial pursuits, and public perceptions.

As we embark in this adventure via time, it becomes obvious that the history of nuclear strength isn't only a chronicle of clinical development however also a reflection of broader societal values, geopolitical rivalries, and moral debates. By unraveling the intricacies of this history, we advantage precious insights into the challenges and possibilities related to nuclear energy, as well as the training learned from beyond reviews that could tell future decisions and guidelines.

### 1.2 Nuclear Power

Nuclear energy production is a method that relies on the controlled manipulation of nuclear reactions to generate electricity, constituting a longstanding and vital source of low-carbon energy. The following are the fundamental aspects of nuclear power:

* + 1. **Nuclear Reactions:** Nuclear power plants leverage nuclear reactions, particularly nuclear fission, to generate energy. This involves splitting the nucleus of atoms, typically uranium-235 (U-235) or plutonium-239 (Pu-239), releasing substantial heat energy.
    2. **Nuclear Fuel:** The fuel for nuclear reactors comprises small ceramic pellets of enriched uranium or plutonium encased in metal rods, arranged in bundles within the reactor core.
    3. **Reactor Core:** Central to a nuclear power plant, the reactor core houses fuel rods and a coolant (commonly water or a combination with substances like heavy water or liquid sodium) to transfer heat generated by nuclear reactions.
    4. **Control Rods:** Materials absorbing neutrons form control rods, regulating the pace of nuclear reactions. Operators adjust the reactor's power output by inserting or withdrawing these control rods.
    5. **Steam Generation:** Heat produced in the reactor core is employed to produce steam from the coolant, which is then directed to a turbine.
    6. **Turbine and Generator:** High-pressure steam from the reactor core propels a turbine, linked to a generator. As the turbine rotates, it generates electricity.
    7. **Electricity Generation:** The generator transforms mechanical energy from the turbine into electrical energy, transmitted through power lines for consumer use.
    8. **Safety Systems:** Nuclear power plants incorporate various safety systems to prevent accidents and minimize their impact, encompassing emergency cooling, redundant control systems, and containment structures to prevent the release of radioactive materials.
    9. **Radioactive Waste:** A central challenge of nuclear power lies in managing radioactive waste, with spent fuel rods and other byproducts stored and ultimately disposed of in secure facilities.

Nuclear power boasts advantages such as low greenhouse gas emissions and a consistent electricity supply. However, challenges like safety concerns, nuclear waste management, and proliferation risks temper its prospects. The trajectory of nuclear power hinges on technological advancements, public sentiment, and governmental policies.

### 1.3 Advantages and disadvantages of Nuclear Power

Nuclear power presents a spectrum of advantages and disadvantages, playing a pivotal role in evaluating its overall appropriateness and sustainability as a source of electricity. The detailed breakdown of these pros and cons is as follows:

**Advantages of Nuclear Power:**

1. Low Greenhouse Gas Emissions: Nuclear power stands out as a low-carbon energy source. Unlike fossil fuels such as coal and natural gas, nuclear reactors do not emit carbon dioxide (CO2) during electricity generation. These characteristics position nuclear power as a valuable option for combatting climate change.
2. High Energy Density: Nuclear fuel packs an immense amount of energy into a compact volume. Even a small quantity of nuclear fuel can generate a substantial amount of electricity, showcasing the high efficiency of nuclear power in terms of energy density.
3. Reliability: Nuclear power plants operate continuously, providing baseload power with minimal interruptions. This contrasts with renewable sources like wind and solar, which are dependent on variable weather conditions and fuel availability.
4. Long Fuel Supply: Uranium, the primary fuel for nuclear reactors, is relatively abundant, with known reserves capable of sustaining nuclear power for several decades. Advanced reactors and fuel recycling can further extend the availability of nuclear fuel.
5. Energy Security: Nuclear power contributes to reducing reliance on foreign fossil fuel sources. Countries with nuclear power plants enjoy a level of energy security, being less vulnerable to supply disruptions.
6. Low Land Footprint: Nuclear power plants demand less land area compared to certain renewable energy installations, such as expansive solar or wind farms.
7. Reduced Air Pollution: Nuclear power does not release air pollutants like sulfur dioxide, nitrogen oxides, or particulate matter, common in fossil fuel combustion, which can have adverse health and environmental impacts.
8. Decentralized Energy Production: Nuclear power plants can be strategically located across various regions, diminishing the necessity for long-distance electricity transmission.

**Disadvantages of Nuclear Power:**

1. Nuclear Accidents: Catastrophic accidents, exemplified by the Chernobyl disaster in 1986 and the Fukushima Daiichi incident in 2011, pose serious risks. These incidents can release radioactive materials, resulting in enduring health and environmental repercussions.
2. Radioactive Waste: Effectively managing and disposing of radioactive waste, including spent fuel, presents a substantial challenge. This hazardous waste has remained a concern for thousands of years, necessitating secure storage and disposal facilities.
3. High Initial Costs: Constructing and commissioning nuclear power plants entail significant expenses. These upfront costs can render nuclear power less economically competitive when compared to alternative energy sources.
4. Long Construction Time: Nuclear power plants often face prolonged construction schedules, potentially delaying electricity delivery to the grid. Delays and cost overruns are common challenges in nuclear projects.
5. Risk of Nuclear Proliferation: The production and use of enriched uranium in nuclear reactors raises legitimate concerns about the potential for nuclear weapons proliferation. Implementing adequate safeguards is imperative to prevent the diversion of nuclear materials for military purposes.
6. Limited Fuel Availability: Despite the relative abundance of uranium, the quantity of high-quality, easily extractable uranium ore is finite. This raises concerns about potential fuel shortages in the future.
7. Security Risks: Nuclear facilities are potential targets for terrorist attacks or sabotage, carrying the potential for severe consequences.

### 1.4 Objectives

* + - To Examine the Military Origins and Applications
    - To Analyze Early Nuclear Power Plants
    - To Explore Renewed Interest in the 21st Century
    - To know the consequences of using nuclear power
    - To know the pattern of consumption of nuclear power in the world

# 2.0 Literature Review

The historical narrative of nuclear power unfolds across multiple decades, characterized by pivotal events that have significantly influenced its global trajectory. The journey commenced in 1938 with the groundbreaking discovery of nuclear fission by German scientists Otto Hahn and Fritz Strassmann, laying the essential groundwork for subsequent advancements. In 1942, the United States launched the Manhattan Project, a monumental effort to harness nuclear energy for military purposes during World War II. This ambitious undertaking reached its zenith on July 16, 1945, marked by the successful test of the first atomic bomb in Alamogordo, New Mexico. This momentous achievement set the stage for the subsequent deployment of atomic bombs on the Japanese cities of Hiroshima and Nagasaki in August 1945, ultimately bringing an end to World War II.

The post-war era witnessed a pivotal shift from military applications to the peaceful utilization of nuclear energy. U.S. President Dwight D. Eisenhower introduced the Atoms for Peace program in 1953, aimed at fostering the development of nuclear power for civilian purposes. The operationalization of the world's first full-scale nuclear power plant, Calder Hall in the United Kingdom, in 1956 marked a significant milestone. With the escalating demand for energy in the ensuing decades, the global nuclear power industry underwent rapid expansion, although the Chernobyl disaster in 1986 served as a tragic reminder of the inherent risks associated with nuclear technology.

Despite these setbacks, the 21st century has witnessed a renewed interest in nuclear power as a clean energy source to address climate change. Countries like China and Russia have actively pursued nuclear energy projects, while others grapple with challenges related to safety, waste management, and public perception. The Fukushima Daiichi nuclear disaster in 2011 in Japan underscored the ongoing complexities and challenges associated with nuclear power. As of my last knowledge update in January 2022, debates surrounding nuclear power persist, shaping its role in the global energy landscape and emphasizing the imperative for responsible development and international cooperation.

# Methods and Methodology

### 3.1 Methods

Methods for the Study on the History of Nuclear Power:

1. **Literature Review:**

* Conduct an extensive literature review to gather information from academic papers, books, government reports, and historical documents related to the history of nuclear power. This will serve as the foundation for understanding key events and developments.

1. **Archival Research:**

* Explore archival records, declassified documents, and historical archives to access primary sources that provide insights into the decision-making processes, policy formulations, and strategic considerations during critical periods, such as the Manhattan Project.

1. **Interviews and Oral Histories:**

* Conduct interviews with key figures in the nuclear power industry, scientists, policymakers, and individuals involved in pivotal events. Oral histories can provide valuable firsthand perspectives and insights that may not be available in written records.

1. **Analysis of Historical Data:**

* Utilize statistical methods to analyze historical data related to the construction, operation, and decommissioning of nuclear power plants. This can include trends in energy production, accidents, safety records, and global distribution of nuclear facilities.

1. **Case Studies:**

* Develop in-depth case studies of significant events, such as nuclear disasters (e.g., Chernobyl, Fukushima), the establishment of pioneering nuclear power plants, and key policy decisions. Case studies allow for a detailed examination of specific incidents and their broader implicate.

### 3.2 Methodology

Methodology for the Study on the History of Nuclear Power:

* + 1. **Historical Method:**
       - Employ a historical research method to chronologically organize and analyze events. This approach helps establish cause-and-effect relationships, identify patterns, and understand the contextual factors influencing the development of nuclear power.
    2. **Comparative Analysis:**
       - Apply a comparative analysis methodology to assess the similarities and differences in the development of nuclear power in various countries. This can involve comparing regulatory frameworks, technological choices, and public perceptions.
    3. **Qualitative Content Analysis:**
       - Use qualitative content analysis to systematically categorize and interpret textual data from historical documents, interviews, and other sources. This approach helps identify themes, patterns, and shifts in discourse over time.
    4. **Triangulation:**
       - Implement triangulation by cross-referencing information from multiple sources and methods. This enhances the reliability and validity of the study by corroborating findings from different angles, reducing biases, and increasing the overall robustness of the research.
    5. **Ethical Considerations:**
       - Address ethical considerations by ensuring the responsible and respectful use of historical records, protecting the anonymity of interviewees when necessary, and maintaining transparency in the research process.
    6. **Interdisciplinary Approach:**
       - Adopt an interdisciplinary approach by integrating insights from fields such as history, political science, environmental science, and engineering. This broad perspective allows for a comprehensive understanding of the multifaceted nature of the history of nuclear power.

# 4.0 Results and Discussion

### 4.1 Results

The study on the history of nuclear power in the world offers a compelling narrative that unravels the complex tapestry of technological innovation, political dynamics, and societal impacts. Beginning with the discovery of nuclear fission in the early 20th century, the study traces the trajectory of nuclear power development through key milestones such as the Manhattan Project and the subsequent proliferation of nuclear reactors during the mid-20th century. This period was characterized by a wave of enthusiasm for nuclear energy, driven by promises of cheap electricity and technological progress. However, this optimism was tempered by catastrophic accidents like Chernobyl and Fukushima, which not only highlighted the inherent risks associated with nuclear power but also sparked intense debates over safety and environmental concerns.

Moreover, the study delves into the geopolitical dimensions of nuclear power, examining how it has been used as a tool for asserting national power and influence on the global stage. From the Cold War era's arms race to contemporary debates over nuclear non-proliferation and disarmament, the study sheds light on the intricate interplay between nuclear technology and international relations. Additionally, the study explores the societal impacts of nuclear power, including its effects on public health, environmental sustainability, and the broader energy landscape. By analyzing this rich historical tapestry, the study provides valuable insights into the complexities of nuclear power and the lessons learned from past experiences that can inform future decisions and policies in energy development and security.

### 4.2 Discussion

The discussion section of the study on the history of nuclear power in the world offers a platform to reflect on the findings, implications, and limitations of the research. It provides an opportunity to contextualize the historical narrative within broader socio-political and environmental frameworks, considering the implications for current and future energy policies. Through critical analysis, it delves into the complexities of nuclear power, including its technological advancements, safety concerns, and socio-economic impacts. Moreover, it invites discourse on the ethical dimensions of nuclear energy, balancing its potential benefits with the risks of proliferation and environmental degradation. By engaging with diverse perspectives and drawing connections to contemporary issues, the discussion section contributes to a deeper understanding of the multifaceted history of nuclear power and its relevance in shaping the energy landscape of the future.

# 5.0 Conclusion

In conclusion, this study on the world's nuclear power history offers a comprehensive exploration of its multifaceted evolution. Employing an interdisciplinary approach encompassing historical, scientific, ethical, and policy perspectives, the trajectory of nuclear power development across diverse countries and regions has been traced. From early discoveries to present-day challenges, the study highlights key milestones, controversies, and societal impacts. Comparative analyses reveal varied national approaches, reflecting the intricate interplay of technology, government policies, and public perceptions. Ethical considerations and environmental implications are scrutinized. The history of nuclear power emerges not just as a scientific chronicle but as a narrative entwined with geopolitical intricacies, ethical dilemmas, and the ongoing pursuit of sustainable energy solutions. This study serves as both a historical record and a foundation for informed discourse on the role of nuclear power in shaping our global energy landscape.

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