

The Current State and Future Development of New Energy

Xinrui Wu *

No.86 Middle School, Guangzhou, 510700, China

* Corresponding Author Email: ylh724@gmail.com

Abstract. With the prolonged use of fossil fuels, the energy world faces the crisis of resource depletion. The emergence of new energy is driving a transformational development in the energy sector, initiating a shift in the energy structure. New energy plays an increasingly important role in development, reducing people's dependence on traditional fossil fuels. This study examines the global energy transition, focusing on the shift from coal to renewable energy sources. It reviews the environmental and health hazards of traditional energy, particularly coal, and explores advancements in renewable technologies like solar, wind, and nuclear energy. The research highlights the role of technological innovations, such as concentrated photovoltaic (CPV) and offshore wind power, in improving efficiency and reducing costs. It also emphasizes the importance of government policies in driving the energy transition. The study concludes that renewable energy will dominate future global energy systems, with countries like China leading the way in reducing coal dependence and promoting sustainability. The transition to low-carbon, renewable energy is essential for achieving global carbon neutrality goals and addressing climate change.

Keywords: Energy background, new energy, new energy technology, new energy development.

1. Introduction

Given the continuous growth of global energy demand and severe environmental issues, the research and innovation of energy technology have become critically important. Currently, energy is still dominated by traditional non-renewable fossil fuels, facing resource scarcity and environmental damage caused by fossil fuels. The research and innovation of energy technology are key to solving global energy demand and environmental problems. For example, researchers have significantly improved the photoelectric conversion efficiency of photovoltaic cells by developing new materials such as perovskite and crystalline silicon-perovskite tandem cells. The application of these materials allows cells to absorb sunlight more effectively and convert it into electrical energy [1].

Future development directions will focus more on the application and promotion of renewable energy technologies, as well as the improvement and optimization of traditional energy technologies. Meanwhile, the emergence of new technologies and the integration of energy systems will push the energy industry toward a cleaner, more efficient, and more sustainable direction.

2. Energy Background

2.1. Reliance on Energy During the Industrial Revolution

From the late 18th century to the early 19th century, the invention and widespread use of the steam engine promoted the continuous development of heavy industry in the United Kingdom, which was the first to begin the industrialization process. The large-scale development of heavy industry in the UK increased the energy demand, and biomass energy dominated by wood could no longer meet the needs of large-scale industrial production.

Meanwhile, the use of steam engines in coal mining greatly improved coal production efficiency, promoting the development of the coal industry and providing a guarantee to meet the rapidly growing energy demand.

The coal industry was the earliest mechanized industry developed during the UK's industrialization process, with the steam engine as its core technology. The success of the First Energy Revolution was marked by coal replacing wood as the dominant energy source. By 1850, coal

accounted for 92% of energy consumption in the UK [1]. Compared with wood, coal has a high energy density, is easy to transport, and its production is not affected by seasons. Replacing wood with coal separated the energy industry from agriculture.

2.2. Hazards of Traditional Energy

Air Pollution: The combustion of coal releases large amounts of sulfur dioxide, nitrogen oxides, and particulates. These substances are major contributors to acid rain and air pollution, causing severe impacts on human health and the ecological environment. For example, sulfur dioxide can convert to sulfuric acid mist in the atmosphere, forming acid rain that poses a significant threat to plants and forests, potentially reducing annual grain production by 10%.

Greenhouse Gas Emissions: Coal combustion produces large amounts of carbon dioxide, a primary greenhouse gas that significantly impacts global climate warming. Approximately 6 billion tons of carbon are emitted globally each year, increasing atmospheric carbon dioxide concentrations, exacerbating the greenhouse effect, and leading to global warming and sea-level rise.

Release of Harmful Substances: Harmful substances released during coal mining and utilization, such as heavy metals and polycyclic aromatic hydrocarbons, can enter the human body through air, water, and soil, causing long-term health effects.

Health Threats: The emission of coal dust and particulates poses health threats to residents in mining areas and surrounding regions, increasing the incidence of respiratory diseases.

2.3. Turning Point in Energy Structure

The core of the global energy transition lies in shifting from high-carbon fossil fuels to low-carbon and renewable energy sources, driven mainly by climate change and environmental issues. Since the 1930s, the proportion of renewable energy in global primary energy consumption has gradually increased, reaching 10.9% in 2018, marking preliminary progress in the third energy transition. Simultaneously, economic entities like the European Union have formulated clear low-carbon energy transition goals and pathways, planning to increase the proportion of renewable energy in energy consumption to 50% by 2050 to reduce dependence on fossil fuels.

3. Energy Technologies

3.1. Coal Energy Technology

Coal, as a traditional energy resource, is one of the world's primary energy sources. However, coal combustion produces large amounts of carbon dioxide and other pollutants, causing severe environmental impacts. Current research and development focus mainly on improving combustion efficiency and reducing pollutant emissions. For example, supercritical combustion and chemical absorption methods can reduce pollutant emissions, while coal gasification and liquefaction can improve coal utilization efficiency.

3.2. Solar Energy Technology

Solar energy is a clean, safe, and renewable green energy with broad application prospects. It is a significant branch in the renewable energy field with vast market potential. The main solar technologies currently include photovoltaic power generation and solar thermal utilization. Photovoltaic power generation converts solar radiation into electrical energy, while solar thermal utilization uses solar energy for heating and hot water production. Current research and development directions include improving the conversion efficiency of photovoltaic cells, reducing costs, and enhancing the stability and flexibility of solar energy utilization.

Significant progress has been made in solar photovoltaic technology over the past decades, especially in silicon-based solar cell research. However, the low conversion efficiency of silicon-

based cells limits further improvements, prompting research to develop new cell materials and structures to enhance conversion efficiency and reduce costs [2].

Concentrated Photovoltaic Technology (CPV): As an emerging technology, CPV uses optical components to concentrate sunlight and then converts it directly into electrical energy using high-efficiency photovoltaic cells. This technology's conversion efficiency is twice that of traditional photovoltaic technology and is considered one of the future development trends in solar power generation. In the future, solar power is expected to dominate the energy structure, especially in developing countries, providing an important solution to energy shortages. Photovoltaic power generation has enormous potential not only in non-electrified regions but also in building applications with technological advancements and cost reductions, opening up broad prospects for the future development of the solar industry.

3.3. Wind Energy Technology

Wind energy is a clean, renewable energy source that does not produce pollution during power generation, making it a green energy. However, wind energy has a low energy density and is unstable and intermittent due to geographical location and climatic conditions. Wind energy technology is another crucial renewable energy technology, converting wind turbine dynamics into electrical energy. Current research and development directions mainly include improving the efficiency and reliability of wind turbines, addressing network access and stability issues faced by wind farm scale expansion, and exploring new forms of wind energy utilization, such as offshore wind power and the integration of energy storage technologies.

In recent years, wind power technology has made significant progress, particularly in developing large-scale wind turbines. Currently, megawatt-class wind turbines have become mainstream, with research ongoing for even larger units, such as 10 MW wind turbines. These large units significantly improve wind energy capture efficiency through advanced aerodynamic designs, such as new blade airfoil designs and the application of flexible blades. These technological improvements have continuously reduced the cost of wind power generation, making it one of the most economical new energy sources.

The global wind power market is rapidly expanding, especially in Europe and Asia. Europe's wind power development has been leading, with countries like Germany and Denmark achieving significant results in wind energy utilization. For example, Germany plans to have wind power account for 25% of total electricity consumption by 2025 and 50% by 2050, while Denmark's wind power generation already meets 18% of its electricity demand. The wind power market in Asia is also growing rapidly, with China's and India's wind power installed capacity increasing at annual rates of 30% and 23%, respectively, making them some of the most promising regions for wind power development. These countries are pushing the wind power industry toward larger scales and higher efficiency through policy support and technological innovation.

3.4. Nuclear Energy Technology

Nuclear energy technology is a highly efficient energy technology but also comes with issues such as safety and nuclear waste disposal. Current research and development focus mainly on developing fourth-generation nuclear energy systems, aiming to improve nuclear energy utilization efficiency, enhance safety, and reduce nuclear waste generation. Nuclear energy is also considered an important way to solve future energy problems. According to predictions, the proportion of nuclear energy in the global energy structure will continue to rise, especially after breakthroughs in fast neutron breeder reactors and controlled nuclear fusion technology, which will significantly improve nuclear fuel utilization. Although the development and utilization of nuclear energy is a long-term and gradual process, its role in meeting global energy demand is irreplaceable. Particularly in the context of the gradual depletion of traditional fossil fuels, nuclear energy provides a sustainable energy solution [3].

3.5. Hydropower Technology

Hydropower is a clean, renewable energy source that directly converts primary energy into secondary energy (electricity) through hydroelectric power generation. It utilizes the potential energy of water to generate electricity without consuming water resources or producing pollutants. Hydropower development has multiple comprehensive benefits, including flood control, irrigation, navigation, fisheries, and tourism. Hydropower units can start and stop quickly, making them ideal for peak regulation, frequency modulation, and emergency backup power sources in the grid.

Hydropower technology mainly includes hydroelectric power generation and tidal energy utilization. Hydroelectric power generation is a mature technology but faces challenges such as water resource scarcity and environmental impacts. Tidal energy utilization is an emerging energy technology with stable and predictable characteristics but currently faces technical costs and environmental adaptability issues [4].

Rational planning and management are key to achieving sustainable utilization of water resources. Through scientific planning and management, water resource allocation can be optimized, particularly in agricultural irrigation, industrial water use, and residential water consumption, improving water resource utilization efficiency. Additionally, establishing water rights systems and implementing quota management can effectively prevent overexploitation, ensuring the sustainable supply of water resources.

In summary, the overall trend of future energy technology development is toward low carbon and renewable directions, effectively replacing fossil fuels and providing new guarantees for future development. However, challenges such as the lack of widespread technology adoption remain.

4. Future Trends

4.1. Rise of Renewable Energy

Renewable energy sources like solar, wind, and hydropower are gradually becoming important components of the global energy system due to their clean and low-carbon characteristics. According to forecasts by the International Energy Agency, by 2030, the global photovoltaic installed capacity will exceed 1,000 gigawatts, making photovoltaic power generation one of the world's largest electricity producers. Meanwhile, wind energy technology continues to advance, and the cost of wind power keeps declining, making wind power one of the most competitive energy forms in many regions [5].

4.2. Policy Support and Market Drive

Governments worldwide are introducing policies to encourage the research and application of new energy technologies through investments, financial subsidies, and market mechanism reforms. For example, the Chinese government proposed vigorously developing new energy storage in the "14th Five-Year Plan" to promote energy transition and achieve carbon neutrality goals. Policy support not only promotes the rapid growth of the new energy industry but also provides a broad market space for related enterprises.

4.3. Energy Transition and Carbon Neutrality

Globally, to achieve carbon neutrality goals, countries are accelerating energy transitions. It is expected that by 2050, approximately 70% of global electricity demand will be supplied by renewable energy sources like solar and wind power, and the proportion of energy storage configurations will reach close to 30%. This transition will not only help reduce greenhouse gas emissions but also promote the intelligent and diversified development of energy systems.

4.4. China's Energy Transition

China's energy transition faces severe challenges because its energy consumption has long been dominated by coal, leading to high carbon emissions and serious environmental problems. In recent years, China has vigorously promoted the development of non-fossil energy, especially renewable energies like wind and solar, significantly increasing their proportion in the energy structure. Additionally, China is actively promoting the optimization of energy consumption structures through policy guidance and technological innovation, striving to build a clean, low-carbon, safe, and efficient energy system. These measures are not only strategic choices for China to address global climate change but also requirements for achieving ecological civilization construction and sustainable development.

5. Conclusion

In conclusion, the energy transition is a complex and long-term process and necessitates technological innovations, economic development, policy changes, and societal consensus. Through global cooperation, countries can better respond to climate change and achieve sustainable development. New energy is leading the transformation of the global energy system and will profoundly impact future economic and social development. With technological progress and policy support, the new energy industry will undoubtedly usher in a brighter future.

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