

HYDROPOWER AND ITS ROLE IN GREEN ENERGY

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Abstract: *This article analyzes the role of hydropower in the green energy sector. Hydropower converts the kinetic and potential energy of water into electricity, making it a sustainable, environmentally friendly, and renewable energy source. The article examines the advantages, ecological aspects, global significance, and future prospects of hydropower. Additionally, the efficiency and environmental impacts of large and small hydropower projects in the context of green energy are discussed. It is concluded that hydropower plays a strategic and sustainable role in the global green energy system.*

Keywords: *Hydropower, Green energy, Renewable energy, Sustainable development, Electricity generation, Environmental impact*

Introduction. In recent decades, climate change and environmental challenges have forced humanity to focus on sustainable and renewable energy sources. Conventional fuels — such as oil, gas, and coal — are limited and their carbon emissions contribute significantly to atmospheric pollution. Consequently, renewable energy sources are gaining global attention. In this context, hydropower, which generates electricity by utilizing the kinetic and potential energy of water, occupies a crucial place in the green energy sector. Hydropower is not only a reliable energy source but also environmentally clean, renewable, and economically efficient.

The Essence of Hydropower. Hydropower converts the flow of water into electrical energy. Water turbines rotate with the movement of water, driving generators to produce electricity. This process produces electricity with minimal carbon emissions. By using reservoirs, hydropower ensures continuous and stable energy production, helping balance supply and demand in electrical grids. In addition, hydropower contributes to water management, irrigation, and potable water supply.

Hydropower can be categorized into two main types:

1. Large Hydropower Stations (LHPs) – capable of generating significant amounts of energy but require large reservoirs and may have higher environmental impacts.
2. Small and Mini Hydropower Plants – generate less electricity but have minimal ecological impact and are suitable for meeting local energy needs.

Role in Green Energy. Hydropower is a central component of green energy systems. Globally, hydropower accounts for approximately 50% of renewable electricity production. Its role in green energy is evident in several aspects:

1. Renewable Energy Source – relies on the natural water cycle, ensuring sustainable energy production.
2. Carbon Footprint Reduction – significantly decreases harmful emissions compared to fossil fuels, contributing to climate change mitigation.
3. Stable Electricity Supply – helps balance variable sources such as solar and wind power. In regions where rainfall and river flow are stable, hydropower acts as a reliable “reserve” for the grid.
4. Economic and Social Benefits – reservoirs created by hydropower plants support irrigation, potable water supply, and transportation, thereby fostering regional development.

Hydropower enhances both large- and small-scale renewable energy systems. Countries such as Norway, Canada, and Brazil derive a substantial portion of their electricity from hydropower, while many developing nations use small-scale hydropower plants to provide electricity to local communities.

Ecological Considerations and Limitations. Although hydropower is environmentally friendly, large reservoirs can create ecological challenges:

- *Alteration of natural river flows and aquatic ecosystems.
- *Reduction of wetlands and riparian habitats.
- *Restriction of natural fish migration patterns.

Therefore, modern hydropower projects emphasize ecological standards and sustainable management. Measures such as maintaining natural flow patterns, building fish passages, and monitoring water quality help minimize environmental impacts.

Future Prospects. With technological advancements, the role of hydropower in green energy is expected to grow. Innovations can enhance energy efficiency, reduce the ecological footprint of reservoirs, and expand small-scale projects. Hydropower also provides essential support to balance other renewable sources, such as solar and wind energy.

Moreover, hydropower plays a vital role in global energy security. Many countries prioritize hydropower in their energy strategies, recognizing its strategic importance for reducing carbon emissions and combating climate change.

Conclusion. Hydropower is an integral component of the green energy system, offering sustainability, renewability, and environmental benefits. Beyond electricity generation, it provides economic, social, and ecological advantages. Future improvements in hydropower technology, environmentally safe and efficient projects, and integration with other renewable sources will enhance its strategic role in ensuring global energy security and mitigating climate change.



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