

## Development of Hydropower as a Natural Energy Source and its Challenges

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### DESCRIPTION

The renewable energy source known as hydropower, commonly referred to as hydroelectric power, has a long tradition that originated back to ancient civilizations. It involves converting the kinetic energy of moving water typically found in rivers and streams into electrical energy. Hydropower is one of the most significant contributors to the global energy sources.

### Basics of hydropower

Hydropower systems operate on a fundamental principle. The kinetic energy of flowing water can be converted into mechanical energy, which in turn is transformed into electricity.

**Water source:** Hydropower plants are mainly located near water sources, typically rivers or reservoirs. These water sources ensure a continuous flow of water, a key element for consistent power generation.

**Dam or diversion:** In many cases, a dam is constructed across the river to create a reservoir. This damming process stores water, which can be released in controlled amounts to generate electricity.

**Turbines:** Water from the reservoir or river flows through a series of turbines. The kinetic energy of the moving water spins the turbine blades, converting the energy into mechanical power.

**Generator:** The turbines are connected to generators, which transform the mechanical energy into electrical energy through the principles of electromagnetic induction.

**Transmission and distribution:** The generated electricity is transmitted through power lines to homes, industries and businesses, where it powers appliances, lights, and machinery.

### The environmental benefits of hydropower

Hydropower has long been celebrated for its positive environmental impacts, which make it a basis in the transition towards a sustainable energy future.

**Zero emissions:** One of the most noticeable advantages of hydropower is its minimal greenhouse gas emissions. Unlike fossil fuels, hydropower produces no direct carbon dioxide emissions during operation. This makes it a main component of efforts to combat climate change.

**Low environmental footprint:** Hydropower plants have a relatively small physical footprint compared to many other energy sources. While the construction phase may have localized environmental impacts, once operational, they have minimal ongoing effects.

**Water management:** Dams and reservoirs often serve dual purposes, providing water storage for irrigation, flood control and recreational activities. These multipurpose reservoirs are important for efficient water management in many regions.

**Habitat creation:** In some cases, hydropower projects can lead to the creation of new aquatic habitats, fostering biodiversity. Properly managed projects incorporate fish ladders and other measures to minimize ecological disruptions.

**Energy storage:** Pumped storage hydropower, a specialized form of hydropower, acts as an energy storage solution. During periods of low demand, excess electricity is used to pump water uphill to a reservoir. When demand rises, the stored water is released to generate electricity, helping to stabilize the grid.

### Challenges

**Environmental impacts:** The construction of dams and reservoirs can have some environmental effects. These may include habitat disruption, altered water flow patterns and the accumulation of sediment in reservoirs.

**Social impacts:** The displacement of communities due to the construction of dams is a significant concern. Hydropower projects can have social and cultural implications, particularly for indigenous peoples and local populations. Ensuring proper resettlement and compensation mechanisms is important.

**Climate vulnerability:** Climate change presents a dual challenge for hydropower. Changes in precipitation patterns and increased variability in water flow can affect the reliability of hydropower generation. Furthermore, as temperatures rise, water temperature and water quality can be impacted, potentially affecting aquatic ecosystems.

**Sediment management:** Over time, reservoirs can accumulate sediment, reducing their capacity and affecting power generation. Effective sediment management strategies are necessary to maintain the long-term viability of hydropower facilities.

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Received: 02-Aug-2023, Manuscript No. JFRA-23-27519; Editor assigned: 07-Aug-2023, PreQC No. JFRA-23-27519 (PQ); Reviewed: 21-Aug-2023, QC No. JFRA-23-27519; Revised: 28-Aug-2023, Manuscript No. JFRA-23-27519 (R); Published: 04-Sep-2023, DOI: 10.35248/2090-4541.23.13.317

Citation: Sin J (2023) Development of Hydropower as a Natural Energy Source and its Challenges. J Fundam Renewable Energy Appl. 13:317.

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