

RENEWABLES

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The current era is of great significance for researchers in power systems, as it shares similarities with the transformative period that followed the liberalization of the electricity sector in the late 1990s. This transformative nature is primarily driven by the pressing concern of climate change and the imperative to mitigate greenhouse gas emissions. While the full extent of climate change impacts may span decades, centuries, or even millennia, the consensus is clear: urgent action is needed to curb emissions and avert the worst, irreversible consequences of climate change.

Simultaneously, the world grapples with concerns over an impending energy crisis, stemming from the depletion of fossil fuels. In response to these challenges, renewable energy has assumed a pivotal role on the global stage, capturing the attention of governments, industries, and society at large. This paradigm shift has been accelerated by international agreements aimed at reducing carbon emissions, escalating energy demand, and the imperative to ensure energy security.

Energy supplies derived from renewables, encompassing biofuels, solar technologies, wind power, hydropower, geothermal energy, and more, have become a crucial component of every nation's energy strategy. These renewable sources address pressing concerns for both local and global environmental preservation, energy security, and sustainability. Given the urgency of climate change and the imperative to reduce carbon emissions, keeping fossil fuels underground has become imperative to prevent the release of carbon dioxide and methane into the atmosphere. Achieving this requires a substantial expansion of renewable energy capacities alongside efficient energy utilization. The good news is that such a transformation is already

underway.

Over the last five decades, scientific advancements, technical innovations, manufacturing growth, and economic impacts related to renewables have experienced exponential growth. This remarkable progress, which began around the 1973 oil crisis, shows no signs of slowing down. The integration of modern renewables with digital electronic control and advanced communication systems has led to a second industrial revolution. This time, the driving force is energy harnessed from and returned to the natural environment, in stark contrast to the era of fossil fuel dependence.

Renewable energy sources have emerged as the linchpin in the transition to a low-carbon future, with wind power emerging as a frontrunner in this transformation. A significant factor contributing to this evolution is the favorable support policies and incentives that renewable power producers received during the early stages of their deployment, enabling them to participate in power generation while mitigating market risks.

Notably, renewable energy costs have consistently declined, bringing various technologies, such as wind and solar, closer to grid parity. Consequently, renewables are not only expected to coexist with conventional energy sources but also to compete within the marketplace. However, it is essential to acknowledge the fundamental distinctions between renewable energy technologies and conventional sources, excepting hydro and biomass. Renewable sources are characterized as non dispatchable, with limited control over their output, and subject to stochastic variations, rendering advance prediction challenging.

As long as we prioritize ecological sustainability, the multifaceted benefits of renewables promise to bring distinct advantages to humanity.

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