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Recent Trends in Power Electronics for Renewable energy Systems

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Abstract

The complete world is focused on renewable power to reduce the global energy issue. Power electronic based energy conversion is being used extensively to improve the efficiency of the renewable energy conversion. It has a significant impact on the control and interface of renewable energy systems with both the network and stand-alone applications. As a result, increasing attention is being placed on the design and implementation of power converters. This study discusses the renewable energy systems (wind and solar) and the features of their energy conversion. The fundamental principles underlying their operations are discussed, as well as their recent technological advancements. It is a fact that power electronics is critical for interfacing and thus improving the system capacity.

Keywords: Power electronics, hybrid renewable energy source, wind power generation, solar power generation

1. Introduction

With fast increase in power generation and the detrimental effect of green house gas emission into the atmosphere, there is a shift toward the usage of solar and wind power. Numerous research projects are being conducted to determine how non-conventional energy sources might be used to meet present and future power demands[1]. According to Ministry of New and Renewable Energy, the installed capacity of renewable energy is 150 GW with solar energy is 49 GW and wind power is 40 GW in India. However, the technical potential

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for compensating the power generated by renewable sources is increased with 18 times than its existing capacity.Fig.1.revealed that the renewable power generation growth in the year 2019-2022.

Wind and solar energy are the vital demanding power resources accessible. In the case of wind power generation, the likely movement of air is used as the input source of energy creation (WECS). Although wind energy generates noise and is affected by meteorological conditions, these drawbacks are overlooked in comparison to the negative effects of conservative sources. The improved worldwide renewable energy generation in the year 2021 is exposed in Fig. 2.

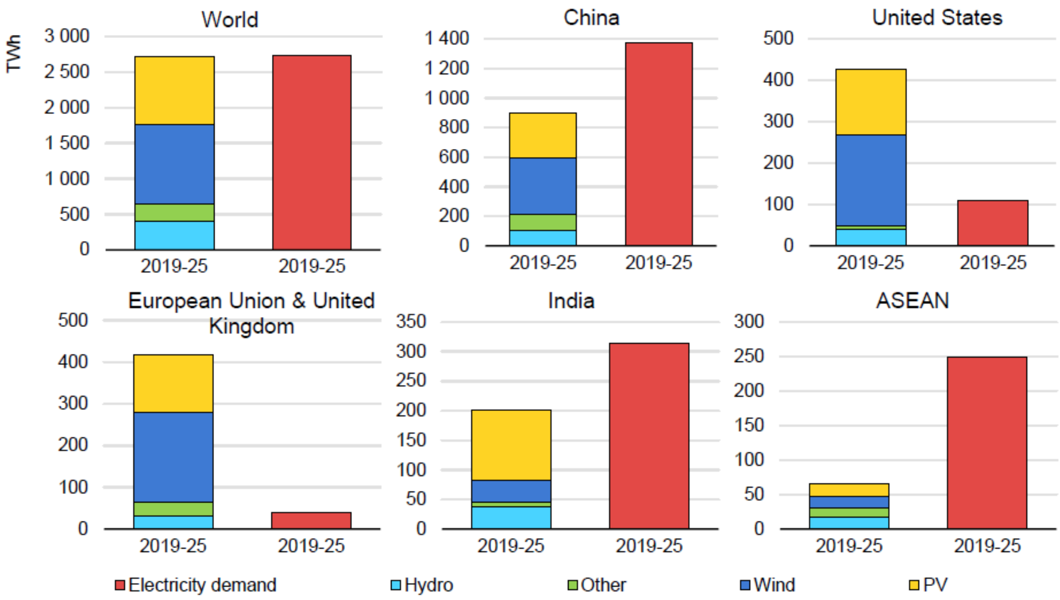

Figure 1. Hybrid clean energy generation development in 2019-2022

Solar energy, like wind, can be used to generate power. Solar module is coupled in string - shunt to improve the voltage level ratings of the system.

However, because a photovoltaic module's output power is dependent on sun irradiation, shade, and temperature, its efficiency is low [2]. Grid management and control are essential to the effective power transmission of various renewable energy systems, which is focused on improving power quality and dependability. Recent advancements in power electronic technologies have simplified the penetration of renewable energy sources into the

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electrical grid. owing to the utilization of novel converter system topologies, low-cost high-performance components, and smart energy management techniques.

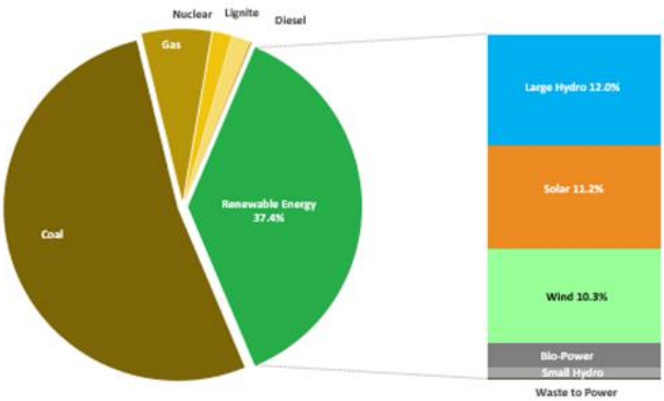

Figure 2. Capacity of renewable power installed in India (2021)

Multistage converters, as well as hybrid converters, are frequently utilized for high level dual converter in hybrid renewable power generation. On the grid side, multistage inverters are used to convert electricity from a DC bus to an AC utility grid application. Power electronics are used in conjunction with a variety of renewable energy systems to create electricity in a highly prohibited approach[3]-[6]. The block diagram of a power electronics based system is exposed in Fig.4. It focuses on the different renewable energy and their interaction with power electronics converters at different way to generate the preferred output using monitoring and control units.

Figure 3. Target of renewable power in India (2022)

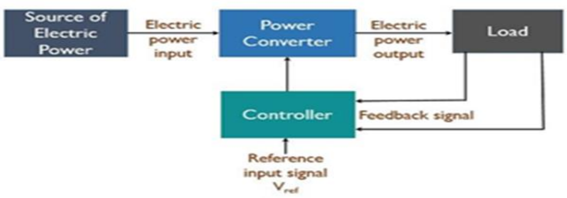

Figure 4. Configuration of a power electronics-based system.

This article discusses the current status in power electronics for renewable power conversion systems. Second Section presents the hybrid renewable energy system in general, as well as the various converter topologies. Third Section explains various photo - voltaic inverter designs as well as newly designed inverter topologies. Fourth Section proposes the use of smart grid system to enhance the overall system's performance. At the conclusion, these two primary energy sources are discussed.

2. Wind Power Geneartion System (Wpgs)

Wind power generation systems are capable of compensating for a considerable portion of the power demand in distribution system.The primary issues associated with it was real power compensation, voltage and frequency deviation. Thus, variable speed turbines were developed in order to manage voltage fluctuation and shearing forces. It includes the benefit of regulating a stable speed regardless of the wind speed, which reduces automatic tension and allows for the extraction of more wind energy. However, the two primary challenges with variable wind turbines are voltage and frequency management. The PE network makes a significant contribution to these goals [7]-]12].The basic components of wind energy system is shown in Fig.5

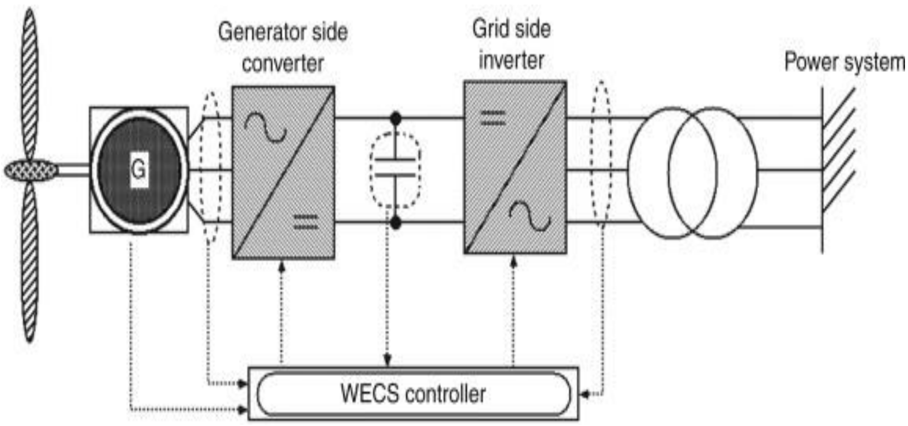

Figure 5. Wind energy system

3. Solar Power Generation System (SPGS)

When exposed to sunlight, a photovoltaic cell generates electricity. It has a maximum life of 30 years due to its static nature. A basic photovoltaic array consists of 34 or 68 series-interconnected cells [13]. PV systems can be operated either in grid-connected or stand-alone. PE serves as a link between the photovoltaic system and the electric grid. A photovoltaic

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system connected to the grid is comprised of a photovoltaic array and dual converter as seen in Fig 6.

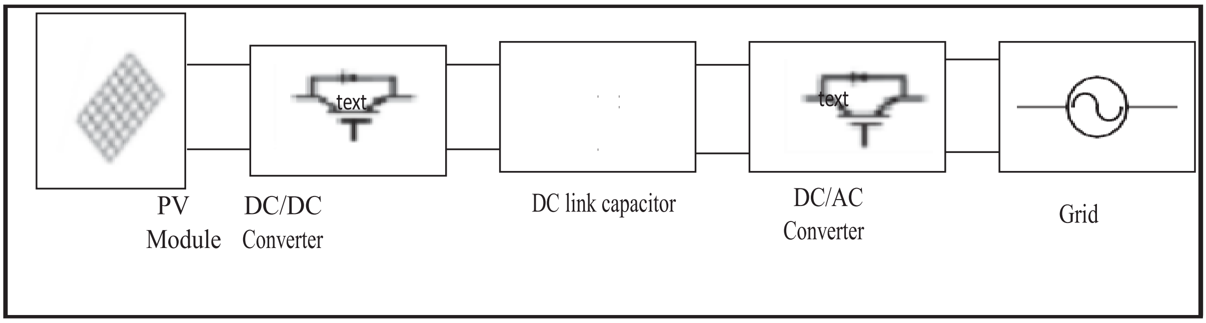

Figure 6. Configuration of PV system

4. Smart Approach to Enhance the Efficiency of Power Generation with Renewable Sources

Solar and wind power are the most abundant forms of energy. Wind power, on the other hand, is more changeable than solar power. Thus, hybrid energy systems are chosen because they have more energy resources, signal conditioning circuit, a controller, and a battery system to mitigate the effects of a networks unexpected failure state [14][15]. As a result, academic institutions and research laboratories are conducting research to increase grid integration standards protection and control. Additionally, various technical considerations such as minimizing energy loss and meeting load demand while concerning to the power network should be considered.

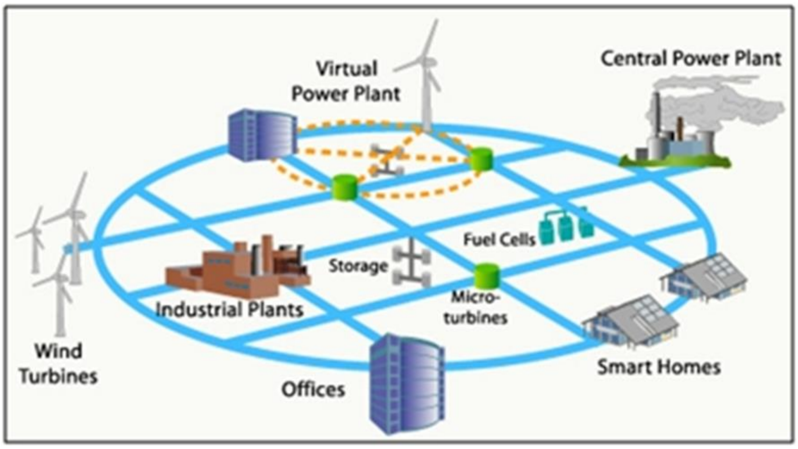

Figure 7. Smart grid technology with renewable energy sources

As illustrated in Fig 7, the entire hybrid renewable system can be connected with a smart network. It is an intelligent technology that allows renewable power to increase their power superiority and dependability to reduce consumer demand. It gives relevant information and increases efficiency in the most commercial approach. Smart electronics are connected with power electronics. For this new transformation, control mechanisms will be implemented [16].

5. Conclusion

Current advancements in power electronics based smart approach have made the biggest involvement to a greater extent to the invention, incorporation, and communication with renewable energy. The advancement of gadgets with a high power rating has simplified energy conversion. This article discusses the current status in power electronics for renewable energy systems. Hybrid power resources have been discussed, as well as their energy conversion systems. The many photovoltaic arrangements and configurations of various wind power generation in relation to the power network have been briefly outlined. The incorporation of clean energy generation systems with intelligent approach has been argued in detail. Owing to the state-space origin of classical control, hybrid energy resources cannot be characterized in terms of state equations. As a result, intellectual systems for estimate the generating power are required. This paper will discuss current technology for hybrid energy systems, as well as future research directions.

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Author's biography

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