

Power electronics in smart grid

Power electronics is possibly the most important element in modern smart grid ...

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The ongoing worldwide trend in power generation and distribution pivots toward sustainable and renewable energy sources, pushing conventional grid structures to evolve into "smart grids". Smart grids can be considered as a revolutionary step in the energy industry, combining traditional electrical engineering principles with advances in information and communication technology. In essence, a smart grid is a modern electric grid infrastructure aiming for optimized generation, distribution, and electricity consumption, thereby enhancing grid reliability, efficiency, and sustainability.

Power electronics are an indispensable component of smart grids, offering the ability to control and convert electric power efficiently. The use of power electronics in smart grids extends across various areas, such as renewable energy systems, electric vehicles, energy storage systems, and customer-side energy management systems.

Power electronic interfaces are the bridging element between the electricity generation source and the grid. These interfaces handle the conversion and control of electrical power to ensure it aligns with the specific grid requirements. As such, they play a crucial role in integrating renewable energy sources, energy storage systems, and loads into the smart grid.

Moreover, power electronics have paved the way for advanced smart grid functionalities, such as bidirectional power flow, active and reactive power control, grid resiliency against faults, and frequency and voltage regulation.

In the case of renewable energy sources, electronic interfaces convert the generated power, typically DC, into AC, suitable for grid connection. They can also adapt to the varying characteristics of renewable sources and maximize their output power (for instance, through maximum power point tracking in solar PV systems).



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In the context of electric vehicles and energy storage systems, power electronic interfaces enable bidirectional power flow, allowing not only the charging of the batteries but also the supply of energy back to the grid, a functionality known as vehicle-to-grid (V2G) or battery-to-grid (B2G).

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