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The key technologies and development of offshore wind farm in China

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China is one of the largest energy consumer in the world. Excessive consumption of primary energy such as coal causes serious environmental pollution and energy crisis. China must get rid of the over-reliance on coal, and needs to make great efforts to develop clean and efficient renewable energy. In recent years, offshore wind energy has been developing rapidly because of many advantages, e.g. not taking up land resources, high utilization rate and so on. By the end of 2013, the total installed capacity of offshore wind power was 389.6 MW in China. And the planning capacity will be 5 GW by 2015 and 30 GW by 2020. Compared to onshore wind, offshore wind power development is facing some new problems and challenges, such as power of offshore wind farm transmission technique and equipments, VSC-HVDC Converter, etc. In recent years, the large-scale development and utilization of offshore wind farms have significantly increased the requirements on converters for VSC-HVDC applications in offshore wind farms, including novel converter topology and advanced control methods. Key converter technologies of VSC-HVDC for large offshore wind farm integration involve detailed multilevel converter topology, modulation, voltage balancing strategies and offshore wind farm modeling techniques etc. Their studies can provide good theoretical foundations for offshore wind farm development. Series connection of large numbers of switches makes the manufacturing process difficult with reduced reliability. To tackle such problems, a variety of multi-level converter topologies have been proposed, including the re-injected multilevel converter, active neutral point clamped (ANPC) converters, multiplex converter, and the modular multilevel converter (MMC).

This paper firstly analyses irrationality of China's energy consumption structure, and necessity for the development of new energy. Secondly, an overview of schemes, such as AC and DC transmission technology, for offshore wind farm grid integration are given. Comparing the different topologies and modulation methods, MMC with half or full bridge sub-modules has the advantage of being easily configurable according to the required voltage level with a common DC side. It is thus suitable for large-scale offshore wind farm VSC-HVDC application. The NLM can be used with the strategy of DC capacitor voltage sorting for converter control. Thus, they are the preferred schemes for offshore wind farm VSC-HVDC application. Finally, we analyses the existing problems and obstacles during the process of offshore wind farms construction from three aspects, including technical, economic, and national policy. And corresponding recommendations to accelerate the development of offshore wind farm are proposed.

Keywords: offshore wind farm, MMC VSC-HVDC, AC and DC transmission technology, control strategy