Solid state transformer in modern power system

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The Solid-state transformer, also known as power electronic transformer or energy router, represents an emerging technology that achieves voltage transformation, electrical isolation, and energy transfer through power electronics techniques. With the rapid development of smart distribution networks, energy internet, and related fields, solid-state transformers have garnered extensive research attention due to their flexible voltage and power regulation capabilities. This presentation will introduce the current applications and technical advantages of solid-state transformers across various fields, including traction power supply, electric vehicle charging, data centers, photovoltaic power generation, and hybrid AC/DC distribution networks. Despite the considerable potential in these applications, solid-state transformers still face a series of technical challenges. This presentation will focus on the following aspects: 1) Efficiency: analyzing the causes of losses in the solid-state transformers, exploring efficiency optimization methods, and discussing their limitations; 2) Wide-range voltage regulation: introducing techniques for adjusting output voltage and highlighting the trade-offs involved in wide-range voltage regulation; 3) Power density: analyzing the main factors restricting the power density of solid-state transformers and discussing methods for its enhancement, with focus on key components such as medium-frequency transformers and capacitors; 4) Medium-frequency transformers: introducing technical solutions and design conflicts concerning materials, structure, heat dissipation, and insulation; 5) Cost and fault protection: evaluating the cost breakdown of solid-state transformers, discussing potential cost reduction approaches, and outlining the challenges in fault protection within the power grid. This presentation systematically examines the current status and challenges faced by the solid-state transformers, aiming to serve as a reference for the advancement of this technology.

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