VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Yang Wang**

The public defense will take place on **Wednesday 9th April 2025 at 10am** and will be held online.

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DEVELOPMENT OF MODULAR AND FLEXIBLE MULTILEVEL INVERTERS FOR STATIONARY APPLICATIONS

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Abstract of the PhD research

In recent years, the demand for clean and renewable energy has grown significantly, driving major advancements in the power industry. However, integrating renewable sources like wind and solar power into the electricity grid comes with challenges. These include the need for efficient long-distance power transmission, managing the unpredictable nature of renewable energy, and ensuring grid stability. Battery energy storage systems (BESS) play a crucial role in addressing these issues by storing excess energy and releasing it when needed, helping to balance supply and demand.

One promising technology for connecting BESS to the grid is the modular multilevel converter (MMC), an advanced type of power converter that improves energy efficiency and flexibility. However, using MMCs with BESS is complex. It involves managing many electrical components, ensuring smooth control of power flow, preventing unwanted electrical losses, and maintaining battery health for long-term performance.

This PhD research focuses on solving these challenges. It involves developing mathematical models, designing advanced control methods, optimizing power usage, managing heat generation, and testing the system in real-world conditions. A new control method for balancing battery energy, called soft arm state-of-charge (SoC) balancing, was introduced and found to perform better than traditional methods. This improvement leads to a more stable and efficient system with cleaner power output.

Further research efforts optimized key electrical components using advanced computational techniques. Thermal management studies helped understand and reduce heat-related energy losses. Finally, the research tested a prototype system using modern semiconductor technology. The results confirmed that the system could effectively regulate power, eliminate unnecessary electrical currents, and maintain balanced battery performance in different operating conditions. These findings contribute to making renewable energy grids more reliable, efficient, and adaptable for future energy needs.