

„Power Electronics 5.0“— Standing on the Shoulders of Giants

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Power electronics is a key technology for all forms of generation and utilization of electric power in modern societies, ranging from renewable energy systems and highly diverse power supply applications, including fast-charging of EVs and hyper-scale datacenters, to variable-frequency drives for industrial automation. Over the past 40 years, the progress in the area has been driven by new power semiconductor device concepts and corresponding circuit topologies with a focus on voltage-source converter (VSC) structures and/or the application of switching elements limited to unipolar voltage-blocking capability.

With reference to recently intensifying R&D activities on two-gate monolithic bidirectional switches (M-BDSs) featuring bipolar voltage blocking and bidirectional current control capability, the talk starts with highlighting the advantages of M-BDSs for the realization of ultra-compact non-isolated and isolated three-phase PFC rectifier systems and next-generation inverter systems with low motor insulation stress. Next, the performance gains achievable with three-level T-type VSC topologies, new single-stage isolated AC/DC converter structures, and the unique features of current-source converter approaches—today solely employed in thyristor-based high-power medium-voltage motor drives—and AC/AC matrix converter concepts over state-of-the-art VSC systems are emphasized. All this identifies M-BDSs as one of the main drivers of a 4th wave of disruptive performance improvements of power electronic converter systems.

The talk will conclude with remarks on the urgency of a transition from a linear economy to a circular economy, which also needs to be considered for future power electronic converter designs. Building on the understanding and knowledge gained by brilliant engineers over the last decades, i.e., standing on the shoulders of giants, power electronics research must now target “beyond tomorrow” improvements, and enable a circular-economy-compatible Power Electronics 5.0 to ensure that the 2050 net-zero-CO₂ target is reached on a sustainable basis.