High-Frequency Power Loss of Magnetic Components for DC-DC Converters in Sustainable Power Grids

Future electrical grids with Direct Current technology (DC) provide higher flexibility and efficiency for decentralized energy systems compared to conventional AC technology. In the framework of the research project “Flexible Electrical Networks” (FEN), high-efficient magnetic components for dc-dc converters as key technology are developed.

In this work, by using different analytical power loss models and FEM analysis you investigate the winding, core and insulation losses of new three-phase medium-frequency transformers (MFT) at high-frequency operation.

The focus of the work is on the comparison and optimization of different winding types and core shapes in terms of high-frequency power losses. Promising winding types for MFTs are foil and litz wire windings to reduce high-frequency losses. Promising core shapes are E-core and toroidal core with new symmetrical configuration. You derive improved analytical calculation methods of the windings, cores and insulation by considering the harmonic content of the dc-dc converter operation, the effect of 2D magnetic fields and stray losses. You perform FEM simulations and measurements of MFTs with a test bench to evaluate the new high-frequency mathematical formulas.

The goal of this work is to compare analytical calculation methods of power losses with reality and to derive valid closed-form formulas for high-frequency magnetics of dc-dc converters. You have the ability to work with available design tools in Matlab and FEM software to develop novel techniques and ideas. You can build up required software skills within this thesis. Good luck!