Special Session on

Design and Thermal Management of High-Specific-Power Electrical Machines

Organized and co-chaired by:

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Abstract

The global transition to electrification, particularly in demanding sectors like aerospace and electric mobility, has created an urgent and accelerating demand for electrical machines with exceptionally high specific power and power density. Achieving more power from a smaller, lighter package is a fundamental enabler for next-generation technologies. However, this demand is increasingly colliding with a critical "thermal wall". As specific-power increases, so does the density of heat generated from copper, iron, and mechanical losses. Inefficient heat dissipation leads to severe performance degradation, including accelerated insulation aging, irreversible demagnetization of permanent magnets, and a significant reduction in operational reliability. Traditional cooling methods, such as air cooling or simple water jackets, are proving fundamentally insufficient for these advanced applications.

This Special Session is motivated by the need to address this critical challenge through a focus on advanced electromagnetic design and innovative thermal management. The core issue is that electromagnetic optimization often creates a direct conflict with thermal requirements; for example, maximizing the size of hairpin windings can increase AC losses, while reducing machine size leaves less surface area for heat removal. A multi-physics co-design methodology is no longer optional but essential. This special session will explore cutting-edge cooling technologies, such as Direct Liquid Cooling (DLC) or In-slot Cooling arrangements. These are not only incremental improvements but also enabling technologies that shift the design paradigm. As recent studies demonstrate, they can allow for significantly higher current densities—increasing continuous torque and are indispensable for managing transient overload conditions where conventional methods fail dramatically.

The expected contributions from this session are significant and timely. We invite papers presenting novel machine topologies, and advanced winding technologies, alongside the thermal management systems required to unlock their full potential. The session will showcase new frontiers in multi-physics modelling, co-design optimization algorithms, and experimental validation techniques for high-specific-power machines. This session aims to foster collaboration, share state-of-the-art solutions, and accelerate the development of the next generation of compact, powerful, and robust electrical machines that are essential for a sustainable future.

Topics of interest include, but are not limited to:

- Multi-physics Modelling: Integrated electromagnetic, thermal, and mechanical modelling and optimization of high-specific-power machines.
- Advanced Cooling Technologies:
  - Direct Liquid Cooling (DLC) with stranded or hairpin windings.
  - In-slot cooling with stranded or hairpin windings.
- High-Specific-Power Machine Topologies
- Advanced Materials for High-Performance Machines
- Thermal Management of High-Speed Machines
- Application-Specific Case Studies: Design and thermal management of high-specific-power machines in aerospace, automotive, marine, and other demanding industrial applications.

Important dates

- Full Paper Submission: February 1, 2026
- Full Paper Notification: May 1, 2026
- Final Paper Upload: June 1, 2026

Submission of papers

Paper submission follows the rules of regular papers. All the instructions for paper submission are included in the conference website:
https://icem2026.ubi.pt/submission.html