# Italian initiatives on superconducting power cables: thermo-hydraulic design at RSE and the INFN IRIS and SURE projects

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To achieve the EU energy transition goals, Renewable Energy Sources are expanding across the Italian territory, often installed in remote regions; they are also penetrating distribution grids, increasingly requiring new infrastructures or retrofitting. Together with the development of large data centers, these trends are increasing the demand for high-capacity power transmission. In this context, superconducting (SC) power cables offer compact solutions to carry very large currents with reduced footprint. Among the available technologies, $MgB_2$ cables are particularly suited for DC transmission of high power while the use of liquid hydrogen as their coolant could enable the combined transport of electrical and chemical energy.

Within this context, several Italian projects and initiatives are addressing the development of SC power transmission technologies. At RSE, a specific model has been developed for the thermo-hydraulic design of cables, as pressure drops and temperature rise of cryogens directly constrain cable operation, reliability, and system layout. The presentation discusses trends of thermo-hydraulic fluid properties for representative SC cable case studies in the Italian grid, considering different cryostat architectures (single-channel helium or hydrogen cooling, with or without nitrogen thermal shielding). Parametric analyses highlight the main design trade-offs and operating limits also from a techno-economic standpoint.

Moreover, the main features of the installation of a $MgB_2$ DC line powering a data center at LNF Frascati, within the SURE (Superconductivity – Reliability & Efficiency) project, will be presented. The project, started this April and funded by the Italian Ministry of University and Research (FISA2024), involves INFN and ASG Superconductors. In parallel, the INFN IRIS project aims at the creation of a nationwide infrastructure for testing superconducting cables, proposing also a cable demonstrator in collaboration with ASG Superconductors.

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