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DC Superconducting Cables for Present and Future Power Needs

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***Abstract*—Superconducting power cables, including liquid nitrogen-cooled power cables based on ReBCO-coated conductors as well as gas-helium or liquid hydrogen-cooled power cables based on MgB_2, offer ultra-high transport capacity combined with exceptional efficiency and compactness. Typical layouts of HTS and MgB_2 cables are shown in Figure 1. Their adoption has the potential to transform future power transmission and distribution grids. HTS power cables can be designed for both DC and AC operation across various voltage levels, from medium voltage (MV) to high voltage (HV). This versatility positions them as a key element for a wide range of applications, including the connection of massive and widespread offshore wind power to onshore substations and the development of supply infrastructures for power- and current-intensive facilities such as data centers or metallurgical industries. Additionally, HTS cables are a critical enabler for upgrading existing AC grids in densely populated areas, eliminating the need for extensive new civil infrastructure.**

This contribution presents the fundamental concepts and layouts of HTS and MgB_2 power cable technology and reviews their current state of development. It also explores future research directions, focusing in detail on the emerging trends in power grids. These include high-power- density DC corridors as well as AC corridors aimed at increasing the capacity of existing sub- transmission grids. Further examples involve power- and current-intensive DC power supply applications such as those in the metal industry, data centers, railway systems, and high-energy.

***Keywords (Index Terms)*— HTS power cable, MgB2 power cable, grid applications**

(a) (b)

Figure 1. Typical superconductor cables' layouts. a) Multilayer HTS cable; b) Multistage MgB_2 cable.