

## Requirements for large scale implementation of HVDC high temperature superconducting (HTS) cable systems

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### ABSTRACT

*The aim of this paper is to propose actions to verify the required capabilities and foster the development of HVDC HTS (High Temperature Superconductors) technology. The feasibility of super-grids using DC HTS cable systems depends on both the technical maturity of the technology and confidence of policy makers and grid operators. Three key factors are believed to be needed to enable such conditions. First, agreed test and qualification plans and relevant operational experience is needed, ensuring reliability and acceptance. Second, presence of multiple suppliers and proven manufacturing standards is required. And third, clear advantages must be provided in terms of life cycle costs and environmental impact compared with extruded HVDC cable technology.*

### KEYWORDS

HTS HVDC cable systems, Qualification Plan, HTS Supply Chain, Life cycle cost (LCC).

### INTRODUCTION

High temperature superconducting (HTS) cable systems (operating at 77 K) can be used for different technology applications, with one possible application being bulk power transmission.

The main advantages of such systems are:

- The absence of Joule losses in the cable conductor.
- The relatively low voltages needed to carry large power quantities, and thus a relatively reduced footprint and smaller system infrastructure.
- Absence of a voltage drop along the cable transmission line.

A power grid comprising of HTS DC cables could represent an efficient way to connect countries in a scenario where the majority of the power is generated through distributed production from renewable sources, and therefore high transmission capacity is needed to fulfil the power demand in areas distant from the generation.

While HVAC superconducting cable systems have been extensively studied and demonstrated, there is a lack of experience, literature, and standardization for HVDC HTS cable systems.

### RESULTS

The first section of this article presents the results from a survey performed in 2022 including some major players in the power transmission and distribution industry, on the current perception of HTS cable systems. In the second section, the qualification requirements emerging from the survey and from available standards and literature

concerning HTS systems are reported. In the third section, the current situation in terms of supply chain and manufacturing standards for HVDC-HTS cables is presented. In section four, the scenarios in terms of life cycle costs and environmental impact in the use of HVDC-HTS are described.

### HTS cable market fit investigation results

The results presented in this section were collected through a survey from April to August 2022, it is important to point out that the survey did not focus on HTS HVDC technology but was developed to receive an un-biased opinion on the interest in both AC and DC HTS cable systems.

A total of 25 responses were collected (17 utilities, 7 consultants and 1 project developer), the geographical distribution of the respondents and the main field of expertise of the participants are respectively shown in Fig 1 and Fig 2. Seventeen one-to-one follow up interviews were performed to investigate and clarify certain answers.

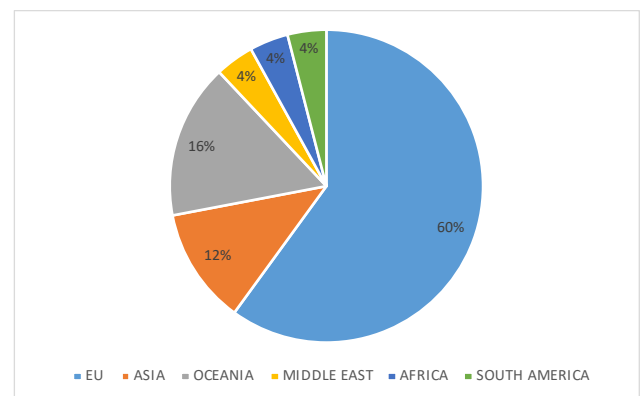


Fig. 1: Geographical distribution of participants

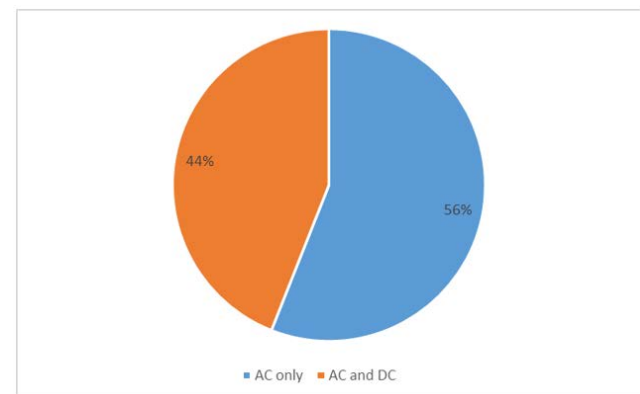


Fig. 2: Field of expertise of the participants

While the market fit analysis produced a broad spectrum of results, it yielded valuable insights concerning relevant obstacles to be overcome.

Utilities show a conservative attitude towards disruptive