

# TECHNICAL REPORT



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## Grid connection of offshore wind via VSC-HVDC systems

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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Full information on the voting for its approval can be found in the report on voting indicated in the above table.

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- reconfirmed,
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## INTRODUCTION

New technical solutions to meet the engineering development of grid integration of offshore wind generation via HVDC are the content of this document. The new solutions include new technologies, methods and practices to provide more flexibility and improve the efficiency of power systems, constantly balancing generation and load.

The development of offshore wind is progressing steadily, and VSC-HVDC systems are commonly adopted to link long distance offshore wind farms with the onshore bulk power grid. According to this fact, the purpose of this Technical Report (TR) specifically focuses on the planning, interaction and coordinated control between offshore wind farms and VSC-HVDC systems.

For various stakeholders, including transmission system operators, offshore wind farm owners, research institutes and so on, this Technical Report is to collect information from regulatory contents including relevant issues in different countries and regions, and work out a TR for offshore wind farm Integration via DC Technology, which mainly addresses the technology development tendency, best practices, and the future standardization activities.

The aim of this document is to draft a strategic, but nevertheless technically oriented and referenced TR, which represents the core and key issues of offshore wind integration via VSC-HVDC systems. Offshore wind farm developers and owners, transmission system operators have a common understanding about the key issues based on practices and challenges between offshore wind farms and VSC-HVDC systems.



# GRID CONNECTION OF OFFSHORE WIND VIA VSC-HVDC SYSTEMS

## 1 Scope

The voltage source converter based on high-voltage direct current (VSC-HVDC) transmission technology has attracted increasing attention because of its advantages such as flexible control, supply to passive systems, and black start capability, which has been widely used in offshore wind farm integration. Although offshore wind farms generate electricity just like any other power plants on a system-wide level, such offshore wind generation has quite distinctive characteristics to be considered in terms of capacity optimization, voltage and power control, fault response, multi-frequency oscillation, power DC collection, etc., when compared to conventional generation integration via HVDC. Understanding these distinctive characteristics and their interaction with the other parts of the power system is the basis for integrating large-scale offshore wind farms via VSC-HVDC.

This document discusses the challenges of connecting offshore wind farms via VSC-HVDC, key technical issues and emerging technologies. The potential solutions include new technologies, methods and practices to provide more flexibility and improve the efficiency of power systems. The primary objective of this document is to provide a comprehensive overview of challenges, potential solutions, and emerging technologies for grid integration of large-scale offshore wind farms via VSC-HVDC. It is expected that this document can also provide guidance for further standardization on relevant issues. The purpose of this document is not intended to hinder any further development of state-of-art technologies in this field.

This Technical report is not an exhaustive document in itself to specify any scope of work or similar, between a purchaser and a supplier, for any contractual delivery of a HVDC project/equipment. It is expected that this document is used for pre-study and then to make studies, specification for delivery of specific HVDC project, as applicable.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TR 62001-5, *High-voltage direct current (HVDC) systems – Guidance to the specification and design evaluation of AC filters – Part 5: AC side harmonics and appropriate harmonic limits for HVDC systems with voltage sourced converters (VSC)*

IEC 62747, *Terminology for voltage-sourced converters (VSC) for high-voltage direct current (HVDC) systems*

IEC 62934, *Grid integration of renewable energy generation – Terms and definitions*

IEC TR 63401-1, *Dynamic characteristics of inverter-based resources in bulk power systems – Part 1: Interconnecting inverter-based resources to low short circuit ratio AC networks*