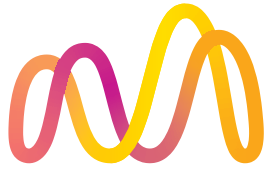


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Middle East
Energy Dubai

The Middle East's Strategic Shift to Renewable Energy

The Role of HVDC Technology

By Analyst, Kainat Yousaf– at PTR Inc.



- High Voltage Direct Current (HVDC) technology plays a pivotal role in achieving ambitious targets for sustainable power.
- Major HVDC projects are reshaping the power sector of the Middle East, especially with cross-border HVDC projects alongside a vision for the super grid and plans for cross-continental HVDC interconnection.
- VSC technology provides added flexibility and reliability, making it a preferred choice over older Line Commutated Converter (LCC) systems for a wide range of applications.

As the Middle East accelerates its shift towards renewable energy, High Voltage Direct Current (HVDC) technology plays a pivotal role in achieving ambitious targets for sustainable power. Countries in the region, such as the UAE and Saudi Arabia, have set bold goals to transform their energy landscapes—net zero by 2050 and 2060, respectively. HVDC systems offer the high-efficiency, long-distance transmission capabilities needed to meet these objectives while also powering offshore and industrial facilities.

Landmark projects like Saudi Arabia's NEOM-Yanbu HVDC system and the UAE's Lightning Project illustrate the transformative impact of HVDC, reducing reliance on carbon-intensive power sources for offshore operations. Additionally, cross-border transmission projects like the Saudi-Egypt HVDC interconnection enhance regional energy security and cooperation, demonstrating the potential for broad energy integration across the Middle East and beyond.

This article explains how HVDC transmission projects are unlocking the potential for renewable energy projects in the Middle East.

Renewable Energy Initiatives in the Middle East

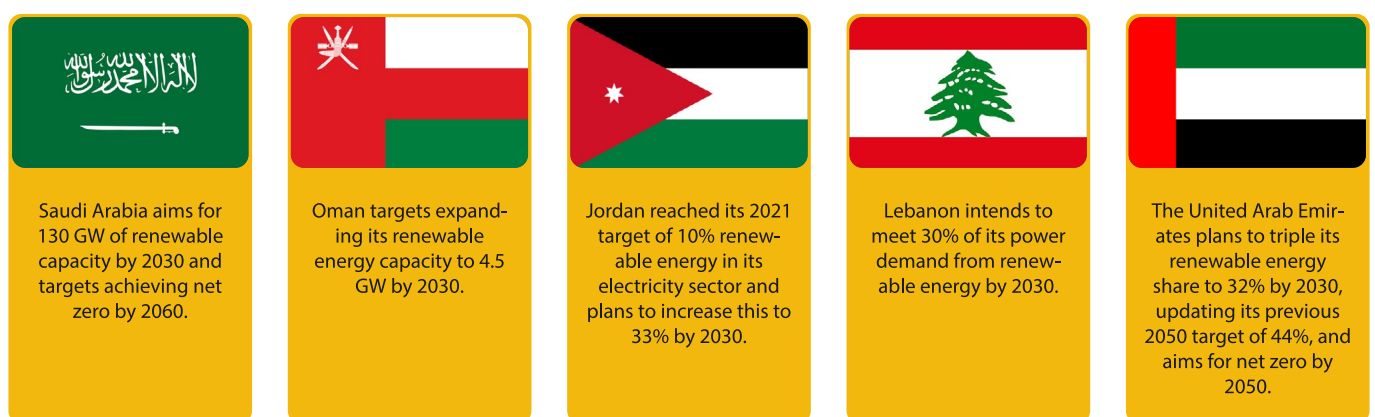


Figure 1: Renewable energy initiatives in the Middle East.
Source: PTR Inc.

Middle East Energy Transition and HVDC Technology

The region's push for renewable energy adoption has placed HVDC technology at the forefront of efficient energy transmission and grid stability enhancement. The ability of HVDC to transmit large amounts of power over long distances with minimal loss makes it indispensable for integrating renewable sources, such as solar and wind, into national grids.

This is particularly relevant for the Gulf Cooperation Council (GCC) countries, where HVDC is helping to bridge gaps and align differences between transmission systems, like Saudi Arabia's 380 kV, 60 Hz grid and the 400 kV, 50 Hz systems used by other GCC nations. Furthermore, HVDC systems are reducing the carbon footprint of offshore oil and gas facilities, demonstrating their value beyond terrestrial applications.

Transformational HVDC projects in the Middle East

Major HVDC projects are reshaping the power sector of the Middle East, especially with cross-border HVDC projects alongside a vision for the super grid and plans for cross-continental HVDC interconnection.

Cross-border HVDC projects

Cross-border HVDC projects play a crucial role in fostering energy cooperation and security in the Middle East. A prime example is the Saudi Arabia-Egypt HVDC interconnection, which represents the first large-scale cross-border power exchange project in the Middle East and North Africa (MENA) region. Once operational in 2025, this 3,000 MW electricity exchange will employ a mix of substations, overhead lines, and undersea cables, creating a model for future regional collaborations that enhance stability and optimize resource utilization.

Saudi Arabia's NEOM-Yanbu HVDC transmission system and the UAE's Lightning project exemplify the deployment of advanced systems to transmit renewable energy efficiently over long distances. The NEOM-Yanbu system, for example, features cutting-edge 525 kV HVDC technology, making it one of the world's most advanced systems. This focus on robust, efficient power transmission is evident across the region, with subsea and land-based HVDC systems enhancing connectivity and supporting industrial energy needs.

Super grid vision and cross-continental HVDC interconnections

The Middle East's ambitions extend beyond regional boundaries, as evidenced by plans for undersea HVDC links that could connect to India and, potentially, Europe. India's proposed undersea HVDC project from Gujarat to the Middle East aligns with the One Sun One World One Grid (OSOWOG) initiative, promoting renewable energy sharing and deepening ties with Gulf countries. Simultaneously, the GCC's expansion of cross-border interconnections sets the stage for a possible future super grid with cross-continental reach.

Potential Regions for HVDC Deployment in the Middle East

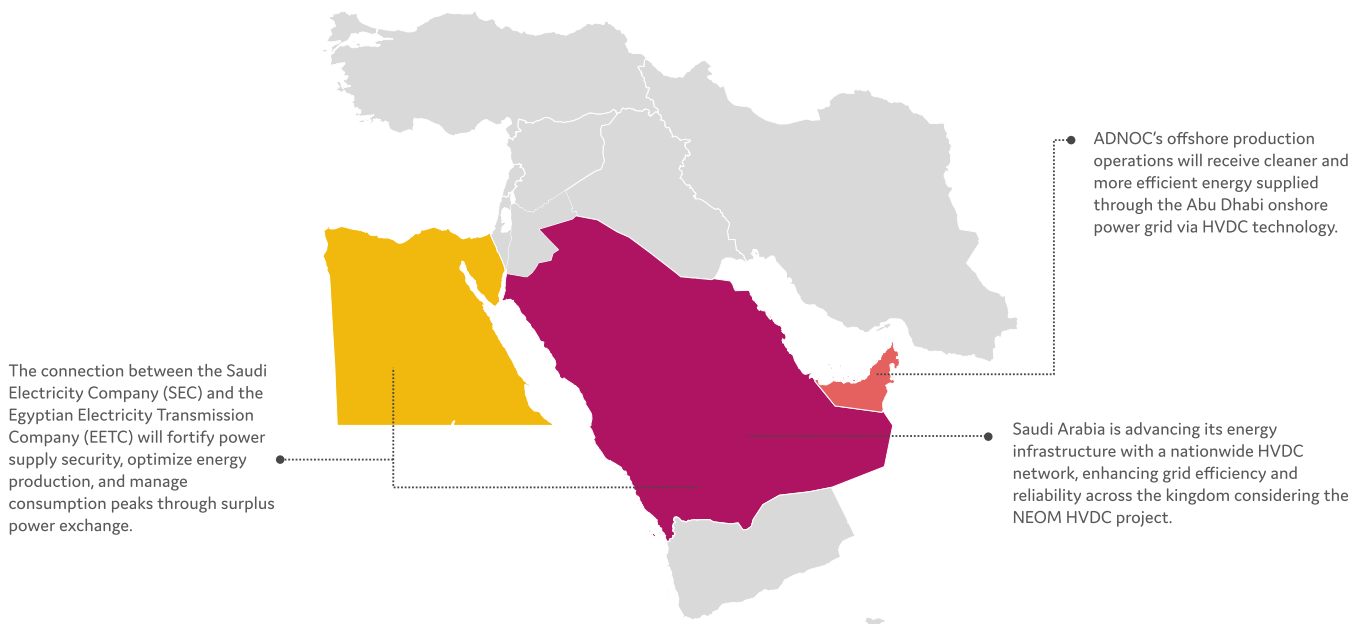
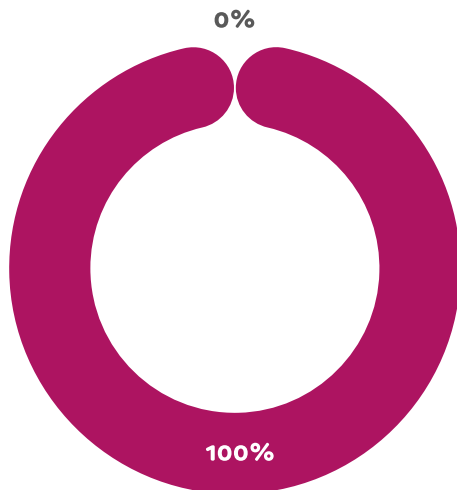


Figure 2: HVDC projects in the Middle East.
Source: PTR Inc.

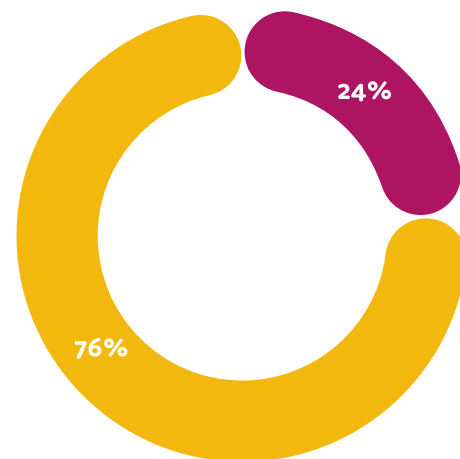
Advancements in HVDC Technology

The ongoing evolution of HVDC technology is a major enabler of renewable energy goals in the Middle East. Voltage Source Converter (VSC) technology, favored for its bidirectional energy flow capability and superior grid control, is gaining prominence across the region. Notably, the UAE has led the way in pioneering VSC systems for offshore oil facilities, demonstrating its utility in demanding environments. VSC technology provides added flexibility and reliability, making it a preferred choice over older Line Commutated Converter (LCC) systems for a wide range of applications.

HVDC Technology Split in the Middle East (2000-2023)



HVDC Technology Split in the Middle East (2024-2030)



● LLC ● VSC

Figure 3: Technology evolution in the HVDC sector of Middle East
Source: PTR Inc.

Looking Ahead

The Middle East's focus on HVDC technology represents more than a technical leap; it signifies a bold commitment to transforming the regional energy landscape for a sustainable future. By investing in HVDC infrastructure, the region is enabling efficient, long-distance transmission of renewable energy while reducing reliance on carbon-intensive sources.

This transformation extends beyond national borders, fostering cross-border collaboration through projects like the Saudi-Egypt HVDC interconnection, which enhances energy security, stability, and cooperative resource management across the region. As countries in the Middle East strive for ambitious renewable energy targets, HVDC serves as a crucial enabler, integrating vast renewable resources, optimizing grid performance, and supporting economic diversification through cleaner, more reliable energy systems.



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Kainat Yousaf is an analyst at PTR Inc. Her research focuses on High Voltage Direct Current Transmission (HVDC), she is passionate about advancing renewable energy integration and ensuring seamless power delivery in the evolving landscape of electrical infrastructure. She holds an electrical engineering degree from Lahore University of Management Sciences (LUMS).

About PTR

With over a decade of experience in the Power Grid and New Energy sectors, PTR Inc. has evolved from a core market research firm into a comprehensive Strategic Growth Partner, empowering clients' transitions and growth in the energy landscape and E-mobility, particularly within the electrical infrastructure manufacturing space.

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