Middle East Energy Dubai

Navigating Renewable Energy Challenges: Grid Flexibility Solutions in the Middle East & Africa

Authored by PTR Inc.

Introduction

As countries transition from centralized to decentralized grid networks, the necessity for investments in new energy technologies becomes imperative. The trend of rapid adoption of renewable energy sources is restructuring our energy infrastructure, leading to a shift towards decentralization. Geographical regions such as North America and Europe are expected to double their renewable energy capacity by 2028 compared to the last five years.

These regions have introduced policies and acts such as the Inflation Reduction Act and the European Green Deal to support the transition toward clean energy. One of the key challenges these regions face while integrating a large number of renewable energy sources and catering to varying loads is maintaining grid flexibility in the electricity grids.

The decentralized grid networks encounter grid bottlenecks such as curtailment, voltage stability, and peak demands. The legacy electricity systems are no longer efficient. A more advanced network is required for real-time demand and supply matching, allowing bidirectional flows to and from utility grids. To address these issues, advanced solutions such as high-voltage direct transmission lines, flexible alternating current transmission systems, energy storage, and smart grids are becoming increasingly important for the electrical infrastructure.

Overview of Middle East and Africa's Renewable Energy Growth

According to the International Energy Agency (IEA), renewable energy generation in the Middle East and Africa (MEA) surged by approximately 20% in 2023, with projections indicating a further substantial increase of 23% in 2024. Renewable capacity in the Middle East and Africa will triple in growth over the next five years compared to the previous five-year period. Seven countries, including Saudi Arabia, UAE, Morocco, and Egypt, will account for over 90% of the region's growth.

Cumulative Renewable Capacity - 2023

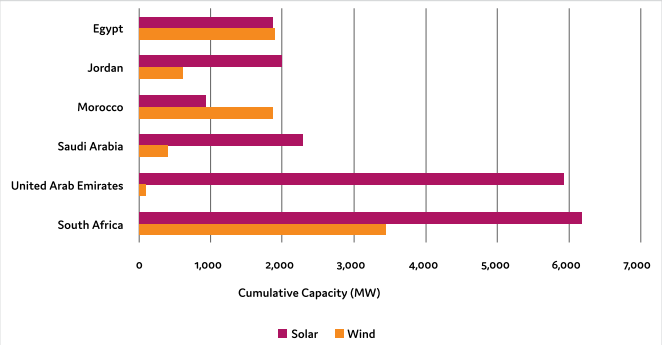

Figure 1: Overview of Renewable Energy Additions in the Middle East & Africa
Source: IRENA

The below infographic represents an overview of the renewable energy targets set by the key countries in the Middle East & Africa.

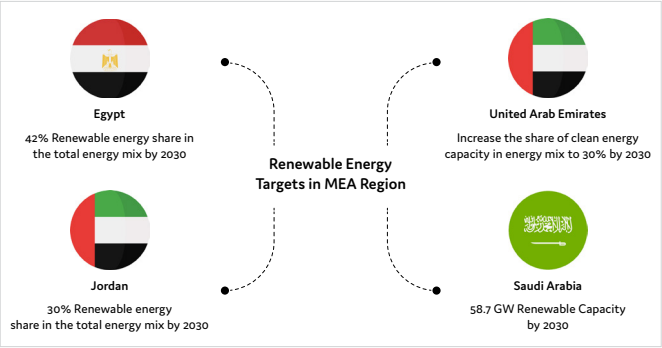

Figure 2: Renewable Energy Targets in MEA Region
Source: PTR Inc.

Saudi Arabia

Saudi Arabia is diversifying its energy mix, with plans to introduce nuclear power alongside a significant push for renewable energy. The country aims to achieve 50% renewables in its generation mix by 2030, with initiatives such as shortlisting contractors for 1.5 GW of solar PV projects.

United Arab Emirates (UAE)

UAE has plans to reach 12% renewables by 2026 and 30% by 2030 and ambitious targets for solar power capacity expansion in Abu Dhabi, the country is making substantial strides towards a more sustainable and resilient energy future.

Egypt

Egypt has set a new target to increase its use of renewable energy sources to 42 percent by 2030. This is five years earlier than its previous goal of achieving the same target by 2035. The country has taken this step to demonstrate its commitment to the Paris Agreement on climate change.

Jordan

Renewable energy makes up around 27% of the country's energy mix. Jordan aims to achieve a target of 30% renewable energy share in its energy mix by 2030. Jordan has shown commitment to increasing the target by the end of 2024.

South Africa

Renewable energy makes up around 11% of the country's energy mix. South Africa aims to achieve a target of 41% renewable energy share in its energy mix by 2030. However, South Africa has been facing challenges due to aging infrastructure along with a decline in the growth of renewable energy in the country.

In addition to countries' renewable energy goals, overall economic growth will drive increased electricity demand, necessitating the integration of new energy technologies into the existing electrical infrastructure to accommodate evolving needs and demands.

Key Drivers to Instigate Technological Advancement in MEA

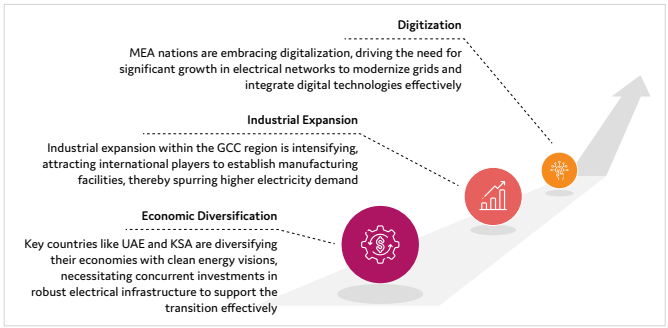

Figure 3: Key Drivers to Instigate Technological Advancement in MEA
Source: PTR Inc.

Challenges

Transitioning to renewable energy sources poses multifaceted challenges. These include establishing robust interconnections for efficient distribution, ensuring voltage stability amidst variable demand, and balancing supply and demand to maintain grid reliability.

Interconnecting Grids for Renewables

The integration of renewable energy sources presents a challenge to establishing robust interconnections within and between countries. As renewables increasingly dominate the energy mix, cross-border transmission lines become essential to distribute and balance electricity supply efficiently. This challenge arises from the geographical distribution of renewable resources, often far from population centers and existing grid infrastructure.

Voltage Stability

The rising adoption of solar power mandates grid compensation to stabilize voltage amidst variable demand and renewable generation. Historically, this role relies on the inertia from rotating machinery like conventional gas power plants. However, as the share of renewable energy sources increases in the energy mix in the MEA region, alternative solutions will become essential to maintain the grid stability without compromising on the clean environment goals.

Highlighting the Potential Impact Due to the Rollout of Renewables in MEA

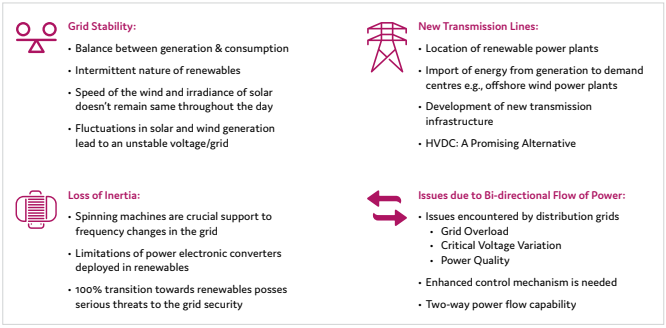

Figure 4: Highlighting the potential impact due to the rollout of renewables in MEA
Source: PTR Inc.

Energy Balance Dilemma

As the prevalence of intermittent renewable energy sources increases in the MEA region, ensuring a balance between supply and demand becomes a challenge. While renewable energy generation might be abundant during the day, demand fluctuations may occur. This situation can result in curtailment during peak renewable energy supply periods and necessitate the utilization of conventional sources to meet peak demand hours.

Grid Flexibility Technologies Overview

This section contains an overview of the new energy technologies that will become essential in the evolving grid infrastructure of the MEA region to solve the challenges discussed in this article:

High Voltage Direct Current

High Voltage Direct Current (HVDC) transmission enables efficient long-distance power transmission using direct current, enhancing grid stability and facilitating renewable energy integration. HVDC utilizes two types of converter technologies:

- Line Commutated Converters (LCC)
- Voltage Source Converters (VSC).

MEA's HVDC market focuses on transcontinental connections between Europe and Africa to address energy crises and meet rising electricity demand. Major developments include:

- Hitachi Energy's contract for a 3 GW HVDC Light transmission system in NEOM, integrating renewables and energy storage.
- ADNOC's deployment of subsea HVDC systems to reduce offshore carbon emissions by over 30%, replacing conventional gas turbine generators with sustainable power sources.

HVDC technology is crucial in the MEA region for seamless power flow control and supply flexibility.

Development in HVDC Market in Middle East & Africa

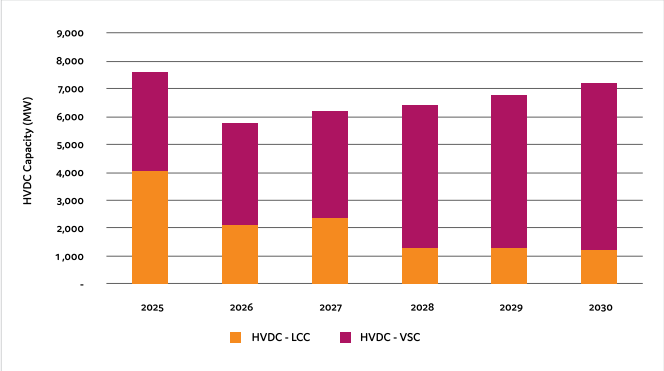

Figure 5: Breakdown of HVDC Application in MEA
Source: PTR Inc.

Battery Energy Storage Systems

Battery energy storage systems (BESS) play a vital role in enhancing grid flexibility and stability, effectively managing the intermittent nature of renewables.

Across the MEA region, countries are prioritizing energy storage to advance renewable energy goals, leading to significant developments:

- Emirates Water and Electricity Co. (EWEC) plans a 400 MW BESS project to participate in energy markets and ensure grid flexibility.
- Saudi Arabia invests in energy storage infrastructure, with projects like ACWA Power's 1.2 GWh system at the Red Sea Project and plans for a 600 GWh BESS in Neom.
- Scatec and the Egyptian Electricity Holding Company (EEHC) collaborate on Egypt's first solar and battery storage project, featuring a 1 GW solar plant and a 200 MWh storage facility.
- South Africa launches tenders for battery energy storage systems installation at distribution substations through its Energy Storage IPP Procurement Programme.

MEA will need BESS to support renewable energy initiatives and ensure a reliable energy landscape. However, clear policies and energy market participation rules for BESS must be defined for an effective energy transition in MEA.

Cumulative Capacity Installation of BESS in Middle East & Africa

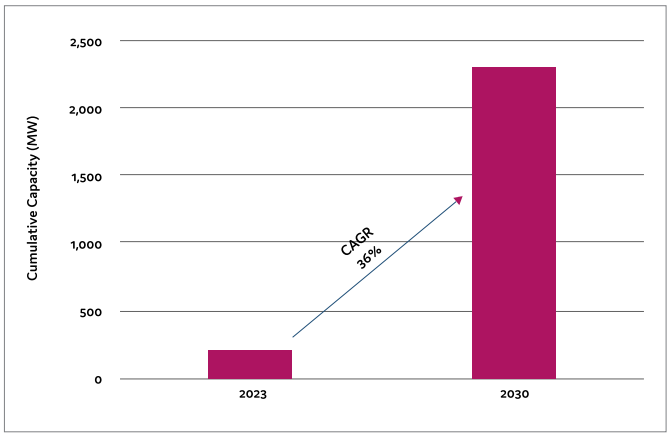

Figure 6: Cumulative Capacity Installation of BESS in MEA
Source: PTR Inc.

Flexible Alternating Current Transmission Systems

Flexible Alternating Current Transmission System (FACTS) technology, incorporating devices like Static Var Compensator (SVC) and Static Synchronous Compensator (STATCOM), enhances transmission infrastructure reliability and flexibility.

These systems, utilizing power electronics and static devices, are crucial for voltage stability, regulating levels, and mitigating fluctuations, especially amidst renewable energy integration and changing demand. MEA's ambitious renewable energy plans necessitate technologies like FACTS. Key developments include:

- General Electric (GE) and Alfanar's contract to install a Hybrid STATCOM for the Saudi Electricity Company in Tabuk, northern Saudi Arabia, with a capacity of 600 MVAR
- Hitachi Energy installed a 200 MVAR STATCOM in Egypt for the Egyptian Electricity Transmission Company (EETC) to improve power quality and expand transmission network capabilities.

MEA's FACTS Market Overview

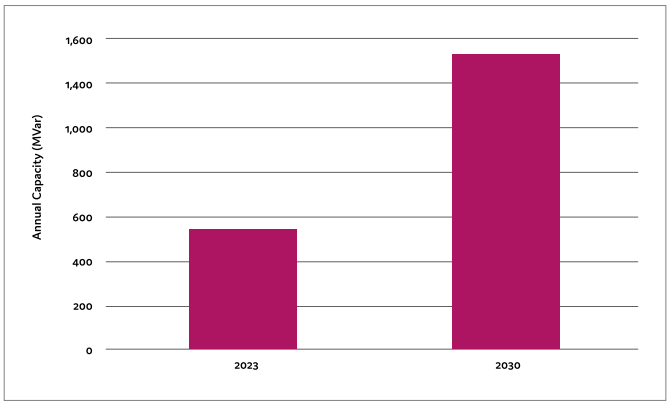

Figure 7: Annual Additions of FACTS in MEA
Source: PTR Inc.

MEA will see more STATCOM adoption and a decline in SVC adoption, led by UAE and KSA due to renewable expansion. Bahrain, Egypt, and Iran also exploring STATCOM, with operational projects expected by 2025.

Noteworthy Developments in the MEA Region

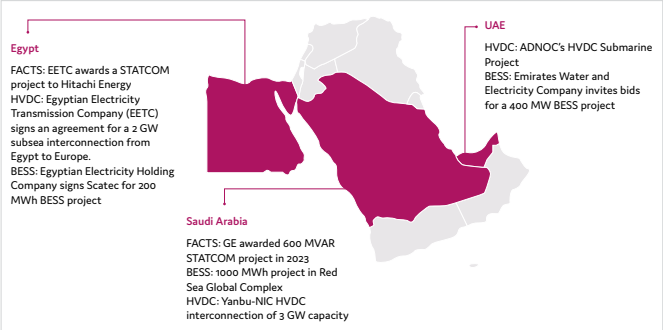

Figure 8: Noteworthy Developments in the MEA Region
Source: PTR Inc.

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.

Conclusion

As renewable energy gains traction in countries like KSA and UAE, the demand for grid flexibility technologies such as battery storage, HVDC, and FACTS will soar. However, to facilitate investment in these technologies, a restructuring of the policy framework for storage investments is crucial. Moreover, stringent power quality standards and policies are essential for a smooth transition towards renewable energy in the region. Additionally, developing countries facing challenges, such as Egypt and South Africa, may require government funding support to advance their clean energy journey through these technologies. By addressing these factors and providing necessary support, the MEA region can effectively embrace a sustainable energy future.