Middle East Energy Dubai

How Middle East Energy Transition Will Stimulate Grid Modernization & Digitalization

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Introduction

The energy and electricity landscape in the Middle East (ME) is in a midst of transition as climate change, and energy security concerns took center hold in 2022. Extreme weather events and geo-political events highlight the need to reduce emissions and shield the region from upheavals in the international energy market.

ME is already in a phase shift from an economic perspective as a region is investing to become a sustainable and low-carbon tourism, trade, and technology hub rather than remain reliant only on petroleum exploration and export. This has spurred investment into mega infrastructure, such as new cities, plants, electric transportation networks, massive desalination, and renewable power plants.

However, for the ME to be successful in moving away from a petroleum-based economy, while ensuring that emissions are reduced and net zero is achieved within the timeframe, revamping the electricity sector, especially the transmission and distribution grid, remains the key and biggest challenge. Not only will the capacity of the system have to be enhanced to cater to increased electricity demand, but the structure of the grid will also need to be modified so that bi-directional power and information can flow more efficiently while allowing enhanced monitoring and control capabilities.

CO_2 Emissions by Key ME Countries

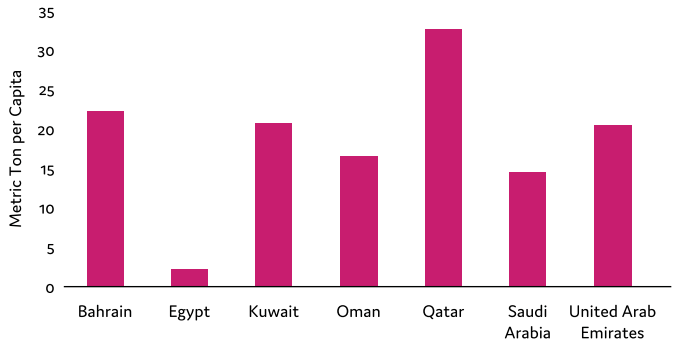


Figure 1: CO_2 Emissions in Key ME Countries in 2019 [1]
Source: World Bank Data, 2020

ME has traditionally been one of the largest per capita emitters of greenhouse gases (GHG) including CO_2 in recent decades due to the reliance on the petroleum-based economy. Figure 1 depicts the ton per capita CO_2 emissions in 2019 from select ME countries.

However, recent efforts across the region suggest that countries are investing in renewable power plants to diversify the energy mix, as depicted in Figure 2 which shows the forecast till 2030. This is in addition to the targets of switching to low-carbon industry and transport electrification.

Figure 2: Growth of RE Installed Capacities in key ME Countries [2]
Source: PTR Inc. Generation Database, 2023

Until 2030, the region's power demand is predicted to increase by 3.3% year-on-year as the population increases, more infrastructure is added, the transportation sector is electrified, and industry switches to low-carbon Hydrogen or electrified sources. Some nations, like Kuwait, Oman, Qatar, Saudi Arabia, and the UAE, have population growth rates of 3.5%. Early estimates suggest that ME countries need at least 25-30% of new capacity to match the increased usage. [3]

This paper presents an overview of grid modernization and digitalization technologies that can be deployed to achieve these objectives and, make a case for how the energy transition will be a crucial driver for the growth of substation automation and grid digitalization.

What Does Grid Modernization and Digitalization Entail?

A smart grid is a modern and digitalized interconnected grid and essentially corresponds to substation automation with real-time management implemented locally at the substation/system level.

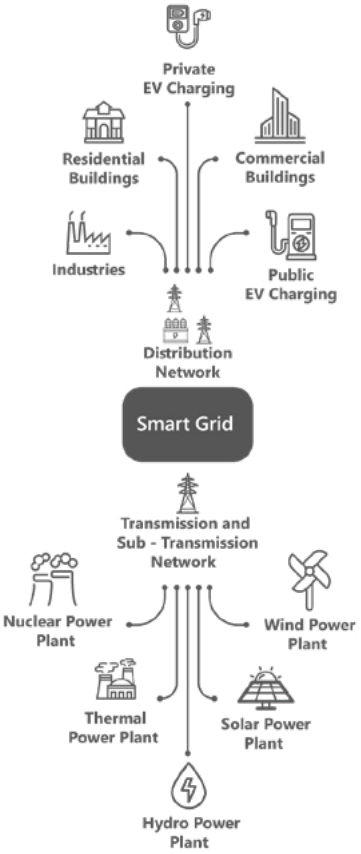


Figure 3: Digitally Transformed Power Grid.
Source: IEEE [4]

A substation automation system (SAS) is a set of hardware and software components that monitor and control an electrical system on-site and remotely. To improve the system's overall efficiency and productivity, SAS automates repetitive, time-consuming, and error-prone tasks. A substation automation system can be distributed or centralized.

Digital Switchgear is a significant component of SAS. It is a device that not only monitors conventional parameters like voltage, current, etc. but is also equipped with different kinds of intelligent sensors such as thermal and humidity sensors (wireless or wired) to 24/7 monitor and record equipment health and generate alarms in case of interruption or fault.

Digital switchgear is also able to communicate the data to either cloud or a local server, which can then be analyzed and used to predict any future potential failures and reduce downtime. It also has Intelligent Electronic Devices (IEDs) for protection and control functionalities that can communicate with the local SCADA via IEC-61850 or other communication protocols.

Grid Modernization as a Solution for DER Integration Issues

Grid modernization can act as a panacea for issues arising from intermittent renewable energy sources while ensuring that increasing demand does not offset emissions reduction targets. Central to the theme of a modern grid is having the ability to integrate multiple sources of power generation such as traditional central base load plants and nascent distributed energy resources (DER), which further include utility-scale renewable energy plants, small-scale distributed renewable energy setups, battery storage and even demand response (DR). DR remains an essential tool in the utility arsenal to keep emissions in check as it allows for decreasing demand instead of increasing supply in response to peak loads, as DR can be considered a form of demand optimization.
Another method to keep emissions in check is to increase the energy efficiency of transmission and distribution systems, which can be achieved with digital and communication technologies to monitor and control power systems. [5]

COP27 and COP28: ME Gets Serious about Emissions Reductions

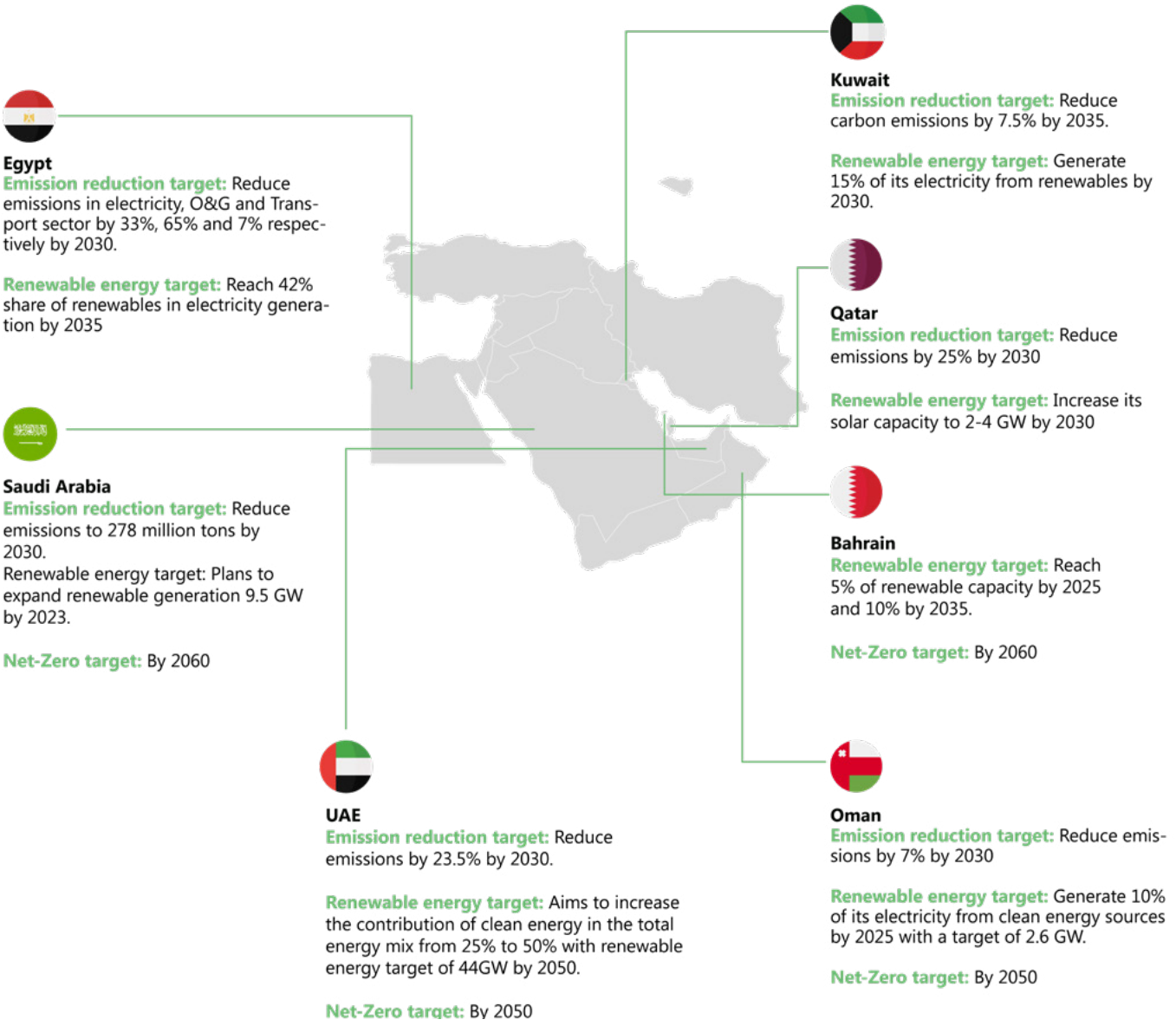


Figure 4: Emission Reduction and RE Targets of Key ME Countries [6] | Source: Climate Action Tracker, 2022

Through COP27 in Egypt and the upcoming COP28 in UAE, the seriousness of shifting towards a low-carbon future can be gauged as ME countries are major polluters as producers and exporters of oil and gas in the world, and naturally, fossil fuels meet a substantial part of their energy and electricity demand.

The initiatives and pathways announced to reach the ambitious aim of the energy transition are to limit global average temperature rise to less than 2°C and achieve a zero-emissions energy system by 2050, similar to pledges made by other developed economies in the world.

The UAE was the first country in the ME to pledge net zero emissions by 2050 with an increased share of 50% from clean energy sources, followed by an aim to reduce carbon emissions by 23.5% by 2030. [7] "Breakthrough Agenda" was a set of measures to decarbonize power generation, the transport sector, and steel manufacturing in addition to scaling up low-emission hydrogen production and accelerating the shift to sustainable agriculture first introduced after COP26.

A recent version of this agenda requires countries representing more than 50% of global GDP to set out sector-specific 'Priority Actions' before the COP28 conference in 2023. The main points of Priority Actions include agreements to accelerate the deployment of infrastructure that contributes to emissions reduction, including 50 large-scale net-zero emission industrial plants, at least 100 hydrogen valleys, and a package of major cross-border power grid infrastructure projects. Additionally, set an expected target date to phase out polluting cars and vehicles, consistent with the Paris Agreement. [8]

Besides UAE, Saudi Arabia has also announced targets to achieve Net-Zero by 2060, followed by the aim to reduce carbon emissions by 278 MTPA by 2030 under Saudi Green Initiative (SGI); the agenda will be facilitated by achieving 50% of renewable energy penetration by decade-end. Under SGI, the first wave of more than 60 initiatives accounted for USD 185 billion in investments, assisting in developing the green economy. In 2022 His Royal Highness the Crown Prince announced that Saudi Arabia would establish and host a dedicated Middle East Green Initiative (MGI) Secretariat and allocate USD 2.5 billion to support MGI projects and governance to accelerate the implementation of initiatives to achieve the MGI goals.

The MGI is a regional initiative led by Saudi Arabia to reduce the regional impact of climate change and collaborate to meet regional emission targets of a 60% reduction in emissions. [9] [10]

Whereas Egypt in an updated Nationally Determined Contributions (NDC) submitted in 2022, Egypt, host of COP27, pledged to reduce emissions by 33% in the electricity sector, amounting to 70 Mt CO_2e, 65% in the oil and gas sector which amounts to 1.7 Mt CO_2e, and 7% in the transportation sector (translating to 9 Mt CO_2e by 2030 compared to business-as-usual. Moreover, the country plans to install additional renewable energy capacities that will generate 42% of electricity by 2035. [11]

ME Energy Demand Outlook

The following section presents some major developments in key ME countries which will call for the need to have an enhanced grid; these include infrastructure projects and transport electrification.

Infrastructure Projects

The development of mega Infrastructure projects is the result of increasing urbanization and efforts to diversify the region's economy from O&G to tourism, trade, and technology.

Egypt

Egypt has a substantial construction industry, and the country has announced several projects that will remain a driver for increased smart grid capacity.

- Up to 14 additional smart cities will be built across Egypt. The housing minister recently announced that Egypt has finished infrastructure projects totaling roughly USD 106.25 billion in less than two years. Additionally, the government is modernizing transit systems, ports, and airports. [12]

Kuwait

- Al-Khiran Residential City Development Project with an investment of USD 13 billion, expected to finish by the end of 2025. [13]

Oman

Oman has appeared as an active player in the region and has announced several projects to diversify its economy.

- Duqm Special Economic Zone Development Project with planned investments of USD 17.8 billion, expected to finish by the end of 2026. [13]
- Oman's sustainable city Yiti, a development by Sustainable Development Investment Company (SDIC), reaffirmed its commitment to roll out initiatives to support Oman Vision 2040 and the National Tourism Strategy by creating a green, energy-efficient city, which is people-centric. Reportedly, nearly 58 SMEs in Oman have also benefited from the job opportunities spurred by the sustainable city in the last two quarters. [14]

Qatar

In addition to development for the FIFA World Cup, Qatar has announced further development projects.

- Planned entertainment Lusail city with an investment of USD 8.2 billion expected to finish by the end of 2025. [13]

Saudi Arabia

Following are the critical infrastructure projects driving the electricity demand and are a vital part of the energy transition.

- Neom city is a mega-project spread over an area of 26,500 km^2 with a planned investment of USD 500 billion expected to finish by the end of 2029.
- The Line Project is a linear city in Neom that will be powered 100% by renewable energy [14]
- King Abdullah Economic City with USD 59 billion investment expected to finish by the end of 2034.
- Red Sea Tourism Project with USD 9 billion expected to finish by the end of 2024.
- Jeddah Economic City with an investment of USD 28 billion, expected to finish by August 2031. [15]

UAE

In 2017, the UAE government unveiled the 'Energy Strategy 2050,' under which the UAE government plans to invest more than USD 160 billion by 2050 to meet rising energy demand and ensure the country's economic growth is sustainable. To meet the UAE's economic and environmental goals, the strategy aims for an energy mix that combines renewable, nuclear, and clean energy sources. [7]

- Abu Dhabi International airport expansion with USD 9.8 billion investment. [16]
- Mohammed Bin Rashid Real Estate Development Project worth USD 28 billion is expected to finish by the end of 2035. [13]

Growth of EVs in ME

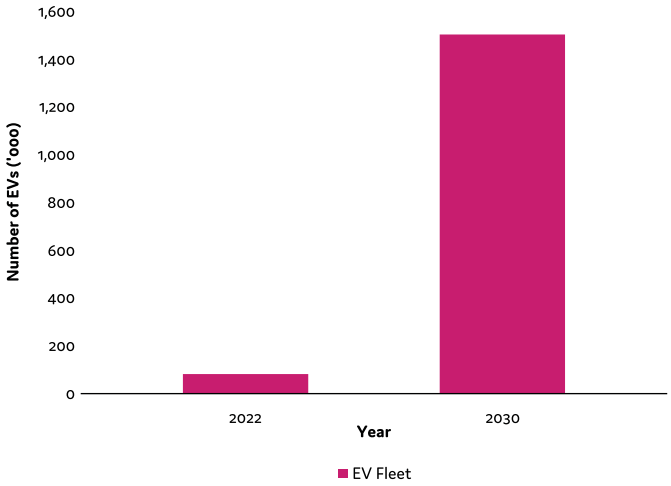


Figure 5: EVs Fleet Growth in ME [17]
Source: PTR Inc. EV Market, 2023

Growth of EVs

The ME EV infrastructure is expected to grow in the coming decade. Increased electrification of transportation would increase grid load, necessitating more energy supply. As technology advances, the V2G (Vehicle to Grid) systems will impact ME power grid. The bidirectional flow of electricity would need network expansion to accommodate this growing fleet.

Energy Supply Outlook: Energy Mix and T&D Expansion

Energy Mix Diversification

ME power generation capacity mix is typically characterized by high fossil fuel and low renewable installed capacity. However, as ME countries have embarked on diversifying and decarbonizing their economy, a trend is also evident in power generation. Taking benefit of plentiful solar irradiance, solar has seen increasing adoption at both utility and rooftop scales in the last five years.

In terms of percentage, UAE has considerably increased its renewables capacity in recent years and is expected to remain the regional leader by 2030. However, other nations are forecasted to increase their pace of investment in this sector substantially and, in terms of installed capacity in GW, Egypt and Saudi Arabia will be the market leader. The region is expected to add 73GW of renewable energy installed capacity by the decade's end.

Share of Renewables in Key ME Countries

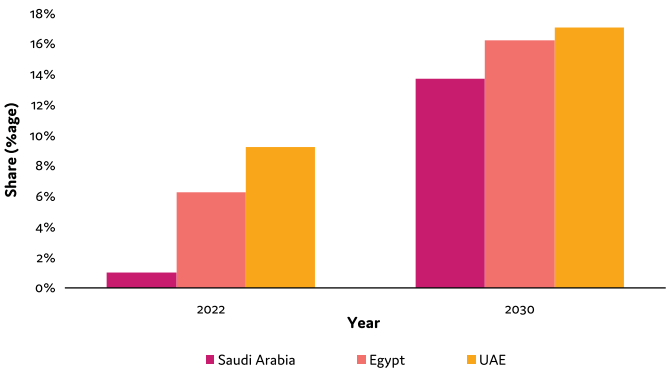


Figure 6: Percentage Share of Renewables in Key ME Countries [2]
Source: PTR Inc. Generation Database, 2023

Renewable Energy Investment Plans

As mentioned before, regional countries are now investing in several large-scale solar renewable projects as regulations have been modified to streamline and fast-track the development of these plants. Some of the notable projects are mentioned below.

Egypt

- During the COP27 in 2022, Egypt announced signing long-term agreements for several renewable power projects, which are forecasted to generate 12GW during the trial period and about 55GW when completed. One of the major projects is a Green Corridor initiative, a 10GW onshore wind farm to be built by 2035. [18]
- The Gulf of Suez-II 0.5GW wind power plant achieved a significant milestone as the project broke ground in 2022.

Oman

- Oman Electricity Transmission Company (OETC), Oman's state-led power transmission firm, has unveiled a roadmap to add 1.9GW of renewable energy capacity through seven projects by the end of 2026. [19]

Qatar

- The Al Kharsaah solar power plant has a capacity of 0.8GW and was inaugurated in 2022 to become Qatar's first central utility-scale renewable plant. [20]

Saudi Arabia

- According to the country's energy minister Prince Abdul-Aziz bin Salman, Saudi Arabia plans to award contracts to renewable energy projects with a total capacity of around 15 GW in 2022 and 2023. [21]
- Sudair Solar Plant Project was inaugurated in 2022 with an installed capacity of 1.5GW; to date, this is the largest single-contracted solar PV plant in the country. [22]
- PIF subsidiary and ACWA power will jointly develop the Shuaibah Two 2.06GW solar farm by 2025, making it the ME region's largest solar energy plant announced. [23]
- The 0.4GW Dumat Al-Jandal wind farm was the first utility-scale wind power project in Saudi Arabia and one of the biggest wind farms in the ME when it achieved commercial operations in 2022. [24]
- Saudi Electricity Company (SEC) is planning to build a 1GW hydroelectric pumped storage power plant in Baysh, Jizan Region, Saudi Arabia.
- NEOM Green Hydrogen Project will be the world's largest utility-scale, commercially based hydrogen facility powered entirely by renewable energy when it achieves commercial operations in 2026 and will produce 600ton Hydrogen per day and be powered by 3.9GW renewable power. [25]

UAE

- SirajPower, the UAE's leading distributed solar energy provider in the region, and master developer Nakheel teamed up to install solar panels across key communities in Dubai, which is in line with the UAE's vision to achieve net-zero emissions by 2050. [14]
- Phase IV and Phase V of the Mohammed bin Rashid Al Maktoum Solar Park are in various stages of completion. By 2023, the park will have an installed capacity of 2.83GW from Solar PV and Solar CSP technologies. DEWA has planned to raise its capacity to 5GW by 2030. [26]
- Al Dhafra Solar (ADS) is a 2GW farm and is on track to be commissioned before COP28. Once online, ADS will be one of the largest single-site solar power plants in the region to date. [27]
- Hatta Hydroelectric Power Plant is under construction 0.25GW, and 1.5GWh pumped storage plant estimated to be completed in 2024. [28]

Network Expansion Plans

Transmission and Distribution (T&D) will be a crucial sector in achieving decarbonization to smartly transfer electricity at the lowest losses possible. Numerous projects and initiatives have been underway in the region at all voltage levels to enhance the grid's capacity and integrate modernization technologies. Some of the critical projects are mentioned below.

Egypt

- As part of the country's plan to become an energy hub, Egypt has constructed several energy interconnectors with neighboring countries (Jordan, Sudan, and Libya). The country is also working on finalizing an interconnector with Saudi Arabia. In 2019, an MOU was signed to establish an interconnector with Cyprus and Greece as well.
- Egypt's new national control center at the strategic command headquarters in the New Administrative Capital was completed by Siemens and Hassan Allam Construction in 2022. Siemens deployed advanced software and equipment to monitor, manage and control 220kV and 500 kV transmission networks and power generation stations across the country. [12]

- The government is also working on modernizing 47 distribution control centers around the country. In this regard, Schneider Electric announced during COP27 that they had finalized the first phase of the Distribution Control Center in Sharm El Sheikh, and the opening of four new distribution control centers was in the final execution phase. [29]
- Transmission and distribution utilities have invested in increasing Egypt's network capacity in recent years. According to reports from 2021, the transmission capacity expanded by a significant 17.7%, corresponding to additional 16,893 MVAs, during the fiscal year 2020-2021. [30]

Oman

- For upgrading and increasing the efficiency of the electrical grid, OETC plans to invest USD 1.2 billion by 2023. [13]
- Plans are also underway to link Oman's Main Interconnected System (MIS) and Dhofar system grids through a new 400kV interconnector by the end of 2026. [19]
- GCC Interconnection Authority (GCCIA) is conducting a feasibility study on establishing an additional interconnect linking the Sultanate of Oman to the Kingdom of Saudi Arabia, allowing Oman Power and Water Procurement Company (OPWP) to obtain an additional 1.2GW of electricity. [31]

Qatar

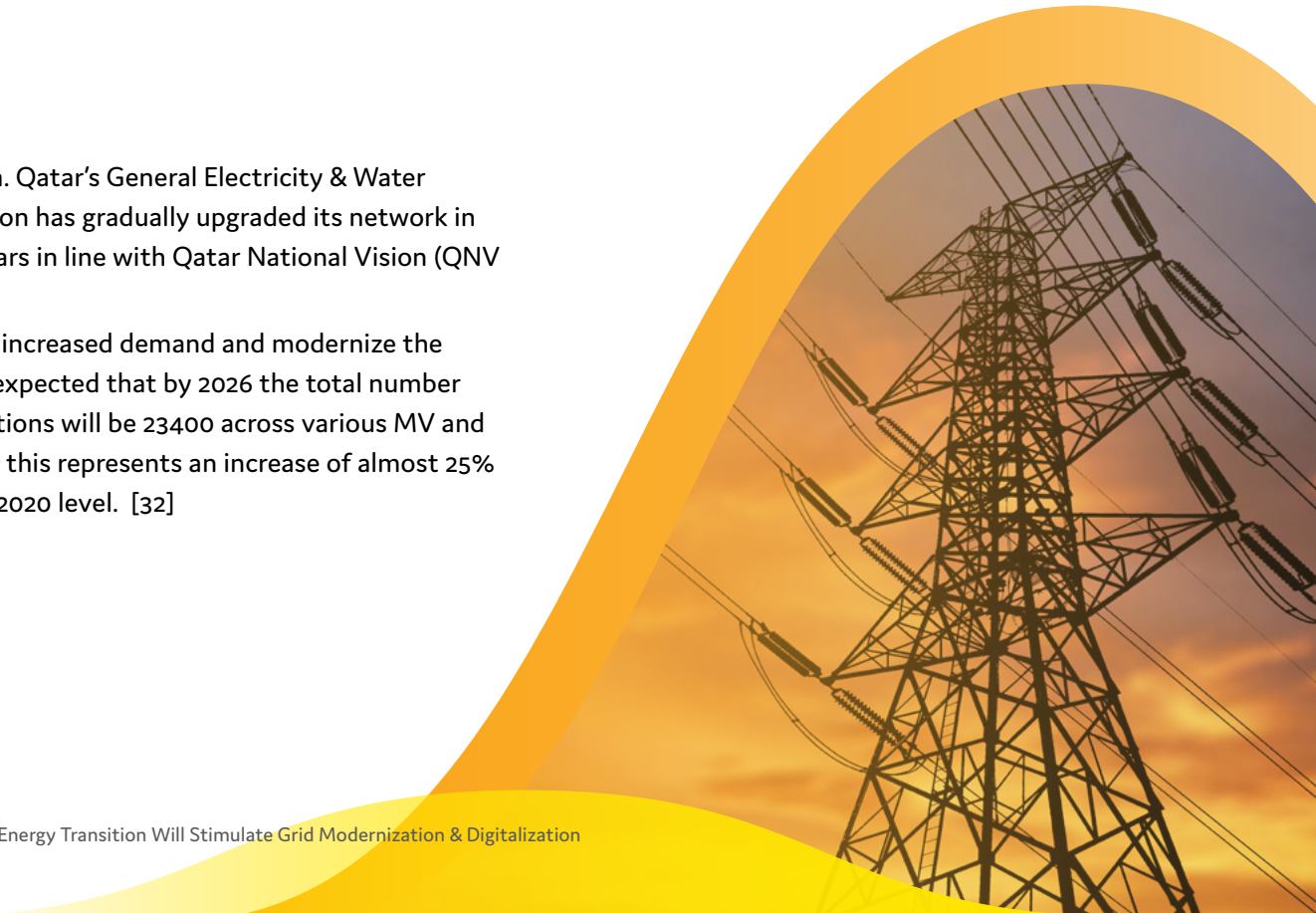
- Kahramaa. Qatar's General Electricity & Water Corporation has gradually upgraded its network in recent years in line with Qatar National Vision (QNV 2030).
- To match increased demand and modernize the grid, it is expected that by 2026 the total number of substations will be 23400 across various MV and HV levels; this represents an increase of almost 25% from the 2020 level. [32]

Saudi Arabia

- Saudi Arabia will increase its HV transmission substations capacity by 214,000 MVAs by 2030. This will result in the construction of almost 560 transmission substations with a total of ~1,500 new power transformers by SEC. [15]
- Additionally, Saudi Arabia has recently announced that it intends to invest more than USD 266 billion in cleaner electricity generation and grid expansion, further enabling the country to meet growing demand while staying true to decarbonization targets. [33]

UAE

- Currently, to fulfill the growing demand, DEWA has invested USD 2.31 billion to expand the electrical network. Similarly, TRANSCO plans to add 4,680 MVA by 2026. [30]



Digitalization in EU: A Blueprint for ME Region

EU released its "Digitalizing the Energy System-EU Action Plan" in October 2022, which outlined the steps to ensure the EU reached its "Fit-for-55" and REPowerEU targets. [34] The plan focused on increasing DER integration to the pan-European grid, installing IoT and smart meters at LV and MV sides with all equipment connected via 5G with Advanced Distribution Management Solutions (ADMS) in a control center. This initiative aims to increase the visibility of the transmission and distribution system operators in the network infrastructure and create a digital twin as well. EU is hopeful that this plan will enable an intelligent flow of energy, increase energy efficiency by 13% by 2030, and lead to a resilient cross-border grid. [35]

According to PTR's research, Europe already has a strong substation automation market and accounted for 28% of the market in 2020. [36] This has allowed the utilities to incorporate digitalization into their system rapidly. As per PTR's research on digital MV switchgear, Europe had the biggest market share in 2022 and European digital MV Switchgear market is expected to grow at a rapid CAGR of 27% from 2022 to 2030. [37] Overall, the EU estimates that they will spend almost USD 585 billion by 2030 to achieve their targets.

MV Digital Switchgear Growth in Europe

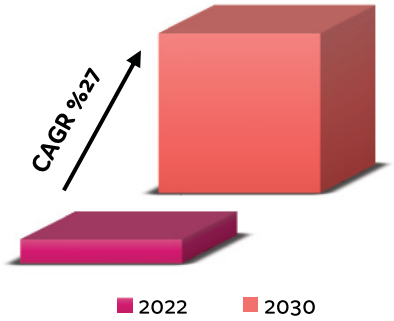


Figure 7: Growth of MV Digital Switchgear Units in Europe. [37]
Source: PTR Inc. Digital Switchgear Report, 2022

Through grid modernization and digitalization investment, the ME region can achieve similar to EU levels of system visibility, control, efficiency, and resilience, which can lead to an effective Pan-Arab energy market.

2030 Outlook: Grid Modernization in ME

Increased electricity consumption is projected with planned mega infrastructure investments (e.g., NEOM) and increasing electrification of industry and transport sector is leading to a high demand for grid equipment in the power sector and as renewable energy penetration increases, the intermittent nature of the source will lead to a demand for digital solutions. Smart city projects, infrastructure development projects, and the growing tourism industry require more network monitoring. Additionally, following COVID, technical teams are under intense pressure to reduce maintenance costs. Digital solutions are now included in the specifications of every consultant and OEM. As a result, these digital solutions will progress to the point where they will no longer need in-person maintenance and will be monitored remotely via software.

Substation Automation System (SAS) in ME

ME very closely follows Europe and America, as per technology and the latest trends. Growth in renewables is one of the main drivers for the substation automation market in the ME region. PTR predicts that transmission, Oil & Gas, and mining sectors will install centralized substation automation systems in the short term (3-5 years). On the flip side, the rest of the sectors will prefer installing distributed substation automation systems in the next 5 years.

ME SAS Application Split (2022)

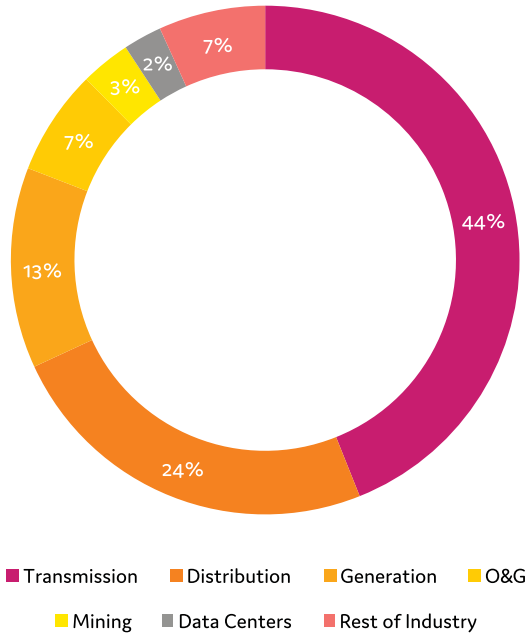


Figure 8: SAS Application Split in ME. [36]
Source: PTR Inc. SAS Report, 2022

- In the last 5 years, 26 HV substations were installed in Egypt, out of which 14 were automated. In the future, there is a plan to have automation for all MV substations (especially 22/11 kV). Process bus will take a lot of time to be implemented in Egypt. Currently, a semi-substation automation topology is being implemented in Egypt, using IEC 61850 communication protocol for data transmission between IEDs and the station level.

- From an application perspective, generation, transmission, and distribution accounted for 90% of installed SAS in 2022.
- Saudi Arabia is taking decisive steps towards digital transformation, as a critical lever to achieve its vision 2030 goal of diversifying the economy and becoming less reliant on hydrocarbon resources. To this effect, it has set up the National Digital Transformation Unit, coordinating efforts across sectors and monitoring the overall progress of digital transformation in the Kingdom. In Saudi Arabia, it is a must for all transmission substations to have a SAS and for them to communicate via IEC 61850. However, it is not mandatory for Distribution substations in Saudi Arabia to have a SAS. Most of the distribution substations in the country have conventional RTU-based protection schemes.
- The transmission sector is the biggest demand generator for distributed SAS. However, in the coming years, distribution and industry (especially oil & gas) will create the most significant demand for centralized SAS.
- Process bus is comparatively a new trend and proposed for digital substations. There are a couple of substations being planned where they will have total digitalization, no copper wire will be used, but only tenders are being floated for now. Major infrastructure projects like Neom city and Red Sea city is one of the primary growth drivers for the substation automation market in Saudi Arabia. [36]

Smart Meters a Step Towards Modernization in ME

As a first step towards grid modernization, ME utilities are installing smart meters. Smart meters increase efficiency and reduce consumption while allowing customers to monitor their consumption at any time and location. Utilities in the ME had previously concentrated on MV control while overlooking LV. However, they have begun LV smart meter projects in recent years. Smart meter penetration is, however lower, and most utilities are running pilot projects.

- Egypt's government is attempting to control energy consumption; the Ministry of Electricity has installed 10 million smart meters of 38 million targets. The remaining units will be installed over five years.
- In 2021, Saudi Electricity Co. (SEC) installed and replaced over 10 million LV smart meters. According to SEC, smart meters are the most crucial step in the company's digital transformation. Furthermore, SEC signed two contracts totaling USD 720 million with a Chinese and a Saudi company for the supply and installation of 60,000 smart devices to the Kingdom's electricity distribution network.
- DEWA installed over 2 million smart electricity and water meters in Dubai in 2021 as part of DEWA's efforts to create a cutting-edge digital infrastructure that meets the most stringent international standards. [37]

Digitalization in the ME Grid

Digitization has been ongoing for the last decade, progressing from the pilot project stage. Conventional brownfield systems are updated with the necessary equipment to meet current and future digitization requirements. At the same time, greenfield projects will include digital substations with fiber-based communication systems integrated into the cloud for communication with smart meters. Utilities will not store their data in the cloud due to cyber security concerns. Utilities' main expectations from digitalization are remote asset health monitoring, predictive maintenance, reduced downtime, fault prediction, and reduced maintenance costs. PTR estimates that MV digital switchgear in ME will grow at a rapid CAGR of 30% from 2022 to 2030. [37]

MV Digital Switchgear Growth in ME

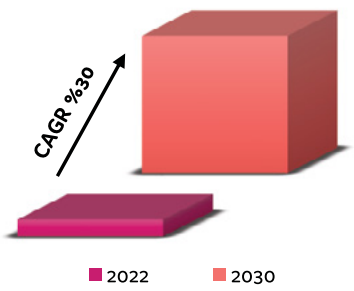


Figure 9: Growth of MV Digital Switchgear Units in ME. [37]
Source: PTR Inc. Digital Switchgear Report, 2022

- Saudi Arabia's Vision 2030 promotes the country's digital transformation; the new smart cities (e.g., Neom) and commercial infrastructure, as part of this vision, will incorporate smart technologies and digital solutions. To accommodate infrastructure development projects, Saudi Electricity Company (SEC) plans to expand its network capacity. This will result in the construction of new substations and drive the digital solutions market. As the Saudi Arabia market moves toward smart grid technologies, there is a greater emphasis on ADMS. Currently, National Grid Saudi Arabia (NGSA) uses IEC 61850, which uses station-bus and PRP radiancy protocol. Process-bus is not yet implemented and will be adapted in the future with Digital Substation. Digital solutions for asset performance management, reducing unexpected downtime, and increasing network reliability are part of SEC objectives. However, at present, this is limited to the HV level.
- Demand for digital solutions is expected to rise significantly as utilities like DEWA are investing in digital substations (both HV and MV) as they work to decentralize power networks. DEWA has an integrated smart grid strategy that includes investments of up to USD 2 billion that will be completed in multiple phases until 2035. [37]

Virtualization in ME Grid

The concept of virtualization corresponds to remote utility management like power monitoring, ADMS, digital twin for maintenance, training simulations, tests, asset management, etc. This is enabled by using a cloud or local server and can manage several data points. Utilities with complex and extensive networks are good candidates for digitalization and virtualization for monitoring, protection, and control, but budgetary constraints determine the extent of transition from conventional protection and control.

Due to very high cyber security concerns and strict government laws, utilities with sufficient funding, control, and protection have not yet been virtualized. However, this concept is gaining popularity in the ME market. In the master control centers, virtualization may follow ongoing SAS installation.

- In Saudi Arabia, virtualization has been widely used in the data centers and distribution control systems (DCS) segment. VMware, Nutanix, etc., are popular products & systems in the virtualization field. As per Saudi Arabia's data protection norms, hosting of data of key critical organizations of Saudi Arabia is not permitted on an outside cloud. So, all major cloud providers need to keep their data centers within Saudi Arabia for any applications offered on cloud platforms. Therefore, those virtualization applications will reside either on-premises or cloud within the country.
- DEWA has its cloud hosting services and hosts its servers, as purported under UAE data laws to store the UAE data within the geographical boundaries of the country. DEWA is planning to sell server space as a part of its product to other organizations. Similarly, they have contracted organizations to develop algorithms for energy management as well. Except for DEWA, utilities prefer third-party cloud services and will continue to do so for virtualization.
- Egypt also has a slight inclination towards virtualization. [37]

Evolving Business Models for Energy Market in the ME: Navigating the Transformation of the Electricity Grid

The ME has set ambitious goals for decarbonization, energy security, and climate change plans, which require a significant overhaul of the region's electricity grid. To take advantage of this opportunity, regulators, utilities, and grid technology companies will need to adopt new strategies to drive grid modernization and digitalization in the region.

Regulators have an essential role to play in the development of policies and regulations, by collaborating with utilities and technology companies, that support the deployment of advanced technologies and systems. That would require, for instance, advanced metering systems, grid management software, and real-time analytics tools will be essential in integrating the growing number of intelligent nodes to support the power system throughout the ecosystems of electricity supply, delivery, and end-use. Another critical step will be to set clear guidelines that promote investment in modern grid technologies while complying with the region's strict localization laws.

Electric utilities will need to rethink their business models to remain relevant and competitive. In the past, utilities' primary role was to generate and distribute electricity to end-users. However, the role of utilities is shifting towards managing and integrating these resources into the grid. Energy storage solutions, advanced grid analytics, and demand response and energy management services will be crucial in managing the variability and intermittency of DERs while ensuring the losses remain minimal.

The stringent localization laws in the ME may pose a challenge for grid technology companies, such as OEMs and suppliers, seeking to introduce new technologies, but it also provides an opportunity for partnerships with local entities to develop solutions that cater to the local context, establish raw material supply chains, and further boost economic growth. This might involve developing and providing new and more flexible transmission and distribution equipment that can support the integration of renewable energy sources into the grid while also being compatible with existing electric infrastructure to ensure cost does not become a significant restraining factor. For instance, digital switchgear, microgrids, battery storage solutions, and solar technologies can help accelerate the transition toward clean energy.

Cybersecurity Concerns

Attacks by cybercriminals on vital infrastructure, including the power grid, are becoming more frequent and sophisticated. Furthermore, as the electricity grid becomes more interconnected and reliant on digital technology, the risk of cyberattacks also increases. Therefore, ensuring the security of the smart grid and electricity infrastructure is critical for the ME's energy security and resilience.
To address this growing challenge, it is crucial to integrate security into smart grid policy and electricity infrastructure technical design from the ground up. By doing so, security measures can be more effectively integrated and implemented to address the vulnerabilities and potential risks to the grid's stability and reliability. In addition, regulators, utilities, and technology companies must work together to implement security measures that cover the entire lifecycle of the infrastructure, from design and implementation to operation and maintenance.

The Way Forward

Utilities are investing in substation modernization to meet the challenges posed by renewables. As renewable energy penetration grows, regulators require utilities to increase visibility into electric networks. Most ME countries are only beginning to implement the net-zero agenda, and the current impact of renewable integration on the grid is negligible. However, increased renewables penetration, industrial and commercial infrastructure expansions, and increased electrification of transportation in the coming decade will necessitate modern solutions to ensure grid resilience and efficiency. Regulators and System Operators (SO) have initiated several automation and digitalization studies and projects to develop a way forward towards transitioning the grid; however, it is suggested that the pace and magnitude of investments be increased to ensure that ME remains the energy leader of the future.

In conclusion, the ME's decarbonization, energy security, and climate change plans are driving a fundamental transformation of the electricity grid, creating an opportunity for regulators, utilities, and grid technology companies to collaborate and develop innovative solutions and services. To capitalize on the opportunity, stakeholders should work together to develop and implement policies and regulations that support the deployment of advanced technologies and systems while considering the unique challenges and opportunities presented by the ME region's localization laws.

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