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SOLAR ENERGY: EVOLUTION AND EMERGING OPPORTUNITIES IN THE GULF COOPERATION COUNCIL (GCC)

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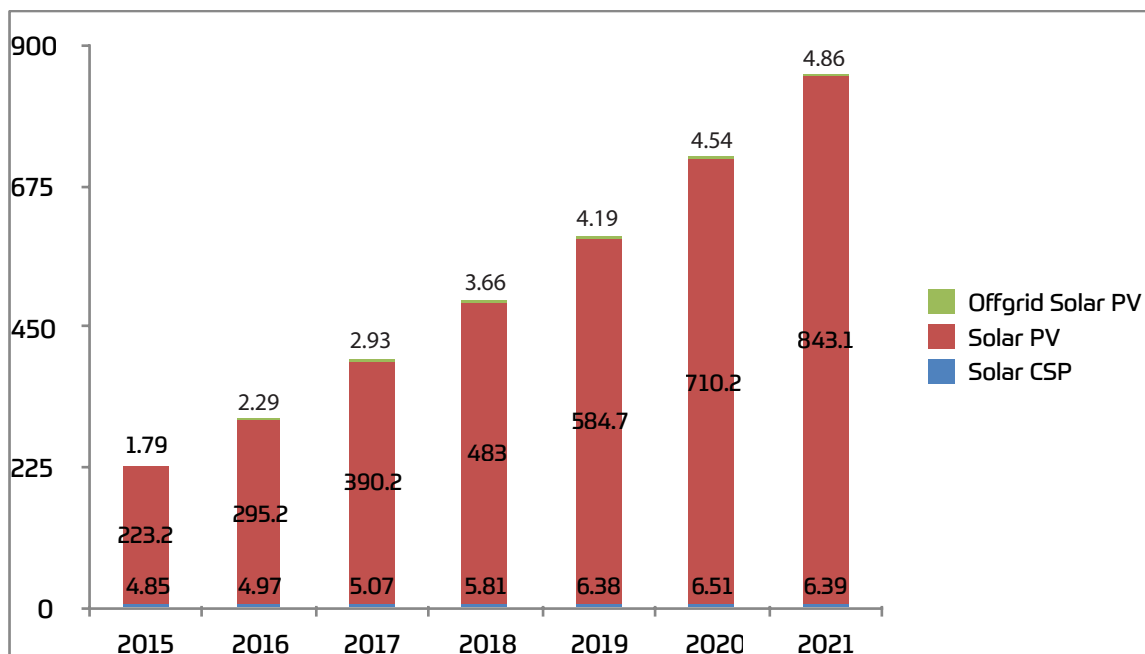


SOLAR ENERGY: EVOLUTION AND EMERGING OPPORTUNITIES IN THE GULF COOPERATION COUNCIL (GCC)

The energy sector is undergoing a major transition toward a decentralized, decarbonized, and digitalized future. The energy industry and its associated technologies are continually evolving as demand, supply dynamics and consumer preferences change, supported by economic development and technology advancements. Globally, electricity generation has been dominated by traditional hydrocarbon sources like coal and natural gas, cumulatively accounting for over 54% of the total installed capacity globally; hydroelectric power, renewables and nuclear account for the remainder 46%. The 21st century has witnessed a transition where the global energy industry is gradually shifting toward low-carbon energy sources dominated by wind and solar-based technologies. While a majority of the global electricity demand is still expected to be met by coal and natural gas through 2040, the ongoing energy transition is one of the most prominent mega trends that will shape the future of the global energy economy and technologies.

Global installed power generation capacity has increased at 3.1% CAGR from an estimated 6,213GW in 2015 to 7,108GW in 2020. Among the various power generation technologies, the highest growth in installed capacity was recorded by renewable energy, where installed capacity has increased from 1,851GW to 3,064GW between 2015 and 2021. Increasing contribution from renewable energy is driven predominantly by large-scale investments in wind and solar power generation projects. Despite the COVID-19 pandemic, over 260GW of renewable capacity was added in 2020, which exceeded the recorded capacity addition in 2019 by 50%. Renewable energy growth witnessed over the past decade will continue over the next two decades with increasing investments in solar PV and wind power capacity.

FIGURE 1: GLOBAL SOLAR POWER INSTALLED CAPACITY (GW), 2015 TO 2021



As depicted in Figure 1, solar power has been dominated by solar photovoltaic installations, while concentrating solar power and distributed solar PV have accounted for only a fraction of the total installed capacity since 2015. Globally, the total installed capacity of solar PV has increased at a 25% CAGR from 2015 to 2021. Solar PV capacity is expected to grow more than

4X to over 3,100GW, and wind capacity approximately 2.5X to 1,850GW by 2040, according to the International Energy Agency's (IEA) Stated Policies Scenario.

While decarbonization and climate change mitigation are key drivers for large-scale solar installations

globally, other evolving trends in the sector demand consideration over the short and medium term.

Improving efficiency:

Technology improvements and advances in solar panels and solar inverter design have boosted overall solar system efficiency. Future advancements in these critical technologies will further boost system efficiencies. These improvements would enable consumers to produce more electricity in a limited space.

Reducing costs and better accessibility:

Since 2010, the costs for residential, commercial rooftop and utility-scale solar PV systems have decreased by 64%, 69% and 82%, respectively. A significant portion of these declines in system costs can be attributed to the decline in solar module prices, which have decreased by 85% during the same period. Cost reductions will improve technology access and penetration as consumers seek alternatives to traditional sources of power for centralized and distributed power generation applications.

Technology Developments:

With increasing module manufacturing capabilities and reducing solar panel and storage costs, solar technologies are being considered in combination with traditional sources of electricity to deliver uninterrupted power across locations that currently suffer from limited or no access to grid-based electricity. Solar microgrids and solar diesel battery hybrid (SDBH) systems are some of the few examples leveraging solar energy for the electrification of healthcare centers, critical military installations, telecommunication networks, etc., across remote global locations.

Artificial Intelligence, Machine Learning and Digitization:

With the increasing penetration of solar energy in day-to-day activities, the use of artificial intelligence and machine learning algorithms to manage energy generation, consumption and load balancing will gain prominence. Higher incidences of microgrid installations would require intelligent controllers and networks that can meet energy demand without hampering system integrity and capabilities.



GCC IS EXPERIENCING AN ENERGY TRANSITION THAT HAS NEVER BEEN WITNESSED, AND THE REGION IS SLOWLY EMERGING AS A HOTSPOT FOR RENEWABLE ENERGY-RELATED INVESTMENTS

Global trends have gradually made their way to the GCC and wider Middle East region, where large-scale renewable and particularly solar-based installations are driven by the GCC governments' Nationally Determined Contributions (NDCs) to mitigate the impact of climate change and reduce dependency on fossil fuel-based power generation. Due to the impact of climate change on human civilization and the economy, each of the GCC member countries has ratified the Paris Agreement to align their economic development agendas such that they set the world on a course for sustainable development while limiting warming to 1.5 to 2 degrees Celsius above pre-industrial levels. GCC countries currently seek to achieve energy sustainability through a combination of renewable energy integration and energy-efficiency implementations, which will be the key pillars to the evolution of the energy sector in the region. The following table highlights some of the modalities that GCC countries would adopt to achieve their NDCs.

TABLE 1: PROPOSED MODALITIES TO ACHIEVE NATIONALLY DETERMINED CONTRIBUTIONS (NDCS) ACROSS GCC

COUNTRY	DECARBONIZATION COMMITMENT
Bahrain	5% renewable energy generation by 2025 and 10% by 2035; 6% reduction in energy consumption by 2025
Kuwait	15% electricity generation from renewable sources by 2030 and a 30% reduction in energy consumption
Oman	20% renewable energy penetration by 2030 and 35%-39% penetration by 2040
Qatar	25% emissions reduction through interventions in the power, energy, construction, infrastructure and water sectors
Saudi Arabia	50% energy generation from renewable sources by 2030 and 20% reduction in energy consumption
UAE	Net-zero carbon emissions by 2050 with an investment of over US\$ 163 billion in clean energy

Renewable energy across the GCC has grown at a staggering 59% CAGR since 2015, increasing from 216MW in 2015 to 3,498MW in 2021. As of 2021, installed solar energy capacity accounts for ~97% of the total installed renewable energy capacity in the region and is expected to be the most prominent

source of renewable energy in the ongoing decade. As per the vision documents published by the different GCC economies, the total installed capacity for solar power could exceed 75GW by 2040, making it the single largest source of renewable power in the region.

SEVERAL FACTORS ACCELERATE THE ADOPTION OF RENEWABLE ENERGY TECHNOLOGIES, ESPECIALLY SOLAR-BASED POWER GENERATION. THE MOST PROMINENT INCLUDE:

- Suitability of the region for grid-scale projects.
- Rapidly declining technology costs.
- Increase in average size/installed capacity of grid-scale projects coupled with lower technology costs that have reduced the overall levelized cost of electricity (LCOE).
- Policy decisions, government strategies and regulatory frameworks that encourage large-scale renewable energy deployment.

FIGURE 2: EVOLUTION OF INSTALLED SOLAR POWER CAPACITY (MW) IN THE GCC, 2015 TO 2021

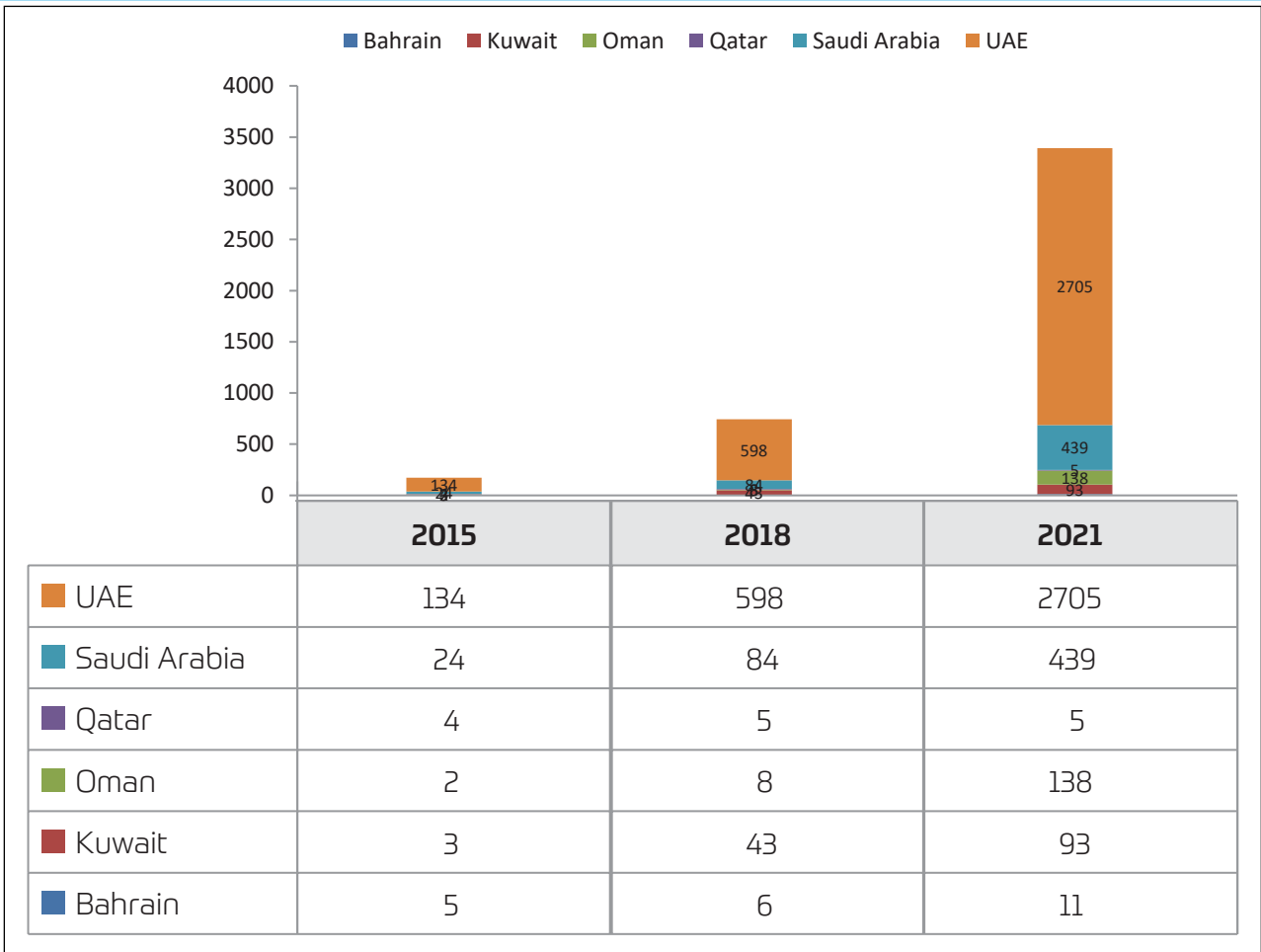
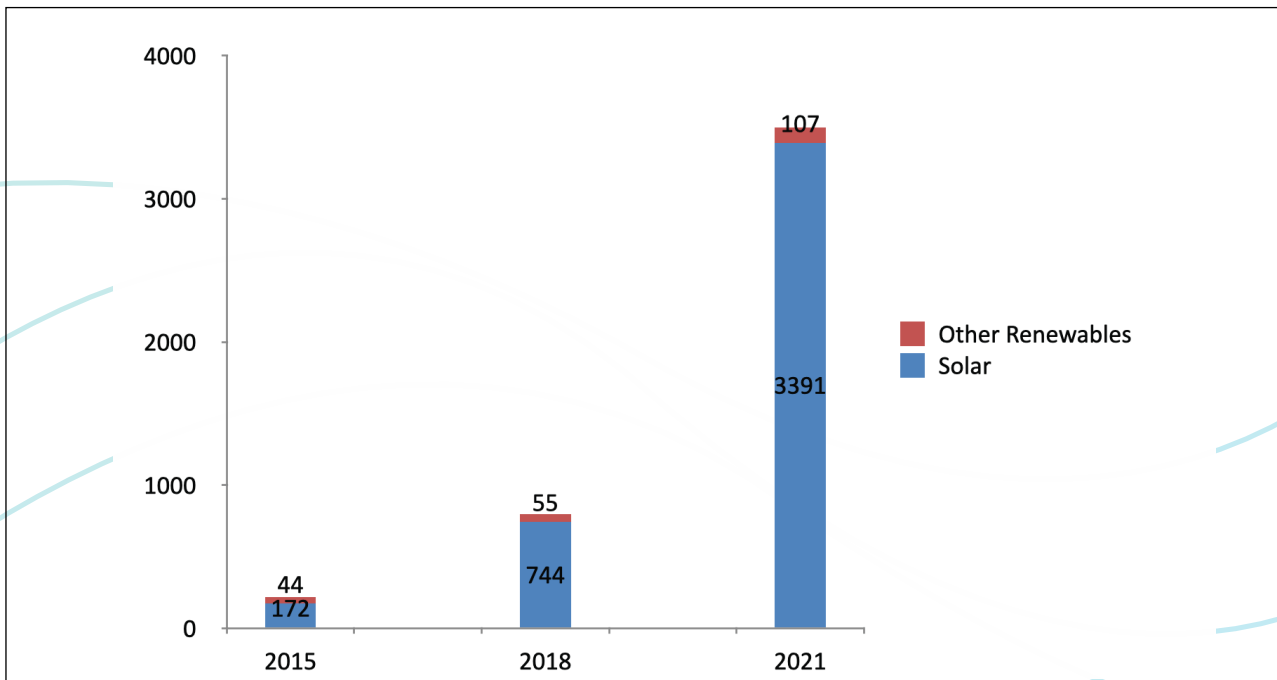


FIGURE 3: SHARE OF INSTALLED SOLAR POWER CAPACITY (MW) IN OVERALL RENEWABLE ENERGY INSTALLED CAPACITY (MW) IN THE GCC, 2015 TO 2021



Energy diversification initiatives through renewable energy and solar power installations are expected to positively impact the wider economic diversification that GCC economies envisage achieving. GCC

countries have outlined policy initiatives with varying degrees of progress in introducing localization programs aimed at ensuring local availability of critical functionalities, attracting

and establishing domestic energy-related industries capable of competing at the global level, and contributing to human capital development. KSA, UAE, Oman and Kuwait have already put in place local content requirement targets for organizations bidding to develop renewable energy-based projects in the region; 30% to 60% of the technology demand, equipment, service and manpower, depending on the countries, could be impacted by the ongoing localization initiatives.

Additionally, diversification away from oil allows GCC economies to develop new avenues for revenue generation and employment creation. Energy diversification (through renewable energy and energy efficiency) reduces local demand for these hydrocarbon resources, which can be exported/downstream processed to derive additional revenue for the country's economy. This additional revenue generated either through the conservation of a resource or export can be directed toward investment in other sectors of economic interest. If the region's renewable energy plans are realized, it could result in cumulative savings of 2.5 to 3 billion barrels of oil equivalent in fossil fuel consumption, effectively translating into savings of US\$ 225 billion to US\$ 250 billion, depending on oil and gas prices (considered at US\$ 100.39 per barrel as of April 12, 2022).

Growing investment in renewable energy is expected to further enhance various sectors of

the economy like construction, services, and research and development. Provided GCC countries can achieve their renewable energy implementation targets, the sector could create over 320,000 jobs in the region, with the majority of these jobs concentrated across the UAE and KSA due to their significant deployment plans. Despite the concerted effort made by governments toward solar power integration in the overall generation mix, challenges exist in realizing the true potential of the technology:

- Highly subsidized electricity and energy available in the region hampers the competitiveness of new technologies and could negatively impact their adoption.
- Large quantities of renewable energy in the grid have the potential to create stability issues, which will require modernizing the transmission and distribution infrastructure.

Grid-scale solar energy projects provide a wide spectrum of opportunities for energy, economic and human development in the region. The development of rooftop solar and hybrid systems along with advances in grid infrastructure to support solar integration present opportunities for project developers, consultants and technology providers to showcase capabilities and contribute significantly to an evolving energy landscape in the region.

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Hosted by TAQA and held under the patronage of HH. Sheikh Khalid Bin Mohamed Bin Zayed Al Nahyan, The World Utilities Congress will convene the global power and water industry to converge and discuss trends and technologies impacting future power and water demand. The focus will be on the proactive measures for decarbonisation, curbing carbon emissions and attracting the long-term capital investment needed for a sustainable future.

The event will be in-person taking place in Abu Dhabi from 8-10 May 2023.

The World Utilities Congress, hosted by TAQA, provides an unrivalled platform to explore the latest products, innovations and technological advancements across the global power and utilities landscape, bringing together water and power leaders to provide insights on building resilient low carbon business models with agile automated digital operations.

More than 120 regional & international exhibiting companies will be present, showcasing the latest technologies and solutions in power generation, transmission and distribution, nuclear energy, water management and desalination.

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