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Knowledge for All

Solar Energy in the Gulf
The Pros and Cons

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The views and opinions expressed in this publication are those of the author and do not necessarily reflect views of the Center.

The Gulf region has emerged as a global center for solar energy development, supported by abundant resources, large-scale solar projects, and highly competitive generation costs. The Gulf Cooperation Council (GCC) countries are increasingly investing in solar power in an effort to diversify their economies reduce carbon emissions, and meet growing electricity demand, particularly from air conditioning, water desalination, and industrial activities. Utility-scale projects are typically led by state-owned entities, while the private sector is becoming increasingly active in solar applications distributed across commercial and industrial sectors.



Despite this progress, the Gulf still represents only 0.7% of the global solar capacity while accounting for around 2.5% of worldwide electricity generation. Solar and renewable energy penetration has historically remained low in the Gulf, yet the region is now establishing itself as a leader in large-scale solar deployment, with Saudi Arabia and the United Arab Emirates (UAE) driving much of the growth. By mid-2025, the GCC had installed about 19.3 GW of grid-connected renewable energy capacity, while more than 40 GW remained under construction or in advanced stages of development (mostly in Saudi Arabia), the vast majority of which consists of solar photovoltaic (PV) projects.

The outlook for solar power in the Gulf remains highly positive. Renewable electricity generation could increase fourteenfold by 2040, while non-fossil energy sources may account for around 90% of regional electricity production by 2060. The relatively modern electricity infrastructure in the region is well positioned to integrate growing volumes of renewable energy, although substantial grid enhancements and storage investments will likely be required beyond 2035 to sustain long-term expansion.

All GCC countries have established ambitious renewable energy targets, solar in particular, with Saudi Arabia and the UAE sitting clearly at the forefront. Saudi Arabia aims to exceed 130 GW of renewable energy capacity by 2030, representing approximately 50% of its total installed electricity capacity, including an additional 40 GW of planned solar PV projects. In the UAE, solar generating ca-

Electricity generation from solar and renewable energy could increase fourteenfold by 2040

pacity is expected to reach around 14 GW by 2030, while clean energy is projected to account for some 44% of total power capacity by 2050. Oman and Kuwait aim to generate 20% and 15% of their electricity, respectively, from renewable sources by 2030. Qatar plans to install 5 GW of solar capacity by 2035, while Bahrain seeks to raise its share of renewable energy in total power capacity to 20%, although limited land availability continues to constrain progress.



Drivers For and Against Solar Energy in the Gulf

Solar energy in the Gulf is among the most cost-competitive sources of electricity in the world. The levelized cost of electricity (LCOE) for solar PV projects in the region ranges between US$1.24-1.62 per kilowatt-hour, reflecting exceptional solar irradiance levels exceeding 2,200 kWh/m² annually, strong operational performance, and favorable financing and procurement structures. These exceptionally low costs have made solar power increasingly competitive compared to conventional oil and gas-fired generation.

In fact, the GCC benefits from one of the world's highest levels of solar irradiance and extended daylight hours, providing ideal conditions for solar energy production. Combined with vast expanses of low-cost desert land suitable for utility-scale projects, large project sizes, state-supported development strategies, and access to low-cost capital, these advantages have allowed countries such as Saudi Arabia and the UAE to set global benchmarks for low-cost solar electricity.

Another important driver has been the continued growth in electricity demand across the region. Rising consumption, particularly for air conditioning during daylight hours, aligns closely with solar generation profiles, making solar energy especially attractive from both economic and operational perspectives. At the same time, GCC governments are increasingly investing in electricity storage solutions, particularly battery systems, to improve grid flexibility and support higher solar and renewable energy penetration.

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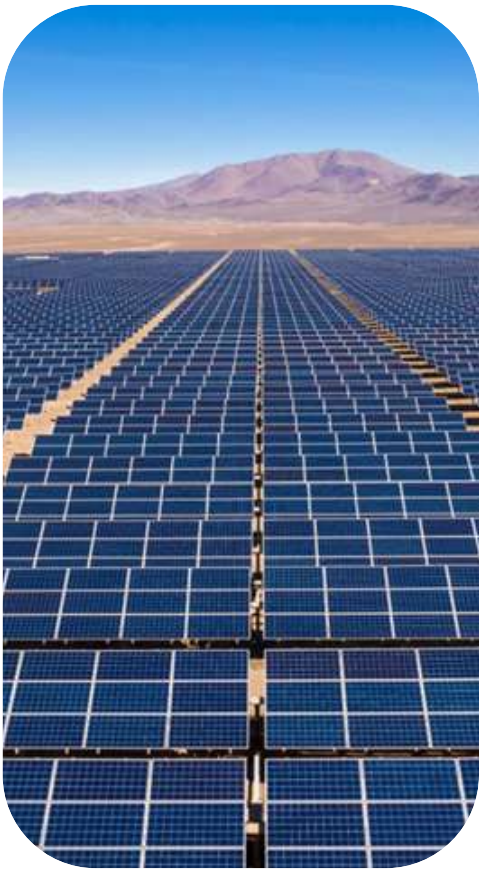
Despite these advantages, the development of solar energy across the GCC continues to face several challenges. Progress remains uneven due to regulatory constraints, low domestic electricity prices far below costs, limited land availability in few countries, and the continued dominance of oil and gas within regional energy systems.

Regulatory and administrative barriers also continue to impede deployment. Solar and renewable energy projects in many Gulf countries are required to navigate lengthy approval procedures involving multiple government agencies. These processes increase development costs, delay project implementation, and create uncertainty for investors seeking efficient and predictable regulatory environments.

The structure of the region's energy sector presents an additional challenge. Historically, electricity generation, transmission, and distribution have been dominated by state-owned entities operating within highly centralized systems. While this model successfully supported the development of oil and gas industries, it can constrain innovation and limit opportunities for independent power producers and solar renewable energy developers. As a result, the participation of the private sector in renewable energy markets often remains below its potential.

Furthermore, fossil fuel subsidies continue to affect the competitiveness of solar and renewable energy technologies in domestic Gulf markets. Governments have traditionally supported the consumption of oil and natural gas as part of broader economic and social development strategies. Together with institutional inertia in hydrocarbon-based economies, these subsidies can create fierce resistance to energy transition efforts. Existing infrastructure, established industries, and long-standing policy priorities remain closely linked to fossil fuel revenues, making the shift toward solar and renewable energy both economically and politically complex.

Consequently, despite abundant solar resources and growing solar and renewable energy ambitions, significant regulatory, institutional, and market reforms may still be required to fully realize the potential of this clean energy in the Gulf region.



Fossil fuel subsidies continue to affect the competitiveness of solar and renewable energy technologies in domestic Gulf markets

Advantages

The foremost advantage of solar energy is its ability to generate electricity without producing greenhouse gas emissions during operation. Solar power converts the sun's radiation directly into electricity without emitting smoke, pollutants, or other harmful by-products. This environmental benefit has become a major driver of renewable energy adoption as Gulf countries seek to meet climate commitments and reduce their carbon footprints.

A second major benefit is the low operating cost of solar energy once installation has been completed. Unlike conventional power generation, solar energy does not require a continuous supply of fuel that must be extracted, processed, transported, and purchased. Operational requirements for solar plants are relatively modest, with most systems requiring only limited maintenance throughout their lifespan. Solar panels are durable assets that can operate for decades, often requiring little more than periodic inspection and cleaning.

Solar energy also offers opportunities for decentralized electricity generation. Conventional energy sources such as oil, coal, and natural gas frequently require extensive transportation and distribution networks that involve considerable economic and environmental costs, while local solar generation reduces dependence on fuel transportation and enhances energy self-sufficiency, particularly in remote locations. Although solar potential varies according to location and sunlight availability, decentralization remains one of this technology's most significant advantages.

Another important advantage of solar energy is the insulation from the price volatility that often characterizes fossil fuel markets. The sun is an abundant and freely available resource, reducing exposure to fluctuations in oil, gas, and coal prices. While fossil fuel prices have experienced significant volatility over the past decades, the cost of solar energy technologies and solar generation has steadily declined and is expected to continue decreasing as technological improvements and economies of scale further reduce production costs.



> **The main advantage of solar energy is its ability to generate electricity without producing greenhouse gas emissions during operation**

In addition, solar technologies continue to advance at a rapid pace. Researchers and manufacturers around the world, including the GCC, are consistently developing systems that are more efficient, affordable, and easier to deploy. Technologies that were once expensive are becoming cheaper and increasingly accessible ,helping to strengthen the long-term competitiveness of solar energy in both regional and global markets.



Shortcomings

The most widely recognized limitation of solar energy is its intermittent nature .Electricity generation depends on the availability of sunlight ,meaning that power production ceases during the night and declines during periods of reduced solar radiation .Although seasonal variations are less pronounced in the Gulf than in many other regions ,solar output still fluctuates throughout the year and requires complementary generation sources or energy storage solutions to ensure reliable electricity supply.

Another frequently cited drawback of solar energy is the relatively low conversion efficiency of solar panels .Modern photovoltaic panels typically convert only around 22% of incoming solar radiation into electric power .As a result ,large surface areas are often required to generate substantial amounts of power .In fact ,solar panels not only require substantial physical space but can also be relatively bulky ,particularly traditional crystalline silicon modules, which remain the dominant technology in the market .Newer thin-film technologies offer lighter and more flexible alternatives and have enabled innovative applications such as solar roof tiles and flexible solar surfaces .However ,these technologies generally remain less efficient than crystalline silicon panels.

Finally ,energy storage remains another big challenge .Although battery technologies have advanced significantly and continue to improve ,large-scale storage solutions remain relatively expensive. Existing battery systems are more commonly deployed in smaller residential and commercial applications than in utility-scale projects ,with the hope that declining costs will gradually improve their viability for larger installations.

> **Solar energy technologies have become cheaper and more accessible, enhancing their long-term competitiveness in regional and global markets**

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