MESIA جمعية الشرق الأوسط لصناعات الطاقة الشمسية
Middle East Solar Industry Association

SOLAR OUTLOOK
REPORT 2026

Released in January

Exclusive Partner
WORLD FUTURE ENERGY SUMMIT

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Middle East Solar Industry Association

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We invite you to get involved!

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FORWARD

Denisa Fainis
General Secretary at MESIA

NAVIGATING THE GREAT PIVOT—RESILIENCE, INTELLIGENCE, AND THE NEW ERA OF SOLAR

Welcome to the 2026 edition of the MESIA Annual Outlook Report. In the tradition of numerology, this year signifies a "Universal Year 1"—a collective season of reinvention, identity activation, and courageous new beginnings. For the global solar industry, this symbolism is precisely timed. We have moved beyond the era of growth at any cost and entered a more sophisticated, albeit challenging, phase of structural transformation.

The global landscape reached an extraordinary milestone at the end of 2025 as installations surpassed 500 GW AC. Yet 2026 marks a definitive turning point. Market analysis from S&P Global Energy and BloombergNEF (BNEF) suggests that global annual solar additions may decline for the first time in two decades. This shift is driven primarily by a historic policy pivot in China. In response to oversupply and "destructive competition," the Chinese government has reduced export tax rebates from 13% to 9%, with further cuts expected, while also implementing a revised Foreign Trade Law effective March 2025. Together, these measures signal the close of an era defined by artificially low pricing, forcing a global structural reset. At the same time, BNEF underscores that clean-energy fundamentals remain robust; in fact, under its Economic Transition Scenario, renewables are projected to supply 67% of global power demand by 2050 based purely on competitive economics.

While global markets recalibrate, the Middle East is accelerating from ambition toward enforceable execution. The UAE's Federal Decree-Law No. 11 of 2024 has transformed policy targets into legal obligations, while Saudi Arabia has normalised gigawatt-scale developments such as the 2,060 MW Shuaiba 2 plant. This regional momentum is closely intertwined with the emergence of the Green AI economy. Initiatives such as the USD 100 billion "Stargate UAE"—a collaboration between G42, OpenAI, Oracle, and NVIDIA—alongside the NEOM–DataVolt campus, demonstrate that the Middle East is positioning itself as the world's Green AI Factory. With the regional green data-centre market projected to reach USD 9.3 billion by 2032, solar resource availability is becoming a decisive factor in geoeconomic competitiveness.

As attention turns toward 2030 targets, the emphasis has shifted from scale alone to grid intelligence and operational autonomy. Across the region, Operations and Maintenance strategies are evolving as artificial intelligence and robotics address the harsh realities of desert environments. Automation is steadily replacing hazardous manual labour, with waterless robotic cleaning systems achieving up to 99.5% efficiency. In parallel, digital twins and machine-learning models are transforming power networks into critical intelligence infrastructure. This intelligence revolution enables real-time coordination between trackers, weather stations, as well as storage systems—ensuring solar is no longer viewed as a variable resource, but as a reliable, dispatchable pillar of the region's energy future.

To sustain this momentum, trade stability and regional cooperation remain essential. MESIA extends its sincere appreciation to its stakeholders, partners, and dedicated contributors whose technical expertise and data-driven insights made this report possible. Your commitment to transparency and innovation continues to position the MENA region at the forefront of the global energy transition.

As we enter this Universal Year 1, the industry is not merely adding megawatts—it is building an intelligent, stable, and resilient energy system. On behalf of the entire MESIA team, we wish our members and the wider energy community a prosperous and sustainable year ahead.

Happy New Year 2026.

MESIA
جمعية الشرق الأوسط لصناعات الطاقة الشمسية
Middle East Solar Industry Association

EMPOWERING SOLAR ACROSS MENA

The Middle East Solar Industry Association (MESIA) is the region's leading non-profit solar organization dedicated to promoting solar energy across the Middle East and North Africa (MENA). Established in 2009, MESIA serves as a unifying platform for industry stakeholders by connecting the entire industry.

OUR ORIGIN

MESIA was established through a collective effort by solar pioneers committed to unlocking the region's solar potential. Led by Vahid Fotuhi (BP Solar) and Prof. Georgeta Vidican (Masdar Institute), the initiative began with a landmark industry gathering that brought together key players from across the local market.

This led to the creation of a steering committee and the formation of MESIA, with founding members including Enviromena, Masdar, First Solar, Siemens, Schneider Electric, and others.

WHAT WE DO

We support Mesia members through

- Speaking opportunities at internal and key industry events.
- Expanding your network & connecting you with your peers through both online platforms and live events
- Market intelligence & exclusive reports- get your expertise in front of a focused audience
- Original content, Branding visibility, PR & media exposure to our 90+ followers
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16 Years History

100 *Partners & Members

***Partners include regional and international associations, media, event organizers.**

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POWER SYSTEMS & GRID EVOLUTION

01 STRENGTHENING GRID INFRASTRUCTURE FOR A RENEWABLE-DOMINANT MENA

SCALING RENEWABLES IN MENA: THE CRITICAL ROLE OF TRANSMISSION AND GRID INVESTMENT

Mark Dowdall
Power & Water Editor
MEED

INTRODUCTION

The Middle East's power sector is entering a decisive phase as governments accelerate the transition from thermal generation to large-scale renewable energy.

Solar and wind capacity is expanding rapidly, reshaping planning frameworks and placing new demands on transmission networks originally designed for centralised, gas-fired plants.

MEED Projects data shows that 2025 was a record year for solar investment, with more than $19 billion in new contract awards across the GCC.

This rapid increase in renewable investment is driving an equally significant shift in grid requirements, with utilities needing to accommodate greater variability, longer-distance power flows, and greater operational complexity.

EVOLVING GRID REQUIREMENTS FOR RENEWABLE INTEGRATION

Strengthening the grid now involves expanding 380 kilovolt (kV) and 400 kV transmission corridors, constructing new gas-insulated substations (GIS), installing shunt reactors and capacitor banks, and deploying modern control systems to maintain voltage and frequency stability.

Saudi Arabia illustrates the scale of activity. Over the past decade, GCC countries have awarded almost $62 billion in solar photovoltaic (PV) contracts, with the Kingdom accounting for $37.3 billion, or 60% of the total.

SAUDI ARABIA: SCALING TRANSMISSION TO MATCH RENEWABLE GROWTH

In November, financial close was achieved on five solar PV plants and two wind farms under the Public Investment Fund's (PIF) 15GW renewable energy plan.

Separately, Saudi Power Procurement Company (SPPC) recently awarded contracts for 4.5 gigawatts (GW) of capacity under round six of the National Renewable Energy Programme (NREP) and invited companies to pre-qualify for a further 5.3 GW under round seven.

The country's total signed renewable capacity has now reached 43.2 GW, with 12.3 GW already connected to the grid.

To manage this, Saudi Electricity Company (SEC) is delivering extensive 380 kV works, including new double-circuit overhead lines exceeding 200 kilometres in some regions and a series of new GIS substations designed to integrate remote renewable clusters. Voltage-support equipment is also being deployed to accommodate steep solar output ramps and maintain system stability.

SEC's long-term plans reflect the scale of the grid expansion. The utility secured a $3 billion financing agreement in October to support its network upgrades and has announced a $58.7 billion investment programme for 2025–2030, including $36 billion for transmission projects alone.

The plan covers the construction of new high-voltage substations and an estimated 12,900 kilometres of overhead transmission lines. These investments align transmission development more closely with the pace of renewable procurement, though continued expansion will be required as gigawatt-scale renewable phases progress.

UAE: GRID MODERNISATION AND STORAGE DEPLOYMENT

The UAE is following a similar path. Over the past ten years, the country has awarded almost $20 billion in solar contracts, including $8 billion in new awards in 2025.

In October, construction began on Abu Dhabi's 5.2 GW solar PV plant, which includes a 19 GWh battery energy storage system (BESS). The project will be the largest combined solar and BESS project, designed to deliver 1 GW of round-the-clock power.

A consortium of Etihad Water and Electricity (EtihadWE) and South Korea's KEPCO also recently won a contract to develop the UAE's largest grid-side BESS project, which will deliver up to 1 GWh of storage capacity across two sites.

To accommodate rising renewable penetration, Abu Dhabi is reinforcing its 400 kV system with new lines and substations linking Al Dhafra, Al Ain, and coastal load centres, increasing east–west transfer capacity and improving dispatch flexibility. These upgrades are part of an ongoing effort to synchronise grid expansion with successive waves of renewable development.

REGIONAL INTERCONNECTION AND OMAN'S GRID EXPANSION

Meanwhile, in Oman, overall contract activity in the power sector slowed in 2025, but progress continued in the renewables sector. In September, the main contract for Ibri 3, the Sultanate's fourth large-scale solar Independent Power Producer (IPP) project, was awarded.

Grid development continues to be a primary focus. In September, the GCC Interconnection Authority signed a $500 million interim financing agreement with Sohar International Bank to facilitate the development of the direct Oman-GCC electricity interconnection.

This involves constructing a 400 kV double-circuit line, approximately 530 km in length, to connect the UAE's Al Sila station with a newly established Ibra substation in Oman.

The purpose of this link is to enhance regional power exchange capacity, improve reserve margins, and support the integration of intermittent renewable energy sources.

These regional works complement domestic transmission upgrades, including the ongoing expansion of Oman's North-South Interconnection Project (Rabt). The initial phase, completed in 2023, linked the Main Interconnected System (MIS), which serves the northern half of the country, to the Duqm Power System in Al Wusta.

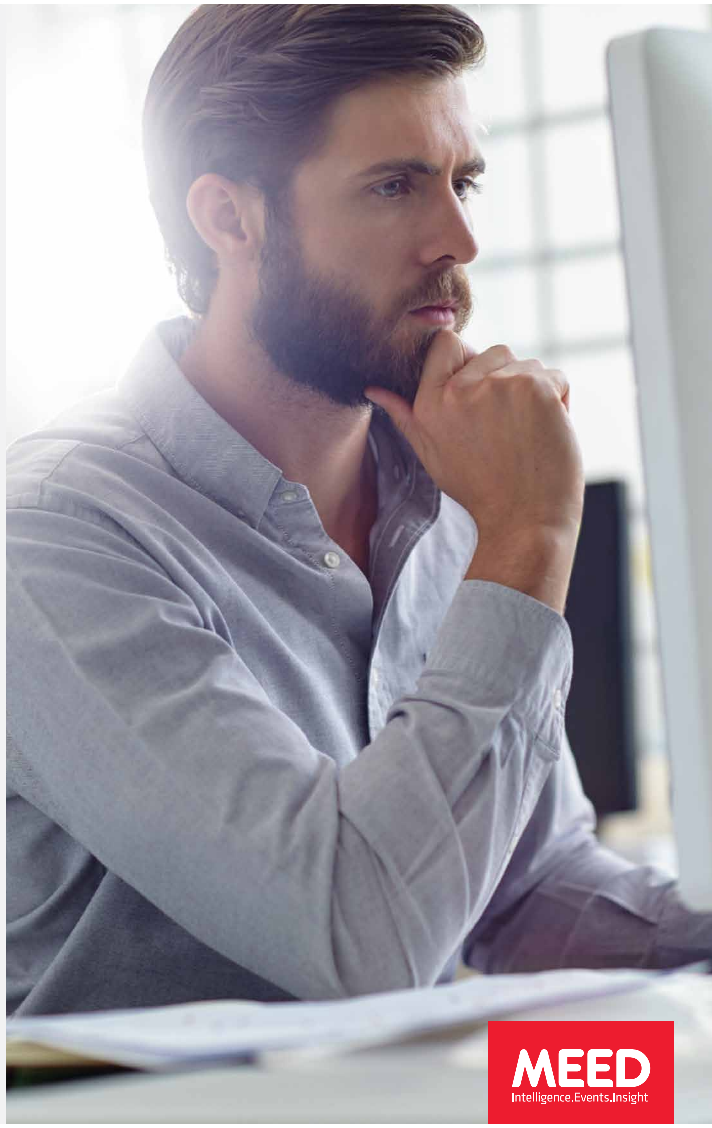
Construction of the second phase, expected to reinforce the 400 kV backbone southwards towards Dhofar, is underway.

01 STRENGTHENING GRID INFRASTRUCTURE FOR A RENEWABLE-DOMINANT MENA

THE TIMING CHALLENGE: GENERATION VS TRANSMISSION

Throughout the region, the deployment of renewable energy sources is exceeding projections outlined in previous grid development plans. Typically, solar power facilities can progress from tendering to commissioning within two to three years, whereas significant transmission projects often require five to seven years to complete.

This timing mismatch remains one of the most significant challenges faced by system operators. The number of annual solar awards has risen sharply since 2021, and several multi-gigawatt clusters are progressing in parallel, placing additional pressure on transmission networks.



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STRENGTHENING GRID INFRASTRUCTURE FOR A RENEWABLE-DOMINANT MENA

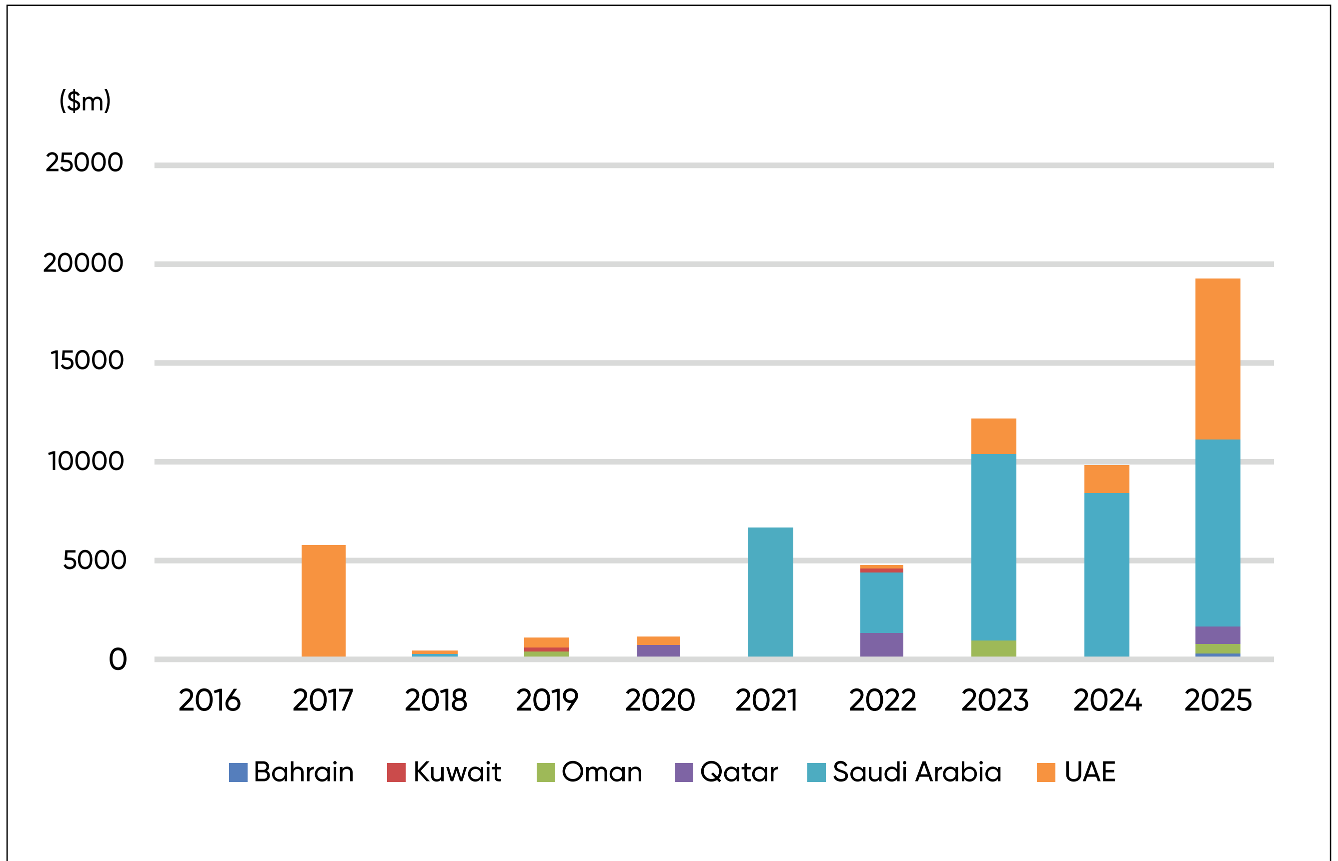

Figure [1] : Contract Awards for solar projects in the GCC

CONCLUSION

Storage and digitalisation are increasingly vital to bridging this divide. Large-scale BESS facilities are being installed to stabilise output, minimise curtailment, and manage evening peak demand.

The updated SCADA and forecasting systems are improving real-time visibility of the grid. Several countries are also assessing the use of high-voltage direct current (HVDC) solutions for long-distance transmission and future cross-border links.

The region has made significant progress in upgrading its transmission infrastructure, supported by major investment programmes and long-term planning frameworks. The key test will be whether grid modernisation can keep pace with the almost $80 billion in solar projects currently in procurement.

Continued reinforcement of 380 kV and 400 kV systems, expansion of flexibility assets, and advancement of regional interconnection will be essential to ensuring that renewable capacity can be reliably integrated.

02

AGRI-PV SYSTEMS FOR THE DESERT: STRENGTHENING FOOD AND ENERGY RESILIENCE

AGRI-PV SYSTEMS FOR ARID DESERT CONDITIONS: PERFORMANCE & ENVIRONMENTAL IMPACT – A JOINT RESEARCH PROJECT BETWEEN THE FUJAIRAH RESEARCH CENTRE AND AESOLAR

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In the UAE's arid environment, agriculture faces constant pressure from heat, drought, and limited freshwater. With nearly 90% of land across the Middle East and North Africa (MENA) classified as arid or semi-arid, securing water, food, and energy is a fundamental challenge for sustaining human life and economic development. At the same time, the region's intense sunlight represents an enormous, untapped resource for solar energy.

This pilot study evaluated the technical feasibility, agricultural response, and environmental impact of an agrivoltaic system deployed in Fujairah, United Arab Emirates—a hyper-arid region characterized by extreme summer heat (>40 °C), high UV irradiance, heavy dust, soiling and chronic water scarcity.

The project integrates photovoltaic electricity generation with native medicinal crop cultivation using a dual-use approach designed to address land competition between energy and agriculture in desert climates. Field performance data, PVsyst simulations, and agronomic observations were collected between May and June 2025.

The results demonstrate that agrivoltaics maintain reliable power output under harsh conditions while substantially improving crop survival, water efficiency, and soil parameters.

PROJECT OVERVIEW

The system was deployed in Fujairah and analysed using a 38.9 kWp standalone PV array paired with a 320 kWh lithium-ion (NMC) battery bank.

The project was delivered in collaboration with the Fujairah Research Centre (FCR), led by Dr Fouad Lamghari Ridouane, which oversaw agronomic monitoring, alongside an independent engineering team responsible for PV modelling and design optimisation. AESOLAR, led by Dr Hamed Hanifi, Director of Technology and Innovation, contributed advanced PV technologies specifically optimised for desert environments.

TECHNICAL INTEGRATION STRATEGY

The agrivoltaic configuration serves a dual function:

1. Solar electricity generation
2. Microclimate modification through controlled shading leading to lower water consumption and better crops production

Geometric simulations were conducted to determine:

- Panel tilt (40°),
- Intra-array spacing (GCR ≈ 46%),
- Shading limit angle (24.5°), and
- Mounting height necessary to maintain acceptable photosynthetic photon flux density (PPFD) for crops.

A reinforced standard ground-mount structure was used rather than specialized AgriPV frames, improving scalability and reducing structural cost while maintaining adequate shading. Prior to installation, different installation setups are simulated to understand and control the shading over the plants in different times of the year.

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AGRI-PV SYSTEMS FOR THE DESERT: STRENGTHENING FOOD AND ENERGY RESILIENCE

High-temperature power electronics (>50 °C rating) ensured stable operation during peak summer, preventing derating losses commonly observed in desert climates.

The system itself consists of 72 photovoltaic modules, each rated at 540 W, arranged in three arrays of 24 modules with two strings per array connected to a DC combiner. Energy from the arrays is stored in a battery system with 2 racks of 4 modules each, providing roughly 318 kWh of capacity.

The greenhouse load averaged around 10 kW during operation, resulting in an annual energy demand of ~25 MWh, which is fully covered by the PV-battery system that generates 67 MWh annually - leaving more than 40 MWh excess energy available to support other systems in the agricultural field (pumps, cooling etc).

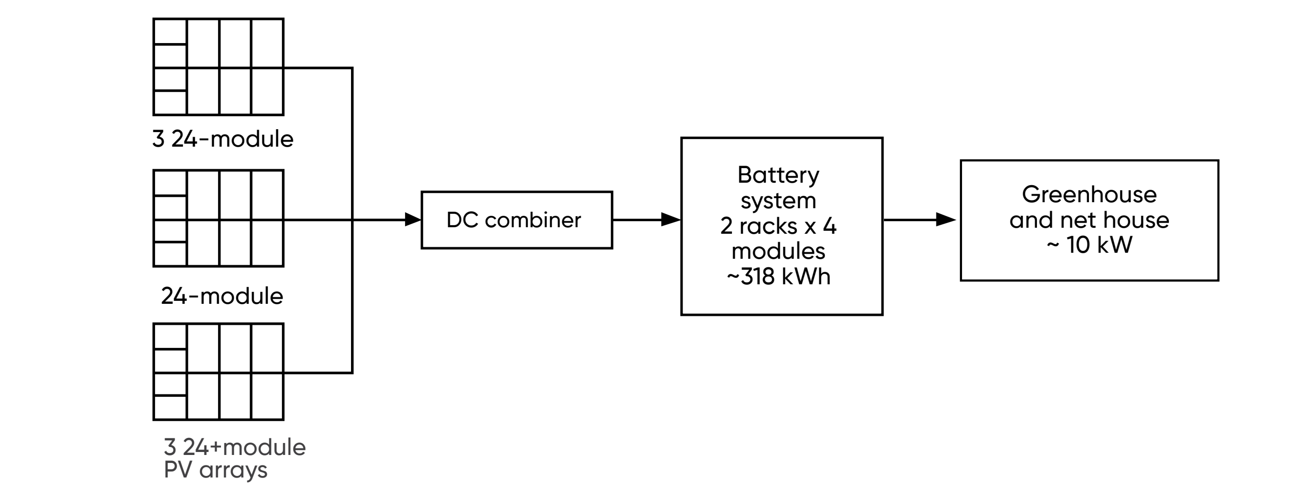

Figure [1] : visual illustration of the Agrivoltaics set-up pilot project

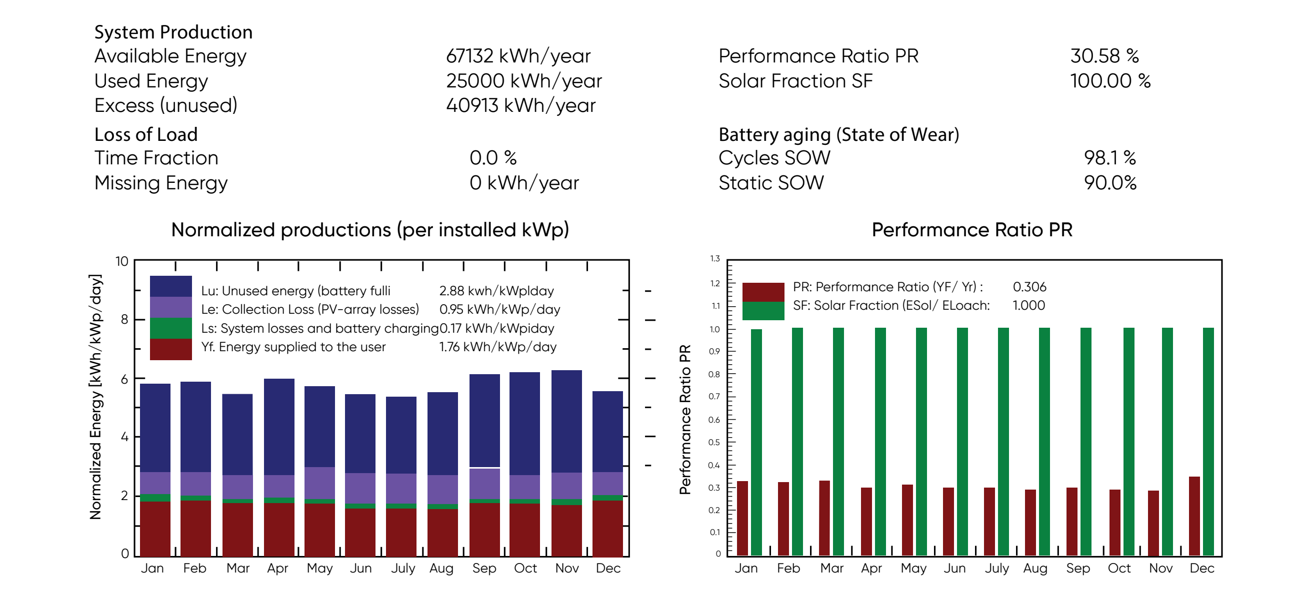

Figure [2] : Installation data from PVSys

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AGRI-PV SYSTEMS FOR THE DESERT: STRENGTHENING FOOD AND ENERGY RESILIENCE

AGRONOMIC SET-UP: MONITORING NATIVE PLANTS UNDER SOLAR PANELS

This project is the first documented agrivoltaic trial on native UAE plants, focusing on two medicinal species, Senna italica and Senna alexandrina - selected for their cultural, medicinal, and ecological value.

These plants were grown under solar panels and compared with plants in open fields. Seeds germinated in pots for two weeks under shade, after which half were moved to open areas, while the rest remained under the panels. Initially irrigated daily for two weeks and then every other day, the plants were monitored for growth and physiological parameters in May and June 2025.

Researchers tracked temperature, relative humidity, and Photosynthetic Photon Flux Density (PPFD) to understand how microclimate changes affected plant development.

UNDER THE PANELS: STRONGER CROPS AND LONGER GROWING SEASONS

Agronomically, the system produced clear and measurable differences between shaded and unshaded conditions: The shading layer moderated extreme heat loads and improved the microclimate sufficiently to enable plant survival in a period where open-field cultivation was impossible.

- Soil under the solar panels showed 20–30% lower salt content, retained more beneficial minerals, and had higher organic matter
- Higher soil moisture retention, reducing irrigation needs
- Senna italica plants under the panels grew more vigorously, stayed greener, showed significantly lower canopy temperatures, and were more resilient to stress than their counterparts in open fields.
- Shaded plants also retained water better and experienced less cell damage: showing stronger root, better shoot and higher number of leaves
- Greater physiological stability overall
- Ultimately showing prolonged planting periods under the agrivoltaic system.

A SCALABLE MODEL FOR DESERT AGRICULTURE

This dual benefit — healthier crops and clean electricity — shows how agrivoltaics can transform arid regions with limited farmland.

"In a region where water scarcity, high temperatures, and limited fertile land intersect, integrating solar energy with crop production is not just innovative — it's necessary,... Our work shows that we can meet energy needs and protect crops without compromising one for the other." ***says Dr. Ridouane.***

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AGRI-PV SYSTEMS FOR THE DESERT: STRENGTHENING FOOD AND ENERGY RESILIENCE

AESOLAR'S ROLE AND REGIONAL IMPACT FOR A MORE RESILIENT FUTURE

As the technology partner, AESOLAR supplied the photovoltaic panels and provided technical expertise for the project's design and implementation. The collaboration has transformed the Fujairah pilot from a research concept into a field-tested demonstration of agrivoltaic feasibility under harsh climatic conditions.

The insights gained are expected to guide future solar-agriculture projects across the MENA region, offering practical solutions for nations seeking to enhance food security, water efficiency, and renewable energy capacity simultaneously.

ABOUT FUJAIRAH RESEARCH CENTRE (FRC)

The Fujairah Research Centre (FRC) conducts applied research to support sustainable agriculture, fisheries, and natural resource management in the UAE. It brings together scientific expertise to develop practical solutions for the region's environmental and food security challenges.

Figure [3] : Drone photograph of the installation

03

ENERGY STORAGE IN MENA: THE BACKBONE OF GRID STABILITY AND FLEXIBILITY

ENERGIZING MENA'S GREEN FUTURE WITH ENERGY STORAGE

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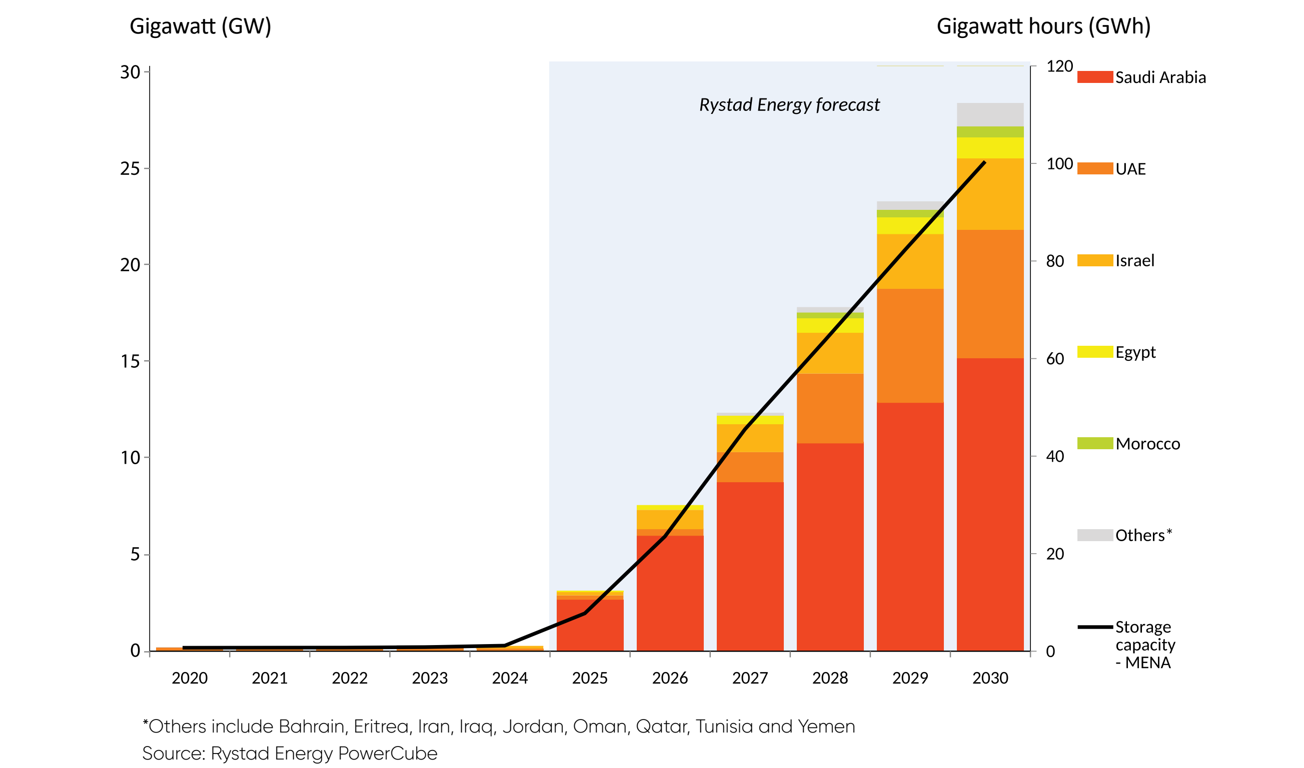
As the Middle East and North Africa (MENA) region accelerates the development of renewable power generation, energy storage systems will play a key role in enabling a smooth transition. Solar photovoltaic (PV) and wind are expected to account for nearly 6% of the estimated 2,000 terawatt-hours (TWh) of power generated in 2025, up from 4% last year, on their way to supplying about 20% of the region's power by 2030. The variable and intermittent nature of renewables has elevated the importance of energy storage systems. While countries such as Morocco, Egypt, Tunisia, and Israel are already at the forefront of developing pumped storage facilities, battery energy storage systems (BESS) are expected to play a larger role as they are better suited to meet rapid demand changes. As of 2025, there are 17 operational utility-scale BESS projects totalling over 2.9 gigawatts (GW) in MENA, with an expected increase to over 29 GW by 2030.

These systems are pivotal to enhancing the reliability and stability of renewable power generation, enabling smoother grid integration by effectively balancing supply and demand. By storing excess energy during peak production and dispatching it during demand spikes or low-generation periods, BESS reduces overall system costs and decreases dependence on fossil-fuel backup. Recent technological advancements in battery chemistry and management, combined with sharply



*Others include Bahrain, Eritrea, Iran, Iraq, Jordan, Oman, Qatar, Tunisia and Yemen
Source: Rystad Energy PowerCube

Figure [1] : BESS installed capacity by country (left) and storage capacity (right), MENA declining costs of both renewable energy generation and storage solutions, are rapidly positioning the MENA region as a leading player in the global energy storage market. This surge is also driven by large-scale projects and supportive government policies aimed at accelerating the region's energy transition. Furthermore, emerging trends such as hybrid storage solutions, longer-duration battery technologies, and smart energy management systems are enhancing the flexibility, scalability, and economic viability of BESS in the region.

BELOW ARE KEY 2025 PROJECT DEVELOPMENTS FROM ACROSS THE REGION

Saudi Arabia:
BYD secured contracts for five large energy storage projects, totalling 12.5 gigawatt-hours (GWh), building on the prior success of its 2.6 GWh project. Additionally, an auction to award 2 GW/8 GWh is currently underway.

UAE:
Masdar launched a pioneering plant combining 19 GWh of battery storage with 5.2 GWDC of solar PV, designed to provide a 1 GW baseload available 24/7

Egypt:
AMEA Power achieved financial close and ahead-of-schedule commissioning of Egypt's first utility-scale BESS, totalling 300 MWh, linked to its 500 MW solar PV plant in Aswan. Scatec is also constructing a 100 MW/200 MWh storage facility at Egypt's Obelisk hybrid project.

Israel:
The auction award of 1.5 GW BESS capacity marks a significant step in its energy transition. Overall, Saudi Arabia is leading in BESS development, with 2.75 GW/11.6 GWh already installed this year and a further 3.5 GW/15.1 GWh under construction, with commissioning expected next year. This rapid deployment is part of the Kingdom's broader 'Vision 2030', which aims to meet 50% of its power needs through renewable sources by 2030. The principal buyer, state-owned Saudi Arabia Power Procurement Company (SPPC), is targeting 48 GWh BESS deployment by 2030, aligning with its broader goal of over 100 GW of renewable capacity by that year. In 2025, Saudi Arabia surpassed 12 GW of cumulative renewable energy installed capacity, up from 4.6 GW at the end of 2024. Chinese suppliers are dominating the BESS market in the country. Competitive pricing and lower

Project	Country	BESS technology provider	Development status	Start-up year	Capacity (GWh)
Abu Dhabi solar plus %* AA	UAE	CATL	Under-Construction	2027-2028	19
Asir BESS	Saudi Arabia	Sungrow	Operational	2025	2.6
Jazan BESS	Saudi Arabia	Sungrow	Operational	2025	2.6
Najran BESS	Saudi Arabia	Sungrow	Operational	2025	2.6
Bisha BESS	Saudi Arabia	BYD	Operational	2025	2.6
Al Jouf BESS	Saudi Arabia	BYD	Under-Construction	2026	2.5
Dawadmi BESS	Saudi Arabia	BYD	Under-Construction	2026	2.5

Source: Rystad Energy PowerCube

Figure [2] : Top BESS projects in MENA

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ENERGY STORAGE IN MENA: THE BACKBONE OF GRID STABILITY AND FLEXIBILITY

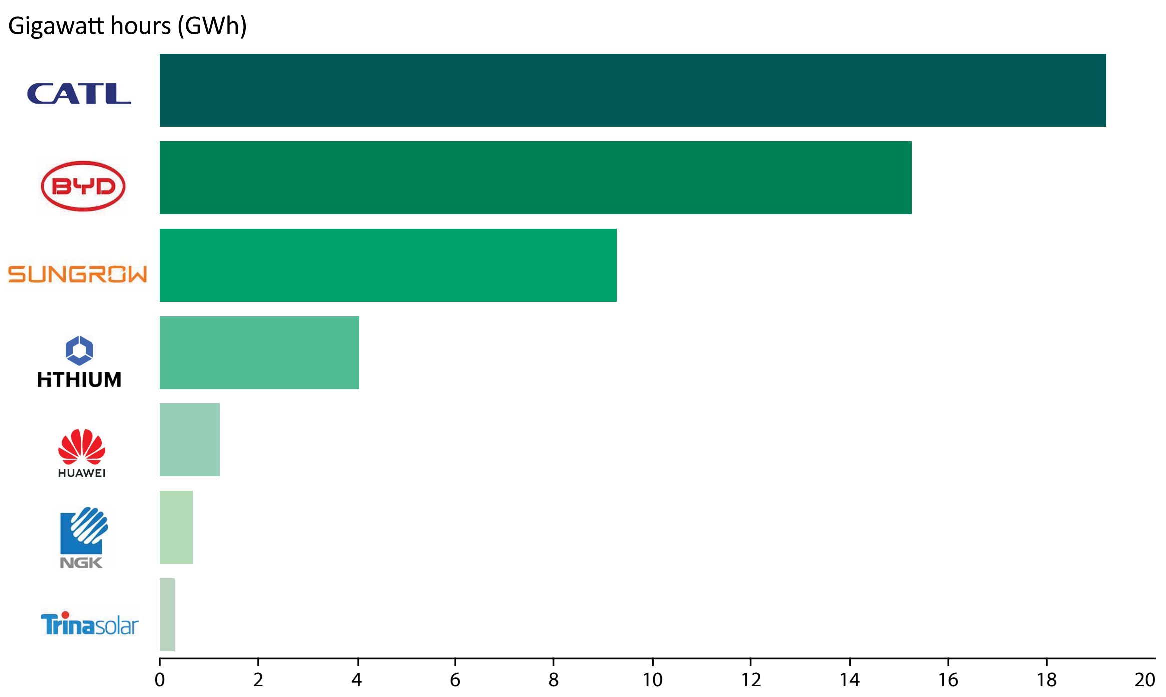
engineering, procurement, and construction (EPC) costs, aided by cheaper labour and lower tariffs, are helping to drive down project costs, making renewable generation combined with storage a viable option compared to traditional thermal generation. The ongoing auction for 2 GW/8 GWh of storage capacity, noted earlier, will further expand Saudi Arabia's role in the global energy storage sector.

With growing demand for grid flexibility and renewable energy integration in MENA, BESS suppliers are rapidly expanding across the region. Leading global companies such as Chinese firms CATL, BYD, Sungrow, and Trina Solar, along with Japan's NGK, have established a strong presence through partnerships and projects. CATL and BYD dominate the MENA BESS market, holding nearly 70% of the market share. This includes a notable deal between BYD and the state-run Saudi Electric Company (SEC) for five 500 MW/2.5 GWh BESS projects, totally 12.5 GWh, located in Al Jouf, Dawadmi, Qaisumah, Rabigh, and Riyadh. CATL also signed a similarly significant agreement with the UAE's Masdar for the flagship Abu Dhabi solar-plus-BESS project, which features 5.2 GWDC solar PV and 19 GWh BESS. Sungrow, Hithium, Huawei, NGK, and Trina Solar share the remaining 30% of the market.

03 ENERGY STORAGE IN MENA: THE BACKBONE OF GRID STABILITY AND FLEXIBILITY

Furthermore, the market is witnessing increasing involvement from specialised energy storage developers and EPC contractors such as Alfanar, Algihaz Holding, L&T, PowerChina, and China Energy Engineering Group Corporation (CEEC), who tailor battery solutions to MENA's harsh climatic conditions, with a focus on robustness and thermal management. This competitive and evolving supplier landscape is critical to scaling up the deployment of lithium-ion and emerging battery technologies in order to improve grid reliability and facilitate large-scale renewable energy integration across the region.

Collectively, these developments illustrate MENA's rapid expansion of large-scale BESS to enhance grid reliability, support renewable energy integration, and achieve ambitious clean energy targets, solidifying its role as a cornerstone of a resilient, low-carbon energy future in MENA.



*Data is based on contracts awarded in relation to utility-scale BESS projects
Source: Rystad Energy PowerCube

Figure [3] : Top BESS technology providers in MENA*

TECHNOLOGY & INNOVATION

PV TECHNOLOGIES BUILT FOR DESERT PERFORMANCE AND LONGEVITY

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Manager MEA&CA

The Middle East and North Africa (MENA) region presents an interesting paradox in the solar industry: while extreme desert conditions, such as ambient temperatures regularly exceeding 50°C, intense UV radiation, coastal humidity, and severe diurnal temperature fluctuations pose challenges to photovoltaic (PV) reliability, these areas also host the world's most ambitious solar deployment programmes and the highest solar irradiance resources.

1. DESERT SOLAR DEPLOYMENT

Despite formidable environmental stresses, the MENA has emerged as one of the world's fastest-growing solar markets. The Regional capacity stood at 22.3 GW as per the end of 2024 and is projected to reach 115 GW by 2030 [1].

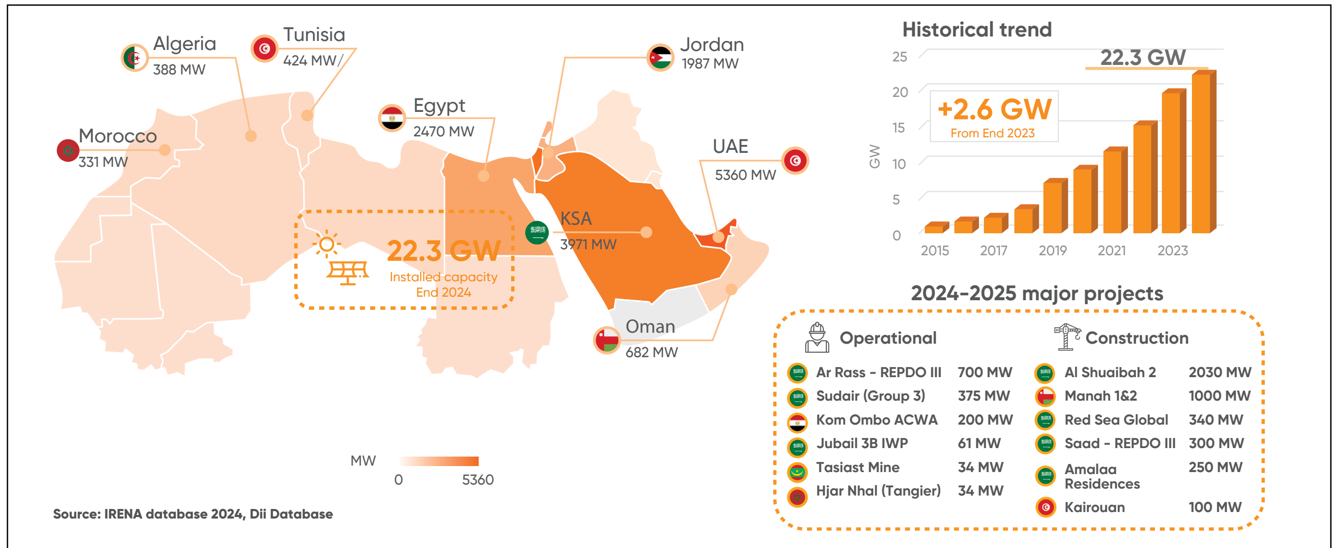

Figure [1] : DII report. MENA Energy Outlook 2025

Saudi Arabia's National Renewable Energy Programme (NREP) aims to reach 100–130 GW by 2030, with an annual tendering of 20 GW. Similarly, the UAE's Mohammed bin Rashid Al Maktoum Solar Park targets 5 GW by 2030, while the 2 GW Al Dhafra project has already reached commercial operations.

Qatar's newly inaugurated 875 MW facilities have doubled the nation's solar capacity to 1.675 GW. Additionally, the 2 GW Dukhan project is progressing towards a total of 4 GW to support liquefied natural gas (LNG) decarbonisation. Kuwait's 1.1 GW Shagaya tender and Oman's 4.5 GW target by 2030 similarly reflect a region-wide commitment.

This unprecedented expansion, with record-low tariffs below $0.0135/kWh, shows that while desert conditions challenge module reliability, they also offer the world's most abundant solar resources (2,200–2,500 kWh/m² annually) and the most significant deployment opportunities.

04
PV TECHNOLOGIES BUILT FOR DESERT PERFORMANCE AND LONGEVITY

2. HOW TO SURVIVE THE DESERT: MEASURING REAL-WORLD PERFORMANCE

To test the endurance of BOM and PV technology under extreme desert conditions, two complementary approaches were employed in the GCC region. First, field testing was carried out at the highest summer temperatures to capture real-world performance under peak-stress conditions. Second, accelerated laboratory testing protocols were applied to simulate prolonged desert operational stress. This dual approach enables validation of how technologies perform in both real-world deployment and controlled, multi-stress environments, ensuring reliable predictions of long-term project viability. [2]

2.1 DESERT VALIDATION: OUTDOOR PERFORMANCE

A comprehensive field assessment was conducted at the Qatar Environment and Energy Resource Institute's (QEERI) Outdoor Test Facility (OTF) in Doha from July to October 2024. It evaluated TOPCon and HJT module technologies under desert conditions, where temperatures reach 47.8°C and humidity exceeds 82%, revealing significant discrepancies between datasheet performance and field results. [6]

Figure [2] : QEERI OTF Field Assessment

TOPCon Technology uses an ultra-thin oxide layer coated with phosphorus-doped polycrystalline silicon. The manufacturing process operates at temperatures above 700°C, resulting in cell structures that are more resistant to thermal stress than those of other technologies [3]. The TOPCon module achieved a performance ratio (PR) of 100.52% and an operational efficiency of 22.38%, with a specific yield of 826 kWh/kWp. [6]

Heterojunction Technology (HJT) combines crystalline silicon wafers with thin amorphous silicon layers, achieving impressive commercial averages of 25%. However, the HJT module achieved a PR of 95.94% and an operational efficiency of 21.31%, which is 4.7% lower than that of the top-performing TOPCon, despite superior theoretical temperature coefficients (-0.26%/°C versus -0.29%/°C). This demonstrates that datasheet advantages cannot offset performance losses under combined thermal and humidity stress. [6]

Thermal analysis revealed that the HJT module operated at significantly higher temperatures than the highest-performing TOPCon under equivalent irradiance, exceeding 60°C. This elevated thermal profile directly reduced operational efficiency. In contrast, the superior TOPCon module maintained cooler operating temperatures, delivering better thermal stability and energy conversion efficiency. [6]

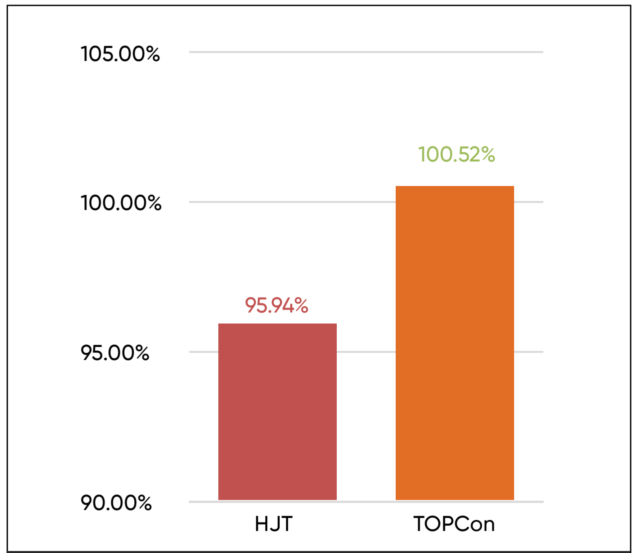

Figure [3] : Performance Ratio Results

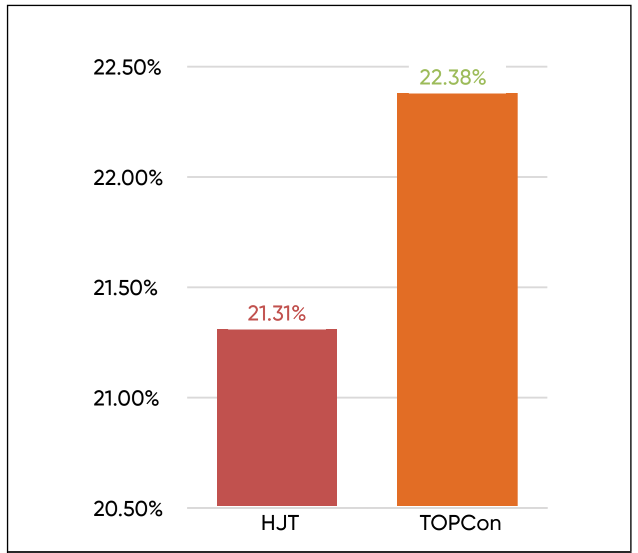

Figure [4] : Operational Efficiency

These findings align with extended, three-year field testing that demonstrated TOPCon's exceptional long-term reliability in desert climates. The combination of short-term intensive testing and multi-year field data confirms that real-world desert performance diverges significantly from datasheet metrics, emphasising the critical importance of localised field validation for technology selection in harsh environments.[6]

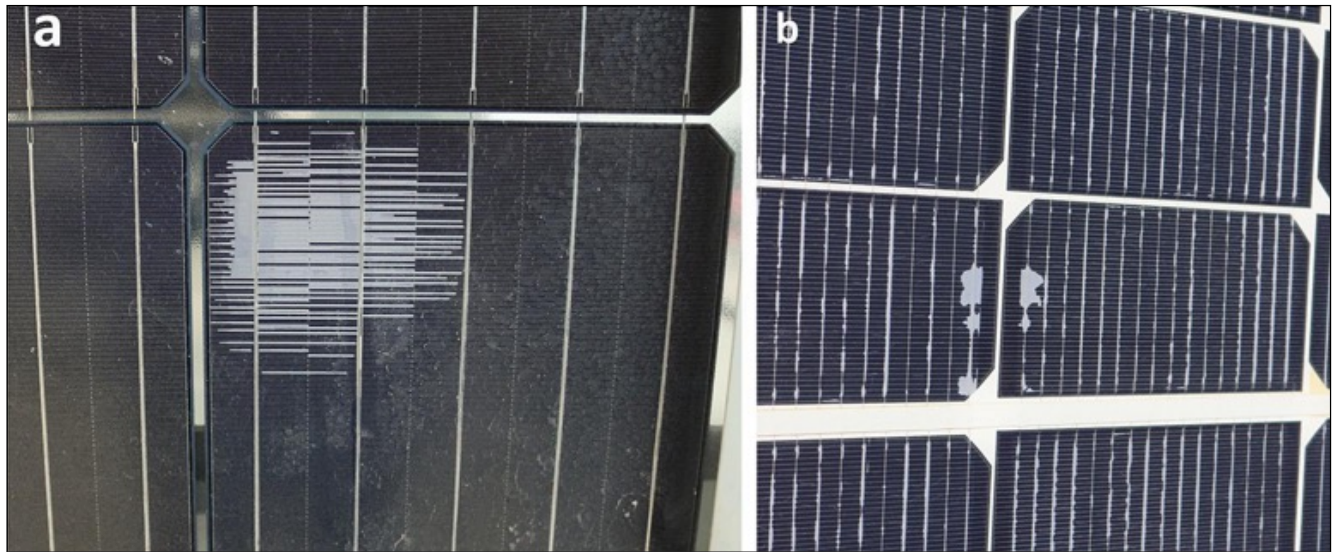

Figure [5] : Delamination in HJT modules. Source: HBKU, Solar Energy, CC BY 4.0

04 PV TECHNOLOGIES BUILT FOR DESERT PERFORMANCE AND LONGEVITY

Within the first year, significant encapsulant delamination occurred in the HJT modules, and imaging revealed severe edge-seal degradation. The cause appears to be HJT's sensitivity to moisture: sodium contamination damages the indium-tungsten-oxide layers, which are critical to its performance. [4]

2.2 ACCELERATED INDOOR TESTING

Standard IEC 61215 certification does not adequately replicate desert conditions. In response, the Gulf Renewables Laboratory (a joint venture between GCC Lab and UL Solutions) developed the 'Desert Code', based on IEC 61215 and IEC 63126, which significantly intensifies testing conditions – thermal cycling (400 cycles at 95–105°C), damp heat (2,000 hours), and UV exposure (120 kWh/m²) – to simulate approximately 25 years of desert operational stress [5].

The Desert Code Verified Mark requires >95% power retention after sequential testing, providing validated reliability indicators beyond conventional datasheets. Testing of TOPCon and Back Contact technologies revealed critical differences in their stress-resistance properties [7].

Under thermal cycling (400 cycles at 95°C), TOPCon modules degraded by only 1.24%, well within acceptable limits. Extended UV exposure (120 kWh/m²) resulted in 3.1% degradation [7]. Although some laboratories have raised concerns about TOPCon's susceptibility to UV degradation, these tests demonstrate that it performs comparably to Back Contact under extended UV exposure, with Back Contact modules showing 3.33% degradation under the same UV conditions. However, under prolonged thermal cycling, Back Contact modules experienced catastrophic failure, resulting in 36.59% degradation [7].

This crucial distinction exposes a fundamental design flaw: while Back Contact technology can withstand individual stress tests reasonably well, the combination of prolonged thermal cycling degrades the technology's complex rear-side structure. The manufacturing precision required for interdigitated back contacts, whether through masked diffusion or laser doping, makes Back Contact both costly and difficult to produce consistently [6]. In contrast, TOPCon's simpler architecture demonstrated superior resilience under combined stress conditions [7].

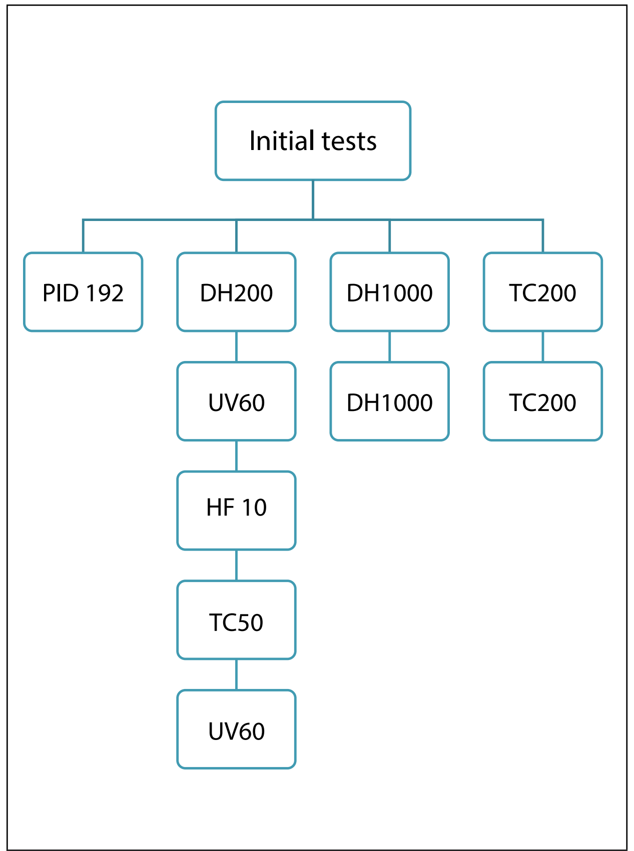

Figure [6] : Desert Code Test Sequence. Gulf Renewable Lab (GCC)

04 PV TECHNOLOGIES BUILT FOR DESERT PERFORMANCE AND LONGEVITY

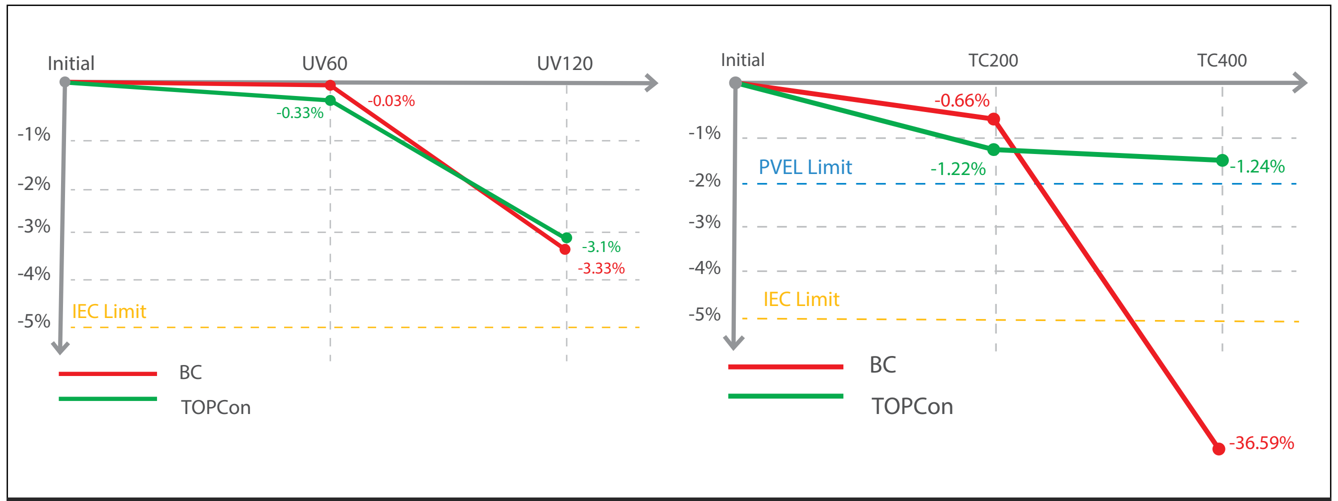

Figure [6] : TC Sequence. Gulf Renewable Lab (GCC)

3. CONCLUSION

The lesson from recent field and laboratory testing is clear: theoretical advantages listed on datasheets do not predict actual desert performance. HJT's superior temperature coefficient did not translate into better results under real desert conditions. In contrast, TOPCon's high-temperature manufacturing process yields structures with proven desert durability. Although Back Contact shows impressive efficiency, it remains vulnerable to prolonged thermal stress. The only reliable way to predict desert performance is through comprehensive field validation and multi-stress laboratory testing that exceeds standard IEC requirements.

References:

[1] *Rystad Energy. (2024). Power surge: Solar PV to help meet soaring Middle East power demand, reduce reliance on fossil fuels.*

[2] *QEERI Field Testing & Desert Performance Analysis. (2024). Three-year field test: TOPCon, HJT and PERC module reliability in Qatar desert conditions.*

[3] *PV-Manufacturing. (2023). Tunnel Oxide Passivated Contact (TOPCon) Solar Cells - Manufacturing Process and Performance.*

[4] *ScienceDirect. (2025). Sodium-induced degradation of tungsten doped indium oxide film and HJT solar cells in damp-heat environment. Solar Energy Materials and Solar Cells, 314, 113004.*

[5] *Gulf Renewable Energy Laboratory (GCC Lab) & UL Solutions. (2024). Desert Code Testing Protocol - IEC TS 63126:2020. C&I Desert Code Certification Documentation.*

[6] *MDPI. (2022). Interdigitated Back Contact Technology as Final Evolution for Industrial Crystalline Silicon Solar Cell. Solar, 3(1), 1-28.*

[7] *Gulf Renewable Energy Laboratory (GCC Lab) & UL Solutions. (2025). Desert Code Testing Protocol. TOPCon and BC testing.*

05 SMARTER SOLAR FARM DESIGN: OPTIMIZING LAYOUTS FOR MAXIMUM YIELD

DESIGNING HIGH-PERFORMANCE SOLAR PLANTS FOR DESERT CONDITIONS

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Senior Engineer –
Technical Office Manager,
Enertis Applus+

INTRODUCTION

Desert environments, such as those in the Middle East, offer excellent solar resource potential but also present challenging conditions that demand a highly specialised approach to solar plant design. High temperatures, intense solar irradiance, and significant dust levels directly influence layout decisions, technology selection, and long-term performance strategies.

Developing project specifications tailored to these site-specific conditions is essential to ensuring both technical reliability and long-term performance. For example, in regions with scarce water resources, robotic dry-cleaning systems are an increasingly viable solution.

LAND AVAILABILITY AND DESIGN COMPLEXITY

In addition to these design considerations, other variables also play a vital role and should be taken into account from the early stages of a project.

Unlike regions such as Europe, where land is limited, desert environments offer a resource that is often scarce elsewhere: vast, almost unlimited space. Although this abundance of surface area may appear advantageous, it introduces additional complexity. When space is no longer a constraint, the range of design possibilities broadens considerably, and determining the optimal solution – both technically and economically – becomes a much more complicated task. In such circumstances, the challenge lies not only in optimising energy production but also in identifying the balance point that maximises the installation's overall profitability.

KEY DESIGN PARAMETERS IN DESERT SOLAR PLANTS

In desert regions worldwide, including Saudi Arabia and Oman, key design parameters such as Ground Coverage Ratio (GCR), tilt angle, and DC/AC sizing play a critical role in determining overall plant behaviour. These variables cannot be optimised solely from a technical standpoint; they require a techno-economic framework that assesses both production gains and their associated cost implications.

In such projects, parameters such as GCR, tilt angle in fixed systems, and the degree of oversizing of the photovoltaic (PV) array relative to the inverter's nominal power or the interconnection point capacity become critically important. Optimising these parameters cannot be approached from a purely technical standpoint; it requires a comprehensive techno-economic analysis.

Consider a solar plant with single-axis trackers. One key aspect of the design is determining the optimal pitch – that is, the distance between module rows. On the one hand, increasing the pitch enhances the global irradiance on the module plane, thereby boosting energy production. This increase, however, is not linear: beyond a certain point, any additional energy gain becomes marginal, and the parameter approaches an asymptotic value.

On the other hand, each additional meter of row spacing results in a proportional rise in investment cost (CAPEX). Alternatively, reducing the pitch allows more peak power to be installed in the same area, which may minimise irradiance per module but still boost total energy production.

The challenge, therefore, lies in identifying the equilibrium point at which the production justifies the cost increase, and beyond which further oversizing becomes inefficient. Engineers address this issue through iterative calculations of the Levelized Cost of Energy (LCOE), analysing multiple scenarios to identify the minimum cost per unit of energy generated.

MULTI-SCENARIO MODELLING AND ECONOMIC ASSESSMENT

This same approach applies to other critical design variables, such as the DC/AC ratio, at both the inverter level and the interconnection point, as well as the configuration of the electrical connection system. In all cases, the goal is to identify the parameter combination that reduces energy production costs while maximising return on investment.

Figure 1 illustrates an example of LCOE minimisation analysis, using GCR and the DC/AC ratio as variables. The 3D plot is based on a set of 517 multi-year simulations over a 30-year period.

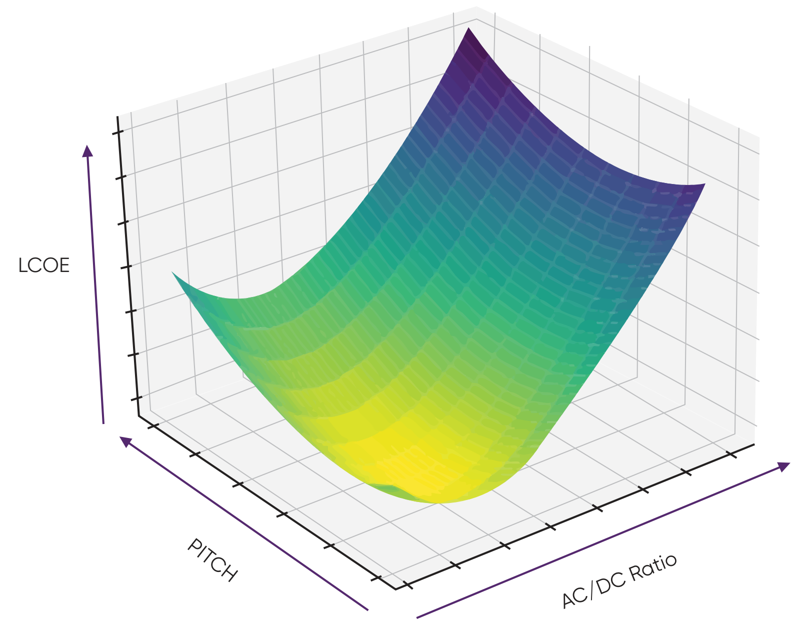

Figure [1] : LCOE minimisation analysis of a solar plant using GCR and DC/AC ratio variables.

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SMARTER SOLAR FARM DESIGN: OPTIMIZING LAYOUTS FOR MAXIMUM YIELD

The complexity of these studies stems from the need to analyse multiple possible configurations. Each scenario involves developing a layout, calculating its impact on CAPEX, estimating energy production, executing a comprehensive financial model to calculate LCOE and, where applicable, evaluating projected returns under different market price scenarios or Power Purchase Agreement (PPA) contracts. All of this requires design capacity and iterative calculations, as well as the traceability of results and a holistic approach to the problem that supports overall optimisation.

To support this level of analysis, advanced modelling tools simulate multi-scenario performance across solar, hybrid, and storage systems. These platforms allow consistent evaluation of hybrid LCOE, Levelized Cost of Storage (LCOS), and long-term profitability.

CONCLUSION

Achieving optimal plant design in desert environments requires a comprehensive approach that accounts for environmental constraints, regulatory considerations, and economic drivers. Combining advanced analytical tools with techno-economic evaluation enables informed decisions that balance cost, performance, and long-term risk in these challenging but opportunity-rich regions.

Source: Yellow Door Energy – Armacell Bahrain 1 MWp

MIDDLE EAST MANUFACTURING EXPANSION

Jade Hu
Market Analyst

Two years ago, the Middle East was primarily recognised as a hub for traditional energy production, hosting several members of the Organization of the Petroleum Exporting Countries (OPEC). Today, many of these leading oil-producing nations are turning to solar energy to diversify their energy mix and transition parts of their local economies towards value-added photovoltaic (PV) manufacturing.

SHIFTING GLOBAL MANUFACTURING DYNAMICS

The majority of manufacturing projects announced in the Middle East are undertaken by Chinese firms in collaboration with local partners, to shift future PV production away from China and Southeast Asia. Domestically, China faces ongoing oversupply and the enforcement of 'anti-involution' policies that affect manufacturing economics. At the same time, an increasing number of nations are imposing trade restrictions to limit PV exports from East Asia.

Supplier	Stage	Capacity (GW)	Status
Trina	Polysilicon-to-module	Polysilicon (50 kt) 22.7 Ingot/wafer 30.0 Cell/module 5.0	Announced
GCL Tech / MDC Power	Polysilicon	(120 kt) 54.5	Construction
United Solar Polysilicon (FZC)	Polysilicon	(100 kt) 45.5	Construction
TCL Zhonghuan	Ingot/wafer, module	Ingot/wafer 20.0 (SAU) Module N/A (OMN)	Announced
JA Solar	Cell-to-module	Cell/module 2.0 (EGY) Cell6.0/Module3.0 (OMN)	Announced Construction
Drinda (Jietai)	Cell	10.0	Construction
Jinko Solar	Cell-to-module	10.0	Construction
Q-Sun	Cell-to-module	Cell 2.0/module 8.0	Construction
EliTe Solar	Cell-to-module	8.0	Construction
HJS SoleFiori	Module	6.0	Announced
Sunrev	Ingot-to-module	Ingot/wafer N/A Cell/module 4.0	Construction
Sunsync	Module	3.0	Announced
Gstar	Module	2.0	Construction

Figure [1] : PV new expansion plans in the middle east, Nov 2025(GW)

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MARKET INTELLIGENCE MATERIAL ON SOLAR PV PRODUCTION

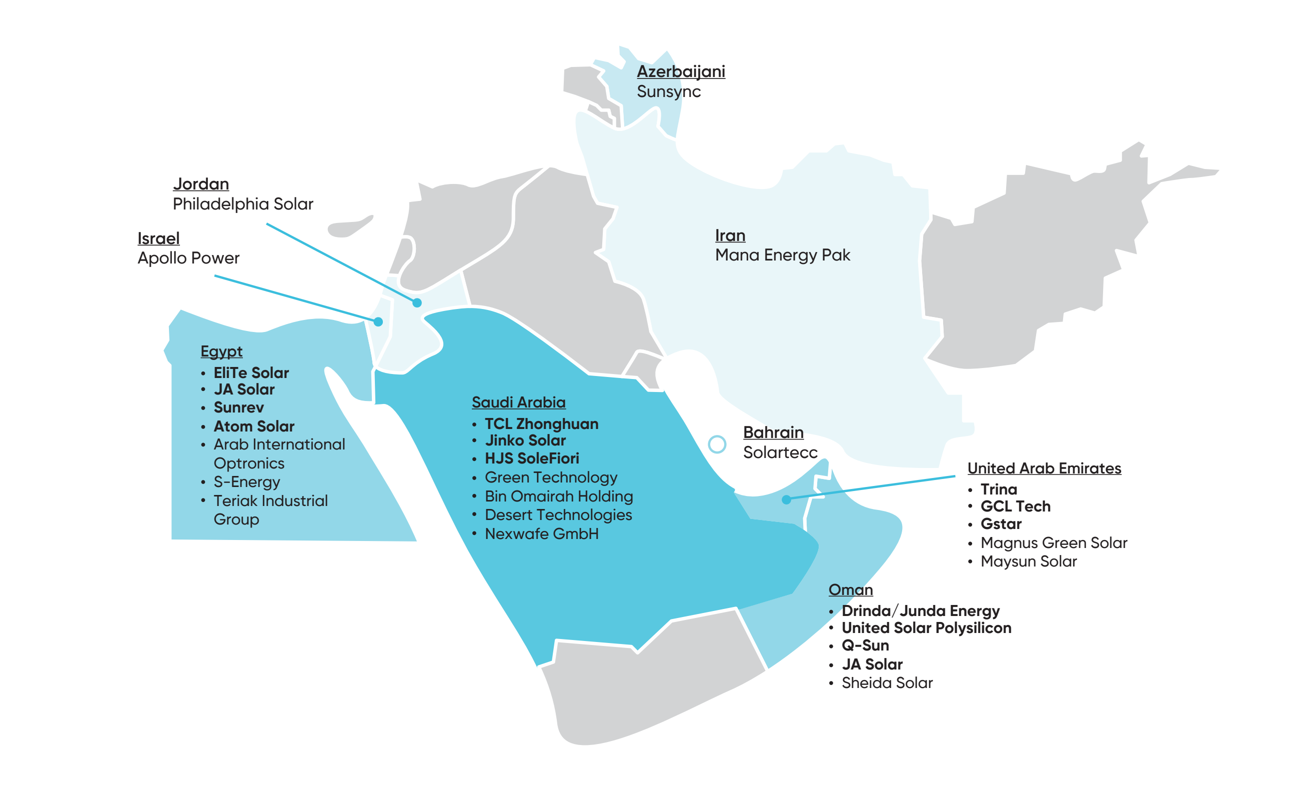

Figure [2] : Nameplate capacity map

CURRENT CAPACITY AND ANNOUNCED EXPANSIONS

Currently, operational plants in the Middle East are run by non-Chinese suppliers, with most having only a few hundred megawatts of designated nameplate manufacturing capacity. However, several suppliers have announced ambitious plans to expand the region's polysilicon, ingot, wafer, cell, and module production capacities to 123 GW (270 kt), 52 GW, 58 GW, 54 GW, and 64 GW, respectively.

Progress across different plans varies: some align with supplier schedules, while others have not updated their expansion timelines since the initial announcements. Several Middle Eastern PV sites are currently under construction, with targets to be online by early 2026, following final investment decisions by suppliers in 2023 and 2024.

PROJECT PIPELINE AND INVESTMENT PROGRESS

Egypt, for example, is set to bring two PV plants online in the Suez Canal Economic Zone in late 2025 (EliTe Solar) and early 2026 (Sunrev), with another planned for the future (JA Solar) [1]. However, other major investment plans announced by GCL Tech and TCL Zhonghuan have made little progress since the factories were unveiled, as lengthy market and site evaluations are likely to both add new manufacturing capacity and ensure that the necessary infrastructure is in place to host the facilities.

PROJECT PIPELINE AND INVESTMENT PROGRESS

PV production in the Middle East is expected to serve export markets and regional installations. As more nations consider imposing trade barriers on established PV production hubs in China and Southeast Asia, there are increased opportunities for diversified manufacturing to cater to nations implementing such barriers on Asian imports. In addition, the growing demand for PV products, driven by new domestic policy incentives, is attracting manufacturers to locate new plants in order to meet political mandates for solar energy.

SAUDI ARABIA: POLICY SUPPORT AND LOCAL CONTENT STRATEGY

Saudi Arabia has set a total renewable energy target of 130 GW by 2030, with solar PV expected to account for a substantial share. Alongside the installation mandate, the Saudi government has established local content requirements for PV modules to support the development of domestic supply chains. Both demand drivers and policy support for domestic manufacturing accompany a shift in Saudi Arabia's investment strategy, which has increased planned clean energy spending from $148 billion to $235 billion. The Saudi Public Investment Fund (PIF) has partnered on several recent PV manufacturing ventures in the country. At the same time, the Saudi Industrial Development Fund (SIDF) offers manufacturers medium- to long-term loans to support the establishment of factories.

EGYPT, OMAN, AND UAE: NATIONAL TARGETS AND INCENTIVES

Egypt aims to achieve a 42% share of renewable energy in its electricity mix by 2030. Strong government support for renewable energy development is provided through the Renewable Electricity Law (No. 203/2014) and the Investment Law (No. 17/2017), which offer tax incentives, expedited licence approval, customs duty exemptions, and reduced levies on imported equipment to support new manufacturing initiatives. The Suez Canal Economic Zone also plays a significant role in attracting investment, due to its proximity to key shipping routes and existing infrastructure. Renewable energy incentives support the long-term application of competitive bidding, feed-in tariffs, favourable land provisions, and zero import duties for renewable energy equipment, thereby attracting a significant share of the sector's current investment. Oman's Vision 2040 aims to achieve 30–35% of electricity generated from renewables by 2040, while the UAE's Renewable Energy Strategy 2050 targets 19 GW of renewable energy capacity by 2030, according to the latest revision.

EGYPT, OMAN, AND UAE: NATIONAL TARGETS AND INCENTIVES

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06 MARKET INTELLIGENCE MATERIAL ON SOLAR PV PRODUCTION

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LOCALISATION OF AUXILIARY PV SUPPLY CHAINS

Several leading PV auxiliary material companies have also invested in localising the PV supply chain in the Middle East, delivering products such as silicon metal from Green Ferro Alloy (under construction), inverters from Arctech Solar (operational), and PV glass from Almaden (under construction), Xinyi Glass (announced), and CSG Holding (two projects announced).

Supplier	Stage	Capacity (GW)	Status
Lihao	Polysilicon	(150 kt) 67.5	Announced
OblinGreen	Module	6.0	Announced
VSUN Solar	Cell	4.0	2.0 Online 2.0 Construction
Oando Clean Energy	Module	1.2	Announced
Hounen	Cell	1.0	Announced
Solarge	Module	1.0	Announced
Tranos	Module	0.8	Construction
Red Sun Energy	Module	0.6	Announced
LONGi	Module	0.5 ~ 1.0	Announced
Canadian Solar	Module	N/A	Announced
Drinda	Cell	N/A	Announced
Hanergy	Cell	N/A	Announced

Figure [3] : PV new expansion plans in the middle east, Nov 2025(GW)

LOCALISATION OF AUXILIARY PV SUPPLY CHAINS

Suppliers are also pivoting to African nations to diversify manufacturing capacity and respond to local policy incentives. Most new expansion projects in Africa were announced over the past year and are primarily in the planning and evaluation stages. A 2 GW cell plant operated by Vsun is currently online in Ethiopia, and small module lines are also operational in South Africa. If all suppliers follow through with their expansion plans,

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nameplate manufacturing capacity for polysilicon, cells, and modules could reach 68 GW (150 kt), 20 GW, and 24 GW by 2030, respectively. Nonetheless, the region faces challenges due to limited infrastructure and skilled labour, particularly in upstream manufacturing.

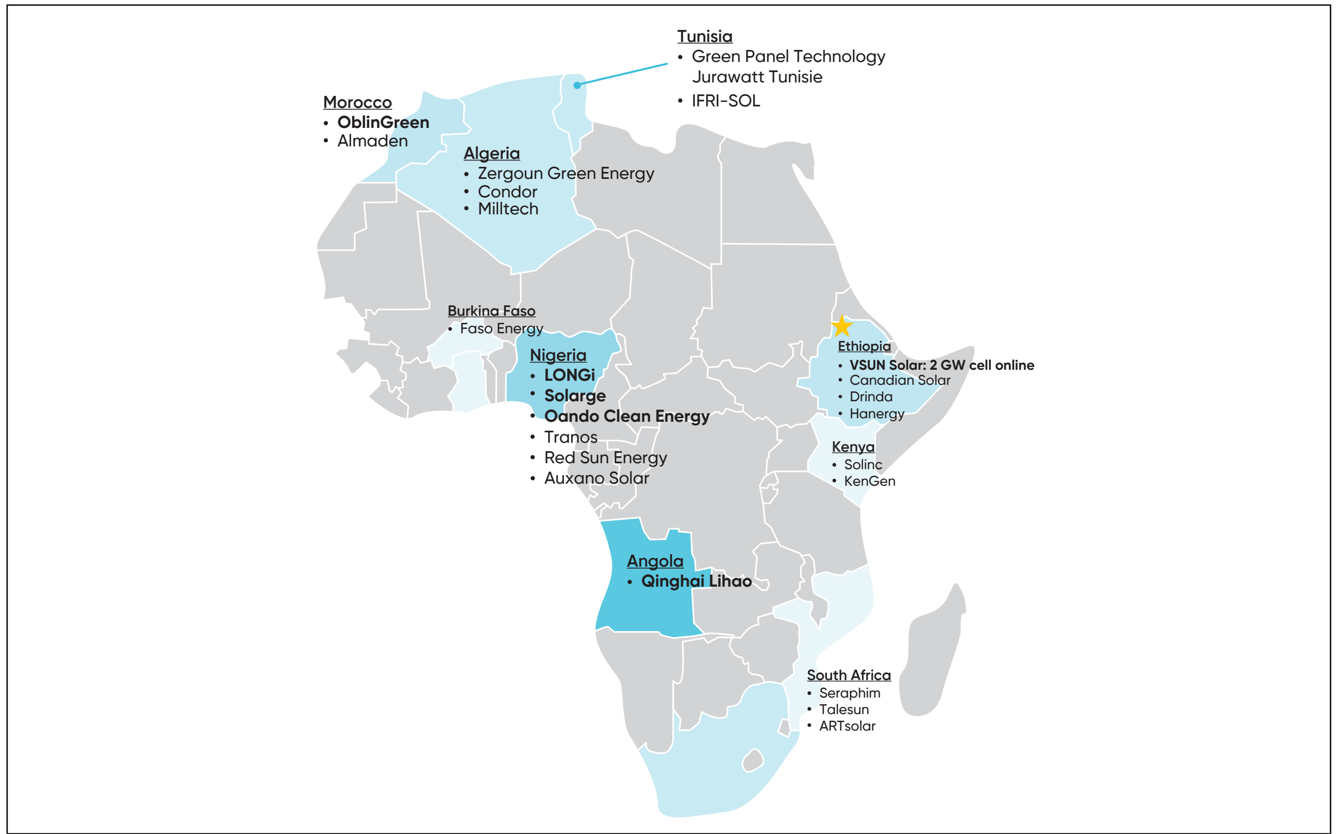

Figure [4] : Nameplate capacity map

CONCLUSION

Nigeria and South Africa have implemented trade policies to promote local production. In April 2025, Nigeria announced plans to ban PV module imports as part of the broader 'Made in Nigeria' policies introduced in 2023 to support its local science and technology sectors. This shift towards solar marks a step in Africa's energy transition and its reliance on PV imports. In South Africa, the Renewable Energy Independent Power Producer Procurement Programme (REI4P) sets out domestic content requirements that determine eligibility to participate in government PV projects. PV imports into Africa increased by 60% from June 2024 to 2025. South Africa, Nigeria, and Algeria were the largest importers during this period.

References:

IEEE format references: (auto-generated by webpage tool)

[1] *A S and A S, "Egypt to open first of three new solar factories in December 2025," MENA Magazine, Nov. 19, 2025. https://menamagazine.com/2025/11/19/egypt-to-open-first-of-three-new-solar-factories-in-december-2025/ (accessed Nov. 24, 2025).*

07 ADVANCED SOLAR CLEANING SOLUTIONS FOR DUST-PRONE ENVIRONMENTS

HOW INTELLIGENT ROBOTICS SUPPORT THE DIGITAL TRANSFORMATION OF SOLAR POWER PLANTS

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Overseas Market Strategy Manager

Frank Yan
Product Manager

SUNPURE

The global solar industry is gradually shifting from a phase of rapid expansion to one focused on operational efficiency and long-term asset value. In the Middle East and North Africa (MENA), large-scale solar power plants face extreme environmental conditions and stringent reliability requirements throughout construction and operation. According to the Middle East Solar Industry Association's (MESIA) 2025 Solar Outlook Report, MENA's solar capacity could exceed 180 GW by 2030 [1]. In 2024 alone, installed capacity reached 24 GWAC – a 25% increase from the previous year – and is expected to surpass 30 GW by the end of 2025.

Against this backdrop, intelligent robotics has emerged as a key enabler throughout the lifecycle of solar power plants, delivering safer, more efficient, data-driven solutions for both construction and operations.

INTELLIGENT PV CLEANING ROBOTS: LARGE-SCALE DEPLOYMENT AND EMERGING SOLUTIONS

In the Middle East, photovoltaic (PV) cleaning robots are now a well-established and widely adopted technology, with several ultra-large-scale plants already employing robotic solutions. Notable examples include the Al Shuaibah 2 (2.6 GW) and SAAD 2 (1.2 GW) projects in Saudi Arabia, as well as the DEWA series of projects in the UAE, where robots have become a standardised tool for plant operations and maintenance (O&M).

As solar project types and technologies continue to diversify, new robotic solutions are being introduced to address specific operational requirements. For commercial and industrial (C&I) rooftop solar installations, subarrays are often irregularly arranged with narrow string spacing, making conventional track-based robots impractical. In such cases, trackless cleaning robots can cover up to 1MW per unit, efficiently resolving rooftop cleaning challenges.

For existing large-scale, ground-mounted plants that were not often designed with robotic cleaning in mind, retrofitting can be complex. Articulated Arm PV Cleaning Robots provide flexible cleaning capabilities that adapt to different module sizes, support structures, heights, and tilt angles, offering an efficient and cost-effective solution for cleaning legacy installations.

By integrating these robotic solutions, operators can implement standardised, efficient, and flexible cleaning management across a range of plant sizes and types in the Middle East.

INTELLIGENT MODULE INSTALLATION ROBOTS: ADDRESSING CONSTRUCTION CHALLENGES

The construction of large-scale solar power plants presents several challenges. The sheer number of modules can slow down manual installation, potentially delaying project timelines. High temperatures, dust, and varying installation heights increase safety risks for personnel. Additionally, traditional construction practices often lack digital record-keeping, making it difficult to integrate installation data into operational management systems and limiting visibility across the entire lifecycle.

Intelligent module installation robots offer a systematic solution to these challenges. They automate the handling and precise placement of modules, ensuring each unit is installed in accordance with design specifications while improving construction efficiency. By minimising manual exposure to high temperatures, elevated positions, and repetitive tasks, safety risks are greatly diminished.

Additionally, installation data can be integrated with monitoring and O&M platforms, enabling a seamless digital connection from construction through to operation, with full traceability and data-driven insights.

When combined with intelligent cleaning robots, operators can achieve standardised, high-efficiency, and traceable management across solar plants of various sizes and types in the Middle East, delivering a fully automated and digitalised solution throughout construction and operation.

SHAPING A SMARTER FUTURE FOR SOLAR POWER PLANTS

Intelligent robotics is transforming how solar power plants are constructed and operated. By integrating automation and data capabilities across both construction and operation, plants can achieve higher efficiency, lower risk, and deeper operational insights. In regions with a concentration of ultra-large-scale projects, such as the Middle East, robotic solutions are no longer merely auxiliary tools – they have become a core technology in the digital transformation of solar assets, enabling operators to achieve complete lifecycle digitalisation and enhancing safety, intelligence, and sustainability in plant management.

Figure [1] : SAAD 2 1200MW PV cleaning project in KSA (source: Sunpure)

Figure [1] : PIF4 Haden 2000MW PV module installation project in KSA (source: Sunpure)

Figure [3] : Sunpure robotic solution for PV power plants (source: Sunpure)

References:

[1] Middle East Solar Industry Association (MESIA), 2025 Solar Outlook Report, 2025. [Online]. Available: https://lp.constantcontactpages.com/sl/oulQR3G/SolarOutlookReport2025

DIGITALIZATION & SMART SYSTEMS

08 SOLAR-POWERED DATA HUBS: DRIVING MENA'S DIGITAL AND ENERGY CONVERGENCE

DIGITALISATION & SMART SYSTEMS: TECHNOLOGY & INNOVATION

Iwan Walters
Partner

Punte-â Hosseini
Associate

STEPHENSON HARWOOD

INTRODUCTION

As the population of the Middle East and North Africa (MENA) region grows, demand for power is increasing. This growth has contributed to greater adoption of technologies, including artificial intelligence (AI) and 5G, and has ultimately increased the number of data centres (including solar-powered ones).

Between 2017 and November 2024, a total of US$4.1 billion in data centre projects was awarded across the GCC alone. [1] This surge is driven by the region's strategic vision to become a global digital leader, with governments and private-sector stakeholders investing heavily in smart cities, cloud computing, and AI infrastructure. This growth is expected to continue, with data centre capacity in the Middle East projected to more than triple over the next five years. [2]

POLICY DRIVERS AND SUSTAINABILITY ALIGNMENT

Aligned with the region's ambition to adopt cleaner energy and its emphasis on sustainability, we are seeing a rise in the number of data centres that are directly powered by dedicated on-site solar plants or that have significant on-site solar capacity. Initiatives supporting this momentum in the market include (among others) the UAE's Net-Zero 2050 Strategy (aiming to increase investment in clean energy, especially solar), Oman's 2050 Net Zero Goal (adopting greater use of renewables and carbon capture), as well as Saudi Arabia's and Bahrain's 2060 Goals (facilitating the transition away from oil-dependent economies). These national strategies are not only setting ambitious targets but are also translating into concrete regulatory frameworks to encourage renewable energy adoption. Saudi Arabia's Vision 2030 and the UAE's National Strategy for Artificial Intelligence 2031 are further enabling and encouraging greater investment in AI, resulting in increased use of data centres.

Source: Yellow Door Energy - Mondelez Bahrain 2.3 MWp

08 SOLAR-POWERED DATA HUBS: DRIVING MENA'S DIGITAL AND ENERGY CONVERGENCE

MARKET EXAMPLES OF SOLAR-POWERED DATA CENTRES

Some examples from 2025 alone, which affirm the rise of solar-powered data centres in the MENA region, include:

- The UAE's entirely solar-dependent Moro Hub (Digital DEWA) in Dubai, which is directly connected to the Mohammed Bin Rashid Al Maktoum Solar Park. The Emirates Group also signed a deal in March 2025 to co-locate its data centre at the Moro Hub from mid-2026;[3]
- The UAE's Khazna Data Center AUH5 in Masdar City, where a 7 MWp photovoltaic (PV) plant has been built as part of the Masdar-Emerge arrangement to supply the AUH6 facility, and where the data centres are focused solely on meeting Environmental, Social, and Governance (ESG) targets;[4]
- Pursuant to Egypt's SoleCrypt Project, SoleCrypt and the Egyptian government signed a Memorandum of Understanding to develop one of Egypt's largest green data centres, powered by solar and wind energy.[5]

OPPORTUNITIES AND MARKET MOMENTUM

While opportunities exist in the data centre market (particularly in solar-powered data centres), challenges remain, including the need for technical expertise and environmental concerns about the region's growing water scarcity. These challenges must be addressed to ensure the seamless, continued use of solar-powered data centres in the MENA region.

THE GROWTH IN THE MENA REGION'S ADOPTION OF SOLAR-POWERED DATA CENTRES:

The region's emphasis on sustainability is a key driving force behind the increased use of solar-powered data centres. In project finance, this is evidenced by the rise in sustainability-linked loans (SLLs). These financial mechanisms encourage the borrower to meet specific ESG sustainability targets, with interest rates varying depending on the borrower's achievement of these goals. The Loan Markets Association (LMA) uses sustainability performance targets (including KPIs) to measure improvements in the borrower's sustainability profile. The availability of such mechanisms encourages developers to use SLLs to finance the infrastructure of solar-powered data centres.

Sovereign wealth funds, such as the Abu Dhabi Investment Authority and Saudi Arabia's Public Investment Fund (PIF), are increasingly prioritising green infrastructure investments, providing both capital and strategic direction to accelerate the deployment of renewable-powered digital assets.

Equally, as the region undertakes giga projects across various sectors, additional data storage capacity will be required, necessitating the establishment of more data centres to ensure optimal operational efficiency. In Saudi Arabia, NEOM and DataVolt signed a US$5 billion agreement in February 2025 to construct a 1.5 GW net-zero 'AI factory' data campus in Oxagon – set to be the 'first truly sustainable' AI data centre in the region.[6]

08 SOLAR-POWERED DATA HUBS: DRIVING MENA'S DIGITAL AND ENERGY CONVERGENCE

APPROACHING GROWTH WITH CAUTION: AN OVERVIEW OF THE CHALLENGES THAT LIE AHEAD

An imminent challenge the region faces is growing water scarcity, which, coupled with the naturally hot and dry climate, makes the construction of data centres difficult. Data centres rely heavily on water in their cooling systems to keep servers operational.

Given the MENA region's proximity to the equator, the warm temperatures experienced almost year-round due to constant sunlight, and the lack of freshwater, the region is increasingly dependent on desalination, itself an energy-intensive process. In the UAE, 42% of drinking water comes from desalination plants,[7] which produce more than 7 million cubic metres per day.[8] Other countries in the Middle East are also highly reliant on desalination for their drinking water; 90% of Kuwait's, 86% of Oman's, and 70% of Saudi Arabia's supply comes from desalinated water.[9] By 2030, the region's desalination capacity is expected to double.[10]

In this context, adding more data centres will increase water consumption, potentially necessitating additional desalination capacity. Although not all data centre water cooling relies on desalination

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SOLAR-POWERED DATA HUBS: DRIVING MENA'S DIGITAL AND ENERGY CONVERGENCE

plants, they can serve as a source of cooling. Addressing this challenge requires contractors and developers to conduct an early, thorough assessment during the design and construction phases of data centres, focusing on ways to reduce water usage. For example, data centre cooling systems can be tailored to local water quality and availability.

Innovative approaches, such as liquid cooling and the use of treated wastewater, are being piloted at select facilities to reduce consumption. Integrating AI-driven energy and water management systems can also optimise resource use and further enhance sustainability.

CONCLUSION

Solar-powered data centres offer a path to sustainable digital growth in the MENA region. By harnessing its abundant solar resources, the region can build resilient, cost-effective, and environmentally friendly data infrastructure. However, realising this potential requires addressing specific challenges. With the available community of experienced developers and funders, the region can become a global leader in green data infrastructure.

References:

[1] *GCC Data Centre Projects Market 2025', Middle East Economic Digest (MEED), December 2024*

[2] *UAE data centre market set to triple by 2030 on back of AI, cloud boom | Khaleej Times , Khaleej Times, 20 October 2025*

[3] *Maktoum bin Mohammed inaugurates second phase of Moro Hub Green Data Centre at the Mohammed Bin Rashid Al Maktoum Solar Park , MORO website, 22 January 2025*

[4] *Masdar | Khazna Data Center Photovoltaic Plant, MASDAR website*

[5] *Partnering with Egypt to Build a Landmark Green Data Center, Solecrypt website, 27 January 2025*

[6] *DataVolt and NEOM to develop region's first net-zero AI factory, NEOM website, 10 February 2025*

[7] *Water | The Official Platform of the UAE Government, 30 December 2024*

[8] *The Geopolitics of Seawater Desalination | Ifri , French Institute of International Relations, 27 September 2022*

[9], [10] *Ibid*

Source: Yellow Door Energy - Mondelez Bahrain 2.3 MWp

09

CYBER RESILIENCE AND DIGITAL PROTECTION FOR SOLAR ASSETS IN MENA

ADVANCED OT SECURITY STANDARDS: ENSURING RELIABILITY AND DEFENSE -IN -DEPTH FOR UTILITY-SCALE TRACKER SYSTEMS

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The Middle East and North Africa (MENA) region is rapidly emerging as a global leader in solar energy, driven by record-level project deployments and ambitious national targets. According to the International Energy Agency (IEA), MENA's solar photovoltaic (PV) capacity is projected to increase tenfold to around 220 GW by 2035, with Saudi Arabia, Egypt, Oman, and the UAE leading the way [1]. This substantial growth, combined with accelerating digitalisation and the expansion of large solar-plus-storage projects, significantly increases the exposure of operational technology (OT) assets to cyber risks. As solar energy becomes central to the region's future power mix, robust and resilient security measures are critical to safeguarding grid stability and ensuring continuous operations.

THE EVOLVING CYBER THREAT LANDSCAPE IN MENA SOLAR

Cybersecurity has evolved from being solely an Information Technology (IT) concern to a crucial operational requirement for Industrial Automation and Control Systems (IACS). MENA's energy and power sector is considered a prime target for advanced cyberattacks. Research highlights critical vulnerabilities in components such as solar inverters, posing significant risks to grid stability and availability. As digitalisation blurs the line between IT and OT systems, traditional defences are insufficient, creating challenges for asset owners seeking to secure highly distributed modern assets. Therefore, it is essential to establish resilient defences in line with international standards.

IEC 62443: THE FRAMEWORK FOR INDUSTRIAL CYBERSECURITY

The International Electrotechnical Commission (IEC) 62443 series is the definitive global framework for mitigating cyber risks in IACS environments, offering a comprehensive, risk-based approach to security. It is specifically tailored to the OT environment, recognising that availability and safety are paramount, as incidents can result in equipment damage, environmental hazards, or loss of life.

The framework is organised into sections that address different aspects of cybersecurity across the IACS lifecycle. For product developers and manufacturers in the solar OT sector, key sections include:

1. **IEC 62443-4-1:** This section outlines the requirements for the Secure Development Lifecycle (SDL) of control systems and component products. Compliance ensures that cybersecurity is systematically addressed throughout the product design process, including essential elements such as threat modelling.
2. **IEC 62443-4-2:** This defines the technical security requirements that embedded IACS components must meet to achieve specific security capability levels.

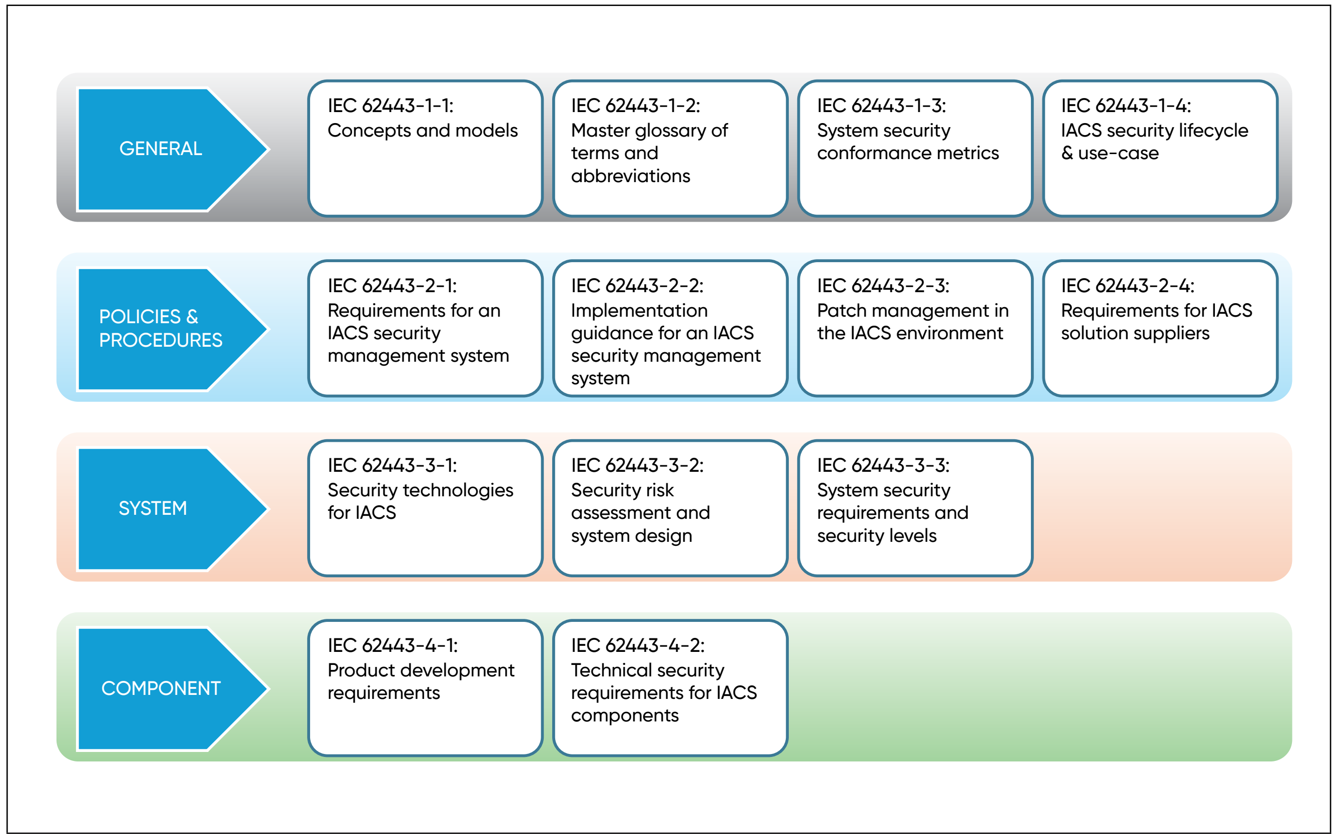

Figure [1] : IEC62443 Cybersecurity Framework for Industrial Automation and Control Systems (IACS)

Achieving this certification demonstrates a commitment to designing components that operate securely within critical infrastructure environments. This compliance helps asset owners enhance their security posture and meet industry best practices, including those for Critical Infrastructure Protection (CIP) environments, as defined by the North American Electric Reliability Corporation (NERC). Furthermore, the IEC 62443 standard emphasises shared responsibility, ensuring that security is a collaborative effort among product suppliers, system integrators, and asset owners.

ENHANCING RESILIENCE WITH CERTIFIED TRACKER CONTROL TECHNOLOGY

In response to industry demands, advanced tracker control technologies have increasingly prioritised cybersecurity, achieving rigorous certifications that validate their maturity in Industrial Control System (ICS) environments. A centralised control system, Game Change Solar's GenuisHub can serve as the on-site operator console for utility-scale tracker assets, securely integrating the tracker system with the solar power plant's SCADA system. It is expressly designed to provide a secure platform that can operate and support trackers in NERC CIP environments throughout deployment and operation, thereby enhancing operational reliability and minimising vulnerabilities across the project lifecycle.

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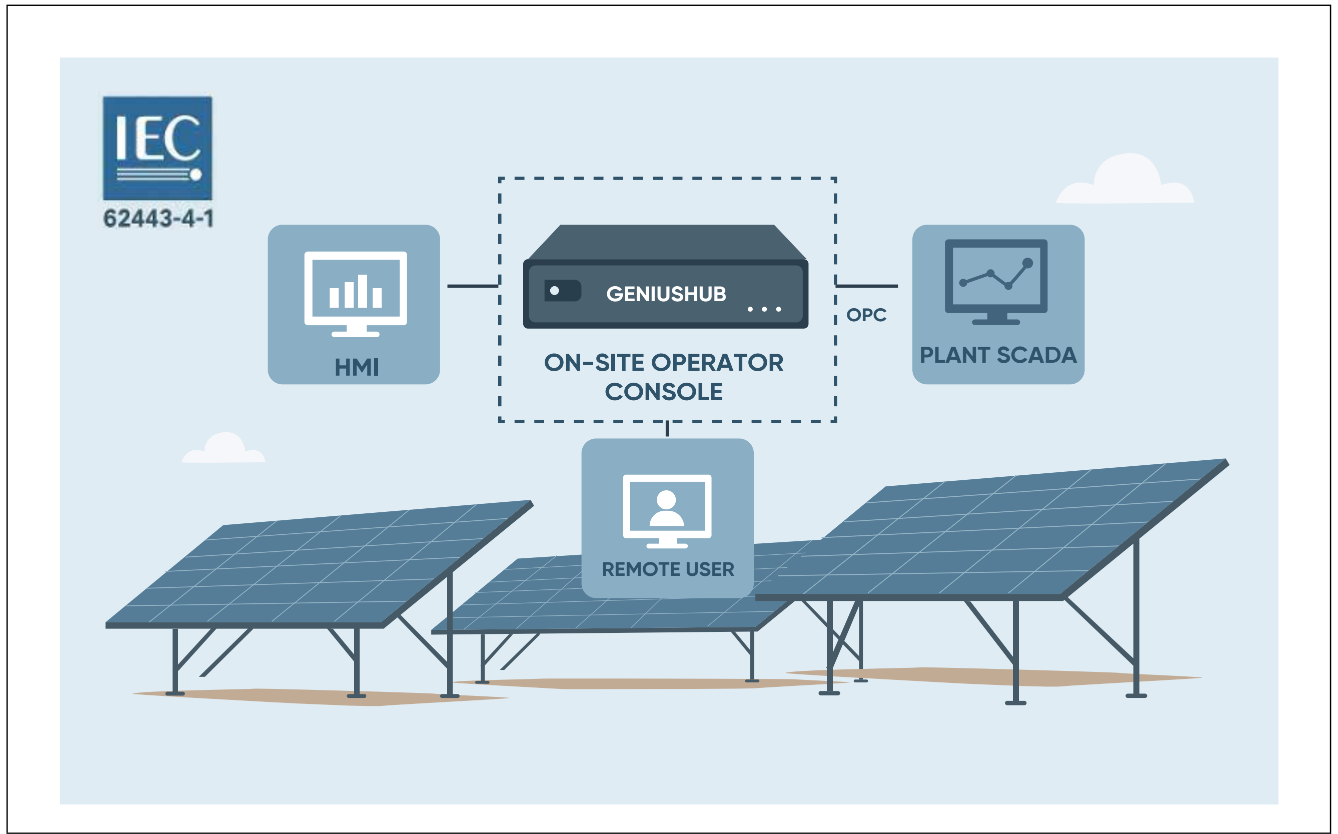

Figure [2] : Genius Hub centralized control architecture enabling secure on-site operator console

KEY CYBER RESILIENCE BENEFITS OF THE CERTIFIED TRACKER CONTROL SYSTEM

- **Secure Architecture and Design:** The system incorporates security measures from the initial design phase and is validated through IEC 62443 certification. It uses a Secure-by-Design development approach that prioritises vulnerability reduction and a layered defence architecture to limit the impact of potential security events, supported by protected enclosures and controlled access to hardware. Redundant pathways ensure continued operational reliability, even under adverse conditions.

- **Encrypted and Resilient Communication:** The system uses industry-standard cryptographic methods to authenticate and protect critical functions. Data at rest is encrypted, and all communication channels are protected to prevent unauthorised access. Secure integration with plant systems is maintained in accordance with approved industrial communication practices.

- **Monitored Integration and Access Control:** The platform uses a highly secure OPC-UA interface to enable seamless data exchange and control functions with plant SCADA systems, while providing real-time analytics, trend graphs, diagnostics, and 60 days of local data storage to support deeper performance analysis and troubleshooting. It offers robust user management with defined roles, accounts, and password controls, and enables easy access to historical on-site tracker data without relying on cloud connectivity, enhancing both cybersecurity and operational integrity.

09 CYBER RESILIENCE AND DIGITAL PROTECTION FOR SOLAR ASSETS IN MENA

- **Enhanced Operational Security:** The system provides immediate response capabilities, such as performing a Site Wide Safety Stow command with a single click. These asset protection functions are managed within a hardened, secure environment and support performance-optimising algorithms, such as intelligent wind protection.

CONCLUSION

As the MENA region triples its renewable capacity and integrates solar assets into sophisticated hybrid power grids, cyber resilience must be paramount. The adoption of stringent standards, such as IEC 62443, by providers of critical OT equipment, including solar tracker control systems, sets a new benchmark for security maturity in the industry. This commitment to secure development and operation reduces the risk of operational disruptions and grid-level security incidents, strengthens compliance, and enables asset owners to pursue the region's ambitious renewable energy goals safely and reliably.

References:

[1] *MENA's solar PV capacity seen to rise tenfold by 2035 - IEA*
https://renewablesnow.com/news/menas-solar-pv-capacity-seen-to-rise-tenfold-by-2035-iea-1282605/

Source: Yellow Door Energy - Imerys Al Zayani Bahrain 4.7 MWp

10 FUTURE OF ENERGY MANAGEMENT BASED ON AI FOR DECARBONIZATION IN MENA

DIGITAL INTELLIGENCE FOR A SUSTAINABLE FUTURE: AI'S ROLE IN ADVANCING MENA'S NET-ZERO TRANSITION (CASE STUDY)

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INTRODUCTION

Across the Middle East and North Africa (MENA), climate motivations are accelerating as countries commit to net-zero pathways, diversify energy systems, and expand large-scale solar infrastructure. The region's renewable energy capacity, particularly solar photovoltaic (PV), is growing at one of the fastest rates globally, supported by national strategies in countries such as the UAE, Saudi Arabia, Morocco, Oman, and others [REF]. As energy systems expand in scale and complexity, it has become clear that traditional approaches can no longer support these ambitious targets. Artificial intelligence (AI) has emerged as a transformative force, enabling a shift from reactive monitoring to intelligent, predictive, and automated energy management and sustainability more broadly [REF].

This article explores how AI is reshaping energy and carbon management across the MENA region, the tangible results of early deployments, and the pivotal role digital intelligence will play in achieving long-term decarbonisation.

1. AI AS THE NEW INTELLIGENCE LAYER IN MENA'S ENERGY TRANSITION

The region's energy sector is undergoing significant structural change. Solar PV capacity in MENA grew by over 20% in 2023, with projections suggesting that installations could exceed 180 GW by 2030, driven by giga-projects, competitive auctions, and record-low cost curves [1]. Meanwhile, grid modernisation, Battery Energy Storage Systems (BESS), and green hydrogen pilot projects are gaining momentum.

Nonetheless, numerous organisations continue to rely on fragmented datasets, manual reporting cycles, and inconsistent measurement frameworks. These restrictions hinder accurate quantification of emissions, optimisation of energy consumption, or effective integration of renewables [REF].

AI provides solutions that offer:

- Automated data capture across assets, sites, and systems
- Real-time energy and carbon intelligence
- Predictive modelling to anticipate loads, faults, and variability
- Faster compliance with emerging climate-reporting regulations
- Integration of solar, storage, and grid data into unified platforms

This digital layer positions AI as the backbone of next-generation decarbonisation systems in the MENA region.

2. TRANSFORMING CARBON ACCOUNTING THROUGH AUTOMATION

Historically, carbon accounting in the region has relied on spreadsheets, manual data entry, and broad emission factors, often resulting in delays of 90 to 150 days and inconsistent accuracy. AI-enabled platforms now automate the full cycle of emissions tracking through:

- Direct transactional data extraction from energy meters, mobility systems, procurement records, and waste streams
- Automated conversion factors aligned with ISO 14064 and the Greenhouse Gas (GHG) Protocol
- Instant anomaly detection to identify unusual patterns
- Consolidated dashboards offering real-time insights into Scope 1, 2, and selected Scope 3 emissions

Automation significantly reduces reporting time, improves transparency, and frees organisations to prioritise decarbonisation measures over administrative tasks.

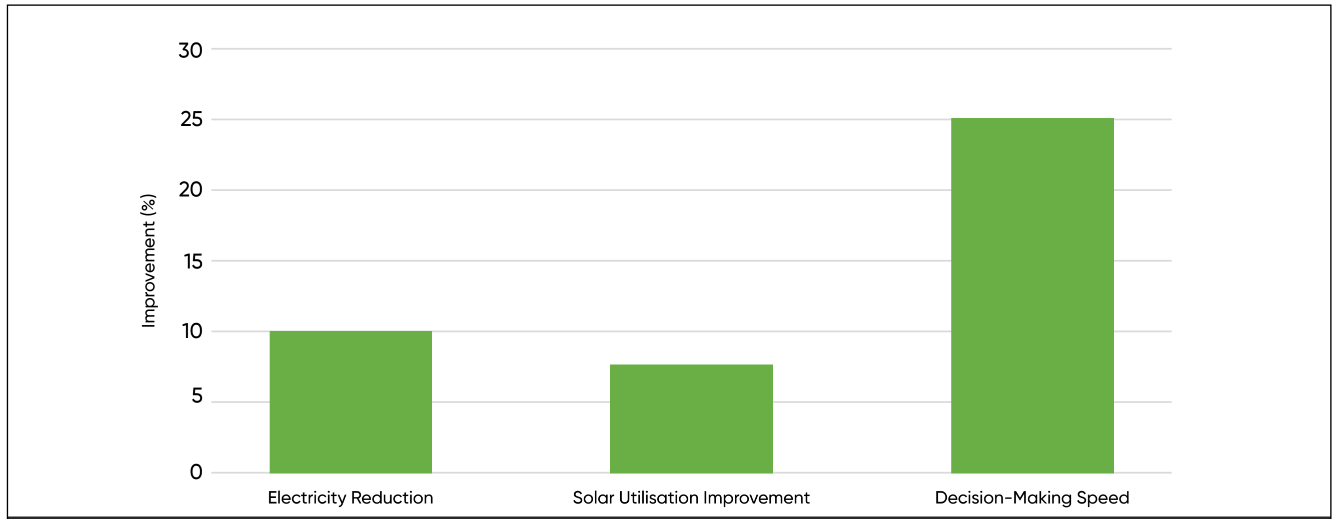


Figure [1] : Carbon accounting time comparison (days per year)

3. PREDICTIVE FORECASTING AND DIGITAL TWINS FOR RENEWABLE ENERGY

The adoption of digital twins' virtual representations of solar plants, buildings, or industrial assets is gaining momentum across the region's expanding renewable energy portfolio [REF]. When combined with AI, digital twins provide a predictive view of how energy systems should perform under optimal conditions, enabling:

- Accurate forecasting of solar generation and grid loads
- Detection of underperformance in inverters, arrays, or HVAC systems
- Loss attribution and root-cause analysis without field visits
- Scenario modelling for renewable integration, storage sizing, and extreme-weather resilience

Validated implementations worldwide have demonstrated forecasting accuracy within 3–5% when calibrated with on-site data [2]. Such precision is crucial in MENA, where variations in solar irradiance and high temperatures affect system behaviour.

4. REAL-TIME ENERGY OPTIMISATION ACROSS FACILITIES

AI facilitates continuous optimisation by analysing millions of data points in real time. Key features that support energy efficiency include:

- Automated alerts identifying inefficiencies across HVAC, lighting, pumping systems, industrial motors, or fleets

10 FUTURE OF ENERGY MANAGEMENT BASED ON AI FOR DECARBONIZATION IN MENA

- Benchmarking against internal baselines and regional performance indicators
- Dynamic load management to reduce peak demand
- Insights into solar contribution, carbon intensity, and renewable penetration

Organisations adopting AI-based optimisation have observed [REF PVI]:

- 7–12% reductions in electricity consumption within the first year
- 5–10% improvements in solar-utilisation efficiency
- 20–30% increases in visibility and decision-making speed

These gains directly support national and corporate decarbonisation strategies as the region prepares for increasing regulatory expectations.

5. ESG REPORTING AND MATERIALITY ENHANCED BY AI

Environmental, Social, and Governance (ESG) reporting frameworks in the MENA region are rapidly evolving. Requirements aligned with Global Reporting Initiative (GRI) Standards, the IFRS Foundation's S1/S2 climate disclosures, and emerging GCC green-finance policies necessitate consistent, transparent, and data-driven reporting [REF].

AI-driven systems streamline this process by offering:

- Automated ESG data consolidation
- Materiality mapping based on real-time impact metrics
- Lifecycle dashboards for environmental performance
- Rapid generation of disclosure-ready outputs
- Scenario-based risk and opportunity analysis

These tools reduce reporting cycles from weeks to hours, enabling timely, robust sustainability disclosures.

6. REGIONAL IMPACT AND DECARBONISATION OUTCOMES

AI-enabled platforms deployed across government entities, real-estate portfolios, industrial facilities, and hospitality groups have shown measurable benefits:

A Operational Emissions Reduction

Predictive optimisation, electrification planning, and smart-meter intelligence have resulted in:

- 4–9% reductions in fuel-related emissions
- 8–15% reductions in electricity-related emissions
- Up to 20% reductions in high-intensity zones following targeted measures

B Enhanced Efficiency in Solar and Renewable Assets

AI-enabled fault detection and automated workflows have supported:

- Faster intervention and reduced downtime
- Lower inverter losses
- Yield-recovery rates comparable to the 5% increases cited in regional PV studies [3]

C Faster Compliance With Emerging Regulations

AI systems comply with UAE Federal Law No. 11 (2024) on climate reporting, national net-zero frameworks, GCC green-finance requirements, and global standards such as ISO, GRI, TCFD, and IFRS.

7. THE NEXT FRONTIER: AI AS THE HEART OF MENA'S NET-ZERO PATHWAY

Looking ahead, AI will play a key role in shaping the region's clean-energy future through:

- AI-integrated smart grids for automated balancing and distributed optimisation
- AI-enabled battery-storage management to extend asset lifespan
- AI for green-hydrogen systems, improving electrolyser efficiency
- AI-driven carbon markets for accurate credit forecasting and verification
- Digital twins for cities to support low-carbon urban planning and climate-resilience modelling

As MENA scales renewables, storage, and green-hydrogen investments, digital intelligence will guide the region's pathway to net zero.

10 FUTURE OF ENERGY MANAGEMENT BASED ON AI FOR DECARBONIZATION IN MENA

CONCLUSION

Artificial intelligence is changing how the MENA region manages energy and carbon systems. By transforming data collection, forecasting, optimisation, and reporting, AI allows organisations to shift from reactive management to predictive, strategic decarbonisation.

As countries strengthen climate policies and expand renewable energy capacity, AI will play a crucial role in enhancing efficiency and transparency and in achieving long-term emissions reductions.

References:

[1] *Middle East Solar Industry Association (MESIA), Solar Outlook Report 2025: MENA Region, Dubai, UAE, 2025.*

[2] *International Renewable Energy Agency (IRENA), Digitalising the Energy System: The Power of Data, AI and Digitalisation, Abu Dhabi, UAE, 2023. Available: https://www.irena.org*

[3] *International Energy Agency (IEA) Photovoltaic Power Systems Programme (PVPS), Performance of Photovoltaic Systems in Hot Climates, Paris, France, 2024.*

[4] *International Energy Agency (IEA), Energy Digitalisation and AI: Optimising Energy Systems, Paris, France, 2023. [Online]. Available: https://www.iea.org*

[5] *World Bank Group, Artificial Intelligence and the Energy Transition in Emerging Markets, Washington, DC, USA, 2022.*

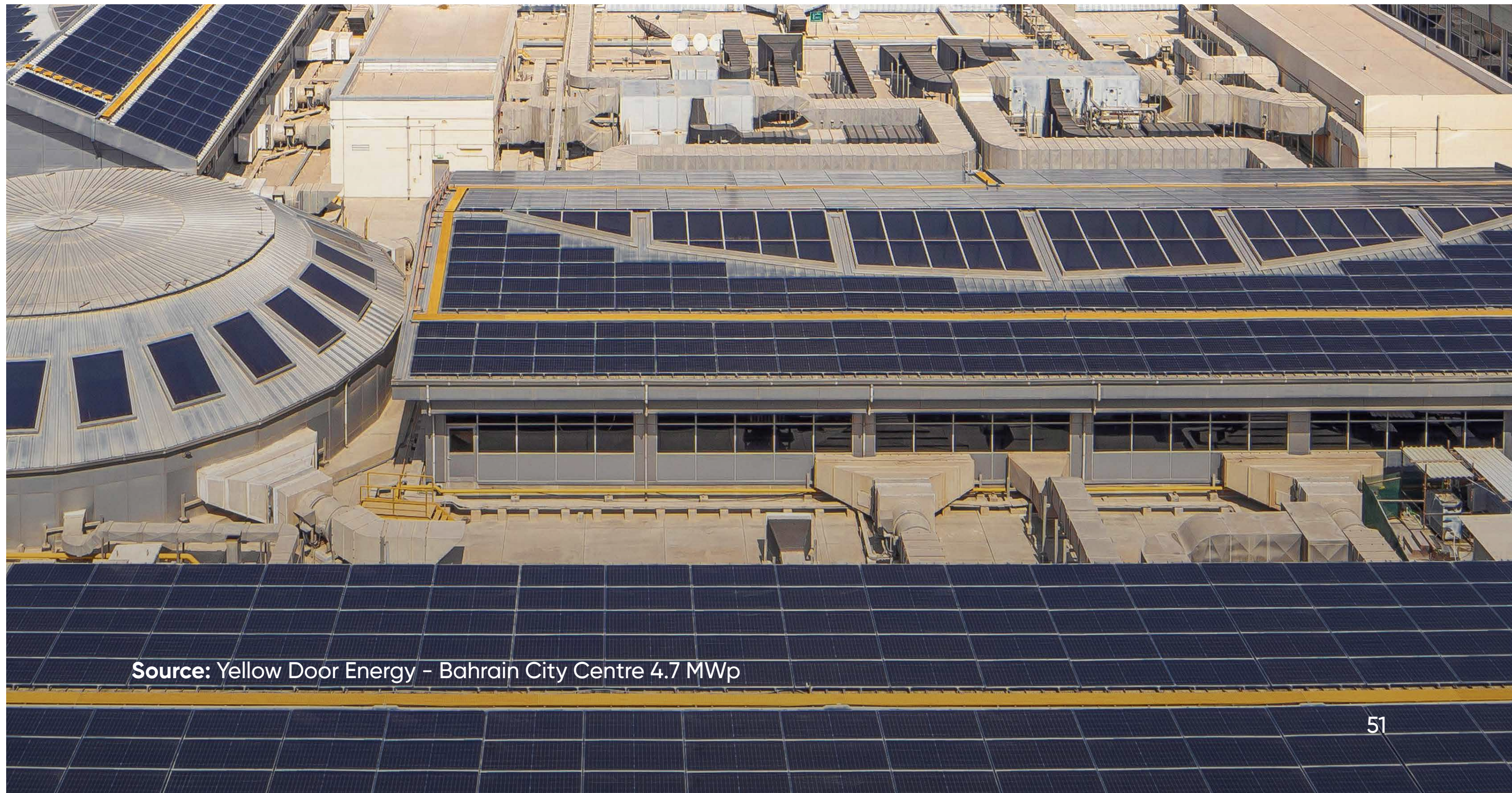
[6] *International Organization for Standardization, ISO 14064-1:2018 Greenhouse Gases Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals, Geneva, Switzerland, 2018.*

[7] *World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), The Greenhouse Gas Protocol: Corporate Accounting and Reporting Standard. [Online]. Available: https://ghgprotocol.org/corporate-standard*

[8] *IFRS Foundation, IFRS S2 Climate-related Disclosures, London, UK, 2023.*

[9] *International Renewable Energy Agency (IRENA), Innovation Landscape for a Renewable-Powered Future: Digital Twins and Smart Energy Systems, Abu Dhabi, UAE, 2022.*

[10] *UAE Ministry of Climate Change and Environment (MOCCAE), UAE Net Zero by 2050 Strategic Initiative, Abu Dhabi, UAE, 2021.*



Source: Yellow Door Energy - Bahrain City Centre 4.7 MWp

SOLAR PANEL SOILING AND THE AMBITIOUS ROLE OF AUTOMATION AS A RELIABLE SOURCE OF INSIGHTS FOR ASSET MANAGEMENT

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GreenPowerMonitor a DNV company

INTRODUCTION

Soiling is a widespread issue that affects photovoltaic (PV) plant performance. As noted by the International Energy Agency's (IEA) PVPS Task 13 study [1], soiling is the most significant factor affecting PV system yield, particularly in arid regions such as the Middle East and North Africa (MENA). To mitigate the impact of soiling, operators must implement countermeasures that affect the profitability of energy generation. This is supported by extensive literature quantifying the effects of this type of loss on solar plant performance. Hammad et al. [2], for example, offer a comprehensive review of soiling in the MENA region and report significant efficiency losses. Their study demonstrates that soiling can reduce performance by anywhere from a few percentage points to as much as 50%, depending on factors such as location, environmental conditions, and cleaning schedules. Preventive or corrective measures are usually implemented either before construction begins or during operations. This article focuses on the operational phase.

UNDERSTANDING THE COMPLEXITY OF SOILING

It is a misconception to view soiling as merely dust accumulation on PV panels. The process is complex and influenced by multiple factors: the physical and chemical properties of soiling, environmental parameters, installation design, and site characteristics. The IEA PVPS Task 13 study classifies these factors into systemic/macroscopic, controllable, and microscale-related categories. [1]

IMPORTANCE OF ACCURATE SOILING DETECTION

The impact of accurate soiling detection can be significant when planning optimal cleaning operations. As reported by Micheli et al. [4], prompt decisions on cleaning dates can increase profits, particularly at sites with high seasonality and prolonged soiling deposition. This underscores the importance of accurate and timely soiling detection

SOILING SENSORS AND OPERATIONAL LIMITATIONS.

As with any human-made installation exposed to the elements, engineers must continually balance harnessing nature's benefits with mitigating its drawbacks. Soiling sensors were designed for this purpose and have been widely deployed. At the same time, the IEC 61724-1:2021 standard mandates soiling sensors for class A monitoring of any plant with >2% annual soiling loss. The number of sensors required depends on the plant's capacity. These sensors estimate the extent of soiling and help operators quantify its severity. Their data, combined with dedicated algorithms, informs decisions about when cleaning operations are worthwhile. This is especially relevant in the MENA region, where installations are often remote and maintenance is carried out under challenging conditions. However, soiling sensors have limitations. They require constant maintenance to remain accurate, necessitating regular workforce deployment. Their discrete nature also means that measurements may misrepresent the plant's overall condition. [3]

ALGORITHMIC APPROACHES TO SOILING ESTIMATION

To address these challenges, algorithms have been developed to predict the soiling ratio – the ratio of energy produced by a soiled plant to that produced under clean conditions. The Humboldt State University (HSU) soiling model [5] is one example; it predicts the soiling ratio based on meteorological parameters (airborne particulates and settling assumptions), plant design (array tilt), and cleaning events. GPM's proprietary model takes a different approach, using the plant itself as the primary data source. By leveraging existing monitoring hardware, asset managers gain insights without relying on external sensors.

This approach, while promising, is not without challenges. Developing a robust algorithm requires filtering out confounding factors, such as inverter breakdowns, clipping, or curtailment. The model analyses the evolution of the gap between the expected PV plant performance (based on environmental and technical parameters) and the actual output. It automatically detects cleaning events, quantifies their impact, provides a daily soiling ratio per device, and aggregates the results to deliver a single, plant-level soiling ratio.

VALIDATION AND COMPARATIVE ANALYSIS

Validation campaigns compared this algorithm with the HSU model, soiling station data, and Solcast® rainfall data. Figures 1 and 2 illustrate these comparisons across two sites in the Middle East over six-month periods.

Figure 1 highlights a key limitation of the soiling stations: their lack of accuracy when not regularly maintained. The GPM algorithm (green trace, top) agrees qualitatively with the HSU model (red trace, top). This comparison highlights a shortcoming of the HSU model: its assumption of perfect cleaning following rainfall events above a threshold. The same graph shows the behaviour of the algorithms and the soiling stations during a specific event, such as a cleaning event, which could be associated with either light rainfall (Solcast® rainfall data on the bottom graph) or a manual cleaning in mid-July 2024. This event translates into a roughly 10% increase in the performance ratio (PR) (black trace, middle). The GPM algorithm correctly detects the event, whilst the soiling stations (brown traces, top) record only a <1% decrease in soiling loss.

Figure 2 tells a similar story to Figure 1. This time, the soiling station (brown trace, top) aligns fairly well with the HSU model (red trace, top). The GPM algorithm (green trace, top) also agrees reasonably well with the soiling station. In this snapshot from the validation campaign, another specific event, which occurred at the beginning of August 2023, shows the behaviour of the algorithms and the soiling sensors. On this date, the PR (black trace, middle) increases by roughly 10%. As no recorded rainfall is present in the Solcast® data, the increase in PR is almost certainly due to a manual panel clean. Manual cleaning would be expected to fully clean the panels, which is what the GPM algorithm records, with a significant reduction in soiling loss. In contrast, the soiling station records only a partial decrease in soiling loss. This example highlights the GPM algorithm's greater sensitivity to cleaning events and the potential pitfalls of relying solely on soiling stations or meteorological models.

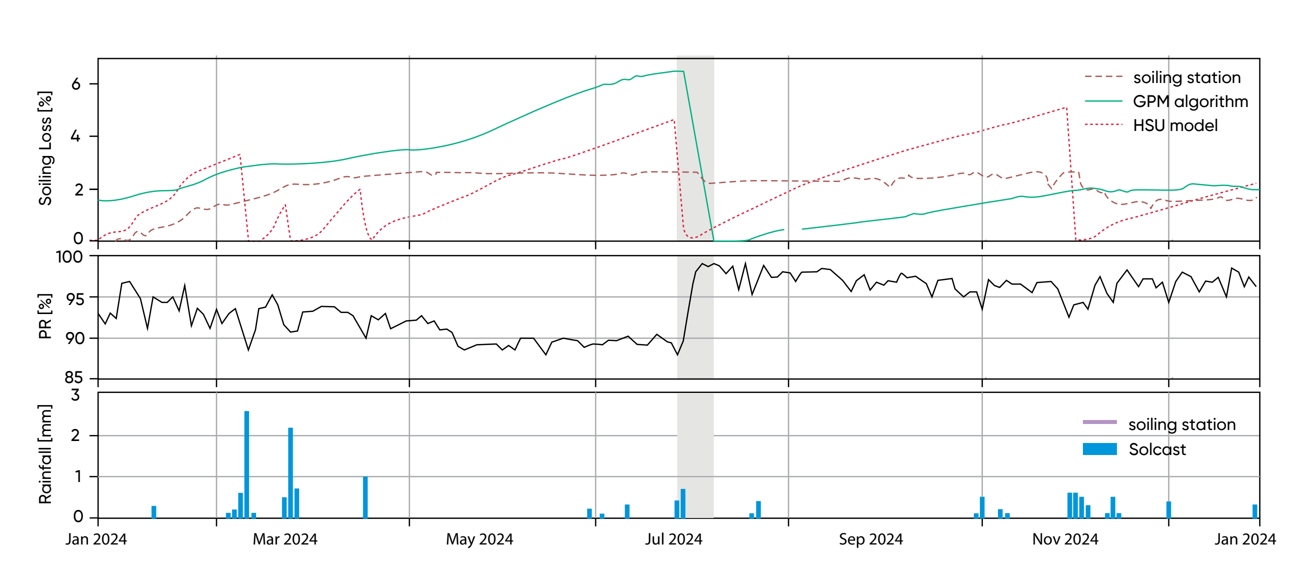

Figure [1] : Validation on Middle East site 1 highlighting sensitivity to light rainfall/cleaning event.

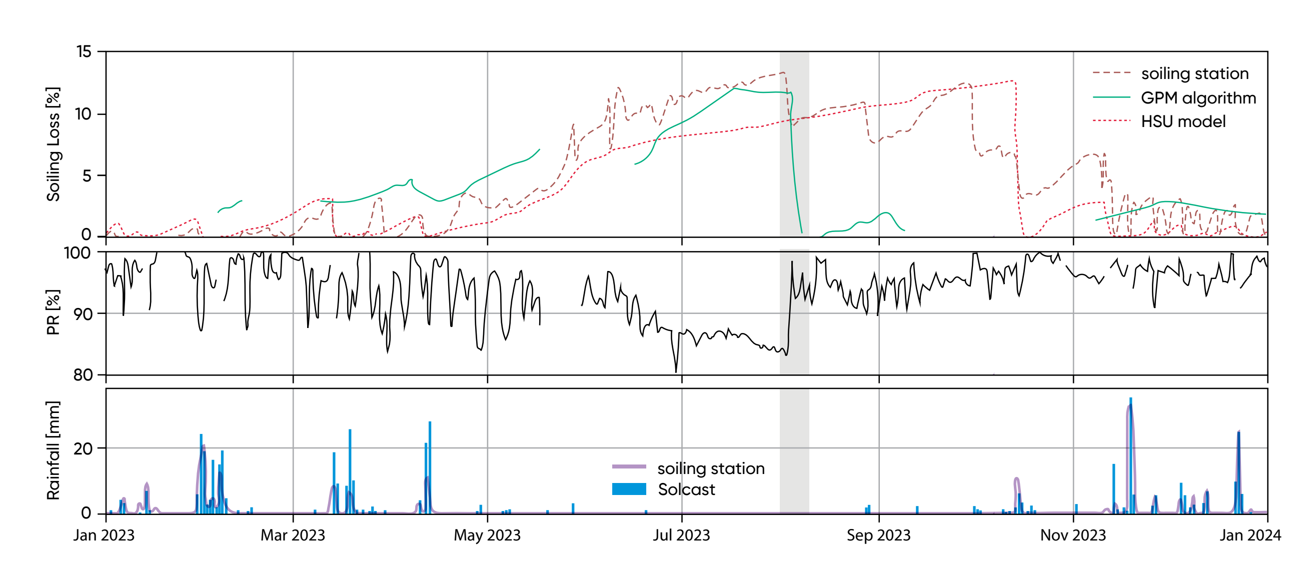

Figure [2] : Validation on Middle East site 2 highlighting high sensitivity to a cleaning event.

CONCLUSION

In conclusion, soiling is far from a trivial challenge; it is a complex, multifaceted phenomenon that can severely undermine PV asset performance, particularly in arid regions such as MENA. Traditional sensors, while helpful, often fall short because of maintenance demands and the limited representativeness of the whole plant.

11 AI & AUTOMATION REDEFINING SOLAR ASSET MANAGEMENT IN MENA.

Automation and advanced algorithms are not only alternatives but also transformative tools. By utilising the plant itself as the primary data source, asset managers receive continuous, sensitive, and actionable insights. Events such as light rainfall or manual cleaning can be detected automatically, enabling smarter, faster decisions.

Optimising cleaning events is another key advantage of using automated tools and algorithms that leverage complete plant data, with clear benefits for profitability. The real promise lies in integration: embedding algorithms into daily operational routines, adapting outputs to specific user needs, and reducing reliance on costly manual interventions. This shift represents more than incremental improvement. It is a step towards redefining solar asset management in the MENA region.

Automation is not merely about detecting soiling; it is about empowering operators to anticipate, respond, and optimise with confidence. In a region where solar energy is poised to play a pivotal role in the energy transition, these innovations ensure that every ray of sunlight is converted into reliable, profitable power.

References:

[1]: *IEA PVPS Task 13, Report IEA-PVPS T13-21:2022, December 2022*

[2]: *B. Hammad et al, "Modeling and analysis of dust and temperature effects on photovoltaic systems' performance and optimal cleaning frequency: Jordan case study," Renewable and Sustainable Energy Reviews, vol. 82, pp. 2218–2234, 2018.*

[3]: *M. Coello and L. Boyle, "Simple Model for Predicting Time Series Soiling of Photovoltaic Panels," IEEE Journal of Photovoltaics, vol. 9, no. 5, pp. 1382-1387, September 2019.*

[4]: *L. Micheli et al, "Economics of seasonal photovoltaic soiling and cleaning optimization scenarios," Energy, vol. 215, 119018, 2021.*

[5]: *HSU Soiling Model – PV Performance Modeling Collaborative (PVPMC)*

Source: Yellow Door Energy – Capital Bank Jordan Solar 02 1.2 MWp

THE ENERGY-AI FEEDBACK LOOP TRANSFORMING THE MIDDLE EAST

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NEXTPOWER

Artificial intelligence (AI) has a symbiotic relationship with solar energy:

1. AI relies on data centres, which in turn require new energy sources to come online rapidly.
2. Solar photovoltaic (PV) and battery energy storage systems (BESS) are the fastest to reach the market.
3. New data centres enable better AI tools, which solar technology companies utilise to optimise solar plant development costs, enhance energy production, and automate construction and operations and maintenance (O&M) work.

The joint advancement of AI, robotics, and solar technology is especially critical in the Middle East, where demand for data centres is expected to triple over the next five years, and where environmental conditions can create serious operational challenges for solar-plus-BESS projects. As demand for AI surges in the region – powered increasingly by large-scale solar – those same power plants now rely on advances in AI and robotics to operate reliably in the Middle East's harsh climate conditions.

DATA CENTRE DEMAND

Data centre spending in the Middle East and North Africa (MENA) is estimated to reach nearly $13 billion in 2026, representing a 37% year-on-year increase, according to Gartner. This growth is driven by the rapid expansion of cloud computing and AI as countries such as the UAE and Saudi Arabia position themselves as global AI hubs. PwC anticipates that data centre capacity in the region will triple over the next five years, from 1 GW in 2025 to 3.3 GW in 2030, driven by demand for generative AI and advanced machine-learning tools across governments, hyperscalers, and technology provider

Globally, data centre development requires a corresponding increase in local power generation. AI-focused data centres, in particular, can consume up to 10 times more power than traditional facilities, creating a new urgency for generation assets that can be deployed rapidly and deliver the lowest possible Levelized Cost of Energy (LCOE) over the plant's lifetime.

SOLAR'S SPEED TO POWER

Solar PV is currently the fastest-growing source of new power generation worldwide. Rystad Energy reports that more than half of all new capacity added in 2024 came from solar. It is also the quickest power-generation technology to deploy at scale. Once fully permitted, a 1 GW solar power plant can be built in a year or less for around $1 billion, compared to four years and $2 billion for natural gas, or 10 years and $15 billion for nuclear.

The case for solar-plus-BESS to support data-centre load growth is even stronger in the Middle East, where land constraints are minimal, and land costs are considerably lower than in major global data-centre hubs.

Conversely, the key challenges for MENA solar-plus-BESS projects stem from harsh desert conditions and their often remote locations. Persistent issues include worker safety risks and the difficulty of operating and maintaining these plants under extreme conditions – intense heat, high winds, and increased soiling from dust storms, to name a few.

Which leads us back to AI. Building on experience with delivering large-scale solar assets across the Middle East, AI-guided robotics is becoming essential for safe, reliable deployment in extreme desert conditions. Here is a snapshot of what this looks like today, and a glimpse of what is next.

12 ARTIFICIAL INTELLIGENCE AS A CATALYST FOR THE REGIONAL ENERGY TRANSITION

DIGITAL AI OPTIMISES DESIGN, PROCUREMENT AND PERFORMANCE

The solar design phase is complex, and each decision can significantly affect project timelines and the LCOE. AI is particularly suited to managing this complexity and generating new efficiencies.

Large language models are increasingly embedded in solar workflows to streamline customer interactions, generate documentation, and interpret field notes. Emerging digital AI tools use contextual intelligence to provide actionable insights and real-time feedback. Design iterations can be produced more quickly and incorporate more variables, ranging from regional supply and stock keeping unit (SKU) counts to cost trade-offs and their combined impact on LCOE.

Digital twins are also becoming critical to plant installation and operational efficiency. They identify issues early and enable proactive mitigation strategies, thereby reducing costs. Drone imaging and sensor data constantly update nonlinear models of each plant component, enabling real-time optimisation of tracker angles, inverter set-points, and storage levels. Once a digital twin exists in the cloud, AI can forecast probable conditions and recommend – or eventually execute – the next best action in a continuous decision-making loop.

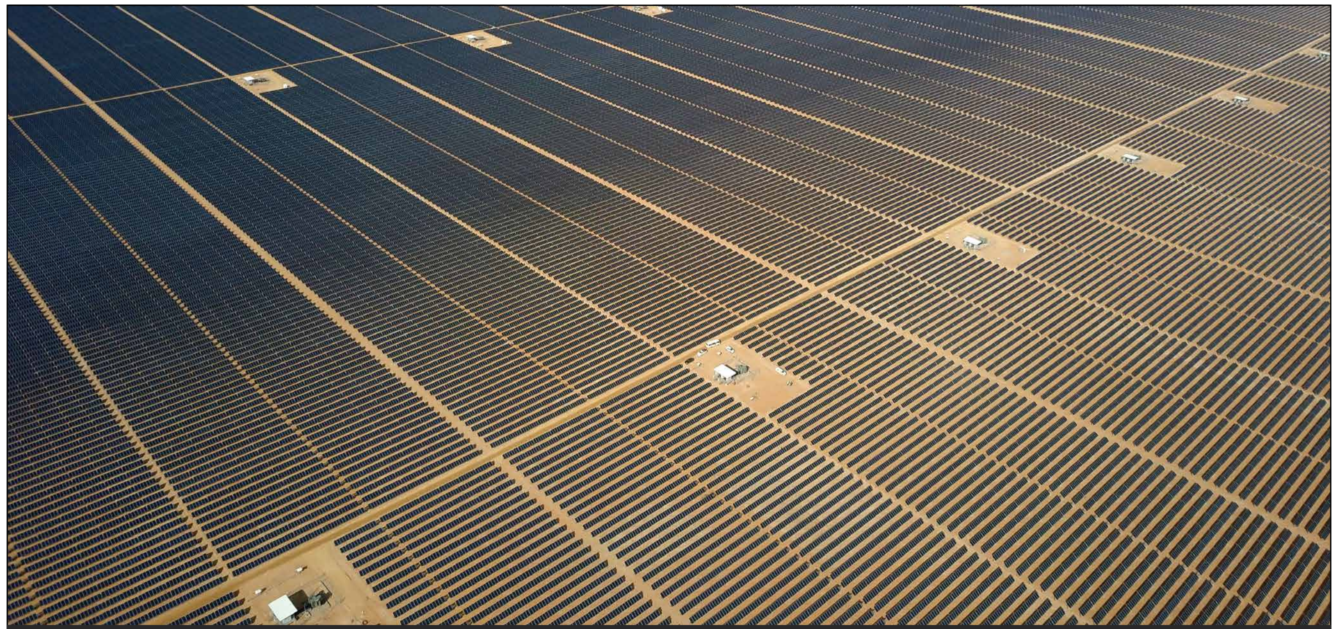


Figure [1] : Sakaka_NX_rows2_ACWA attr

AUTOMATED CONSTRUCTION AND ROBOTIC MAINTENANCE

Automated installation processes are particularly valuable in remote desert environments. Commissioning and inspection can be carried out by ground and aerial robots using AI-driven detection and analytics to flag issues before they lead to failures.

For ongoing O&M, weather stations that record temperature, irradiance, wind speed, and direction can be integrated with drones and autonomous inspection robots that continuously patrol the field. These systems use pattern recognition to perform anomaly detection and predictive maintenance, which is vital given that an estimated 63% of underperformance, safety, and risk issues occur beneath solar panels and cannot be detected from aerial imagery alone.

Figure [2] : NX_Wright Solar

12 ARTIFICIAL INTELLIGENCE AS A CATALYST FOR THE REGIONAL ENERGY TRANSITION

WHAT'S NEXT: PHYSICAL AI AND AGENTIC AI AUTOMATION

Solar monitoring centres still require human operators to monitor screens 24/7. Improvements in agentic AI can further advance the decision-to-action model, enabling AI agents to identify issues, coordinate responses, and, in some cases, autonomously resolve problems before human intervention is required.

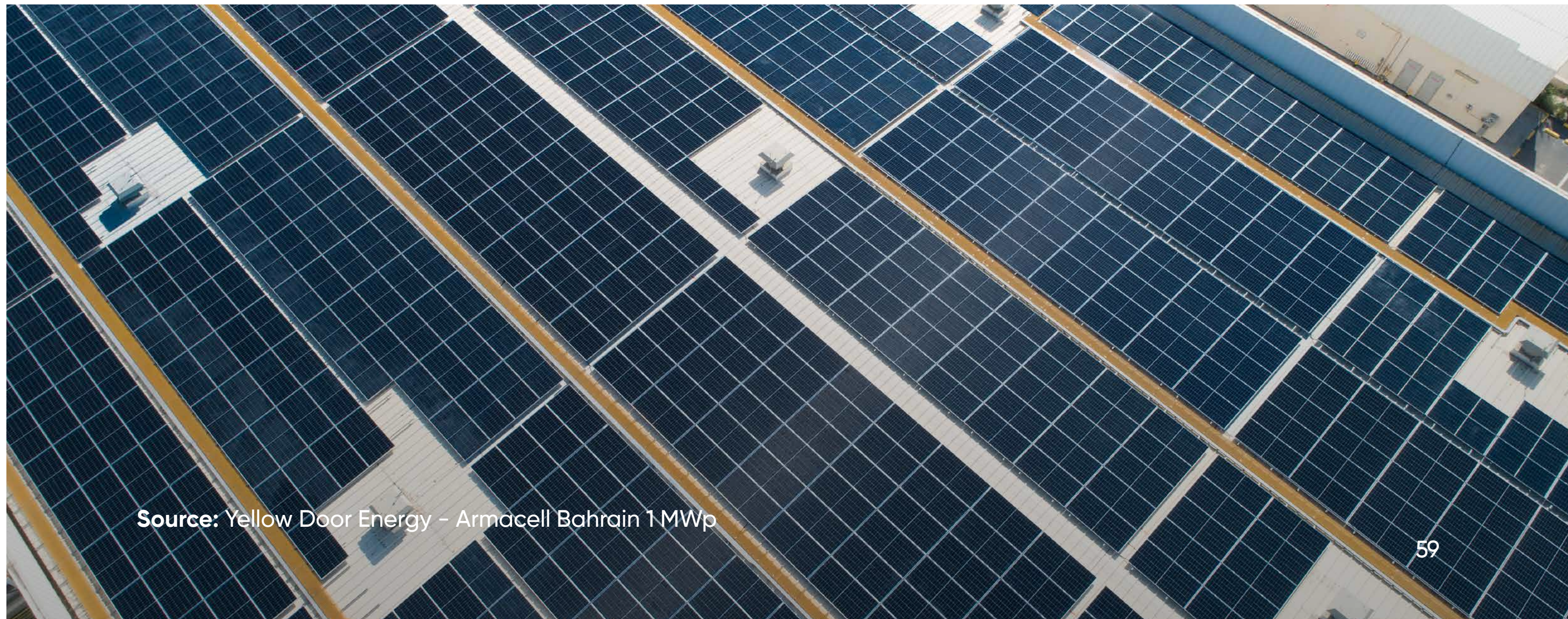
Installation robotics mark the next major shift, falling within the broader concept of physical AI. In the near future, construction robots could support the physical assembly of solar plants. Over time, coordinated fleets of aerial and terrestrial robots could operate in synchronised swarms, sharing data and adapting to each other's actions. This would enable more complex tasks such as joint lifting, dynamic re-routing in response to obstacles, or fully automated inspection sequences.

BOTTOM LINE

The MENA region is prioritising infrastructure for data centres and AI computing, which requires new power sources that can be rapidly deployed. Today, gigawatt-scale solar plants are being delivered at the lowest LCOE and more quickly than any comparable generation source, and performance will continue to improve as abundant operational data feed into advanced, connected AI systems. The result will be smarter decisions and faster actions across design, delivery, construction, and operations, strengthening energy resilience and safeguarding workers and power plant assets in all environments.

Source:

**Raptor Maps Global Solar Report 2025 Edition*
Based on the analysis of 67GWdc in 2024.



Source: Yellow Door Energy - Armacell Bahrain 1 MWp

13 SMART CITIES OF THE FUTURE: SOLAR INTEGRATION IN MASDAR & NEOM SUPPLY CHAINS IN THE SOLAR INDUSTRY

SOLAR PANEL SOILING AND THE AMBITIOUS ROLE OF AUTOMATION AS A RELIABLE SOURCE OF INSIGHTS FOR ASSET MANAGEMENT

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INTRODUCTION

The future of urbanisation depends on critical redesign. According to the World Bank, cities currently contribute up to 70% of global greenhouse gas emissions (World Bank, 2023; Cities Key to Solving Climate Crisis). It is therefore essential that nations urgently decarbonise cities to achieve global climate goals. Diversifying into new energy solutions is central to this transformation, with solar power emerging as a key component in building resilience and rapidly decarbonising urban environments.

Cities such as Masdar in Abu Dhabi and NEOM in Saudi Arabia exemplify how solar integration shapes smart city development, advancing environmental goals while fostering innovation. Global legislation and regulations provide a blueprint for setting ambitious targets to reduce greenhouse gas emissions, and the synergy between legal frameworks and solar technology is crucial to advancing these cities as models of urbanisation.

PIONEERING URBAN AND SOLAR INITIATIVES

Masdar City and NEOM exemplify pioneering urban developments driven by renewable energy and smart design. Masdar City reduces energy demand by approximately 40% through innovative architecture and extensive use of solar power, while NEOM aims to operate entirely on renewable energy, leveraging artificial intelligence (AI) to optimise energy consumption in real time. The Mohammed bin Rashid Al Maktoum Solar Park, the world's largest single-site solar facility under the Independent Power Producer (IPP) model, aims to reach 5,000 megawatts (MW) of capacity by 2030, with an investment of AED 50 billion. It incorporates photovoltaic (PV) and Concentrated Solar Power (CSP) technologies across phases, including a record-setting 260-metre solar tower and 15-hour thermal storage, saving over 6.5 million tonnes of CO_2e annually and powering hundreds of thousands of Dubai residences.

LEGISLATION AS A KEY ENABLER OF SOLAR-DRIVEN CITIES

The UAE's Federal Climate Law, effective from May 2025, establishes a unified regulatory framework to manage and reduce greenhouse gas emissions across all sectors. It requires organisations operating in the UAE to measure, report, and implement emissions-reduction strategies. This requirement applies specifically to organisations in high-emission sectors, including urban development projects such as Masdar, ensuring comprehensive accountability in the country's efforts to combat climate change. The law aligns with the UAE's broader Net-Zero 2050 Strategy and requires transparency, compliance, and concrete actions to reduce emissions through annual targets.

Integrating solar energy into urban areas will reduce emissions and ensure compliance with legal requirements

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by delivering a scalable, verifiable impact. For cities such as Masdar, complying with the law directly translates into expanding renewable energy capacity and embedding solar technologies within their infrastructure.

Beyond mandates, the law also incentivises innovation and the adoption of advanced technologies, such as carbon capture, energy-efficiency measures, and renewable energy integration, including solar PV, which is essential for the development of smart cities. It also institutes climate risk assessment and adaptive planning requirements, ensuring urban developments are resilient to changing environmental conditions. The creation of the National Carbon Credit Registry (NCCR) introduces a robust carbon market mechanism that facilitates emission trading and enables organisations to participate in offset activities in a credible and verifiable manner.

EMISSION REDUCTION AND ENERGY SECURITY

Masdar City's ambitious solar-plus-storage project, currently underway in Abu Dhabi, is set to redefine urban energy resilience by delivering 1 gigawatt (GW) of baseload renewable power 24/7 through a pioneering integration of a 5.2 GW solar PV plant and a 19 GWh battery energy storage system (BESS). By integrating innovative solar technology with stringent regulatory frameworks, such as the UAE's Federal Climate Law, Masdar exemplifies how smart city designs can deliver measurable emissions reductions while bolstering energy security and economic vitality. These efforts demonstrate that solar integration, together with improved energy storage and governance, is essential to building strong, zero-carbon cities around the world.

SOLAR CITIES: THE NEW STANDARD

Masdar and NEOM represent a paradigm shift in urban development, demonstrating how the Middle East and North Africa (MENA) region is leading the global transition to solar-powered smart cities with unprecedented scale and ambition. Masdar's 5.2 GW solar + 19 GWh battery project will deliver 1 GW of continuous renewable power to support AI data centres and research hubs (Masdar, 2025). NEOM complements this by targeting 100% renewable energy through AI-optimised grids and sensor networks, integrating solar, wind, and hydrogen to create a cognitive city that anticipates energy needs in real time (8M Solar, 2025). These initiatives, underpinned by the UAE's Federal Decree-Law No. (11) of 2024, which mandates emissions reporting and reductions across all sectors, aim to translate policy into action. They support decarbonisation, enhanced grid stability, and economic multipliers, including job creation and reduced fossil fuel imports (UAE Legislation, 2024; Library of Congress, 2025). Globally, case studies such as Freiburg's solar urbanism (40% renewable electricity) and India's slum microgrids indicate that solar integration can reduce urban emissions by up to 45%, improve air quality, and build resilience against blackouts and heatwaves (IEREK, 2025). Success requires scaling up, and governments need carbon credit systems and public-private partnerships to expand rooftop solar, building-integrated PVs, and community projects. At the same time, planners must include solar from the outset to prevent waste of funds on outdated infrastructure.

For stakeholders in the Middle East Solar Industry Association (MESIA) network and beyond, the imperative is clear: cities that hardwire solar into codes, finance, and infrastructure today will dominate tomorrow's markets, delivering not only climate compliance but also energy sovereignty, liveability, and competitiveness in a net-zero world. Masdar and NEOM are pioneering

SMART CITIES OF THE FUTURE: SOLAR INTEGRATION IN MASDAR & NEOM SUPPLY CHAINS IN THE SOLAR INDUSTRY

experiments that serve as vital blueprints for the future of urban development. These initiatives demonstrate the importance of innovative approaches in transforming urbanisation from a major source of emissions into effective climate solutions.

References:

8M Solar (2025) 'The future of solar in smart cities'. Available at: https://8msolar.com/the-future-of-solar-in-smart-cities/ (Accessed 3 December 2025).

Carbon Credits (2025) 'MENA's renewable energy boom: Solar capacity to hit 180 GW by 2030'. Available at: https://carboncredits.com/mena-solar-growth-revolutionizing-energy-by-2025/ (Accessed 3 December 2025).

IEREK (2025) 'Solar energy in urban areas: Global impact and case studies'. Available at: https://www.ierek.com/news/solar-energy-urban-areas/ (Accessed 3 December 2025).

Library of Congress (2025) 'United Arab Emirates: Climate law takes effect, supplementing national emissions strategy'. Available at: https://www.loc.gov/item/global-legal-monitor/2025-06-24/united-arab-emirates-climate-law-takes-effect-supplementing-national-emissions-strategy/ (Accessed 3 December 2025).

Masdar (2025) 'Masdar breaks ground on 5.2GW/19GWh solar-plus-storage project'. Available at: https://www.pv-tech.org/masdar-breaks-ground-on-worlds-largest-5-2gw-19gwh-solar-plus-storage-project/ (Accessed 3 December 2025).

Middle East Solar Industry Association (MESIA) (2025) 'Solar outlook report 2026'. Available at: https://mesia.com/solar-outlook-report-2026/ (Accessed 3 December 2025).

UAE Legislation (2024) Federal Decree-Law No. (11) of 2024 on the reduction of climate change effects. Available at: https://uaelegislation.gov.ae/en/legislations/2558 (Accessed 3 December 2025).

World Bank (2023) 'Cities key to solving climate crisis'. Available at: World Bank - Cities Key to Solving Climate Crisis (Accessed 3 December 2025).

POLICY, FINANCE & MARKET DEVELOPMENT

UNRAVELING THE FUTURE OF SOLAR PV IN MENA

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INTRODUCTION

Solar photovoltaic (PV) technology continues to gain traction in the Middle East and North Africa (MENA) region as countries aim to diversify their energy portfolios and reduce dependence on fossil fuels. Currently, fossil fuels – predominantly natural gas – supply 89% of the region's power demand, but renewable energy is projected to account for 21% of the power generation mix by 2030, up from 5.5% as of 2025. Countries such as Saudi Arabia, the UAE, Oman, Egypt, and Morocco are at the forefront of this transition, leveraging some of the world's highest solar energy potential, with average annual solar irradiance exceeding 2,000 kilowatt-hours (kWh) per square metre.

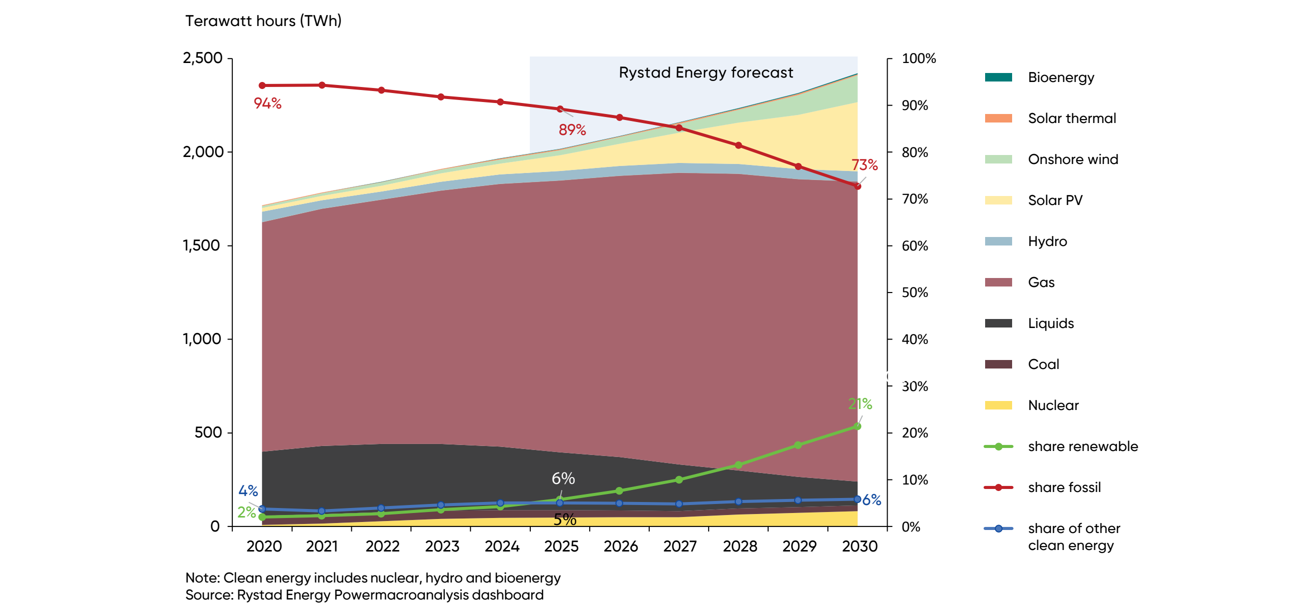


Figure [1] : MENA power generation by energy category (LHS), share of generation (RHS)

MENA has experienced significant growth in solar PV this year, adding approximately 16 gigawatts (GWAC) of new capacity and reaching a total installed capacity of 38 GWAC by year's end. According to Rystad Energy figures, Saudi Arabia leads the region with a 31% share, followed by the UAE at 16.7%, and then Israel, Egypt, Jordan, Oman, and others. Projections indicate that the region will increase its installed solar PV capacity at a compounded annual growth rate (CAGR) of 35%, reaching over 167 GWAC by the end of the decade, with more than 60% of this growth coming from Saudi Arabia, the UAE, and Egypt. Key projects that began commercial operations in 2025 include the 2 GWAC Ar Rass 2 solar PV project in Qassim and the Al Shuaibah 2 project near Jeddah, with an installed capacity of 2.06 GWAC, both operated by the Saudi-based developer and investor ACWA Power.

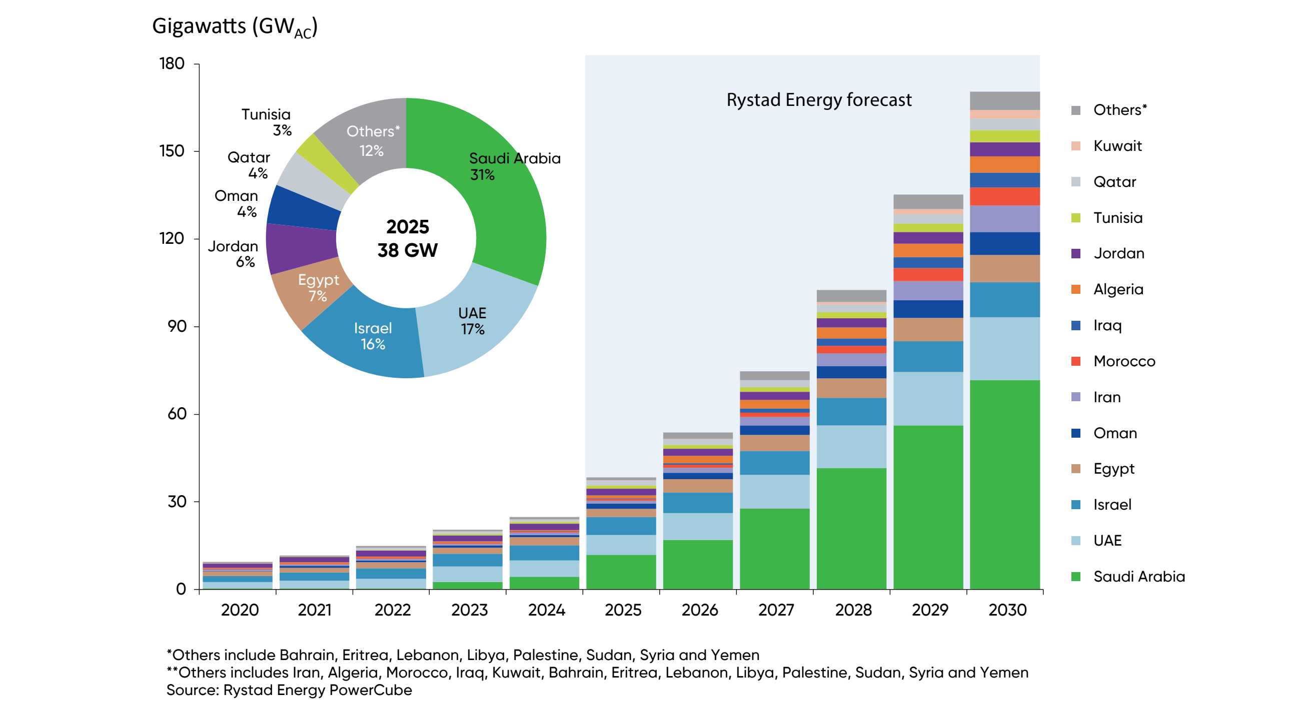


Figure [2] : Solar PV installed capacity by country

BELOW ARE THE KEY 2025 PROJECT DEVELOPMENTS ACROSS THE REGION

Saudi Arabia:
In 2025, Saudi Arabia commissioned over 7.5 GW of new solar capacity, bringing the total to approximately 12 GW by year's end. In July 2025, the Saudi Power Procurement Company (SPPC) signed power purchase agreements (PPAs) with a consortium comprising ACWA Power, Badeel (a wholly owned subsidiary of Saudi Arabia's Public Investment Fund (PIF)), and Aramco Power. These agreements cover seven large-scale projects – five solar PV and two onshore wind – totalling 15 GW of capacity. The combined investment value for these projects is 31 billion SAR ($8.3 billion). Notably, the 2 GW Afif 2 had the lowest tariff among the five solar PV projects, at 47.23 SAR per megawatt-hour (MWh) ($12.59 per MWh). Additionally, the country has awarded 3 GW of solar projects through competitive auctions.

UAE:
Earlier this year, during Abu Dhabi Sustainability Week, Masdar announced the world's largest 24/7 solar PV and battery project. Featuring 5.2 GWDC of solar capacity and 19 gigawatt-hours (GWh) of battery storage, the plant can supply up to 1 GW of baseload power around the clock. During the second quarter of 2025, the UAE awarded the 1.5 GW Al Zarraf solar PV project to a consortium of EDF and Korea Western Power Company (KOWEPO) through a competitive tender. Additionally, Emerge – a joint venture between Masdar and EDF – has commissioned a 60 MWDC solar plant at the Sajaa Gas complex to supply all the electricity required by the facility. The project was developed in partnership with the Sharjah National Oil Corporation (SNOC).

Qatar:
QatarEnergy has awarded Samsung C&T Corporation the contract to build the 2 GW Dukhan solar power plant, which will double Qatar's solar capacity. The project will be developed in two phases, with 1 GW expected to be operational by 2028 and the second phase scheduled for completion by mid-2029.

14 UTILITY-SCALE SOLAR EXPANSION: COMPETITIVE DYNAMICS AND MARKET OUTLOOK IN MENA

Egypt:
Scatec has entered into a 25-year corporate PPA with Egypt Aluminium for a 1.1 GW solar PV and 100 MW/200 MWh battery energy storage (BESS) project, supported by a sovereign guarantee. Egypt Aluminium is the country's largest aluminium producer and its biggest industrial electricity consumer. Additionally, Scatec has commenced construction at its Obelisk project in Egypt, which features a 1.1 GW solar PV plant and a 100 MW/200 MWh BESS facility. The project is backed by a 25-year PPA with the Egyptian Electricity Transmission Company (EETC). Development will take place in two phases: phase one will comprise 561 MW of solar capacity and 100 MW/200 MWh of battery storage, while phase two will feature 564 MW of solar capacity. The project is expected to commence operations in 2026.

Tunisia:
Tunisia's Ministry of Industry, Mines, and Energy has approved four solar PV projects totalling 500 MW. France's Qair International will develop two plants in Gafsa and Sidi Bouzid, while the Paris-headquartered Voltalia will construct a 100 MW solar PV project in Gabès. Meanwhile, Scatec and Aeolus will build another 100-MW plant in Sidi Bouzid.

Morocco:
Qair has obtained authorisation for its 48 MW Tiznit solar PV project. ACWA Power has also secured contracts to develop and operate Morocco's Noor Midelt II and Noor Midelt III, which feature 800 MW of solar PV capacity, complemented by a 230 MW/620 MWh BESS facility. The build-own-and-operate agreements were signed with the Moroccan Agency for Sustainable Energy (MASEN) under a 30-year PPA.

Iraq:
TotalEnergies has commenced construction of a 1 GW solar PV project in Iraq's Basra region. The project will proceed in four phases, with full completion expected in 2028. The initial 250-MW phase is set to begin operations before the end of this year. Ownership of the plant is divided between TotalEnergies (45%), Basra Oil Company (30%), and QatarEnergy (25%).

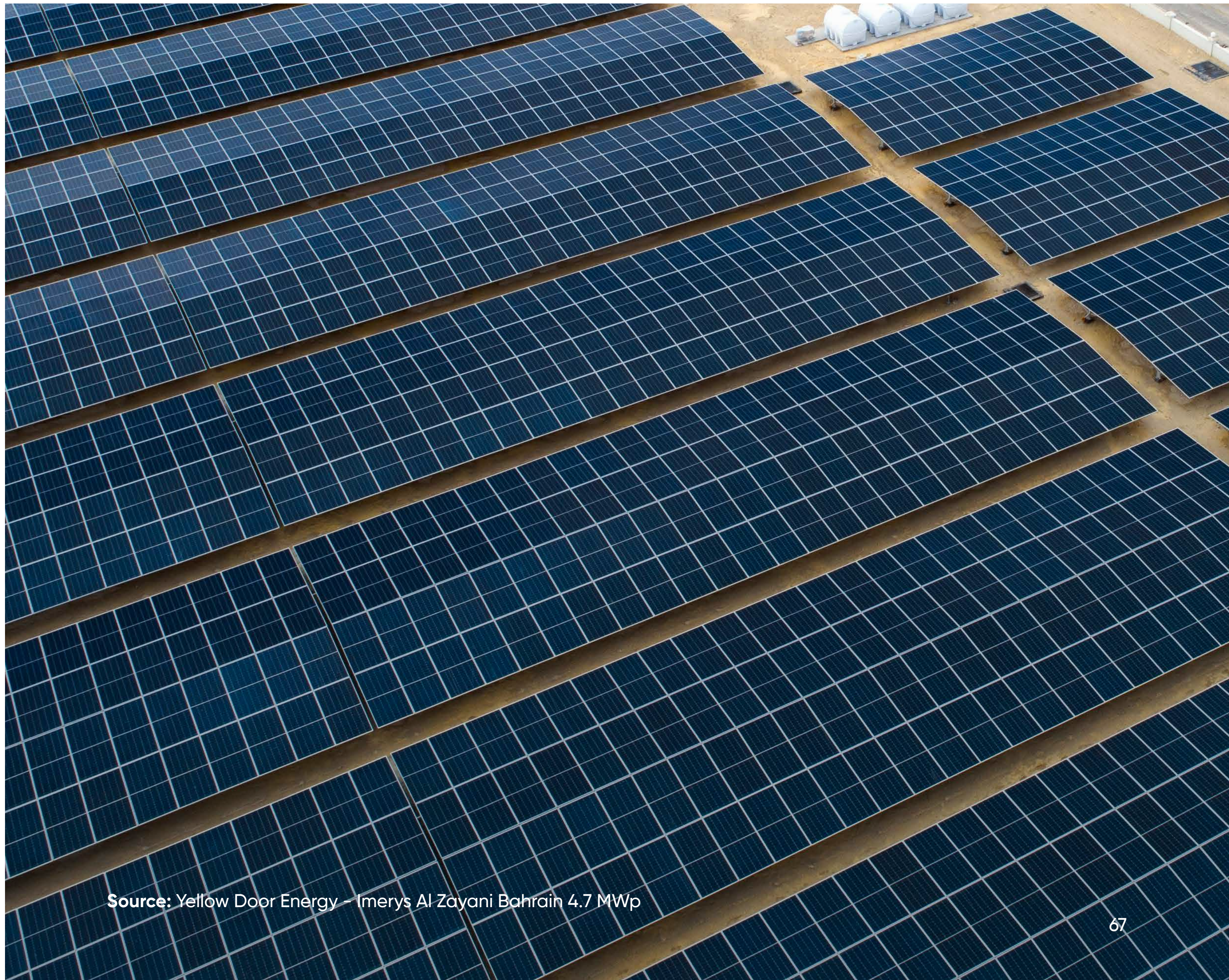
Project	Country	Developer	Development status	Start-up year	Capacity (GW_{AC})
Abu Dhabi solar plus BESS	UAE	Masdar	Under construction	2027-2028	4.4
Al Humajj Solar PV	Saudi Arabia	ACWA Power	PPA signed	2028-2029	3
Bisha Solar PV	Saudi Arabia	ACWA Power	PPA signed	2028-2029	3
Neom Solar PV (Green Hydrogen)	Saudi Arabia	ACWA Power	Under construction	2026	2.2
Al Shuaibah Solar PV	Saudi Arabia	ACWA Power	Operational	2025	2.03
Al Sadawi Solar PV	Saudi Arabia	Masdar	Under construction	2027	2
Ar Rass 2 Solar PV	Saudi Arabia	ACWA Power	Operational	2025	2
Haden Solar PV	Saudi Arabia	ACWA Power	Under construction	2027	2
Dukhan Solar PV	Qatar	Qatar Energy/ Samsung C&T	PPA signed	2028-2029	2

Source: Rystad Energy PowerCube

Figure [3] : Top solar PV projects in MENA

14 UTILITY-SCALE SOLAR EXPANSION: COMPETITIVE DYNAMICS AND MARKET OUTLOOK IN MENA

Competitive solar auctions and gigawatt-scale solar projects are driving the MENA region's energy transition away from fossil fuels. So far in the second half of 2025, the region has collectively awarded 7.7 GW of renewable capacity through auctions. With 5 GW awarded in the first half of 2025, the total capacity awarded this year stands at 12.7 GW, according to Rystad Energy figures. Saudi Arabia, the UAE, and Oman are leading this development, with 4.5 GW, 3 GW, and 1.67 GW of capacity awarded, respectively, across solar PV and onshore wind. The region's strategic location facilitates the export of solar energy to neighbouring markets, either directly as electricity via interconnectors or, potentially in the future, via green hydrogen. This promotes regional cooperation, energy security, and economic growth. Beyond power generation, solar energy in MENA is also used for water desalination, cooling, and industrial applications, boosting its role in sustainable development. Clearly, the region is emerging as a global leader in renewable energy and transitioning towards a more sustainable future, supported by rapidly expanding solar capacity, manufacturing, and financing innovations, while freeing up additional volumes of oil and gas for export.



Source: Yellow Door Energy – Imerys Al Zayani Bahrain 4.7 MWp

REGIONAL FOCUS & EMERGING FRONTIERS

15

FROM SUN TO SERVER: HOW MENA IS POWERING DATA AND DIGITAL INDUSTRIES WITH SOLAR

FROM SUN TO SERVER: HOW MENA IS POWERING DATA AND DIGITAL INDUSTRIES WITH SOLAR

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INTRODUCTION

In a fast-changing digital era, the Middle East and North Africa (MENA) region is experiencing significant technological progress. As more businesses and industries adopt digital solutions, data has become essential for driving innovation, improving efficiency, and maintaining competitiveness. Recognising the vital role of data in economic and social development, organisations across sectors are leveraging data centres to optimise operations, enhance customer satisfaction, and unlock new growth opportunities. The future of data centres in the region is rapidly evolving, driven by artificial intelligence (AI), strategic location, supportive government policies, and rising demand for 5G, cloud computing, and other digital services, all of which are making the region an increasingly important market for global data centre operators, with the core markets being the UAE, Saudi Arabia, and Morocco.

MARKET GROWTH AND REGIONAL LANDSCAPE

Although MENA's data centre market remains nascent, it is expanding rapidly. The region is projected to rank among the fastest-growing data centre markets in the years ahead, given its substantial potential to address the gap between constrained supply and surging demand. More broadly, data centre capacity in the region is expected to grow from the current 1.37 gigawatts (GW) to over 6 GW by 2030.

Saudi Arabia leads the pack, accounting for over 45% of MENA's data centre capacity, or upwards of 600 megawatts (MW), underpinned by Vision 2030, with hubs in Riyadh, Jeddah, Dammam, and NEOM. The UAE follows, accounting for 41%, with Dubai and Abu Dhabi emerging as key hubs, dominating existing infrastructure with robust connectivity and smart city status, and hosting operators such as Khazna Data Centers. Other emerging countries in the region include Qatar, Egypt, Oman, Bahrain, and Morocco, which are supported by sovereign cloud and data security initiatives. Prominent players include Khazna Data Centers, Saudi Telecom Company (STC), SDS Data Center, Equinix, Digital Realty (Teraco), Amazon Web Services (AWS), Microsoft, and Google, as well as regional entities such as Moro Hub (Digital DEWA) and Pure Data Centres.

ENERGY DEMAND AND INFRASTRUCTURE CHALLENGES

Data centres are often clustered near cities, increasing the risk of grid overload and requiring significant upgrades to infrastructure that was not initially designed for such relentless, high-volume electricity demand. As a result, MENA has a vital opportunity to address the energy challenges facing data centres by leveraging the region's booming renewables sector. As of 2025, MENA's data centre power demand stands at approximately seven terawatt-hours (TWh) and is forecast to exceed 35 TWh by the end of the decade. While solar photovoltaic

(PV) is starting to underpin a new generation of data centres in the region, the market remains at an early, flagship-project stage rather than a fully mainstream model. Data centres maintain a flat, continuous power demand profile to support 24/7 operations for AI, cloud computing, and critical services, typically requiring stable loads with minimal fluctuations. However, the intermittent nature of renewables such as solar creates a mismatch that risks outages or curtailment without mitigation. To address this and enable high renewable utilisation, onshore wind and battery energy storage systems (BESS) are paired with solar PV when it comes to electricity procurement.

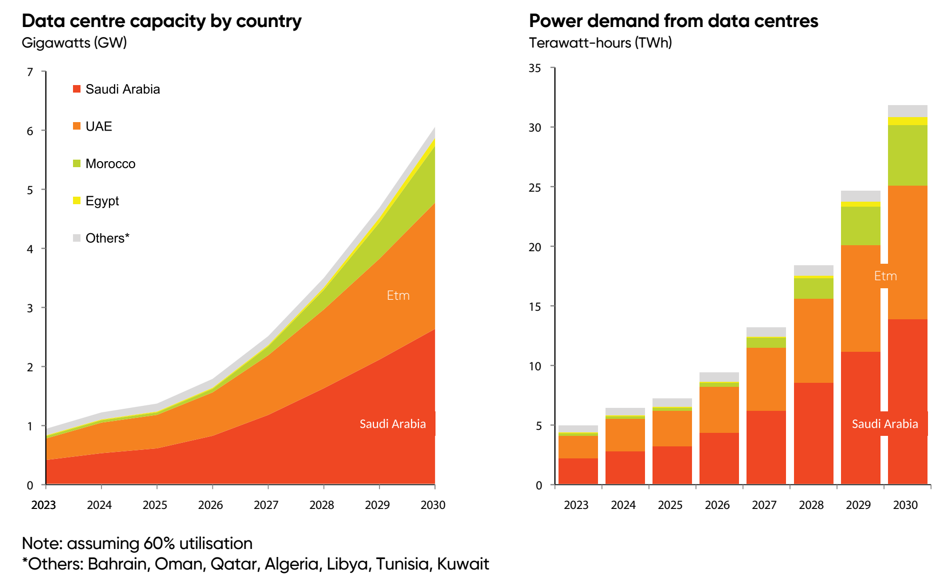

Figure [1] : MENA's data centre capacity and power demand growth

SOLAR-POWERED DATA CENTRE PROJECTS

Countries in the region, such as the UAE, Saudi Arabia, and Morocco, host prominent solar-powered data centres. Below are some key projects:

UAE

Abu Dhabi launched a 5-GW AI campus – one of the world's largest – that is being developed in partnership with G42, an AI company backed by the UAE's sovereign wealth fund, Oracle, Nvidia, Cisco, and SoftBank. The first 1-GW cluster, Stargate, will be built by G42 and operated by OpenAI and Oracle, with Nvidia supplying the latest Grace Blackwell GB300 systems. The project is expected to be built in multiple phases, starting with a 200-MW AI cluster, and the facility will be powered by nuclear, solar, and natural gas to minimise carbon emissions.

Saudi Arabia

NEOM and DataVolt announced a $5 billion investment in a fully sustainable 300-MW data centre at Oxagon by 2028, with plans to reach a total capacity of 1.5 GW. The data centre will be powered entirely by renewable energy. Meanwhile, Quantum Switch Tamasuk (QST), a joint venture between UK data centre firm Quantum Switch and Saudi infrastructure investor Tamasuk, launched a 300-MW project comprising six 50-MW data centre facilities in Riyadh, Dammam, Jeddah, and NEOM, with an estimated investment value of $2 billion. Additionally, Amazon AWS and Humain announced a $5.3 billion investment to build an AI zone.

Project	Company/developer	Country	Status	Power source	Capacity (MW)
Stargate AI Campus	Khazna (G42)/ Open AI	UAE	Planned	Grid; RE-PPA	1,000
Igoudar Dakhla	Naver Nvidia	Morocco	Planned	100% RE	500
Iozera Tetouan AI DC	Iozera	Morocco	Planned	100% RE	386
Data Volt NEOM Oxagon AI Factory	Data Volt/NEOM	Saudi Arabia	Planned	100% RE	300
QST Saudi DC Program	3A@	Saudi Arabia	Under construction	Grid + on-site solar	300
Microsoft Azure KSA East	Microsoft	Saudi Arabia	Planned	Grid; 100% RE goal	245
Google Cloud	Google/CNTXT	Saudi Arabia	Operational	Grid; 100% RE matched	200
Elsewedy DC	Elsewedy Data Centers Gulf Data Hub	Egypt	Planned	Grid	192
Desert Dragon Riyadh & Jeddah	ICS Arabia/ Desert Dragon	Saudi Arabia	Under construction	Grid	187
Oracle Cloud Jeddah	Oracle	Saudi Arabia	Operational	Grid	175

Source: Rystad Energy research and analysis

Figure [2] : Top data center projects in MENA

Morocco

South Korea's Naver plans to build a 500-MW data centre in Morocco through a consortium that includes Nvidia, Nexus Core Systems, and Lloyds Capital. The project aims to deliver sovereign AI computing services across Europe, the Middle East, and Africa, leveraging Morocco's prime location – only 15 kilometres from Europe and linked by submarine optical cables. Construction is set to begin before the end of this year, with a 40-MW supercomputing phase featuring Nvidia's Blackwell (GB200) graphics processing units (GPUs), scaling progressively to 500 MW. A renewable supply agreement with UAE-based TAQA will power the project. US-based start-up Iozera.ai will also develop a 386-MW AI data centre in Tetouan, northern Morocco, near the Strait of Gibraltar, with a $500 million investment. The facility's power supply will be sourced from two renewable energy projects: the Noor Solar Power Complex and the Koudia Al Baida wind farm.

OUTLOOK

Deploying solar PV and other renewable projects to power data centres across the MENA region offers a transformative pathway to meet surging digital demand with sustainable, cost-competitive energy. The region's exceptional solar potential, exceeding 2,000 kilowatt-hours per square metre annually in countries such as Saudi Arabia, the UAE, and Egypt, combined with declining solar PV costs, enables hyperscale facilities to achieve almost 100% renewable operation, slashing carbon footprints by up to 90% compared with fossil fuels while hedging against volatile gas prices. This strategy bolsters energy resilience, aligns with national visions such as Saudi Arabia's Vision 2030 and the UAE's Net-Zero 2050 Strategy, and cements MENA's role as a global green data hub, fostering economic diversification through localised tech ecosystems and the integration of grid-enhancing storage.

DIVERSIFICATION THROUGH LOCALIZATION: MIDDLE EAST'S STRATEGIC SHIFT TO CLEAN ENERGY MANUFACTURING

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S&P Global

INTRODUCTION

Three years ago, it would have been difficult to imagine that major Middle Eastern economies, typically associated with oil and gas exports, would be installing solar and battery energy storage systems (BESS) at the rate they are today. Indeed, it would have seemed even less likely that the Gulf would become the new hub for clean energy technology supply chains outside China.

Nevertheless, some of the world's largest and most competitively priced solar and battery projects are being installed across Saudi Arabia, the UAE, and elsewhere in the region, with substantial investments planned in joint ventures to establish manufacturing facilities with the largest Chinese clean tech suppliers.

DRIVERS OF SOLAR AND STORAGE DEPLOYMENT

Over the past two to three years, there has been a surge in solar installations in the Middle East, driven primarily by large, utility-scale projects in Saudi Arabia and the UAE. Beyond these nations' ambitious 2030 targets, several key factors are driving this growth, including the sharp decline in the global Levelized Cost of Electricity (LCOE) and the reductions in utility-scale solar and BESS capital expenditure (CAPEX). Additionally, these countries benefit from high solar irradiance, abundant flat, sparsely populated land, and straightforward grid connections. Notably, 50% of Saudi Arabia's grid capacity still relies on oil-fired generation. Given the age and high operating costs of these facilities, the Kingdom is working to diversify its energy mix and free up oil for exports.

CHINA'S OVERCAPACITY AND THE MIDDLE EAST AS AN OVERFLOW MARKET

Furthermore, after years of sharp growth, the Chinese domestic solar market is approaching a plateau, resulting in overcapacity for solar component manufacturers and engineering, procurement, and construction (EPC) companies. Middle Eastern nations have relatively low domestic-content requirements and adopt less confrontational trade policies towards China than the US and EU, which have imposed heavy tariffs. PV tenders in these states are characterised by scale and efficiency, achieved through centralised and standardised project specifications that streamline bidding and minimise permitting constraints. As a result, the Middle East serves as an ideal overflow market for these large Chinese players.

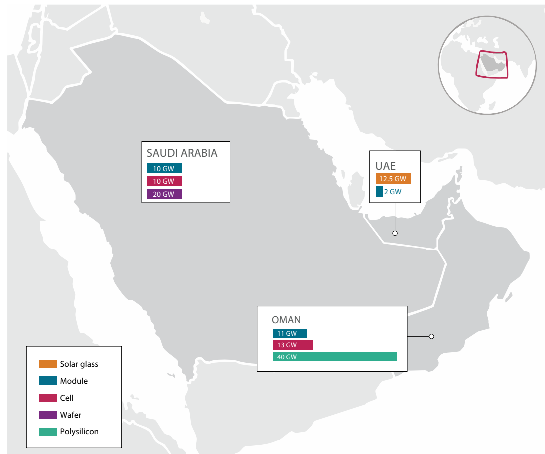
STRATEGIC SHIFT TOWARDS LOCALISATION

Conversely, Gulf countries are now seeking to onshore clean tech manufacturing. This marks a strategic shift away from oil and gas exploration while leveraging their close trade relationship with China. After decades of investment and research, China dominates almost every segment of both solar and battery supply chains. Approximately 90% of each node in the solar module supply chain is located in China, with the majority of the remaining facilities owned by Chinese companies.

Following the volatility of US tariff policy in 2025, China has moved to protect key industries, including rare earth and cathode production, by restricting exports. Moreover, if prioritising intellectual property protection becomes a key focus, it could benefit the Gulf states, as Saudi Arabia's 'Vision 2030' aligns closely with similar initiatives in the Middle East and with China's 'Belt and Road Initiative' (BRI), supported by strong diplomatic ties. Additionally, more than 40% of China's oil is exported from the Gulf. This could prove advantageous, as these states may be exempt from any clean-energy export controls Beijing introduces.

JOINT VENTURES AND MANUFACTURING INVESTMENTS

Joint venture agreements with leading clean tech suppliers are emerging in Saudi Arabia, the UAE, and Oman. In Saudi Arabia, Jinko Solar, the leading supplier of solar modules to the Middle East, is preparing to build 10 GW of both cell and module capacity in an effort to consolidate its position. Jinko and the Kingdom's Public Investment Fund (PIF) will each hold a 40% equity stake, with Vision Industries holding 20%. TCL is also planning a 20 GW wafer factory through its subsidiary Lumetech. Similar to the agreement with Jinko, PIF and TCL will each hold 40%, and Vision Industries will hold the remaining 20%. Hithium is also considering a BESS manufacturing facility in the Kingdom through a joint venture with MANAT, a local engineering and consultancy firm.



Data compiled Aug. 26, 2025.
Source: S&P Global Commodity Insights: 251566-03.

Figure [1] : MENA proposed suply chain developments

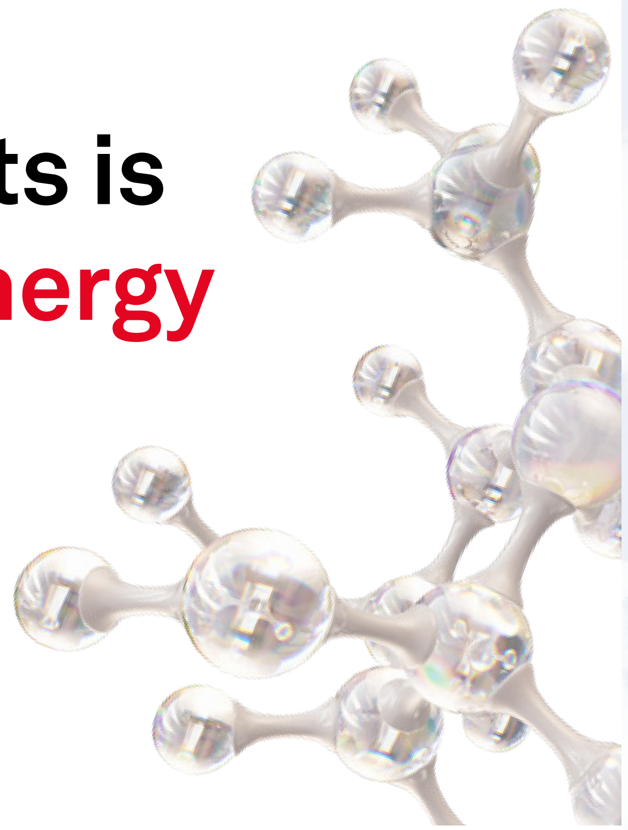
In Oman, there are similar plans for several gigawatts of cell and module capacity through joint ventures with JA Solar and other major players, as well as a 100,000-tonne polysilicon facility – currently under construction – that is being developed by United Solar Polysilicon in Sohar Freezone. This rapidly expanding port offers investor-friendly incentives, including 100% foreign ownership and extended tax holidays.

LATEST UPDATES ON LOCALIZATION ACROSS MENA

In the UAE, plans are underway for a 500,000-tonne solar glass facility to be built by China's Almaden, with completion expected by early 2027. Almaden cited the UAE's location, favourable logistics, free trade zones, and access to cheap energy as reasons for the expansion.

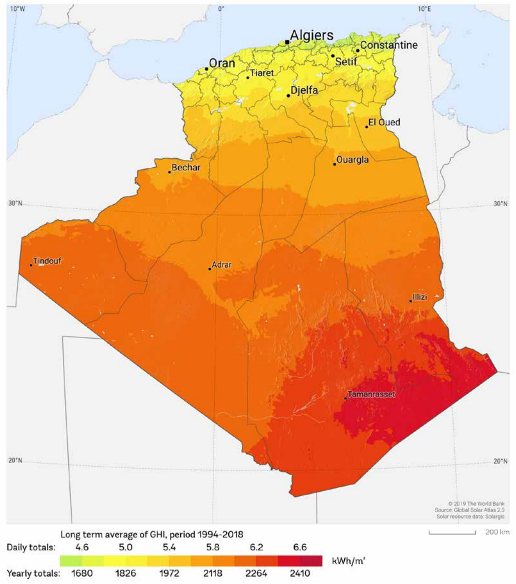
CONCLUSION

Although not all facilities are guaranteed to be completed, development is fast, and the overall aim is clear: the Gulf wants to be a leader in clean energy.



HIGHLIGHT ON MENASA SOLAR PV MARKETS

ALGERIA



RE Target by 2035	15,000 MW
RE Target by 2035	35%
RE Capacity	601 MW by 2024

Source: IRENA

CURRENT SITUATION

Algeria's renewable energy sector is shifting from slow progress to accelerated execution, driven by a national push to diversify the power mix and reduce the economy's long-term dependence on hydrocarbons. As of the end of 2023, Algeria's total installed renewable energy capacity was approximately 600.9 MW, including hydropower. This level of deployment remains modest when assessed against Algeria's stated medium- and long-term renewable energy targets, indicating a significant gap between policy ambition and implementation. Momentum picked up in 2025, with the government indicating plans to commission around 400 MW of solar by end-2025 as an initial milestone within a broader 3.2 GW rollout covering 22 PV plants nationwide. [1]

Over the longer term, Algeria's programme targets 15,000 MW of renewables by 2035, commonly framed as roughly 30% of the electricity mix, supported by a stronger institutional setup following the creation of a dedicated Ministry of Energy and Renewable Energies in September 2025. [2] [3]

Financing capacity remains central to delivery. Algeria announced a $60 billion energy investment plan for 2025–2029; while most of this envelope is oriented toward upstream oil and gas, the plan also explicitly references renewables as part of the diversification agenda, including the 3.2 GW renewables programme. [4]

REGULATIONS AND FRAMEWORK

MINISTRY RESTRUCTURING AND INSTITUTIONAL REORGANIZATION

In September 2025, the government separated the previously unified Ministry of Energy into two independent entities: the Ministry of Energy and Renewable Energies and the Ministry of Hydrocarbons and Mines. This structural change reflects the strategic priority Algeria now places on renewable energy development and signals a shift toward treating clean energy as a distinct policy domain rather than a secondary consideration within broader energy management. [3]

TAQATHY+ INITIATIVE: EU-ALGERIA STRATEGIC PARTNERSHIP

Algeria and the European Union launched the Taqathy+ Initiative in April 2025, a comprehensive framework for renewable energy transformation and green hydrogen development. This strategic partnership addresses three critical pillars: accelerating renewable energy deployment, developing green hydrogen production capabilities, and improving energy efficiency across industrial, agricultural, and residential sectors. The initiative is co-funded by the European Union and Germany, with €28 million allocated to support institutional capacity building, technical expertise development, and the establishment of frameworks to enable sustainable energy projects. [4] [5]

PROJECTS

El Ghrous Solar Power Plant – 200 MW

The El Ghrous facility, situated in Biskra Province, is one of the flagship projects within Algeria's 3,200 MW initiative. The plant was expected to reach full operational status before the end of 2025, contributing significantly to the government's goal of commissioning 400 MW of solar capacity in that year. [6]

Tendla Solar Power Plant – 200 MW

The Tendla facility, situated in El M'Ghair province, operates in parallel with El Ghrous as a twin project within the 3,200 MW program. Both plants were designed to reach operational status simultaneously, ensuring coordinated grid integration and maximizing the impact of Algeria's year-end 2025 commissioning targets. [7]

Gara Djebilet Solar Power Plant – 200 MW

Construction commenced in March 2025 for this major facility in Tindouf province, covering 400 hectares with integrated battery storage. Constructed by the Chinese company CRCC, the project is expected to reach completion in early 2027 and will supply clean electricity to the Gara Djebilet iron ore mining complex, supporting industrial decarbonization. [8]

El Abadla Solar Power Plant – 80 MW

El Abadla Solar Power Plant broke ground in March 2025. The project was scheduled for completion between December 2025 and January 2026 and features advanced control systems, including automated PV module cleaning. Once operational, the portfolio is expected to reduce annual CO_2 emissions by around 1.3 million tonnes and create approximately 439 jobs. [9]

Touggourt and Béchar Solar Tender – 520 MW

Sonelgaz, Algeria's national electricity and gas company, launched a national and international tender on January 8, 2025, for three new photovoltaic solar power plants with a combined capacity of 520 MW. 120 MW in Kenadsa (Béchar), 150 MW in Touggourt, and 250 MW in Timacine (Touggourt). [10]

17
HIGHLIGHT ON MENASA SOLAR PV MARKETS
ALGERIA

CHALLENGES & OUTLOOK

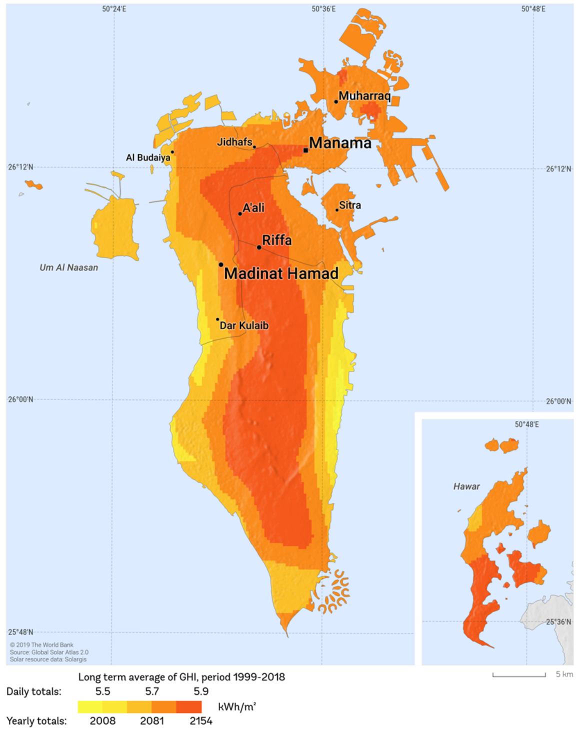
Algeria's rapid renewables buildout brings material grid and financing challenges. Integrating hundreds of MW of new solar by end-2025 and scaling to several GW through 2030 will require major transmission and distribution upgrades across multiple provinces, alongside stronger grid-management tools, storage, and flexible capacity to manage solar intermittency. Delivering the announced multi-year investment program (public + private) remains a key execution hurdle, even as the government promotes PPPs and taps additional channels such as EU-backed initiatives and bilateral partnerships, while project bankability and competition for capital remain ongoing constraints.

Notwithstanding these constraints, the medium- to long-term outlook remains constructive. Institutional commitment to renewable energy development is strengthening, and the project pipeline is relatively broad, with multiple identified sites for both solar and wind deployment. In parallel, Algeria's emerging green hydrogen strategy, supported by growing international partnerships, enhances its strategic positioning as a potential exporter of low-carbon energy to European markets. Progress beyond 2026 will largely depend on consistent financing, on-time execution, and continued international cooperation.

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9], [10]

Source: American School of Dubai 918 kWp

BAHRAIN



Total Power Capacity (2020)	8,781 MW
RE Target by 2025	255 MW
RE Target by 2030	700 MW
RE Installed Capacity	By early 2025 (82 MW)

Source: IRENA

CURRENT SITUATION

Bahrain is positioning itself as a regional clean-energy hub, backing its carbon-neutrality-by-2060 pledge with a growing portfolio of utility-scale, C&I, and distributed solar projects. The Electricity and Water Authority (EWA) is leading this shift through the National Renewable Energy Plan, which targets a higher share of renewables in the national energy mix (20% by 2035), supported by net metering, IPP tenders, and BOO models.

By early 2025, installed renewable capacity under the net metering scheme had reached ~82 MW across around 299 projects, with EWA expecting total renewable output to climb to ~300 MW within the next three years. In parallel, EWA is advancing several utility-scale solar tenders near Al Jazayer Beach, alongside the expansion of the Al Dur Renewable Energy Plant by 100 MW. [1]

PROJECTS

National Solar IPP – Al Jazayer Area (up to 150 MW)

On 8 August 2025, EWA announced the country's first large-scale solar power plant (~150 MW) in partnership with the private sector. Located in southern Bahrain near Al Jazayer Beach on a 1.2 km² site, the project will utilize latest-generation PV technologies and is designed to supply around 6,300 homes and cut more than 100,000 tCO_2/year. [2]

ASRY Solar Project – 44.5 MW (Floating & Rooftop PV)

On 8 August 2025, EWA announced the country's first large-scale solar power plant (~150 MW) in partnership with the private sector. Located in southern Bahrain near Al Jazayer Beach on a 1.2 km² site, the project will utilize latest-generation PV technologies and is designed to supply around 6,300 homes and cut more than 100,000 tCO_2/year. [3]

University of Bahrain Solar Plant – ≥44 MW

On 22 April 2025, Bahrain's Tender Board opened bids for a turnkey PV plant (≥44 MW) at the University of Bahrain campus, targeting around 75 GWh/year of clean electricity. The tender, issued by EWA, covers engineering, design, manufacturing, supply, installation, and commissioning, and forms part of a broader package that also includes new 66 kV transmission stations to meet rising nationwide demand. It attracted bids from eight companies, with the lowest bid at BD 2.4 million. [4]

C&I Rooftop & Distributed Solar Cluster

- **Delmon Poultry – Multi-Site Rooftop Solar**
  On 12 October 2025, Delmon Poultry signed an agreement with Kanoo Clean Max to deploy solar systems across its facilities. [5]
- **General Poultry Company – 1.5 MW PV (Hamala)**
  On 21 October 2025, General Poultry (a Mumtalakat subsidiary) signed a 15-year PPA with Kanoo Clean Max for a 1.5 MW rooftop PV plant at Hamala farms, expected to generate ~2,400 MWh/year, meeting up to 90% of its electricity needs and cutting >1,100 tCO_2/year. [6]
- **Euro Motors – 2.7 MW Rooftop & Car Park PV**
  On 13 May 2025, Euro Motors partnered with Positive Zero to implement a 2.7 MW solar system on rooftops and car parks at its Sitra facilities. The plant will generate around 4.7 GWh/year, reducing emissions by >3,100 tCO_2/year, with Midal Solar acting as EPC. [7]
- **Nasayem Arad Smart Villas – Solar-Ready Housing**
  On 5 May 2025, real estate developer Naseej signed an MoU with Almoayyed Solar to equip smart villas in the Nasayem Arad project with PV systems. One villa will be fully equipped as a showcase, while others are delivered with full solar-ready infrastructure, supporting long-term reductions in household operating costs and emissions. [8]

REGULATIONS & FRAMEWORK

MINISTERIAL RESOLUTION NO. 39 OF 2025 – PV REGULATIONS IN INDUSTRIAL ZONES

In April 2025, the Ministry of Industry and Commerce issued Ministerial Resolution No. 39 of 2025, amending the executive regulations of Law No. 28 of 1999 on industrial zones to explicitly regulate the installation of PV systems in industrial areas. The decision:

- Allows tenants to install PV systems on rooftops, façades, and parking canopies.
- Limits ground-mounted PV on unused open areas to ≤30% of total plot area.
- Aligns with the Industrial Sector Strategy (2022–2026) and the National Action Plan for carbon neutrality.
- Supports initiatives such as the "Green Factory Label" and the "Industrial Transition Accelerator" to promote green production and enhance export competitiveness. Source:[9]

DRAFT RENEWABLE ENERGY LAW – COMPREHENSIVE SECTOR FRAMEWORK

The Shura Council is reviewing a draft renewable energy law (referred in May 2025) that sets an integrated framework for:

- Exporting surplus renewable electricity to the grid.
- Setting annual interconnection limits and technical standards.
- Regulating net metering, feed-in tariffs, EV charging from renewables, and distributed generation sizes.
- Establishing a comprehensive registry of producers and approved equipment, along with clear inter-connection procedures and grievance mechanisms. Source:[10]

CHALLENGES & OUTLOOK

- Land constraints: Limited available land for large-scale solar and wind farms, increasing the importance of rooftops, car parks, and innovative solutions like floating PV.
- Intermittency and integration: Need for grid upgrades and smart systems to manage intermittent PV generation and increasing distributed capacity.
- Uptake barriers: Encouraging wider adoption of rooftop solar under net metering amid awareness, technical, and economic constraints.

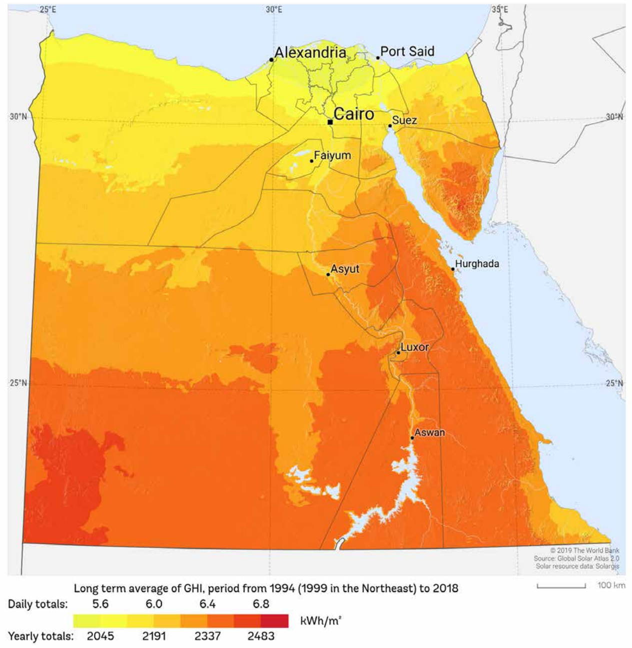
Bahrain's renewable energy sector is entering a scaling phase, driven by a clear regulatory framework, active net metering, and a growing pipeline of utility-scale and C&I projects. EWA's plan to deliver 350–380 MW of solar capacity within three years—alongside feasibility studies for offshore wind and floating PV—positions the Kingdom to move steadily toward its 300 MW near-term target and longer-term carbon-neutrality goals.

With strong private-sector participation (ASRY, Euro Motors, Naseej, poultry sector players), structured PPP/BOO models, and supportive legislation, Bahrain is on track to expand its clean-energy share, enhance energy security, and strengthen its role as a regional model for integrated renewable-energy development. [11]

Source:

[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11]

EGYPT



RE Capacity	8,031 MW By June 2025
RE Target by 2030	42%
RE Target by 2040	60%

Source: Egypt's Ministry of Electricity and Renewable Energy

CURRENT SITUATION

Egypt's renewable energy sector is firmly in an acceleration phase, as the government fast-tracks new clean capacity to meet rising electricity demand, strengthen grid reliability, and reduce dependence on fossil fuels. Official planning targets indicate the renewables share is expected to rise to ~16% in FY 2025/26, up from ~11.5% in FY 2023/24—a meaningful step-up, even as the power system remains heavily reliant on natural gas.

This momentum aligns with Egypt's strategic direction to reach 42% renewables by 2030, supported by continued transmission/grid upgrades and a stronger emphasis on enabling investment. Toward the end of 2025, the sector also saw regulatory and legislative updates under the broader modernization agenda—aimed at improving sector performance and market structure—without changing the overall trajectory toward faster renewables integration.

The scale of investment is unprecedented. The Ministry of Electricity's investment plan for 2024-2025 includes allocating substantial public investments of approximately EGP 100 billion (USD 2 billion) to implement 48 vital projects in the electricity sector. Complementing this public sector commitment, the government has set an ambitious target to attract an additional EGP 100 billion (approximately US$2 billion) in private sector investment over the next two years to support the establishment of new clean energy projects. Combined, these public and private investments totaling approximately EGP 200 billion (USD 4 billion) represent an unprecedented commitment to energy sector transformation. [1], [2], [3], [4]

REGULATIONS & FRAMEWORK

NET-METERING SYSTEM CANCELLATION

A policy change was reported in late 2025 regarding compensation for distributed solar generation. Egyptian media and industry statements cited an announcement by the electricity regulator indicating that the net metering mechanism would no longer be applied starting 31 December 2025.

Based on the same reports, the post–net metering direction has been described broadly as shifting toward self-consumption; however, no detailed technical framework or implementation rules for the alternative mechanism had been published at the time of reporting. [5]

PROJECTS

Kom Ombo Solar Power Plant – 500 MW

Completed in May 2025 by China Energy Construction, this massive photovoltaic facility has an installed capacity of 560 MW and includes over one million photovoltaic panels. The plant is expected to supply approximately 256,000 Egyptian households annually while reducing carbon dioxide emissions by 760,000 tons annually. [4]

Ras Ghareb Wind Power Project – 200 MW

Egypt is moving forward with a 200 MW wind power project in Ras Ghareb (Gulf of Suez) developed by Infinity Power in partnership with Masdar. Announced in May 2025, the project advanced through financial close during 2025, and construction was reported as underway with POWERCHINA as EPC. It is expected to start operations in 2027, generating around 810,000 MWh/year, powering 300,000+ homes, and avoiding about 390,000 tons of CO_2 annually. [6], [7], [8]

Abydos 2 Solar Power Project – 1,000 MW + 600 MWh Storage

Implemented by AMEA Power, this 1,000 MW solar project with 600 MWh battery storage is scheduled for completion in June 2026. The integrated storage capacity represents one of the largest for renewable energy projects in the region. [9]

Opelec Photovoltaic Solar Power Project – 1 GW + 200 MWh Storage

The African Development Bank approved $184.1 million in financing for this 1 GW solar project in Qena Governorate with 200 MWh battery storage in June 2025, which is considered the largest of its kind in Africa. Expected to be operational in Q3 2026, the project will generate 2,772 GWh annually and reduce emissions by approximately one million tons annually. [10]

State Grid Solar Power Plants – 900 MW

On 19 June 2025, Egypt's Cabinet approved an offer from China's State Grid to develop two new solar power plants totaling 900 MW: a 500 MW project in Minya Governorate and a 400 MW project in the Oases (Western Desert). [11]

Sunrev Solar Integrated PV Manufacturing Complex (Ain Sokhna, Egypt) – 4 GW

On 18 June 2025, Sunrev Solar (China) and TEDA–Egypt agreed to develop a US$200 million integrated solar manufacturing complex in Ain Sokhna (SCZONE). Phase 1 (US$90 million) will build 2 GW solar cell and 2 GW solar module production lines, while Phase 2 (US$110 million) targets upstream localization, including silicon ingots and wafers. [12]

Egypt Aluminum Complex Solar Project – 1,000 MW + 200 MWh Storage

By the end of July 2025, Scatec started building a 1,000 MW solar project with 200 MWh battery storage for the Egypt Aluminum Company in Naga Hammadi, supported by an estimated US$650 million investment. The project will be completed within 24 months in two phases of 500 MW each. [13]

State Grid Minya and Western Desert Projects – 900 MW

The final contracts for two solar power projects with a combined capacity of 900 megawatts were signed by the end of July 2025, with actual implementation phases commencing in the last quarter of 2025. The projects will be located in the Minya region of Upper Egypt and the Western Desert oases. [14]

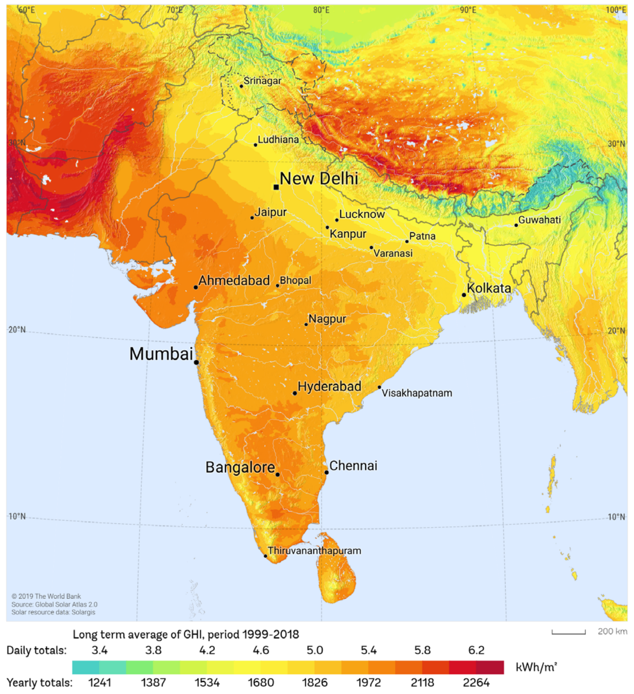
CHALLENGES & OUTLOOK

Egypt's renewable-energy scale-up is progressing fast, but grid integration remains the key constraint: adding large volumes of variable solar and wind increases the need for transmission upgrades, modern grid management, and flexibility options (including storage) to maintain reliability as demand grows. At the same time, the system is still gas-dominant, so the transition is as much about system stability and dispatchability as it is about adding new renewable capacity.

For the distributed generation (DG) market, policy clarity is becoming a decisive factor. Industry and media reports in December 2025 cited the regulator's decision to end the application of net metering from 31 December 2025, which would materially change the economics for rooftop/behind-the-meter solar that relied on export settlement. Egypt already has self-consumption frameworks for solar PV under EgyptERA/NREA documentation (i.e., rules that govern self-consumption projects and related circulars), but there has been no published technical detail (in the same reporting) on the replacement mechanism—including whether a structured self-consumption + storage regime will be formally issued, how surplus energy would be treated, or what settlement/connection requirements would apply. As a result, the DG outlook is directionally shifting toward maximizing on-site consumption (and potentially adding storage), but the practical market impact will depend on the still-unclear implementing rules.

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14]

INDIA



Total RE Installed Capacity in 2025	250.643 GW
Solar installed Capacity	129.924 GW
RE Target by 2030	500 GW

Source: Ministry of Power

CURRENT SITUATION

India has crossed the halfway mark for non-fossil power. As of 30 September 2025, total installed capacity reached 500.89 GW, with 250.643 GW (51%) from non-fossil sources (solar 129.924 GW, wind 53.600 GW). Rapid build-out is exposing grid constraints—solar curtailment averaged ~12% in October 2025 and peaked much higher on some days, highlighting the need for storage and flexible procurement (RTC/FDRE) to absorb midday generation and shift supply to evening peaks.

The market is pivoting from pure capacity additions toward integration. Annual installs remain strong, but rising curtailment highlights transmission and flexibility gaps, driving urgency for storage, ancillary services, and more flexible thermal or gas turndown systems. BESS is scaling but remains nascent, with high capital expenditures and evolving revenue streams. DISCOMs' financial health remains the core execution and offtake risk, compounded by land and permitting frictions and import dependence on upstream components (cells, wafers). In terms of supply chains, ALMM protects domestic manufacturers but can constrain near-term supply flexibility, while PLI offers a credible path to upstream manufacturing resilience. [1]

REGULATIONS & FRAMEWORK

SECI'S FDRE (FIXED/DISPATCHABLE RE) ENABLED LOAD-TRACKING PPAS

SECI operationalized FDRE guidelines, allowing "load-following" PPAs that require developers to combine solar, wind and storage to deliver firm, hourly-profiled renewable power over 25 years—moving beyond simple energy-only PPAs. [2]

GREEN OPEN ACCESS (GOA) ENFORCEMENT TIGHTENED

India's Green Energy Open Access (GEOA) framework has seen rapid uptake, with 23 states implementing the rules by May 2025. The 2022–23 reforms—lowering the threshold to 100 kW and clarifying banking and charges—opened the market for C&I consumers to procure renewables more competitively. This drove strong growth, with C&I open access capacity rising 46% annually between 2022 and 2024, led by Gujarat, Tamil Nadu, Karnataka, Maharashtra, and Rajasthan. While challenges remain, including uneven state policies and uncertainty around the ISTS waiver, GEOA has strengthened competition and accelerated India's shift toward cleaner, more flexible energy options. [3]

PROJECTS

ReNew 2.8 GW Hybrid (Andhra Pradesh)

As announced May 18 2025, ReNew (formerly ReNew Power) is set to build a 2.8 GW hybrid—1.8 GW PV + 1 GW wind—paired with ~2 GWh BESS to deliver up to ~4 hours of firm power during peaks. The plan expands ReNew's ISTS-connected pipeline and targets grid-supportive, peak-shaping supply for DISCOMs in AP. Status: investment intent filed; site and ISTS tie-in studies underway in AP's wind–solar resource zones; staged commissioning expected between 2026 and 2028. [4]

Alterra–Evren Co-Investment (Rajasthan & Andhra Pradesh) — up to 11 GW PV/Wind + Storage

On April 29, 2025, Alterra's Acceleration Fund committed US$100 million alongside Brookfield to Evren to co-develop up to 11 GW of utility-scale solar, wind, and hybrid projects with BESS across Rajasthan and Andhra Pradesh. The pipeline targets ISTS-connected assets structured under long-tenor central/SECI PPAs (RTC/FDRE-style), with phased delivery aligned to state and national capacity auctions. The program is designed to localize supply chains, enable peak-shaping and load-tracking delivery, and accelerate bankable storage integration; initial tranches are expected to reach financial close on a rolling basis from 2026 [5]

TPREL–Andhra Pradesh MoU — ~7 GW

On 8 Mar 2025, Tata Power Renewables signed an MoU with the Government of Andhra Pradesh under the Integrated Clean Energy (ICE) policy to explore ~7 GW of utility-scale PV, wind and hybrid assets with co-located storage. [6]

CHALLENGES & OUTLOOK

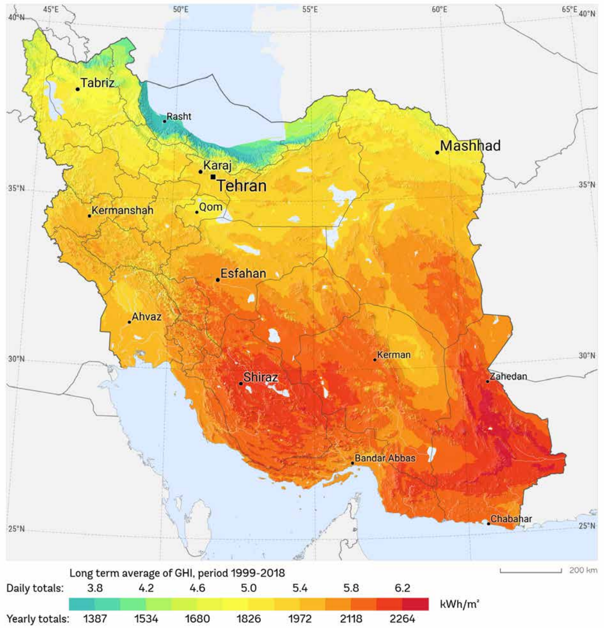
India's solar power sector is encountering a set of structural constraints as capacity expansion accelerates. The pace of photovoltaic (PV) deployment has exceeded the current flexibility of the power system, leading to increasing levels of generation curtailment. Curtailment rates averaged approximately 12% toward the end of 2025, with intra-day peaks reaching as high as 40%. These trends underscore the growing requirement for large-scale energy storage, enhanced ancillary service markets, and improved operational flexibility of thermal and gas-fired generation to enable effective ramp-down and system balancing.. While India has launched a multi-GW BESS pipeline, the sector is still emerging. High capital costs, evolving performance guarantees, and unclear revenue-stacking models (peak arbitrage, ancillary markets) continue to delay scale-up despite government incentives like ISTS waivers and viability gap funding (VGF).

At the execution level, weak financial health of state distribution companies remains a major bottleneck. Although tendering has surged, project delays due to permitting issues, land acquisition, and payment backlogs, now estimated at D5.8 lakh crore, expose developers to significant off-take and cash-flow risk. Even with newer contract structures like FDRE (Firm Dispatchable Renewable Energy) and RTC (Round-the-Clock), financial risk isn't fully mitigated. Transmission constraints are also surfacing: nearly 50 GW of renewables now face evacuation delays due to the slower expansion of interstate transmission infrastructure. For example, Rajasthan alone reported 8 GW of stranded RE capacity in mid-2025. Additionally, India's domestic solar manufacturing push, supported by ALMM and PLI schemes, is progressing but still depends heavily on imported cells and wafers, limiting supply-chain resilience.

Looking ahead, India is transitioning from raw megawatt additions toward dispatchable, profile-matched renewables. FDRE and RTC tenders are now a core part of procurement strategy, driving hybrid solar-wind-storage projects that enhance reliability and minimize curtailment. States like Maharashtra, Gujarat, and Andhra Pradesh are leading large-scale BESS procurements, setting the stage for nationwide storage adoption. The commercial and industrial (C&I) solar segment is also booming—India added 6.1 GW of C&I solar between January and September 2025, with total installations expected to reach 60–80 GW by 2030. While the policy framework is robust, execution challenges—especially state-level regulatory clarity, permitting, and payment enforcement—will determine whether India meets its renewable energy targets in the years ahead.

Source:
[1], [2], [3], [4], [5], [6].

IRAN



RE Target by 2027	20 GW
RE Capacity in November 2025	3,165 MW
Solar Energy Target by 2031	50 GW

Source: Intellinews, tvbrics

CURRENT SITUATION

In Iran's renewable energy sector is transitioning from ambition to accelerated execution, driven by an acute domestic energy crisis and a strategic push to diversify the power mix. By end-2025, grid-connected renewable capacity reached approximately 3.165 GW, up from 1.45 GW in early 2025, representing a 2.5x expansion within a single year. However, renewables still account for only about 3.2% of Iran's 94.5 GW national generation mix, underscoring the scale of the transition ahead.

The regional war and subsequent escalation around the Strait of Hormuz, which escalated in June 2025 and intensified in October 2025, has not caused direct physical damage to renewable energy infrastructure but has significantly exacerbated pre-existing constraints. Sweeping sanctions on Iran's energy exports announced in October 2025, coupled with heightened geopolitical risk, have deterred foreign direct investment and complicated supply chains for essential renewable energy components. The conflict has paradoxically intensified the government's urgency to develop renewable energy as a strategic necessity to address domestic power shortages and reduce reliance on fossil fuels increasingly subject to sanctions. [1], [2], [3]

REGULATIONS & FRAMEWORK

MANDATORY 20% RENEWABLE REQUIREMENT FOR STATE ENTITIES

In January 2025, the cabinet issued a directive mandating that all government buildings must generate at least 20% of their annual electricity consumption through rooftop solar photovoltaic (PV) systems, with implementation at the beginning of the Iranian calendar year (March 21). Once these rooftop arrays are commissioned, buildings are required to fully disconnect from the national grid. [4]

GOVERNMENT OFF-GRID SOLAR INITIATIVE – 11.5 GW BY 2026

Unveiled in April 2025, the "2026 Renewable Capacity Expansion Program" mandates every government building—then schools, universities, and sports venues—to install rooftop PV and exit the national grid. SATBA will channel US $5bn in sovereign-fund loans to finance arrays and has already cleared 35 GW of solar-wind projects; the near-term goal is an 11.5 GW solar boost by March 2026, lifting renewables from 1.8 % to about 12 % of generation. The plan is expected to spur 120,000 jobs and cut CO_2 by 20 Mt / yr while providing a bankable template for industry and rural electrification. [5]

PROJECTS

Five-Province Distributed Solar Build – 297 MW

SATBA reported that a $90 million programme moved into execution when construction was launched on 26 May 2025 for 99 modular solar plants (3 MW each) totaling 297 MW. The plants are distributed across Golestan (96 MW), Bushehr (90 MW), Fars (54 MW), Kish Island in Hormozgan (30 MW), and East Azerbaijan (27 MW). [6]

Solar Capacity Additions – 250 MW

During an inauguration cycle in mid-October 2025, Iran announced the commissioning of 250 MW of new solar capacity, including the 40 MW Aras Talar Amir plant in the Aras Free Zone (East Azerbaijan), described as one of the larger private-sector projects, with reported investment of over $14 million. [7]

Solar-Powered Industrial Parks Programme – 3,000 MW

A January 2025 update from ISIPO stated that 24 specialized solar industrial parks had been approved, with four already operational and offering land to investors. The same update referenced industrial parks consuming about 3,000 MW during autumn demand and outlined enabling measures, including 124 priority grid projects (e.g., line extensions and substations) and 115 "solar zones" inside existing industrial parks spanning roughly 5,158 hectares. [8]

Additional Solar Projects Initiated – 450 MW

During the same national solar inauguration ceremony reported in October 2025, Iranian authorities also announced the start of "execution operations" for a further 450 MW of solar plants, described as moving these projects into the on-the-ground implementation phase (launched via a video-linked ceremony). Public reporting emphasized the government's intent to remove bottlenecks and accelerate delivery, but did not provide a complete technical breakdown for the 450 MW package at the time of the announcement. [9]

Permits For 100 GW Solar Power Projects

In December 2025, SATBA announced the issuance of permits for 100 GW (100,000 MW) of solar power projects, a dramatic increase from the previously reported 29 GW figure. Deputy SATBA official Jafar Mohammadnejad Sigaroudi noted that only approximately 15% of issued permits are expected to translate into actual generation capacity, indicating a realistic conversion rate of roughly 15 GW from the 100 GW permit portfolio. This permitting expansion is designed to attract private sector investment and accelerate the renewable energy transition. [4]

CHALLENGES & OUTLOOK

Iran's renewable-energy transition is constrained by a mix of domestic market distortions and external risk factors. On the domestic side, heavily subsidized energy prices weaken the business case for efficiency and clean alternatives; policy analyses commonly estimate Iran's energy subsidies at roughly 10–12% of GDP. Fuel pricing illustrates the distortion: even after recent adjustments, gasoline remains highly subsidized under tiered pricing, with low administered rates for quota volumes. Seasonal fuel and power imbalances also affect system performance; in late 2025, Iranian reporting described renewed reliance on heavy fuel oil (mazut) at some power plants during shortages.

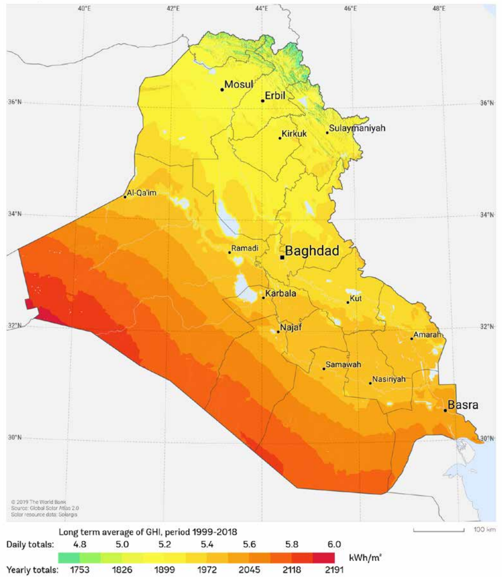
Externally, sanctions and restricted banking channels continue to limit access to project finance, imported equipment, and standard insurance/shipping services—often amplified by "over-compliance" and de-risking behavior among international firms. These constraints were compounded by the June 2025 regional war and subsequent escalation around the Strait of Hormuz, which increased perceived country risk and raised war-risk insurance costs for shipping in the region, adding friction to already complex logistics.

Despite these headwinds, the project pipeline is being actively promoted. In mid-December 2025, SATBA officials stated that permits/licenses were issued for nearly 100 GW of solar projects to encourage private participation—while separate industry reporting cautioned that actual realization will depend on financing, infrastructure readiness, and execution capacity (i.e., permits do not automatically translate into operating plants).

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9]

Source: United Foods - 2 MWp - Dubai, UAE

IRAQ



RE Capacity by 2022	1,599 MW
Solar Target by 2030	12,000 MW
RE Target by 2030	33%

Source: IRENA, Solarabic Database

CURRENT SITUATION

In 2025, Iraq's energy sector continues to struggle with a legacy of conflict, underinvestment, and systemic governance hurdles. The residential sector drives approximately 68% of total energy consumption, creating a massive supply-demand gap that is exacerbated by extreme summer temperatures. Because the national grid cannot consistently meet peak demand, widespread load shedding has become the norm. This forces households and businesses to rely on costly, polluting private generators—a fragmented solution that drains the economy without improving national infrastructure. This crisis is compounded by a structural deficit: electricity is sold at tariffs far below the cost of production, leaving the state with insufficient revenue to modernize networks, improve metering, or reduce its risky dependence on imported fuel and external energy inputs.

To address these vulnerabilities, Iraq is pivoting toward solar energy as a pragmatic pillar of national security rather than a marginal supplement. The economic logic is undeniable: solar production costs have dropped to between 2 and 3 cents/kWh, a stark contrast to the 9 cents/kWh required for conventional government-supplied power. This cost-efficiency, combined with the ability to deploy daytime capacity quickly, makes renewables the most viable path to reducing expensive liquid-fuel consumption. By targeting 12,000 MW of solar capacity by 2030, Iraq aims to transition from a fragile, fossil-fuel-dependent system to a more resilient grid. When paired with storage and flexible generation, this shift promises to stabilize the power supply and provide a sustainable foundation for the country's long-term reconstruction. [1]

REGULATIONS & FRAMEWORK

NATIONAL SOLAR STRATEGY AND 10,000 MW OPPORTUNITY

The Ministry of Electricity confirmed a strategic direction to diversify energy sources, announcing new investment opportunities for up to 10,000 MW in solar, wind, and waste-to-energy projects. These projects are backed

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HIGHLIGHT ON MENASA SOLAR PV MARKETS
IRAQ

by international guarantees and financing from global banks, including approval from the World Bank, which enhances investor confidence. This massive pipeline is a key component of the government's plan to add 24,000 MW of total capacity. [2]

UPDATE TO THE CENTRAL BANK OF IRAQ'S RENEWABLE ENERGY INITIATIVE

In April 2025, the Central Bank of Iraq revised its 2022 renewable energy finance scheme, capping each advance to participating banks at IQD 300 million and setting loan tenors up to 7 years, including a 6-month grace period. The Central Bank policy rate is fixed at 0.5%, with participating banks permitted to apply a margin of up to 2.5%. Accredited banks retain responsibility for monitoring project implementation and for reporting on beneficiary compliance. Financing applications are submitted either through a dedicated online portal or directly via participating financial institutions, with funds disbursed to approved companies supplying renewable energy systems. [3]

GOVERNMENT BUILDING SOLARIZATION PROGRAM

The government approved a comprehensive plan to equip 534 government buildings with integrated solar power systems in the first phase, with a strategic goal of converting approximately 5,000 federal buildings into environmentally friendly structures by 2026. This initiative aims to reduce the load on the national grid and redirect saved energy to the residential sector. [4]

STREAMLINED IMPLEMENTATION AND QUALITY CONTROL

To ensure quality and accessibility, the Ministry of Electricity has qualified 54 local companies to install residential solar systems. Citizens can apply for loans and select accredited companies through the "Ur" digital platform, which provides transparency on technical proposals and prices, along with a mandatory five-year warranty on components. [5]

PROJECTS

Total & ACWA Power Solar Projects – 2,000 MW (Basra & Najaf)

Iraq is preparing to launch two massive utility-scale solar projects totaling 2,000 MW, with Total operating two 500 MW plants in Basra and ACWA Power overseeing a 1,000 MW plant in Najaf. These projects, expected to be completed within two years, represent the core of Iraq's utility-scale solar ambition. [6]

UGT RENEWABLE Mega-Project – 3,000 MW (US-UK Partnership)

The Ministry of Electricity is advancing a colossal project with the American-British company UGT RENEWABLE (or UGG) to establish solar power plants with a combined capacity of 3,000 MW in addition to 500 MW of storage capacity. [7]

Shams al-Basra Solar Power Plant – 1,000 MW

Prime Minister Mohammed Shia al-Sudani laid the foundation stone for the 1,000 MW "Shams al-Basra" project on July 27, 2025. This massive project, a partnership with TotalEnergies, is designed to house two million solar panels, with the first 250 MW unit scheduled to become operational before the end of the year. [8]

Sulaimaniyah Solar Power Plant – 50 MW (Kurdistan Region)

The city of Sulaimaniyah announced the imminent launch of a 50 MW solar power plant on May 21, 2025, making it the largest of its kind in the Kurdistan Region and across Iraq. This project, implemented by a local cement manufacturing company, solidifies Sulaimaniyah's position as a leading center for renewable energy utilization and represents a substantial addition to the region's existing 20 MW of distributed solar capacity. [9]

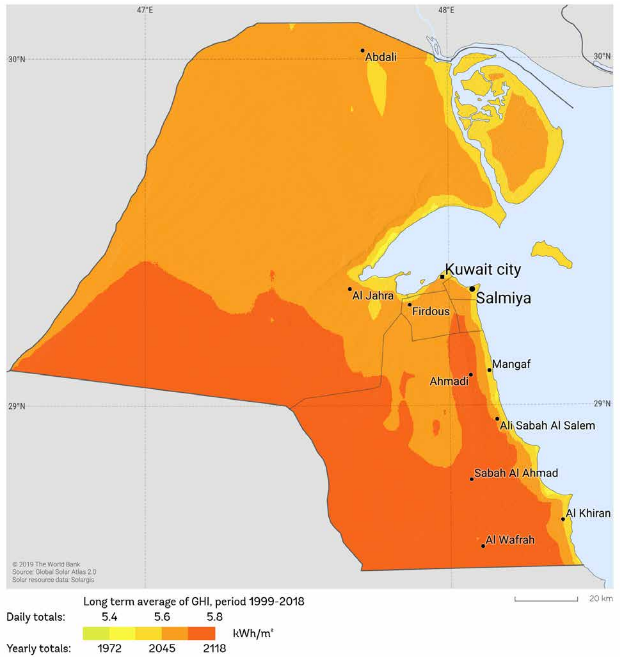
CHALLENGES & OUTLOOK

The primary obstacle to Iraq's energy transition lies in legislative ambiguity and a lack of clear regulatory frameworks for grid connectivity. While the National Investment Law exists, bureaucratic overlaps and complex procedures create significant execution challenges for both individual and institutional projects. This is exacerbated by financing constraints; although the Central Bank of Iraq introduced low-interest initiatives (0.5%–3% over seven years), the high upfront capital required for solar panels and components remains a barrier. Specifically, energy storage costs—exceeding $300/kWh—make systems unaffordable for the average citizen without more robust government subsidies. Technically, smaller stations (under 30 MW) connected to 11kV and 33kV distribution feeders face operational risks, as these feeders are subject to scheduled load shedding and possess weaker protection systems compared to the high-voltage (132kV) grid.

Despite these hurdles, the strategic outlook is anchored by a fundamental shift in government policy toward incentivizing private and foreign investment. To build investor confidence, the government has introduced sovereign guarantees, customs duty exemptions for 10 years, and land lease rates capped at 1% of their actual value. The roadmap toward 12 GW by 2030 is further supported by the planned "solarization" of 6,000 government buildings by 2026, which aims to reduce the load on the national grid. By modernizing control centers and deploying smart meters, the Ministry of Electricity intends to improve collection efficiency and grid stability. Ultimately, transitioning to solar is a pragmatic necessity to mitigate the impacts of dust and high temperatures on traditional generation and to ensure long-term energy security. [10]

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9], [10]

KUWAIT



RE Target by 2030	15%
Solar Energy's share of the total Installed Capacity by 2022	0.4%
Solar Installed Capacity by 2023	114MW

Source: Solarabic Database

CURRENT SITUATION

Kuwait is advancing its clean-energy strategy through large-scale renewable projects centered around the Shagaya Renewable Energy Complex. The Ministry of Electricity, Water and Renewable Energy (MEWRE) is accelerating public-private partnership (PPP) programs to diversify power generation, reduce dependence on fossil fuels, and strengthen long-term energy security.

As of mid-2025, Kuwait is progressing with multiple utility-scale projects—most notably the Al-Dibdibah and Shagaya Phase III developments—which raise the total announced renewable capacity to more than 5.1 GW. Distributed solar adoption is also increasing, including around 20% of South Abdullah Al-Mubarak streetlights now powered by solar energy, along with standalone systems deployed on Bubiyan Island. These initiatives support grid efficiency and align with Kuwait's broader push toward sustainable urban infrastructure.

Kuwait is also addressing rising electricity demand and recent supply pressures. The government announced plans to add 14.05 GW of new power capacity and 228 million gallons per day of desalinated water by 2031, including major IPP projects such as Al-Zour North, Al-Khiran, and the giant Nuwaiseeb complex. These combined efforts strengthen the country's long-term Vision 2035 energy diversification pathway.1

PROJECTS

Al-Dibdibah – Project 2 (500 MW)

On May 19, 2025, KAPP and MEWRE launched the prequalification process for a 500 MW utility-scale solar project within the Shagaya Renewable Energy Complex. The project will be developed under a 30-year PPA model, covering full design, financing, construction, operation, and maintenance responsibilities by the private sector. [2]

Al-Dibdibah Solar Project – Phase III (1,100 MW)

On June 15, 2025, KAPP and MEWRE invited qualified investors to bid for the 1,100 MW Al-Dibdibah project under a PPP model. The winning developer will sign a 30-year PPA and undertake full lifecycle responsibility for financing, construction, operation, and maintenance.

Major consortia—ACWA Power, AEPCO, EDF, Jinko Power, Masdar, and others—were prequalified. Bid submissions are due September 14, 2025. [3]

Shagaya Phase III – 4,500 MW Pipeline

The PPPPA is preparing tender documents for the first project of Shagaya Phase III, expected to deliver at least 4,500 MW using PV and CSP technologies. Prequalified companies were announced in August 2024, with tendering and awarding procedures expected to begin soon as Kuwait moves to accelerate its largest-ever solar program. [4]

REGULATIONS & FRAMEWORK

In May 2025, NBK issued its first report on Kuwait's inaugural USD 500 million green bonds (2024 issuance). Eligible green assets reached USD 625 million, distributed as: 76% green buildings, 17% renewable energy, 7% clean transportation.

The initiative avoided 85,000 tCO_2 and supported 3.8 million+ MW of renewable capacity, positioning financial institutions as key contributors to the national sustainability agenda. [5]

CHALLENGES & OUTLOOK

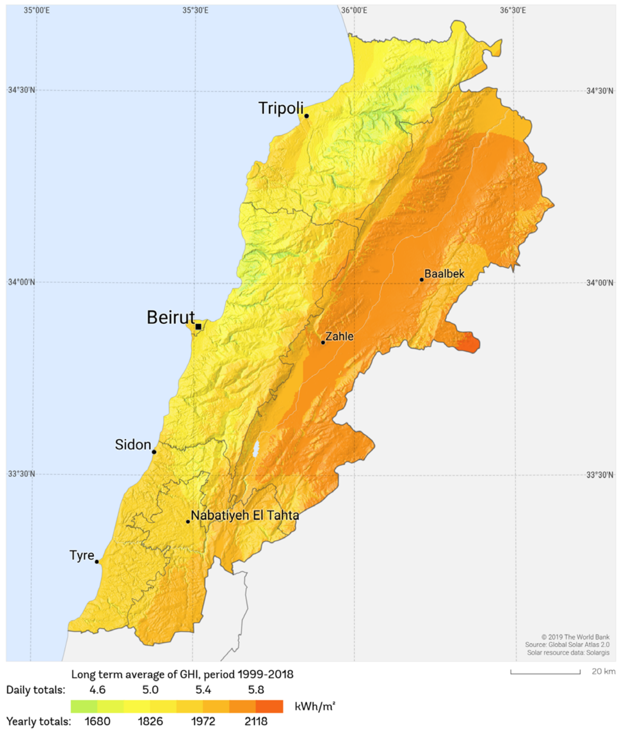
- Rising peak electricity demand is driven by population growth and extreme temperatures.
- Transmission upgrades are required to integrate the large volumes of solar capacity expected at Shagaya.
- PPP project timelines are slowed by extensive tendering and qualification cycles.
- Limited diversification beyond PV, particularly when compared to regional peers.

Kuwait's renewable-energy program is entering a pivotal expansion phase. The 5.1 GW pipeline—led by Al-Dibdibah, Shagaya Phase III, and supporting grid infrastructure—positions the country to scale clean energy alongside major conventional capacity additions.

The government's commitment to delivering 14.05 GW of new capacity and 228 MIGD of desalination by 2031 underscores growing investment in grid resilience and energy diversification
With active participation from leading global developers and strengthened green-finance frameworks, Kuwait is well poçsitioned to advance its Vision 2035 goals. Continued focus on transmission readiness and streamlined PPP processes will be essential to meeting future demand and enhancing long-term energy security.

Source:
[1], [2], [3], [4], [5]

LEBANON



RE Target by 2030	30%
RE Target by 2030	3,000 MW
Solar Capacity by 2024	1.190 MW

Source: IRENA & LCEC

CURRENT SITUATION

Lebanon's power sector remains in severe crisis, with state electricity often unavailable for most of the day. This has transformed decentralized solar PV from an economic option into a critical energy-security necessity, especially after the government removed fuel subsidies in 2022.

A rapid, storage-coupled solar boom followed, adding roughly 777 MW in just two years (2021-2022) and surpassing 1,000 MW of total installed capacity by the end of 2023. Batteries were integrated into about 65% of new systems, highlighting a focus on resilience.

Lebanon's national 2025–2030 strategy reaffirms the target of achieving 30% renewable electricity by 2030. Alongside this distributed growth, the government is advancing plans for utility-scale projects, including a 300 MW solar program with 210 MW of battery storage. [1]

REGULATIONS & FRAMEWORK

SOLAR PERMITTING SIMPLIFICATION (<1.5 MW)

On April 3, 2025, the Minister of Energy and Water announced that solar installations under 1.5 MW would be exempt from the requirement for ministerial approval, reducing administrative barriers and supporting faster private and C&I adoption. [2]

WORLD BANK-LINKED REFORM AND GRID/RE SUPPORT TRACK

On October 8, 2025, Lebanon signed two World Bank loan agreements to fund a renewable energy and electricity grid improvement project. The signing included Lebanon's finance and energy ministers, the head of the state power company (EDL), and the Litani River Authority.

Finance Minister Yassin Jaber stated the loan will primarily upgrade the grid and develop solar projects.

He emphasized that implementing the new electricity law—especially measures enabling private-sector participation in distribution, billing, and generation—is essential for transforming the power sector. [3], [4]

PROJECTS

Utility-Scale Solar PPAs – CMA CGM / Merit Invest (45 MW)

On September 23, 2025, the Ministry of Energy and Water signed PPAs with Merit Invest (CMA CGM Group) to activate three licensed solar PV projects of 15 MW each (total 45 MW) across Mount Lebanon, North Lebanon, and the Bekaa. These projects are expected to connect to the EDL-managed grid and are part of the broader effort to convert previously issued solar licenses into bankable, executable generation assets. [5]

ESCWA / REGEND Rural Solar – Al-Nibras Complex (155 kWp + 155 kWh)

On August 1, 2025, the Islamic Orphanage and ESCWA inaugurated a 155 kWp PV system with 155 kWh lithium storage at the Al-Nibras Care and Development Complex in West Bekaa. The system supports agricultural and social services, reduces diesel dependence, and demonstrates the viability of small-scale solar+storage models for rural resilience. [6]

CHALLENGES & OUTLOOK

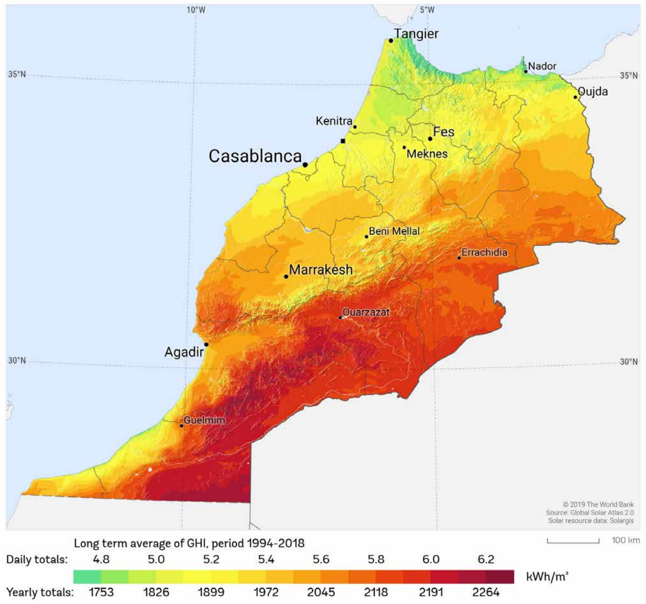
Lebanon's renewable-energy growth continues to face persistent institutional and regulatory hurdles. While the Decentralised Renewable Energy Law (318/2023) is a key step for net metering and peer-to-peer trading, its full execution relies on establishing the long-delayed Electricity Regulatory Authority (ERA) and upgrading the grid.

Institutional capacity gaps and unpredictable short-term net-metering policies continue to slow progress and deter investment.

The outlook remains a dual-track path: decentralized PV and storage will likely lead growth, driven by demand for reliable power. Utility-scale projects, however, depend on creating bankable frameworks, activating the ERA, and advancing grid readiness. Achieving the 30% renewable-energy target by 2030 hinges on these governance and infrastructure reforms.[7]

Source:
[1], [2], [3], [4], [5], [6], [7]

MOROCCO



Solar Energy Capacity	951 MW By 2024
RE Target by 2030	52%
RE Capacity by 2024	4,659 MW

Source: IRENA

CURRENT SITUATION

Morocco's energy transition continues to accelerate in 2025, driven by a strong national strategy and significant public and private investment. As of May 2025, renewable energy sources accounted for over 45% of the country's total installed electricity capacity, a notable increase from 37% in 2021. The government remains firmly committed to its ambitious target of achieving a 52% renewable energy share in the electricity mix by 2030, with plans to reach 56% by the end of 2027. This progress is underpinned by a substantial investment plan led by the National Office of Electricity and Drinking Water (ONEE), which has allocated $17.7 billion to the electricity sector through 2030, targeting the addition of 12.5 GW of new renewable capacity.

The market structure is dominated by large-scale utility projects managed by the Moroccan Agency for Sustainable Energy (MASEN), which acts as a central offtaker and provides a 'one-stop-shop' for private developers, including state guarantees for investments. However, the framework for Independent Power Producers (IPPs) is also evolving, allowing private entities to develop projects and sell electricity directly to consumers with access to the very high voltage (VHV), high voltage (HV), and, under specific conditions, medium voltage (MV) grids. Procurement momentum remains strong, with significant international investor appetite demonstrated by major financing agreements and project awards throughout 2025. Grid readiness is a central focus, with ONEE securing €300 million in financing from the European Investment Bank (EIB) and Germany's KfW in May 2025 to modernize and expand the national transmission network by 731 kilometers, a critical step for integrating the growing volume of intermittent renewable generation. [1], [2], [3], [4]

REGULATIONS & FRAMEWORK

TARGETED 2025 AMENDMENTS TO MOROCCO'S LAWS 13-09, 82-21 AND 48-15

In 2025, Morocco's Ministry of Energy Transition and Sustainable Development advanced its regulatory framework to further attract private investment and secure the national electricity system. Key amendments were made to Law 13-09 on Renewable Energy, Law 82-21 on self-production of electrical energy, and Law 48-15 concerning the regulation of the electricity sector. These changes are designed to streamline the legislative and regulatory processes for private sector renewable energy projects, enhancing clarity and reducing administrative barriers for investors. [5]

PROJECTS

Noor Midelt II & III – 800 MW Solar + 1,200 MWh Storage

In August 2025, MASEN awarded the contracts for the Noor Midelt II and III solar-plus-storage projects to ACWA Power, marking a pivotal moment for grid stability in Morocco. Each project combines 400 MW of PV capacity with a substantial 602 MWh battery energy storage system (BESS), designed to provide 230 MW of dispatchable power for two hours during peak demand. This strategic move, developed under a 30-year Build-Own-Operate (BOO) model. [6]

Essaouira Offshore Wind Farm – 1,000 MW

On Morocco officially announced its first venture into the offshore wind sector in June 2025 with the planned 1 GW farm near Essaouira. Backed by the Mediterranean Blue Partnership, the project capitalizes on the region's exceptional marine wind corridors (averaging 11 m/s) to diversify the energy mix beyond onshore solar and wind. [7]

Oued Rmel Floating Solar Plant – 13 MW

Morocco inaugurated its first floating solar power plant on the Oued Rmel dam reservoir in August 2025, a groundbreaking project with a 13 MW capacity. This innovative approach serves a dual strategic purpose: generating clean electricity to supply the Tangier Med port complex and significantly reducing water evaporation from the reservoir. The project sets a benchmark for combining energy security with water conservation, addressing two of the Kingdom's most pressing strategic priorities. [8]

Guerguerat Hybrid Power Plant – 1.5 MW Solar + 1.5 MWh Storage

ONEE launched an international tender in August 2025 for an integrated hybrid power plant at the strategic Guerguerat border crossing. With a 1.5 MW solar array and a 1.5 MWh battery storage system, the project is designed to ensure a stable and sustainable energy supply for this remote but vital area. This initiative demonstrates a commitment to developing resilient, off-grid solutions that complement the national grid expansion efforts. [9]

CARE Wind and Solar Projects – 178 MW (Tetouan & Tiznit)

In May 2025, the French renewable energy company CARE secured the necessary licenses to launch two vital projects with a combined capacity of 178 MW . The first is a wind farm in Tetouan, expected to be operational by 2029, and the second is a solar energy project in Tiznit, scheduled for late 2027. These investments, approved under Law No. 13.09. [10]

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HIGHLIGHT ON MENASA SOLAR PV MARKETS
MOROCCO

CHALLENGES & OUTLOOK

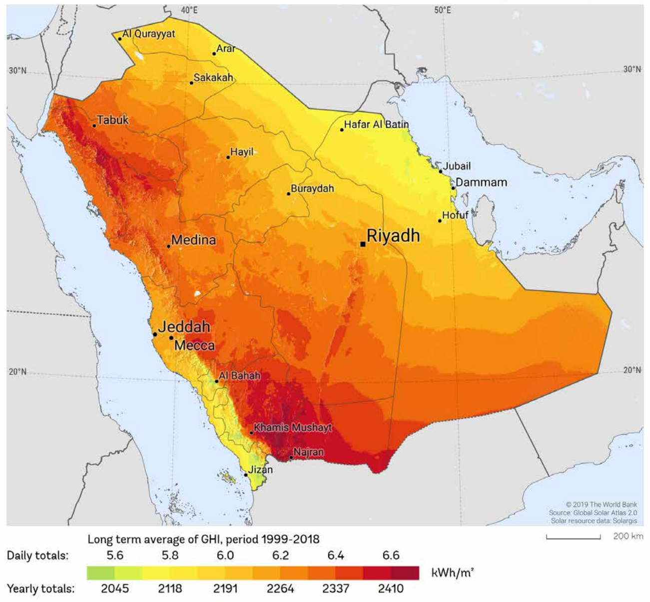
The primary challenge for Morocco's energy sector is the systemic rigidity of its grid, which struggles to integrate the growing share of intermittent renewable energy. Over half of the country's installed capacity consists of inflexible thermal power plants, such as coal-fired stations that require long start-up times and cannot ramp down sufficiently to accommodate midday solar overproduction. This creates a paradox of renewable abundance and systemic inflexibility, leading to risks of grid congestion, curtailment, and instability. Addressing this requires significant investment in grid flexibility solutions. Wärtsilä modeling suggests that at least 2 GW of ultra-flexible capacity, such as modern engine power plants and battery storage, will be needed by 2030 to balance the planned 6 GW of new renewables.

The outlook for Morocco's renewable energy sector remains highly positive, grounded in a clear policy direction and a strong pipeline of projects. The government's commitment to the 52% renewable energy target by 2030, coupled with massive investments in transmission infrastructure like the 3,000 MW HVDC line, provides strong visibility for future growth. The successful award of large-scale solar-plus-storage projects like Noor Midelt II and III indicates a clear understanding of the need for integrated storage solutions. To unlock further growth, the next critical steps will involve activating a more dynamic regulatory framework for private sector participation, particularly in wheeling and net metering, and ensuring the bankability of PPAs to maintain investor confidence. The country's strategic push into green hydrogen and its positioning as an energy bridge to Europe further solidifies its long-term potential as a regional clean energy leader.

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9], [10]

Source: Yellow Door Energy - Classic Fashion 5.5 MWp Jordan

KINGDOM OF SAUDI ARABIA



Target by 2060	Net-zero carbon emissions
RE Target by 2030	50% by 2030
RE Capacity by 2023	9.5 GW by 2023
RE Capacity by 2030	58.7 GW by 2030

Source: Vision 2030 & Solarabic Database

CURRENT SITUATION

Saudi Arabia continues to accelerate its energy transition under the Vision 2030 framework, positioning itself as a regional and global leader in renewable energy deployment. By the end of 2024, the Kingdom had reached an operational renewable energy capacity of 6,551 MW—including nine solar projects totaling 6,151 MW and one wind project of 400 MW. These projects have supplied electricity to over 1.14 million residential units and have attracted SAR 19.8 billion (USD 5.28 billion) in investment, with solar contributing the majority

The National Renewable Energy Program (NREP) remains the central driver of the energy diversification plan, targeting a 50% share of renewables in the Kingdom's electricity mix by 2030. Despite rapid deployment, the energy system still relies heavily on imported fuel and natural gas. As a result, the government continues to prioritize large-scale tenders and strategic partnerships, especially in regions with high irradiation and wind speeds, to reduce reliance on fossil fuels and ensure long-term grid stability. [1]

PROJECTS

Al-Sadawi Solar PV Project – 2,000 MW

A consortium of Masdar, Korea Electric Power Corporation KEPCO, and GD Power secured a 25-year PPA for this flagship project under the NREP's fifth round. Located in northern KSA, it is one of the world's largest utility-scale solar ventures. Financial close occurred in August 2025, with full commercial operation expected by early 2027. [2]

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HIGHLIGHT ON MENASA SOLAR PV MARKETS
KINGDOM OF SAUDI ARABIA

Yanbu Wind Project – 700 MW

Led by Marubeni and Al-Ajlan Bros., this Madinah-based project achieved financial close in July 2025 with a record-low LCOE of SAR 6.46755/kWh (USD 0.0172468/kWh). EPC awarded to Shandong Electric Power Contracting Company No. 3 (SEPCO3); COD expected by late 2026.[3]

Round 6 Awards – 15,000 MW Total

In July 2025, SPPC signed power purchase agreements (PPAs) for a new batch of mega-projects totaling 15,000 MW with an investment volume of approximately ~SAR 31 billion (~USD 8.3 billion) under NREP.

The new projects are distributed as follows:

- Bisha Solar (Asir Region) – 3,000 MW; LCOE 4.83708 halalas/kWh (1.28989 US cents/kWh).
- Al-Hamij Solar (Madinah Region) – 3,000 MW; LCOE 4.90682 halalas/kWh (1.30848 US cents/kWh).
- Khulais Solar (Makkah Region) – 2,000 MW; LCOE 5.10439 halalas/kWh (1.36117 US cents/kWh).
- Afif 1 Solar (Riyadh Region) – 2,000 MW; LCOE 4.74736 halalas/kWh (1.26596 US cents/kWh).
- Afif 2 Solar (Riyadh Region) – 2,000 MW; LCOE 4.72346 halalas/kWh (1.25959 US cents/kWh).
- Sitara Wind (Riyadh Region) – 2,000 MW; LCOE 7.71422 halalas/kWh (2.05712 US cents/kWh).
- Shaqra Wind (Riyadh Region) – 1,000 MW; LCOE 6.99750 halalas/kWh (1.86600 US cents/kWh) [4]

Al-Masaa (MAS) & Al-Hanakiya-2 (AHK2) PV Projects — 1.75 GW (R5, NREP)

On 17 Aug 2025, PowerChina Guizhou Engineering Co., Ltd. broke ground on two utility-scale solar plants under Saudi Arabia's National Renewable Energy Program (Round 5). The flagship Al-Masaa site spans 2,450.4 ha with 1.25 GW of PV capacity, complemented by Al-Hanakiya-2, which spans 936 ha with 500 MW. At full operation, the pair are expected to generate ~4.4 TWh/year, sufficient to power ~550,000 homes, and avoid ~2.88 MtCO2 annually. [5]

Dawadmi Wind Project – 1,500 MW (Round 6)

Awarded on October 28, 2025, the Dawadmi onshore wind farm in Riyadh Province went to KEPCO, Nesma Renewable Energy, and Etihad Water & Electricity, setting a global-record tariff of ~1.338 US¢/kWh under SPPC's NREP IPP model, with new grid-evacuation works and long-term O&M to ensure high availability in desert conditions. [6]

Najran Solar Project – 1,400 MW (Round 6)

Secured on October 28, 2025, the Masdar-led Najran PV plant achieved a PPA of ~1.096 US¢/kWh (the second-lowest globally after Shuaiba-1); structured under SPPC's IPP model. [7]

ACWA Power COD Milestones – 2,790.7 MW

On August 20, 2025, ACWA Power received commercial operation certificates for Al Kahfah (Hail) 1,425 MW, Saad II (Riyadh) 365.7 MW, and the first 1,000 MW of Al-Rass 2 (Qassim)—locking in long-term PPAs with SPPC and materially expanding the Kingdom's operational solar base. [8]

Alfanar Jubail Solar Project – 55 MW

Commissioned on July 29, 2025, the 55 MW PV plant in Jubail Industrial City supplies one of the world's largest RO desalination facilities; using ~93,000 modules over ~39 ha with automated cleaning, it is expected to reduce ~75,000 tCO_2 per year and deliver meaningful OPEX savings. [9]

CHALLENGES & OUTLOOK

- Grid integration and transmission expansion are required for remote utility.-scale projects.
- Bureaucratic delays despite regulatory reforms.
- ntermittency and storage infrastructure gaps.
- Regional competition and tendering complexity.

Saudi Arabia remains on a strong trajectory to achieve its target of a 50% renewable electricity mix by 2030. SPPC continues to drive market momentum through competitive tenders and long-term PPAs. To date, the Kingdom has launched 43.2 GW of renewable capacity, secured agreements for 38.7 GW, and connected 10.2 GW to the national grid.

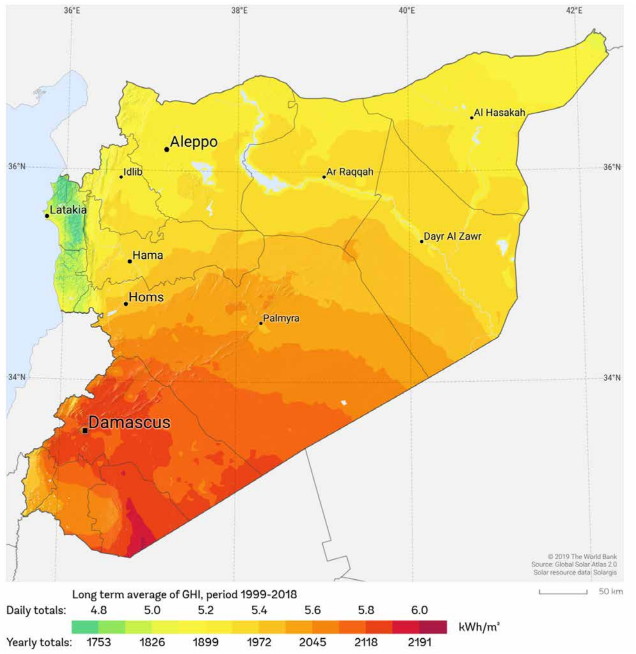
Connected capacity is expected to reach 12.7 GW by end-2025 and approximately 20 GW by end-2026. In addition, the seventh round of the National Renewable Energy Program (NREP)—announced in September 2025—introduced six new projects totaling 5.3 GW, reinforcing the country's long-term development pipeline.

With its market scale, policy stability, and strong investor interest, Saudi Arabia is positioned to remain the region's renewable-energy powerhouse through 2030 and beyond. [10]

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9], [10]

Source: Yellow Door Energy - Imerys Al Zayani Bahrain 4.7 MWp

SYRIA



Direct Standard Sunshine DNI is	About 2191 kWh/m2 year
Solar Energy Capacity	60MW in 2023
RE Target by 2030	20%

Source: Sunevosolar

CURRENT SITUATION

The year 2025 marks a pivotal transition for Syria, moving from a protracted conflict economy to reconstruction and international reintegration. Following the late 2024 political shift, the country's economic outlook has dramatically improved with the easing of restrictive economic measures. The energy sector has become the primary focus for early investment, with Syria's electricity output having collapsed from pre-conflict levels of approximately 9,000 MW to severely degraded infrastructure. This crisis is now being addressed by an unprecedented influx of foreign direct investment (FDI) and the return of multilateral financial institutions, signaling a new era of global support.

The regulatory environment has undergone a dramatic transformation, enabling this investment surge. The dismantling of the Caesar Act—which for six years had restricted international business participation in Syria—has removed the primary legal barrier for US, European, and other international firms. Combined with the May 2025 clearance of Syria's World Bank arrears (facilitated by Saudi and Qatari payments) and the Bank's return after a fourteen-year hiatus, this has created a credible framework for long-term infrastructure financing. The convergence of political openness, regulatory clarity, and multilateral re-engagement has catalyzed rapid capital mobilization toward the energy sector, with over $7 billion in committed investment already signed and additional projects in advanced development stages. [1]

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HIGHLIGHT ON MENASA SOLAR PV MARKETS
SYRIA

REGULATIONS & FRAMEWORK

THE REPEAL OF THE CAESAR ACT

The single most significant regulatory development in 2025 was the effective dismantling of the Caesar Syria Civilian Protection Act of 2019, which had previously crippled international investment. The process began in May 2025 with the US administration issuing a waiver on certain sanctions, immediately creating a window for foreign investment. This culminated in December 2025 when the US House of Representatives voted to repeal the Caesar Act entirely as part of the National Defense Authorization Act (NDAA). This legislative action removes the primary legal barrier for international firms, including those from the US and Europe, to participate in Syria's reconstruction, directly enabling the multi-billion dollar projects detailed below. [2], [3]

WORLD BANK RE-ENGAGEMENT

The Syrian government's settlement of outstanding financial obligations to the World Bank in May 2025 paved the way for the Bank's return after a fourteen-year absence. This move, which led to the discussion of the $146 million SEEP project, signals a critical shift in the international financial framework, opening the door for further grants and technical assistance essential for long-term sector stability. [4]

PROJECTS

$7 Billion Energy Mega-Project – 5,000 MW (Gas & Solar)

In a landmark deal signed on May 30, 2025, a consortium led by UrbaCon Holding, including US and Turkish firms, committed $7 billion to develop 5,000 MW of new capacity. This massive investment will see the construction of four CCGT power plants (4,000 MW total) and a 1,000 MW solar farm. [5]

SolarRex & 20 Solar Energy LLC – 370 MW (Solar & Storage)

The General Electricity Transmission and Distribution Company secured two major solar agreements in June 2025, totaling 370 MW of new capacity. The deals with SolarRex and the American company "20 Solar Energy LLC" include the development of utility-scale solar farms, with a key focus on integrating advanced battery storage systems. [6], [7]

Wind Power Development – 100-200 MW (BOO Model)

In July 2025, the General Electricity Transmission and Distribution Company issued a Request for Prequalification (RFQ) for a 100-200 MW wind farm project [7]. The project is structured under a Build-Own-Operate (BOO) model, signaling the government's openness to private sector participation in diversifying the energy mix beyond solar and gas, and is a key step in utilizing the country's wind resources. [8]

CHALLENGES & OUTLOOK

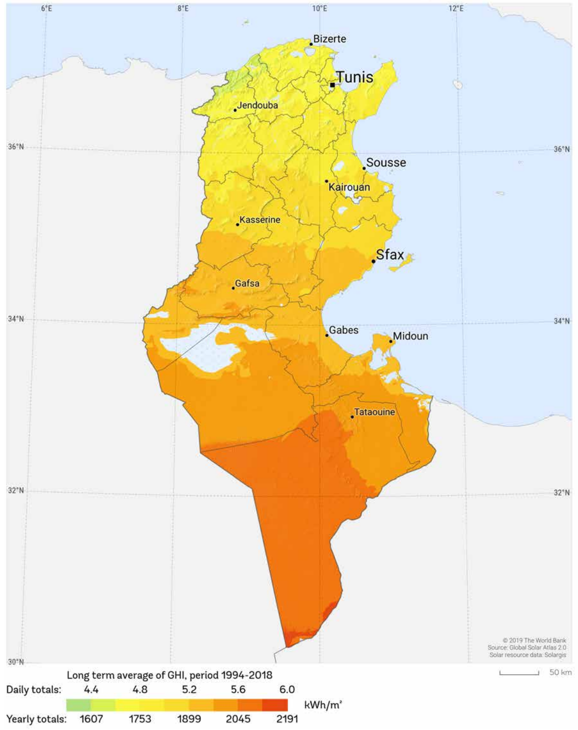
The primary challenge for Syria's energy sector remains the massive gap between electricity demand and current generation capacity, compounded by the severe degradation of the transmission and distribution infrastructure. While the repeal of the Caesar Act has unlocked international funding, the country still faces significant hurdles in project execution, including securing supply chains, managing logistics in a post-conflict environment, and ensuring the long-term stability of political and security conditions to maintain investor confidence.

The outlook, however, is overwhelmingly positive. The immediate influx of multi-billion dollar investment, particularly the 5,000 MW mega-project, promises to rapidly address the generation deficit. The return of the World Bank and the focus on regional grid interconnection (SEEP project) signal a commitment to long-term, sustainable infrastructure development. The government's openness to private sector participation through BOO models and the rapid adoption of utility-scale solar and storage technologies position Syria for a rapid and modern energy sector recovery, provided the current political and regulatory momentum is sustained. [9], [10]

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9], [10]

Source: Yellow Door Energy - Classic Fashion 5.5 MWp Jordan

TUNISIA



RE Target by 2050	50%
Targeted RE Capacity by 2030	3,800 MW
RE Target by 2030	30%

Source: Solarabic Database

CURRENT SITUATION

Tunisia's energy sector is under growing strain, driven by heavy import dependence and widening supply–demand gaps. Electricity imports from Algeria reportedly cover around 60% of national demand, while power generation relies on imported natural gas for over 90% (a significant share sourced from Algeria), leaving the system exposed to supply disruptions and price volatility. This dependence has created a major fiscal burden and pushed energy self-sufficiency down to ~39% in 2025.

In response, the government is accelerating a renewables-led transformation backed by new financing and governance reforms. In 2025, the Ministry of Industry, Mines, and Energy allocated TND 7.1 billion (≈US$2.2 billion) to develop the energy sector and reduce import reliance. Momentum strengthened in November 2025 with the World Bank's approval of the TEREG program (US$430 million over five years, including US$30 million concessional financing), designed to unlock ~US$2.8 billion in private investment and support adding ~2.8 GW of solar and wind by 2028, while improving STEG cost recovery and reducing system costs. [1], [2]

REGULATIONS & FRAMEWORK

STEG REGULATORY SIMPLIFICATION

In July 2025, the Tunisian Electricity and Gas Company (STEG) introduced a new set of regulatory measures to significantly simplify and accelerate the implementation of solar power projects. These measures include binding deadlines for technical approvals (e.g., 15 working days for projects up to 20 kVA, with implicit approval if the deadline is missed) and a commitment to schedule meter installation and commissioning within 30 working days of application submission. This move enhances procedural transparency and directly addresses a key barrier to private sector participation. [3]

500 MW CONCESSION LICENSE GRANTS

The Ministry of Energy granted licenses in March 2025 to four international companies to build solar power plants with a total capacity of 500 MW under the concession system, at a total cost of 1.2 billion dinars ($386.31 million). The recipients include Voltalia (100 MW), Scatec/Aeolus (100 MW), and Kerr International (300 MW). These are the first projects licensed under a major tender aimed at reaching 1,700 MW of renewable capacity, signaling a firm commitment to the private-sector-led utility scale model. [1]

FORMATION OF THE TUNISIAN CLEAN ENERGY ORGANIZATION

The official launch of the "Tunisian Clean Energy Organization" in September 2025 marks a significant step towards unifying the sector's stakeholders. The organization aims to strengthen the role of renewable energy in the national economy, defend the sector's interests, and work with public authorities to shape energy policies, focusing on energy independence and "green employment" opportunities. [4]

PROJECTS

Sbeikha Solar Power Plant – 100 MW (Kairouan)

The Sbeikha solar plant, a pioneering 100 MW project implemented by Amea Power under a PPP, was scheduled to be fully operational by the end of November 2025. This project is the first in a batch of 500 MW of private projects and is expected to reduce natural gas imports by approximately $25 million annually, while providing electricity to about 43,000 homes. [5]

Castellite Solar Power Plant – 100 MW (Gabès)

The European Bank for Reconstruction and Development (EBRD) announced in October 2025 its intention to provide a €37.3 million loan to Voltalia for the development of the 100 MW Castellite Solar Power Plant in Gabès. The project, awarded through a national tender, has secured a 25-year Power Purchase Agreement (PPA) with STEG and is supported by a €3 million grant from the European Union. [6]

Scatec Sidi Bouzid 2 Project – 120 MW (Sidi Bouzid)

Scatec ASA signed a 25-year PPA with STEG in March 2025 to develop and operate a strategic 120 MW solar power project in Sidi Bouzid. This project, a joint development with Japan's Aeolus SAS, builds on Scatec's existing presence. [7]

Medlink Interconnection Project – 10 GW (Tunisia-Algeria-Italy)

The European Commission designated the Medlink energy interconnection project as a priority cross-border renewable energy project in September 2025. This massive project aims to install approximately 10 GW of solar and wind capacity in Tunisia and Algeria for both domestic use and export to Europe, providing access to financing and accelerating the creation of a green energy corridor. [8]

Sidi Daoud Wind Farm Upgrade – 29-33 MW (Nabeul)

The Sidi Daoud wind farm, one of Tunisia's first renewable projects, is undergoing a comprehensive upgrade to increase its capacity from 10.5 MW to between 29 and 33 MW. The contract for this 100 million dinar project, financed by the German Development Bank (KfW), is expected to be signed in the last quarter of 2025, with operations beginning in 2027. [9]

World Bank Hybrid Tender – 350-400 MW (Solar + Storage)

The World Bank launched an international tender in March 2025 seeking technical consultancy for a planned 350-400 MW solar power plant combined with an advanced Battery Energy Storage System (BESS). This focus on hybrid technology highlights Tunisia's commitment to grid stability and managing the intermittency of renewable sources. [10]

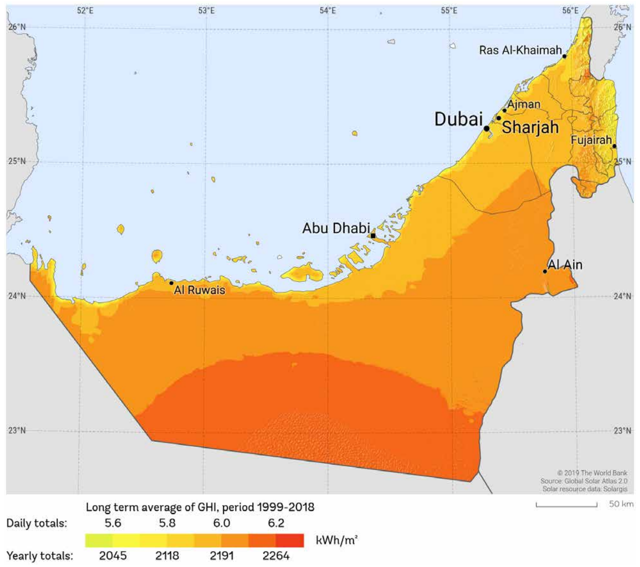
CHALLENGES & OUTLOOK

The primary challenge for Tunisia is the significant financial burden imposed by the energy deficit, which costs the state treasury approximately 11 billion Tunisian dinars annually. This deficit is exacerbated by the reliance on electricity imports from Algeria for 60% of the country's needs.

The outlook is highly positive, driven by a clear national strategy to achieve a qualitative leap in renewable energy production. The government aims to increase total installed capacity from the current 600 MW to 3,000 MW by 2028, with a long-term target of 35% renewable energy in the electricity mix by 2030. The commitment to purchase all electricity from foreign contracting companies at a fixed, low price of 99 Tunisian millimes (3.17 US cents) per kilowatt-hour is expected to generate direct annual savings of around 200 million dinars for STEG, providing a strong economic incentive for the transition. Furthermore, the government's plan to attract investment in waste-to-energy projects and increase biogas contribution signals a comprehensive approach to energy security. [11]

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11]

UNITED ARAB EMIRATES



RE Target by 2030	30%
RE Capacity by 2024	6,815 MW
RE Target by 2030	14,000 MW

Source: IRENA

CURRENT SITUATION

The United Arab Emirates is aggressively pursuing its Energy Strategy 2050 and Climate Neutrality 2050 goals, cementing its position as a global leader in the energy transition. The market is currently undergoing a massive expansion, with 25 energy projects underway, valued at over AED 103.6 billion (US$28.2 billion). These projects are set to add approximately 21,714 MW of generating capacity, representing a 38% increase over the current capacity.

Solar energy dominates this investment pipeline, accounting for 14 projects valued at an estimated AED 61.5 billion (US$16 billion). This strategic focus is expected to raise the share of clean energy in the overall energy mix to 36% by 2030, underscoring the nation's commitment to a diversified and sustainable energy future. [1]

REGULATIONS & FRAMEWORK

STRATEGIC FINANCING FOR SOLAR PROJECTS

A key regulatory development in the clean energy sector is the collaboration between Emerge (a Masdar/EDF joint venture) and the Emirates Development Bank (EDB). An MoU signed in August 2025 established a framework for EDB to provide tailored financing solutions for promising solar energy projects identified by Emerge. This mechanism is designed to empower the industrial sector, offering manufacturers and logistics operators a strategic opportunity to reduce costs and enhance operational efficiency through clean energy adoption. [2]

GULF COOPERATION AND TECHNOLOGY TRANSFER

The UAE is leveraging its expertise to foster regional energy integration. A high-level delegation, including the CEO of Masdar, met with the Kuwaiti Ministry of Electricity in July 2025 to activate an MoU signed the previous month. This agreement focuses on strengthening bilateral cooperation, transferring advanced Emirati expertise, and developing infrastructure, positioning the UAE as a key partner in the Gulf's collective energy transition. [3]

PROJECTS

World's Largest Hybrid Project – 5.2 GW Solar + 19 GWh Storage

The UAE cemented its global leadership in energy storage with the groundbreaking of the world's largest renewable energy project of its kind in October 2025. Developed by Masdar in partnership with EWEC, this colossal project features a 5.2 GW photovoltaic solar plant backed by an unprecedented 19 GWh battery storage system. With investments exceeding AED 22 billion (US$5.9 billion), the plant is designed to provide 1 GW of clean baseload power around the clock, setting a new technological benchmark for stable, dispatchable renewable energy. [4]

Al Khazna Solar Power Plant – 1.5 GW (Abu Dhabi)

A significant step in Abu Dhabi's clean energy transition was taken in October 2025 when EWEC awarded the contract for the 1.5 GW Al Khazna solar plant to a consortium led by ENGIE and Masdar. This fourth major utility-scale solar project for EWEC will feature three million solar panels with sun-tracking technology, supplying electricity to approximately 160,000 homes and reducing carbon emissions by over 2.4 million metric tons annually. [5]

Union Coop Retail Solar Project – 17.3 MW (Distributed Generation)

The retail sector saw a major commitment to sustainability in July 2025 with the announcement of a landmark agreement between Union Coop and Positive Zero. This ambitious project involves installing solar systems across up to 30 Union Coop locations in Dubai and Umm Al Quwain, generating 17.3 MW of clean electricity. The initiative is expected to reduce carbon emissions by 21,650 tons annually. [6]

UAE University Campus Solar – 9 MWp (Educational Sector)

The completion of the third phase of the 9 MWp solar PV project at the UAE University (UAEU) campus was announced in May 2025. This project, a partnership with TAQA Services, utilizes 14,400 solar panels to cover 30% of the university's electricity needs. [7]

Ministry of Defence Solar Integration – 2.4 MW (Critical Infrastructure)

The UAE Armed Forces advanced their climate change strategy with a strategic collaboration announced in June 2025 . The project, a partnership between the Ministry of Defence, Tabreed, and Emerge, will integrate a 2.4 MW solar plant to power the thermal storage and water pumps at two district cooling facilities, enhancing the sustainability and resilience of critical infrastructure. [8]

HIGHLIGHT ON MENASA SOLAR PV MARKETS

UNITED ARAB EMIRATES

CHALLENGES & OUTLOOK

The UAE faces the challenge of integrating massive amounts of intermittent renewable energy into its grid while maintaining the stability required by a rapidly growing economy. The sheer scale of planned projects necessitates equally massive and innovative storage solutions. Furthermore, while the UAE is a leader in utility-scale projects, the challenge remains in scaling up distributed generation and ensuring the regulatory framework keeps pace with the rapid introduction of new technologies like BIPV and large-scale battery storage.

The outlook is bolstered by strong political backing and substantial investment. The UAE recently broke ground on a gigawatt-scale solar and battery storage facility in Abu Dhabi, valued at roughly US$6 billion and designed to deliver round-the-clock clean power, signaling a shift toward dispatchable renewable energy at scale in the region. These projects form part of broader national commitments to expand renewable capacity and diversify the energy mix under the UAE's Energy Strategy 2050 and Net Zero by 2050 goals, supported by tens of billions of dollars in clean energy investments. Additionally, the UAE has pursued international cooperation on renewable projects, such as a clean energy partnership involving Italy and Albania that leverages Emirati expertise in solar and wind. Together, these developments reflect momentum toward expanding clean energy capacity and enhancing the UAE's role in the regional and global energy transition. [9], [10]

Source:
[1], [2], [3], [4], [5], [6], [7], [8], [9], [10]

Source: Standard Carpets - 1.5 MWp - Dubai, UAE

CONCLUSION

REASSESSING SOLAR ENERGY'S ROLE IN MENA'S ENERGY TRANSITION

As the Middle East and North Africa enter the next phase of their energy transition, solar power is no longer an emerging solution but a defining component of regional power systems. Over the past decade, deployment across the region has accelerated from pilot initiatives to multi-gigawatt portfolios. Countries such as Saudi Arabia, the UAE, Egypt, and Morocco anchor large-scale capacity, while others increasingly adopt decentralised and storage-backed systems to address supply constraints. Solar now shapes grid planning, investment priorities, as well as energy-security outcomes across MENA.

Advances in system design, digitalisation, and operations are central to this evolution. The growing deployment of battery energy storage, energy-management systems, predictive analytics, alongside automation reflects the need to manage intermittency and curtailment while maintaining performance under extreme climatic conditions. Technologies including robotic cleaning, infrared and electroluminescence inspections, and AI-enabled optimisation are no longer experimental; they are becoming standard practice across both utility-scale and distributed assets, improving reliability and lifecycle performance.

Beyond electricity generation, solar is increasingly acting as a catalyst for broader structural change. Energy-intensive industries, data centres, desalination facilities, as well as emerging green-hydrogen initiatives are now closely linked to large-scale solar deployment, particularly in markets with strong resource availability and industrial ambition. Egypt's move toward dispatchable solar with integrated storage, together with Saudi Arabia's alignment of solar development with industrial and hydrogen strategies, illustrates how renewable energy is being embedded within long-term economic development frameworks.

Efforts to localise manufacturing and strengthen supply chains further reinforce this shift. Multi-gigawatt manufacturing targets across parts of the region signal a transition from project-based deployment toward industrialised solar ecosystems, reducing exposure to global market volatility while building domestic capability. At the same time, solar's rapid uptake in markets facing grid instability such as Lebanon and Iraq, highlights its role as essential infrastructure, supporting economic activity and public services.

Taken together, developments across the Middle East and North Africa indicate a region moving from rapid expansion toward system execution. The defining challenge ahead is no longer capacity addition, but the integration, management, and resilience of solar within increasingly complex power systems. As solar becomes foundational infrastructure across MENA, the decisions taken today—on grid investment, storage deployment, digital capability, and policy design—will shape the region's energy systems and their role in the global transition for decades to come.

31 GLOSSARY OF TERMS

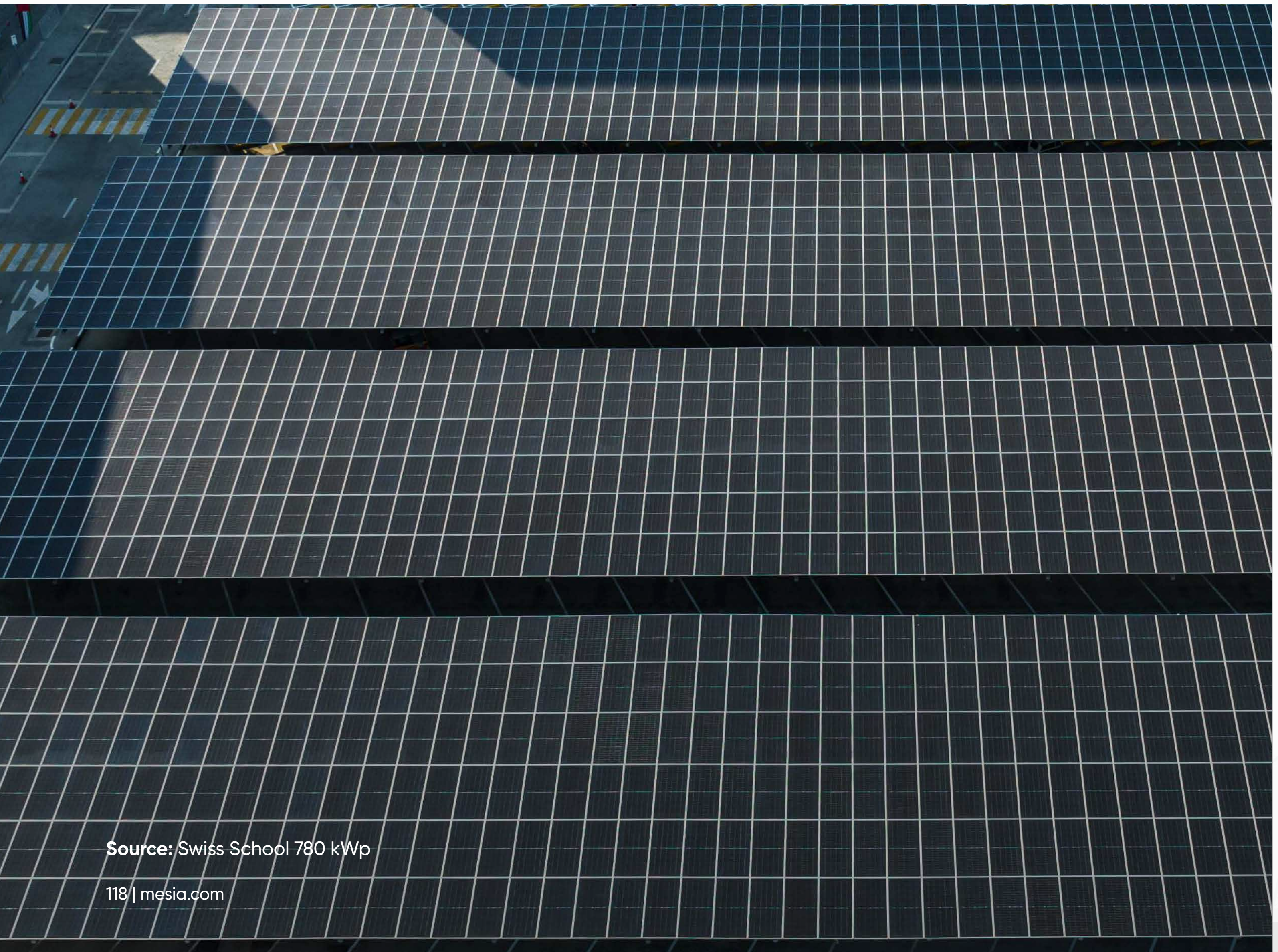
AI	Artificial Intelligence
BESS	Battery Energy Storage System
BTM	Behind-the-Meter
C&I	Commercial and Industrial
CAPEX	Capital Expenditure
CAGR	Compound Annual Growth Rate
COD	Commercial Operation Date
DC	Direct Current
DG	Distributed Generation
EL	Electroluminescence
EMS	Energy Management System
EPC	Engineering, Procurement, and Construction
ESG	Environmental, Social, and Governance
EV	Electric Vehicle
FAT	Factory Acceptance Testing
FITs	Feed-in Tariffs
FPV	Floating Solar Photovoltaic
GCR	Ground Coverage Ratio

31 GLOSSARY OF TERMS

GHG	Greenhouse Gas
GW	Gigawatt
GWh	Gigawatt-hour
HV	High Voltage
HVDC	High-Voltage Direct Current
IoT	Internet of Things
IPP	Independent Power Producer
IR	Infrared
kWh	Kilowatt-hour
LCOE	Levelized Cost of Energy
LCOS	Levelised Cost of Storage
MENA	Middle East and North Africa
MV	Medium Voltage
MW	Megawatt
MWp	Megawatt-peak
O&M	Operations and Maintenance
Opex	Operational Expenditure
PPA	Power Purchase Agreement

31 GLOSSARY OF TERMS

PR	Performance Ratio
RTC	Round-the-Clock
SOC	State of Charge
PV	Photovoltaic
SCADA	Supervisory Control and Data Acquisition
T&D	Transmission and Distribution



Source: Swiss School 780 kWp

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