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

MID-YEAR SOLAR REPORT 2025

Publication date **August**

MESIA

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, connecting policymakers, developers, manufacturers, service providers, consultants, financiers, and more.

WE EMPOWER OUR MEMBERS THROUGH

- Speaking opportunities at MESIA and key industry events.
- Expanding your network & connecting you with your peers through online 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 80k+ followers
- Exclusive discounts and preferential rates for industry events

JOIN THE LARGEST SOLAR NETWORK IN MENA

From global leaders to startups, MESIA offers a platform to grow your influence across the MENA solar sector.

Contact info:

Engr. Zulfa Rasheed

+971 56 2626 159

zulfa@mesia.com

MESIA HAS OVER 100 MEMBERS AND PARTNERS

EPCs | Consultants | Manufacturers | Developers | Investors | Law firms | Media | Academia

LEGACY PARTNERS

ACWA POWER, HUAWEI, LONGi, Pure Energy, Synergy Consulting, SUNGROW

PARTNERS

ARRAY, ASTRONERGY, DASOLAR, GAMECHANGE SOLAR, GCL, GENSOL, HYSOLAR, JA SOLAR, 3E, JinKO Solar, JSOLAR, KUKA CABLE, omas, POSITIVE ZERO, solis, SUMEC, PHONO, TBEA, Trinasolar, TW SOLAR

TABLE OF CONTENTS

MESIA
Middle East Solar Industry Association

AGENDA 2025/26

Webinar: Spotlight on MENA Solar Energy Markets(Kuwait)	August 2025
September 2025	Webinar: Spotlight on MENA Solar Energy Markets(Iraq)
MESIA's Business Breakfast	October 2025
November 2025	Webinar: Spotlight on MENA Solar Energy Markets (Morocco)
Partner-Led Business Breakfast (Holiday Theme)	December 2025
January 2026	Solar Awards Ceremony 2026
MESIA's business breakfast	February 2026
March 2026	Webinar: Spotlight on MENA Solar Energy Markets (Oman)

Join the Journey,

Get Involved contact us info@mesia.com

Office 2310, Dubai Star, Jumeirah Lake Towers, Cluster L
P.O. Box 552, Dubai, United Arab Emirates

01

SOLAR ENERGY, INNOVATION/ TECHNOLOGY

A. Advances in Solar Tracker
B. Floating Solar in MENA
C. Smart Solar Ecosystems

BUILDING RESILIENT SOLAR TRACKERS FOR DESERT ENVIRONMENTS

Ram Charan Inturi
Director, Engineering & Technology at Nextracker for Middle East, India and Africa
nextracker

A recent study suggests that solar energy could supply up to 76% of the world's total energy needs by 2050, a remarkable leap from just 1% in 2015. This vision hinges on our ability to effectively harness the sun's power in desert regions, which cover nearly one-third of the Earth's land surface. These high-irradiance zones, particularly in countries like Saudi Arabia and the UAE, are driving a surge in large-scale photovoltaic developments.

Yet, as projects scale, one critical question emerges: how can solar trackers be engineered to withstand the extreme wind, heat, and dust typical of desert environments?

Figure [1] : Nextracker Project in UAE

CHALLENGES FACED BY DESERT SOLAR PROJECTS

High winds, abrasive dust accumulation and extreme heat are three primary threats to operational stability of desert solar installations.

Tracker failures may occur even under moderate wind conditions. In some cases, the structure itself remains intact, with only the modules developing cracks, but in more severe situations, entire structures can fail, causing the modules to flutter uncontrollably or rip off, often resulting in catastrophic damage. At first glance, the solution seems straightforward: Test the tracker in a wind tunnel, design for the worst storm. Build it stronger. However, the reality is far more complex.

Dust accumulation can reduce panel output by up to 30% and significantly increase maintenance demands, potentially causing damage to critical tracker components such as slew drives and dampers. Similarly, extreme heat—often exceeding 40°C—can lower the efficiency of silicon-based panels by about 5% for every 10°C rise. Without proactive design & maintenance, trackers risk performance losses even under clear, sunny skies.

DESIGNING FOR DESERT WIND: ARE WIND TUNNEL TESTS ADEQUATE?

Desert terrains feature slopes, uneven surfaces, and irregular contours, all of which dramatically influence local wind patterns. For instance, a ridge or crest can amplify wind speeds by as much as 50%. Without thorough wind tunnel studies and site-specific analysis, a tracker installed at the wrong location could experience significantly higher forces than anticipated.

While static wind tunnel tests provide a practical and cost-effective starting point, they fail to capture real-time dynamics. Aeroelastic tests offer deeper insight, but only full-scale field testing reveals how trackers respond to turbulent, real-world wind conditions.

Past failures in markets like the Middle East, Brazil and Australia underscore the risks of relying solely on basic tunnel testing. In volatile desert environments, where sudden wind shifts are common, comprehensive testing and thorough design are essential for tracker stability and energy generation.

ROBOTIC CLEANING IS REVOLUTIONIZING SOLAR MAINTENANCE IN HARSH DESERTS

Soiling from dust storms presents another critical challenge. In the relentless desert conditions, coating panels and threatening to degrade performance while endangering components like slew drives and dampers. Robotic cleaning systems offer a transformative solution, seamlessly integrating advanced robots with tailored infrastructure, docking stations, slew bridges, and row-to-row bridges, rigorously tested to ensure perfect synergy with solar trackers.

These systems tirelessly remove dust buildup, mitigating the impact of soiling, reducing maintenance demands, and protecting equipment from abrasive wear. They've proven indispensable across expansive solar arrays in regions like the Middle East, by maintaining optimal panel efficiency and system reliability. Beyond being a countermeasure to soiling, robotic cleaning systems safeguard investments and extend the lifespan of solar infrastructure, ensuring consistent energy production in the harshest environment.

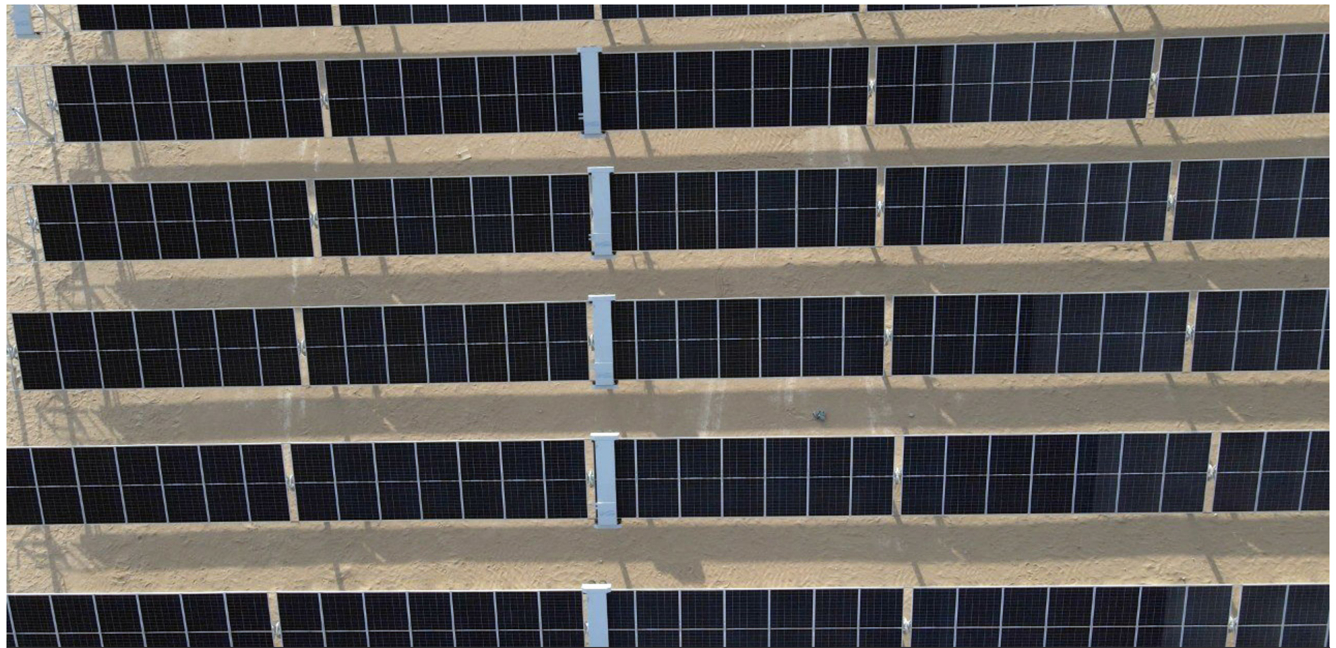


Figure [2] : Robotic Cleaning

SYSTEMS ENGINEERING: THE TRACKER IS MORE THAN JUST A STRUCTURE

Building a wind-resistant tracker is about designing a complete system that can think, respond, and endure. The firmware must be smart enough to read weather signals in real time and trigger protective actions without delay. The mechanical parts must be able to move quickly and safely when wind conditions change. The electrical system must hold steady, even when storms cut off external power. Structural elements must not only resist wind pressure but also support the modules without introducing stress points that can lead to cracks. The tracker must be designed for the best stow angle based on various studies. When all these parts work together as one, the tracker does not merely survive the winds. It stays stable, reliable, and ready to perform every day.

A strong structure is ineffective if the control system fails to act in time. A smart sensor setup is wasted if the tracker cannot move fast enough. In desert environments, where high winds and sandstorms can develop unexpectedly, this integrated, system-wide resilience is essential to help mitigate operational risks and support long-term performance and asset reliability.

INTEGRATED DESIGN FOR RESILIENT PERFORMANCE

Modern tracker systems rely on synergy between mechanical and digital components. Smart control software interprets real-time sensor data and adapts stow strategies accordingly. These are dynamic and optimized not only by historical models but also by on-site weather intelligence to maintain stability of the tracker and energy yield from the plant.

When all parts of the system, mechanical, electrical, structural, and digital work together in sync; the tracker operates intelligently, adapts continuously, and maintains performance even in unpredictable desert conditions.

TORSIONAL AND HEAVING MODES: HIDDEN RISKS

While much attention is given to preventing torsional movement in trackers, another equally critical risk, the instability that occurs at low tilt angles under wind pressures called heaving , often goes overlooked. As solar modules continue to increase in size, the distance between structural supports also increases. This lowers the system's natural frequency, making it more susceptible to oscillations. At these lower frequencies, even moderate winds can induce heaving motion, which could lead to the formation of cracks in modules – small defects that can ultimately escalate into major failures.

Advanced site modelling is essential to accurately predict these effects and optimize tracker placement. By proactively identifying high-risk areas and tailoring designs to local terrain and wind behavior, developers can protect system performance, longevity, and investment.

STRONGER SOLAR FOR A GROWING MARKET

With abundant sunlight and vast expanses of land, deserts are fast becoming the epicenters of global solar energy production. Their potential to harness the sun's power is immense; however, the extreme heat, abrasive dust, and volatile winds demand continuous innovation to maintain efficiency and maximize energy output.

In large-scale solar installations, the stakes are high. A single tracker row malfunction can remove hundreds of kilowatts from production, while widespread module damage can wipe out an entire year's returns. Building reliable solar infrastructure in such harsh environments requires more than just strong materials. It demands a holistic, system-wide approach to engineering and design.

Through rigorous full-scale testing, advanced stow strategies, and an unwavering focus on long-term durability, today's solar tracker technologies are evolving to meet the unique challenges of desert environments. It is this thoughtful integration of structural, mechanical, electrical, and digital innovation that ensures solar energy remains a dependable solution, even in the most demanding conditions.

Figure [3] : Al Kahfha 1.17 GW KSA XTR

References:

[1] *https://enviroliteracy.org/how-much-of-the-earth-is-covered-by-desert/*

[2] *https://www.fitariffs.co.uk/solar-power-energy-in-the-desert/*

[3] *https://www.nature.com/articles/s43247-023-01117-5*

[4] *https://www.nrel.gov/news/detail/program/2024/nextracker-and-nrel-partnership-inspires-new-look-at-pv-tracker-industry-design-standards*

FLOATING SOLAR PV: UNLOCKING POTENTIAL IN THE MENA REGION

Chrysovalantis Mikrommatis
Vice President Sales Enablement
YELLOW DOOR ENERGY

CURRENT LANDSCAPE

Floating solar photovoltaic (FPV) technology is emerging as a promising solution within the global renewable energy landscape. Based on estimates that one-third of the world's 114,000 reservoirs could host FPV, the theoretical generation potential exceeds 9,343 terawatt hours (TWh)[1] annually. This figure excludes untapped potential in other waterbodies such as ports, harbours, agricultural irrigation lagoons, minerals operations and the offshore marine environment.

However, FPV deployment has been slow to date compared with rooftop and ground mount solar PV, with only 10 Gigawatts (GW) recorded as being deployed globally by 2024. However, Wood MacKenzie forecasts sevenfold increase, with installed capacity reaching 77 GW by c.2035[2]

Some notable FPV project initiatives in Middle East and North Africa are as follows:

- **The UAE is assessing FPV on artificial reservoirs near Abu Dhabi, even as ground-mounted solar remains dominant;**
- **Morocco is developing a 480 MW FPV project at Al Wahda to support the mining operations of a large phosphate producer and thus reduce evaporation;**
- **Egypt is exploring hybrid FPV-hydropower setups near Aswan, with potential gains in both energy and water conservation; and,**
- **Lebanon and Tunisia have launched pilot projects focused on rural electrification and water pumping.**

WHY FPV MATTERS FOR MENA

FPV has made significant strides in becoming more cost competitive. The value of technology should not just be seen through the lens of the cost to install alone, but also the inherent benefits that, considered on balance with costs, already make FPV a viable option in many cases. Significant advantages that allow for FPV to flourish in the MENA region are as follows:

Greater panel efficiency- the warm air temperatures that hinder ground mount solar PV efficiency, particularly in warm/hot climates, are offset by the cooling effects of water on FPV installations increasing the efficiency. It fits well with industrial and urban settings especially of the Middle East and North Africa region and its water-cooling effect can help boost PV performance in hot climates.

Preservation of land resource– where access to land and/or land rights are at a premium, or highly valued for other uses such as for quarrying, ports, harbours, and agriculture it provides a credible alternative solution that can meet demand whilst preserving land.

Water conservation– FPV supports the water–energy nexus reducing evaporation while producing clean energy. The coverage that FPV provides over the water surface can significantly reduce surface evaporation, with predictions given of up to 42%[3] reduction in hot/arid climates. The benefits of water conservation are not just relevant in terms of water supply for drinking but also other activities which rely wholly on this resource.

Food Security– FPV aligns particularly well with agricultural operations when deployed on water storage lagoons with the dual benefit of conserving water and powering the irrigation systems.

Co-location with hydroelectric assets– FPV also provides a clear benefit in being compatible energy generation wise with, and conserving the water required for, hydro electricity generation. Lake Kariba is currently the focus of the proposed co-location of FPV with hydro electric generation, at scale[4].

CHALLENGES TO SCALE

As the FPV sector looks to scale up deployment, it is important to recognise the challenges to widespread adoption. Cost competitiveness with ground mount solar remains a challenge. Whilst significant strides have been made in recent years, the evolution of FPV solutions needs to go further to be consistently competitive. From a commercial perspective, ground mount solar PV has benefitted significantly from financial incentives and subsidies. This type of support is something FPV largely lacks at present.

Considering deployment of FPV at scale to meet regional energy demands, often access to regional and national electricity grid networks is a hindrance. The grid system integrity, regional coverage, and available capacity can often be barriers to deployment. Environmental permitting / consenting and funding demands can often lead to prolonged delays, or indeed on occasion failure to secure the necessary consent to proceed. With FPV being new to region, bankability of the technology is sometimes questioned.

Other more technical challenges related to FPV include for anchoring and mooring, an important part of the FPV system to be adapted to artificial reservoirs and harsh wind conditions. Whilst materials used for the components comprising the FPV system need to withstand dust, UV, and salinity leading to more enhance site-specific strategies to tackle soiling and maintenance.

FUTURE POTENTIAL: COMPLEMENTARY, NOT COMPETITIVE

Ground and roof mounted solar PV has been deployed at scale globally, predominantly over the past 15 years, and seen an associated exponential decrease in costs. In comparison, FPV was largely considered less cost effective, with a comparatively higher levelised cost of energy (LCOE), and has therefore struggled to gain traction until recent years where we have seen more focus on optimising the technology and its system components.

FPV does not aim to replace ground-mounted PV but it can complement it smartly. With the right technical design, permitting frameworks, and financing tools, it can become a valuable part of the energy mix especially in the water and energy industry integration strategies and complex industrial infrastructure that have neighboring water bodies. Regions that experience hot and arid climates like the Middle East and North Africa will benefit the most and where the technology will be at its most effective, taking advantage of the additional benefits relating to land preservation, water conservation, reduce water evaporation and optimizing underused water surfaces and greater efficiency in terms of energy production and improving PV performance in high-temperature conditions.

References:

[1] ** Jin, Y., Hu, S., Ziegler, A. D., Gibson, L., Campbell, J. E., Xu, R., Chen, D., Zhu, K., Zheng, Y., Ye, B., Ye, F. and Zeng, Z. (2023), 'Energy production and water savings from floating solar photovoltaics on global reservoirs', Nature Sustainability, 6: 865–874.*

[2] *'Floating solar to reach 77GWdc within 10 years' - reNews - Renewable Energy News*

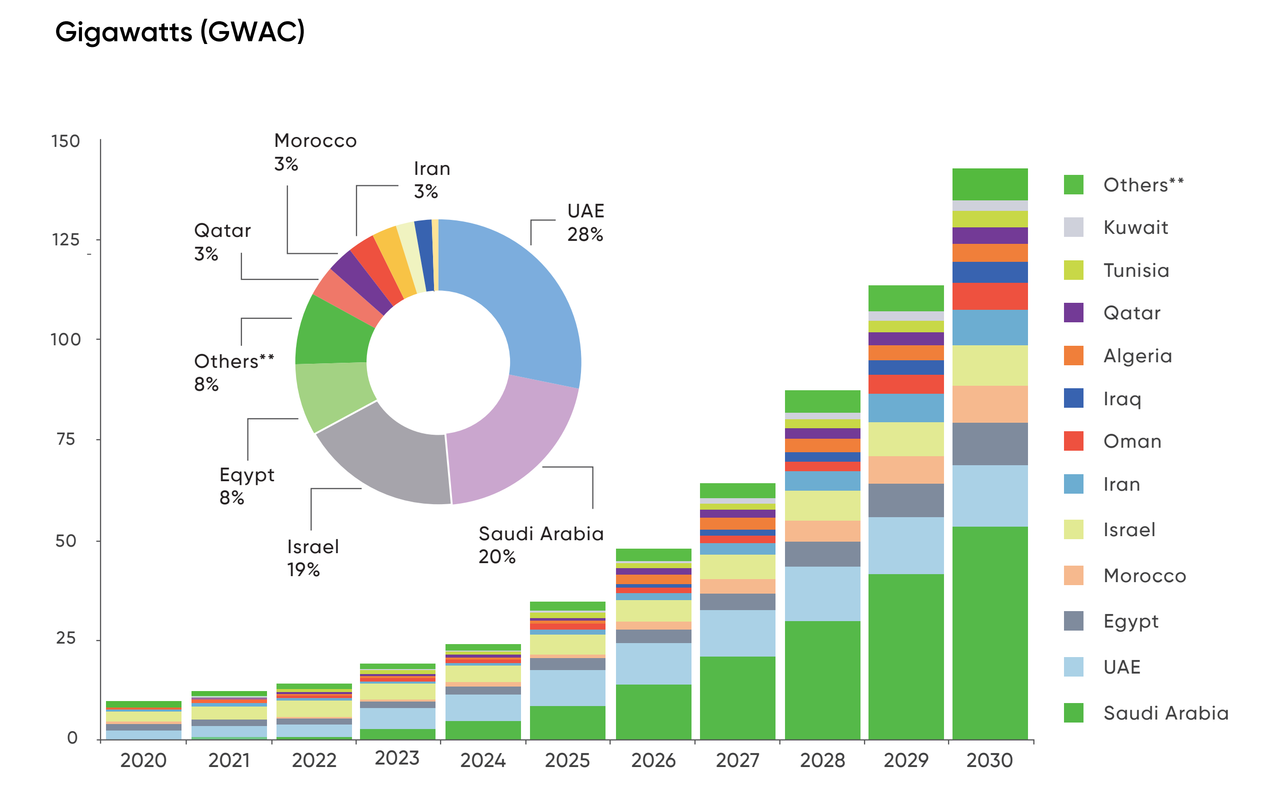
[3] **Farrar, L. W., Bahaj, A. S., James, P., Anwar, A. and Amdar, N. (2022), 'Floating solar PV to reduce water evaporation in water stressed regions and powering water pumping: Case study Jordan', Energy Conversion and Management, 260: 115598*

[4] ** Floating Solar Plant on Lake Kariba Secures $250M for Energy*

SMART SOLAR ECOSYSTEMS: PIONEERING LOCALISED INNOVATION TO POWER MEA'S ENERGY TRANSITION

Vincent Wu
Global Sales Vice President & Head of MEA Region
Trinasolar

As the Middle East and Africa (MEA) region intensifies its pursuit of decarbonisation and energy diversification, solar power is no longer just a promising option, it has become a strategic imperative. Countries across the region have strengthened their solar commitments through new utility-scale tenders, distributed generation policies, and investments in local manufacturing. According to the MESIA Solar Outlook Report 2025, citing data from Rystad Energy, the MENA region's solar capacity reached 24 GW (AC) in 2024, marking a 25% year-on-year increase. Notably, over 80% of this growth was concentrated in Saudi Arabia, the United Arab Emirates, and Egypt, signalling a clear regional prioritisation of large-scale solar infrastructure as a pillar of long-term energy strategy.



*MENA - Middle East & North Africa (excluding Turkey) *Others - Bahrain, Eritrea, Jordan, Yemen, Lebanon, Libya, Palestine, Sudan, Syria, Tunisia and Western Sahara

Source: Rystad Energy Global Powermix Analysis dashboard

Figure [1] : Solar installed capacity by country, MENA*

LOCALISED INNOVATION FOR EXTREME ENVIRONMENTS

Amidst rising expectations and expanding project footprints, solar's future now depends as much on system integration and adaptability as it does on efficiency or cost.[1] Across MEA, project success depends increasingly on how well technologies can perform in some of the world's most demanding environments. From the deserts of Saudi Arabia to the arid zones of Egypt and Morocco, solar assets must contend with extreme heat, dust, intermittency, and infrastructure gaps.

In such settings, innovation becomes inherently localised. Recent advances in materials and system design are enabling solar assets to operate more effectively under high temperatures and dusty conditions. New-generation modules equipped with enhanced cooling, anti-soiling coatings, and bifacial capabilities are being tested in regional pilot projects to address site-specific challenges. These technical adjustments may appear incremental, but their impact on performance ratios and asset longevity is substantial.

Concurrently, a subtle but transformative shift is redefining how solar systems are conceived and deployed. The past decade's emphasis on panel-level efficiency is giving way to fully integrated, intelligent systems. Developers are embracing digital tools, AI-powered monitoring, predictive maintenance, and digital twin modelling—that enhance operational decision-making and system responsiveness. These digital layers do more than optimise uptime; they offer real-time visibility, enable system-wide coordination, and strengthen long-term asset resilience. In a region where environmental conditions and grid dynamics fluctuate quickly, such intelligent responsiveness is becoming essential to managing risk and sustaining energy yields.

From Fragmented Procurement to Integrated Performance

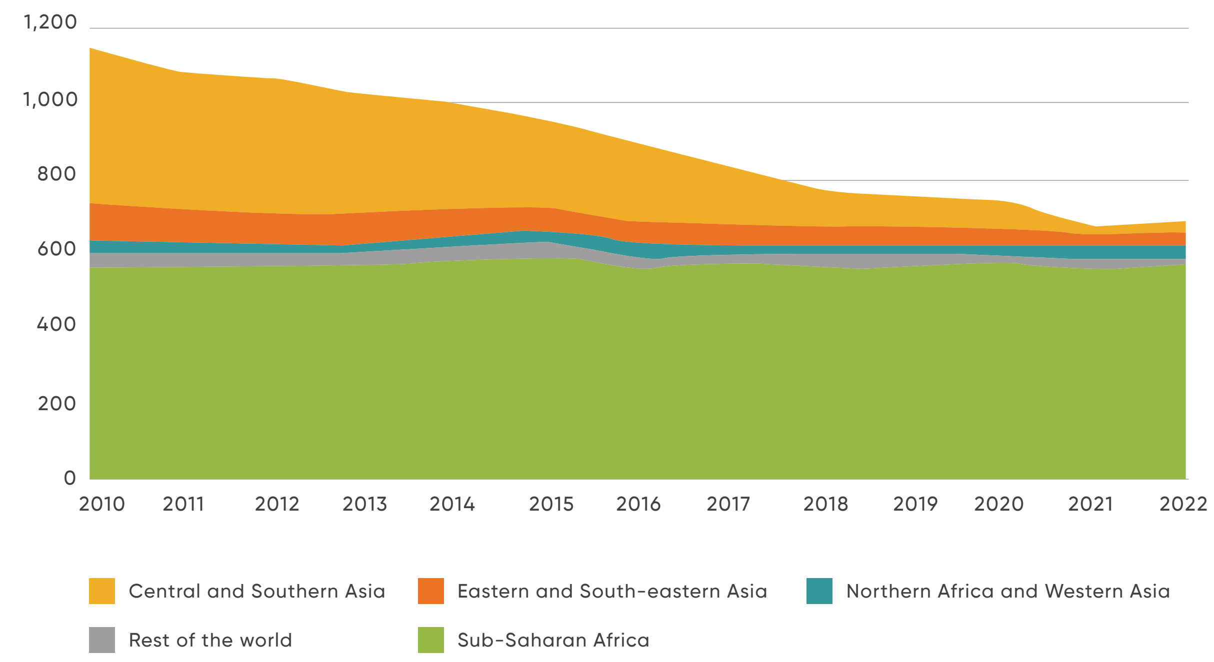
This transition toward smart, connected ecosystems is also disrupting conventional procurement strategies. Project tenders are evolving to favour bundled solutions that offer seamless integration across modules, trackers, storage systems, and control platforms. Governments and financiers are adjusting their evaluation criteria, placing greater emphasis on lifecycle metrics like the Levelised Cost of Energy (LCOE) over traditional cost-per-watt comparisons. By focusing on long-term performance, interoperability, and grid compatibility, decision-makers are driving a new level of accountability and value creation.

A growing number of solar projects now favour operational models built around single-vendor ecosystems. Developers are recognising the benefits of procuring fully integrated, interoperable solutions from a single technology partner. This approach streamlines engineering, minimises integration challenges, and ensures that system components are optimised to work seamlessly together. Involving solution providers early in the project lifecycle helps accelerate timelines, mitigate design risks, and navigate permitting or logistical hurdles more effectively. As regional deployment accelerates, this coordinated model is emerging as a key enabler of efficiency, reliability, and scalability.

As the regional energy mix becomes increasingly diversified, solar is also playing a key role in enhancing grid stability and flexibility. With many MEA countries still facing infrastructure constraints and load variability, solar projects paired with battery storage and smart inverters can offer valuable support in frequency regulation, peak shaving, and black start capabilities. In markets like Egypt and South Africa, where grid resilience is under pressure, integrating solar into national energy strategies is not only about capacity expansion but about creating a more agile, secure energy system.

Supporting this transition is a broader regional push for localisation and capacity building. Across the Gulf, North Africa, and East Africa, governments are introducing local content mandates and investing in domestic manufacturing and training. Customised engineering, whether in tracker design, storage sizing, or system controls helps tailor solar projects to unique site conditions and regulatory frameworks. These efforts not only strengthen project viability, but also drive long-term economic and social value across local ecosystems. Especially in a region that boasts some of the world's highest solar energy potential, with average annual solar irradiance exceeding 2,000 kWh per square metre per year[2]

As solar becomes foundational to MEA's future grid infrastructure, its role is expanding far beyond generation. The region is witnessing the emergence of integrated clean energy systems that combine solar with storage, microgrids, and digital controls. In Sub-Saharan Africa, where 570 million people were living without electricity in 2022, representing over 80% of the global population without access, according to the World Bank[3], hybrid energy systems combining solar and storage are playing a critical role in extending electricity access to off-grid communities. Meanwhile, in countries like the UAE and Morocco, early initiatives are exploring the integration of solar with electric vehicle charging infrastructure, and examining future opportunities around vehicle-to-grid connectivity. Emerging technologies such as blockchain-based energy trading are also being piloted as part of broader innovation strategies aimed at shaping the region's decentralised energy future.



Source: World Bank 2024b.

Figure [2] : Population Without Access to Electricity, by Region, 2010-22

As 2025 approaches, MEA's solar industry stands at a turning point. Success will be defined not just by how many megawatts are installed but by how intelligently systems are designed, integrated, and managed. With the right mix of digitalisation, localisation, and full-solution thinking, the region has the opportunity to leapfrog into a cleaner, more adaptive energy future, one smart solar ecosystem at a time.

References:

[1] *P. Jowett, "MENA region hits 24 GW (AC) of total solar capacity," Pv Magazine International, Jan. 17, 2025. https://www.pv-magazine.com/2025/01/17/mena-region-hits-24-gw-of-total-solar-capacity/?utm_source=chatgpt.com.*

[2] *"MESIA launches 2024 Solar Outlook Report | Middle East Solar Industry Association." https://mesia.com/news/mesia-launches-2024-solar-outlook-report*

[3] *World Bank Group, "Progress on basic energy access reverses for first time in a decade," World Bank, Jun. 13, 2024. [Online]. Available: https://www.worldbank.org/en/news/press-release/2024/06/11/progress-on-basic-energy-access-reverses-for-first-time-in-a-decade*

02

AI & DIGITAL TRANSFORMATION

A. AI & Machine Learning in Solar O&M
B. Current AI Trends in Solar PV Plant Monitoring
C. Middle East Green Data Center Market

AI-ENHANCED O&M TRANSFORMATION IN UTILITY SOLAR

Liang CHEN
Product Director
Weisi DENG
Marketing Manager
Solar-LIT

TRENDS OF O&M IN THE MENA REGION

The Middle East and North Africa (MENA) region is emerging as a key market of solar energy. In 2024 alone, installed solar capacity reached 24 GWAC, marking a 25% increase from the previous year[1]. The rapid expansion across the region has led to unprecedented operational and maintenance (O&M) demands.

At the same time, rising expectations for Performance Ratio (PR) have transformed precision O&M from a competitive advantage into an operational necessity, as every percentage point of energy loss can result in significant revenue erosion.

The O&M trajectory in MENA is clear: reduce costs while improving operational efficiency.

Harsh site conditions including extreme heat, frequent sandstorms, and remote desert locations have amplified labor shortages and operational expenses. These factors are increasingly unsustainable given the pace of regional solar deployment.

Meanwhile, traditional O&M practices face inherent inefficiencies. Repetitive standard tasks like routine inspections, panel cleanings and reactive maintenance on recurring issues, are draining resources. As renewable energy projects evolve, relevant information also becomes complex and interconnected, further complicating signal interpretation. The shift in paradigm requires operation work of higher standards.

This article presents a roadmap in which AI and robotics address these challenges across three evolutionary phases: automation, digitalization, and intelligent operation. Using solar cleaning robots as a recurring case study, we highlight practical applications rather than technical theory.

O&M AUTOMATION: SHIFT TEDIOUS TASKS TO ROBOTICS

Routine tasks such as panel cleaning are vital in solar O&M, especially in desert environments where high soiling rates significantly reduce power output.

In the MENA, the soiling rates are naturally high due to deserts and arid climates. A study by Jones et al. reported soiling rate (the soiling loss increase rate) ranging between 0.1~0.57% per day for Rumah, Saudi Arabia. In Abu Dhabi, UAE, the soiling rate can reach 0.87% per day in March[2].

Regular cleaning is critical for maintaining power output, yet manual methods prove impractical due to high labor costs and water scarcity. As a result, this market has witnessed the growing acceptance of fully automatic waterless cleaning robots in utility plants, especially in UAE and Saudi. Such robot systems can now achieve a 99.5% cleaning efficiency compared to manual cleaning. Beyond cleaning, robotic solutions are also automating fault detection and inspection. AI cameras and inspection devices automate anomaly detection. Using sensors, neural networks, and data analytics, they identify hotspots, bird droppings, cracks, shading, and unauthorized intrusions, accelerating fault responses while slashing manual inspection costs.

A study investigating over 10,000 maintenance tickets revealed that, up to 80% of standard operational tasks can be managed automatically[3]. This liberates on-site engineers from repetitive, time-consuming, and hazardous work, enabling better resource allocation.

O&M DIGITALIZATION: IOT + MACHINE LEARNING TO ENHANCE RELIABILITY

The next step is integrating hardware and software to enable remote monitoring, rule-based automation, and system-wide reliability. Again, we focus on PV cleaning robots to illustrate the transition.

Reliability and robustness under harsh environmental conditions is essential for robotic systems to avoid becoming additional O&M burdens. Cleaning robots often operate daily and cover distances exceeding 3 km per unit. Even minor failures can cause widespread operational losses.

Manufacturers already partially address this problem through several mechanical innovations:

- **Twistable end plates accommodate tracker installation tolerances, preventing panel collisions when crossing obstacles.**
- **Flexible bridges maintain engaged even when angle difference between the two trackers on both sides reaches up to 120°. Such a design eliminates falling risks of robots and manual reconnection labor.**

In addition to that, the hardware now integrates with IoT and machine learning for enhanced stability. The enhancement can be divided into two aspects below:

Intelligent Self-control: During operation, robots may experience tilting, jams or overspeed due to excessive slope angles or installation tolerances. If undetected and unadjusted promptly, robots can get stuck and cause damage to both PV panels and themself. Beyond disrupted cleaning operations, such failures incur additional emergency labor costs and equipment maintenance or replacement expenses.

To mitigate this, multi-sensor fusion combined with edge computing enables real-time monitoring of operational status. When posture abnormalities occur, the system precisely calculates tilt deviation angles and executes immediate corrections, significantly reducing failure probability.

Figure [1] : Intelligent Posture Correction Extreme Test at Site, Solar-LIT

References:

[1] *Kumar, N., & Thaikoottathil, N. D. (2025). MENA Ramps up Its Solar Manufacturing Capabilities. MESIA Solar Outlook 2025, 1.*

[2] *Mithhu, M. M. H., Rima, T. A., & Khan, M. R. (2021). Global analysis of optimal cleaning cycle and profit of soiling affected solar panels. Applied Energy, 285, 116436.*

[3] **Lenhart, R., & Routtier, R. (2025). Digitalization and Automation in Pv Monitoring: The Key to Scaling Solar Portfolios in the MENA Region.*

Real-time Coordination: Robots' safety also depends on continuous environmental perception and responsive action. It is achieved through real-time coordination across four critical systems: tracker SCADA for instantaneous tilt data, plant SCADA for comprehensive site status, and weather forecasting services for meteorological threats, robot SCADA for command and control.

This integrated intelligence enables autonomous safety protocols. For example, upon predicting high-wind events, robots proactively terminate cleaning missions, navigate to docking stations or activate emergency stow mode, and engage anti-wind mechanisms to prevent structural damage. During operation, trackers' angles are also continuously monitored. If any tracker unit disconnects or deviates from preset cleaning angles, the robot on it will take protective actions, either perform partial cleaning only or immediately pause at emergency stow position. Such coordination effectively eliminates fall risks and prevents potential damage.

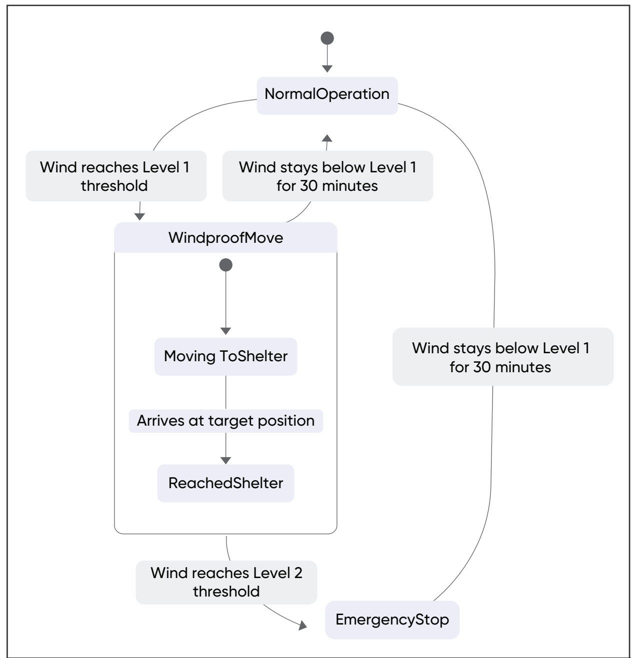


Figure [2] : Logic Diagram of Realtime Coordination Between Robot SCADA and Weather Station

INTELLIGENT O&M: DATA-DRIVEN OPTIMIZATION

O&M digitalization generates large amount of data every day, including weather, irradiance, device status, energy yield and more. Research demonstrates how machine learning leverages site-specific operational data to predict energy yield under varying conditions. Consequently, ML-based models establish quantifiable performance benchmarks, identify power loss patterns, and enable early anomaly detection. To ensure the quality of diagnosis, the model is sometimes cross-validated with a knowledge-base model.

Diagnosis is, however, not the final step of maintenance. Within predefined permission scopes, the system autonomously generates maintenance tickets, assigns them to engineers or automated devices, tracks resolution outcomes, and incorporates feedback, completing the full maintenance ticket lifecycle.

In the case of cleaning, the system determines optimal soiling thresholds and generates dynamic, site-specific cleaning strategies. These strategies adapt based on:

- **Block-specific environmental variables**
- **Forecasted humidity levels (e.g., cleaning before humid days to avoid hardened dust or water stains)**
- **Cost-benefit trade-offs between cleaning frequency and energy gains**

Cleaning robots execute these adaptive plans, while actual vs. predicted generation output is monitored to refine future strategies.

It is noteworthy that during the transition toward automated, digitalized, and intelligent solar O&M, human engineers remain indispensible. As fundamental maintenance and decision-making tasks shift to intelligent systems, engineers will pivot toward addressing more complex challenges requiring problem decomposition, root cause analysis, and defect resolution.

Their experiences and strategies will be codified into shared knowledge ecosystems, accelerating professional development and standardizing best practices across the sector.

In turn, AI systems will draw from this expertise to function as intelligent O&M assistants, flagging risks, recommending actions, and continuously improving through validated outcomes.

THE AI REVOLUTION IN SOLAR ENERGY

Sergio Merelo
AMEA Regional Manager,
Renewable Energy Services Unit
Applus+

The Gulf region is rapidly emerging as a key player in global solar deployment, with the UAE and Saudi Arabia leading the charge. The UAE currently tops the region with over 5 GW of installed solar capacity, followed by Saudi Arabia at 3.9 GW together forming the backbone of MENA's ambitions to achieve 100–130 GW of renewable energy by 2030[1].

This regional momentum mirrors global trends, where the dramatic cost reductions in photovoltaic (PV) technology have catalyzed a shift toward cleaner power systems. Decreasing CAPEX, optimized OPEX, and maturing battery storage technologies are now enabling a new wave of operational innovation—centered around artificial intelligence (AI) and machine learning (ML). These digital tools are quickly becoming critical to maximizing the efficiency, reliability, and financial performance of solar PV assets in increasingly complex energy systems.

AI'S ROLE IN NEXT-GENERATION POWER SYSTEMS

According to the International Energy Agency, "Power systems are becoming vastly more complex as demand for electricity grows and decarbonization efforts ramp up. One of the most common uses for AI by the energy sector has been to improve predictions of supply and demand. Developing a greater understanding of both when renewable power is available and when it's needed is crucial for next-generation power systems. That's where machine learning can play a role. It can help match variable supply with rising and falling demand – maximizing the financial value of renewable energy and allowing it to be integrated more easily into the grid[2].

In the PV industry sector, AI tools and related technologies offer a faster and more efficient way to process large volumes of data from PV assets. The insights derived from these analyses enable better asset management and support project owners in strategic decision-making processes to maximize their return on investment (ROI). AI-powered functionalities include automated inspections, performance analytics, energy forecasting, and demand response.

INFRARED DRONES AND SMART PV INSPECTION TOOLS

Solar facility operations require vigilant management of extensive equipment arrays to maximize energy generation. A typical utility-scale installation contains thousands of photovoltaic modules and hundreds of inverters, creating significant maintenance challenges across large geographic areas.

References:

[1] *Dii Desert Energy, MENA Energy Outlook 2025 – Renewables, Hydrogen and Energy Storage Insights 2030 report https://dii-desertenergy.org/publications/*

[2] *International Energy Agency-Why AI and Energy Are the New Power Couple https://bit.ly/4eHv9mk*

Traditional approaches relied on licensed professionals walking sites manually, capturing photos and infrared (IR) scans of sample modules. Based on these limited data points, experts would then extrapolate system-wide performance assessments and provide general recommendations for repair or replacement. These processes were time-consuming and when anomalies appeared, modules often required shipment to third-party laboratories for validation, leading to delays in problem identification and resolution. These inefficiencies could impair project financing, any Power Purchase Agreements (PPAs), and construction timelines.

Today, advancements in IR drone technology and AI-enhanced software have dramatically accelerated these workflows. Rather than depending on limited manual sampling, fleets of IR drones can scan entire PV sites quickly and comprehensively.

Figure [1] : Drone flying over solar farm and infrared inspection shots taken by on-board came

AI-driven inspection platforms can then analyze collected data in minutes. Thousands of images from drone flyovers are processed to detect underperforming components, prioritize issues, and geo-locate faulty modules. This enables project teams to receive inspection results in a short timeframe, typically within a few days. Time and costs are further reduced when mobile laboratories can be deployed onsite to conduct specialized testing of faulty modules, eliminating the need for external lab analysis.

"SMART" SCADA AND MACHINE LEARNING TOOLS

AI has significantly expanded the capabilities of conventional SCADA systems. Legacy platforms offered limited, high-level metrics, often with delayed reporting. In contrast, smart SCADA systems powered by AI now provide real-time fault detection, cleaning schedules based on soiling analytics, and early warnings of inverter or tracker failures.

Moreover, advanced ML models can process high-resolution performance data across years, delivering detailed diagnostics from the string level up to entire plant portfolios. These tools compute KPIs such as real-time performance ratio (PR), quantify energy losses from curtailment or equipment degradation, and isolate specific issues like AC-side inefficiencies or module aging.

For portfolio operators managing diverse assets across multiple geographies and technologies, AI tools also enable data integration across various SCADA architectures, consolidating insights into a unified monitoring platform.

ADVANCED MODULE DEFECT DETECTION

Anomaly identification in solar modules has been transformed through sophisticated imaging technologies. Thermal infrared and electroluminescence (EL) cameras enable capturing distinctive image patterns associated with specific module defects. These patterns form the foundation for robust ML models that automatically detect and assess defect-affected areas, as well as determine the impact on module performance.

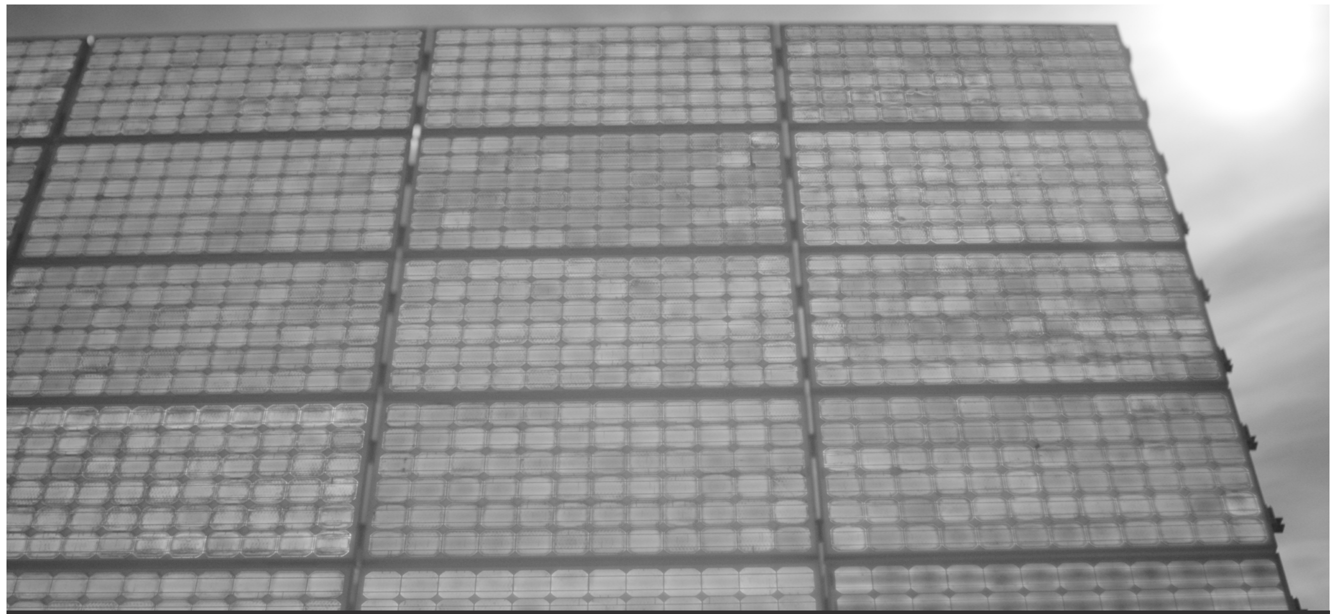


Figure [2] : Electroluminescence tests imaging

INTELLIGENT PERFORMANCE OPTIMIZATION

AI-enhanced algorithms can evaluate real-time data from sensors and other monitoring systems to detect inefficiencies and suggest operational adjustments. These recommendations can improve plant performance and reduce energy losses.

ENERGY FORECASTING

AI models can predict solar output days in advance with remarkable accuracy. These forecasts integrate comprehensive meteorological input and help operators plan daily energy dispatch, optimize storage use, and coordinate with grid requirements.

GRID INTEGRATION INTELLIGENCE

Network-level energy coordination benefits from AI applications that enhance supply-demand alignment. Utilities analyze consumption data to forecast demand and manage grid load accordingly. Based on these projections, system controllers can scale down PV plant output to avoid oversupply or activate supplementary generation sources to meet increased demand, with the ultimate goal of maintaining grid stability.

CONCLUSION

The integration of artificial intelligence with solar photovoltaic technology marks a pivotal advancement in renewable energy, transforming how solar assets are monitored, maintained, and optimized while creating unprecedented opportunities for efficiency gains across the entire power generation lifecycle. As this technological revolution accelerates, particularly in high-potential markets such as the UAE and Saudi Arabia, forward-thinking project owners who successfully implement these AI capabilities will gain significant competitive advantages through enhanced operational performance and economic returns, ultimately contributing to a more sustainable and intelligent global energy system.

POWERING THE FUTURE: SOLAR-POWERED DATA CENTERS IN THE MIDDLE EAST

Kashik Arora
Senior Research Associate
Utkarsh Tiwari
Team Lead
FORTUNE BUSINESS INSIGHTS

Middle East, with its profound digital transformation and strategic investment in AI, is experiencing a rapid surge in the data center industry with the capacity projected to triple in the 2025-2030 period.

With their strong focus on technology and innovation, smart city projects such as Dubai Internet City and Saudi Arabia's Vision 2030 are fueling the demand for data centers.

However, data centers use huge amount of power and rely heavily on electricity generated through traditional sources. Abundance of sunlight and ambitious sustainability agendas provided a strategic advantage to the Middle East region in their push towards solar-powered data centers.

Solar-powered data centers are emerging as a strategic response for accelerating green digital infrastructure and this expansion in creating the need for green energy solutions.

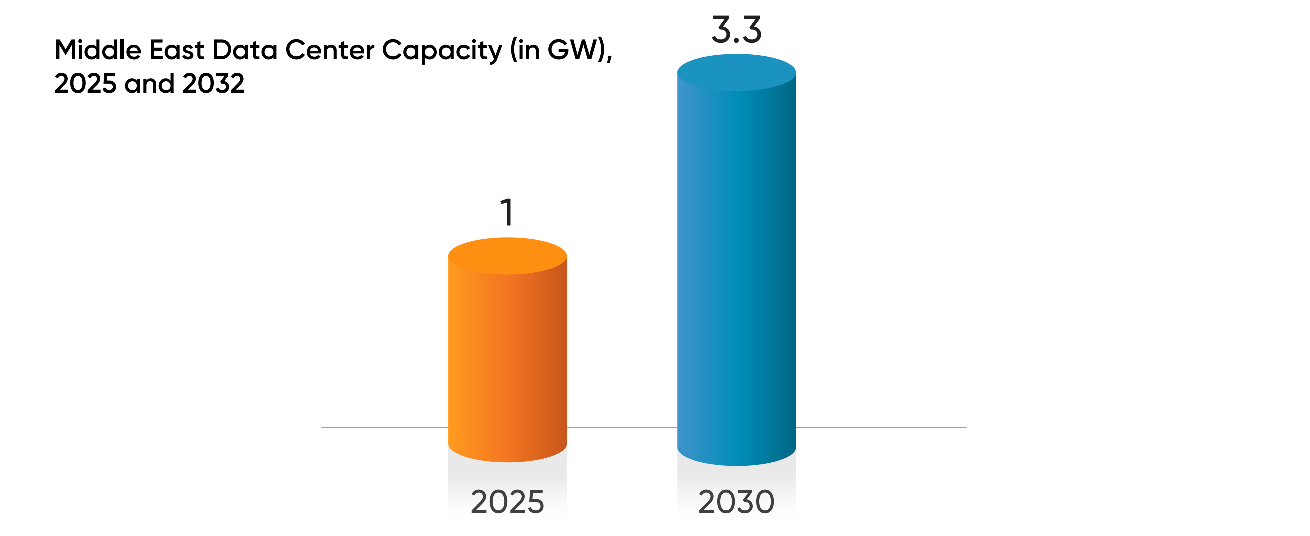


Figure [1] : Middle East Data Center Capacity (in GW), 2025 and 2032

THE PATH TOWARDS GREEN: POLICY AND MARKET MOMENTUM

The Middle East green data center market, valued at USD 2,336.0 million in 2024, is projected to reach USD 9,368.0 million by 2032, exhibiting a CAGR of 19.4% during the forecast period (2025-32). The growth is fueled by net-zero targets, smart city developments, and increasing cloud adoption. The green data center industry is increasingly focusing on solar power to reduce carbon emissions and operational costs.

- **Governments across the Middle East are aligning their digital and climate ambitions. The UAE's Green Agenda targets a reduction of national emissions to under 100 kilowatt-hours per capita by 2030. Saudi Arabia has pledged net-zero emissions by 2060 under its Green Initiative.**

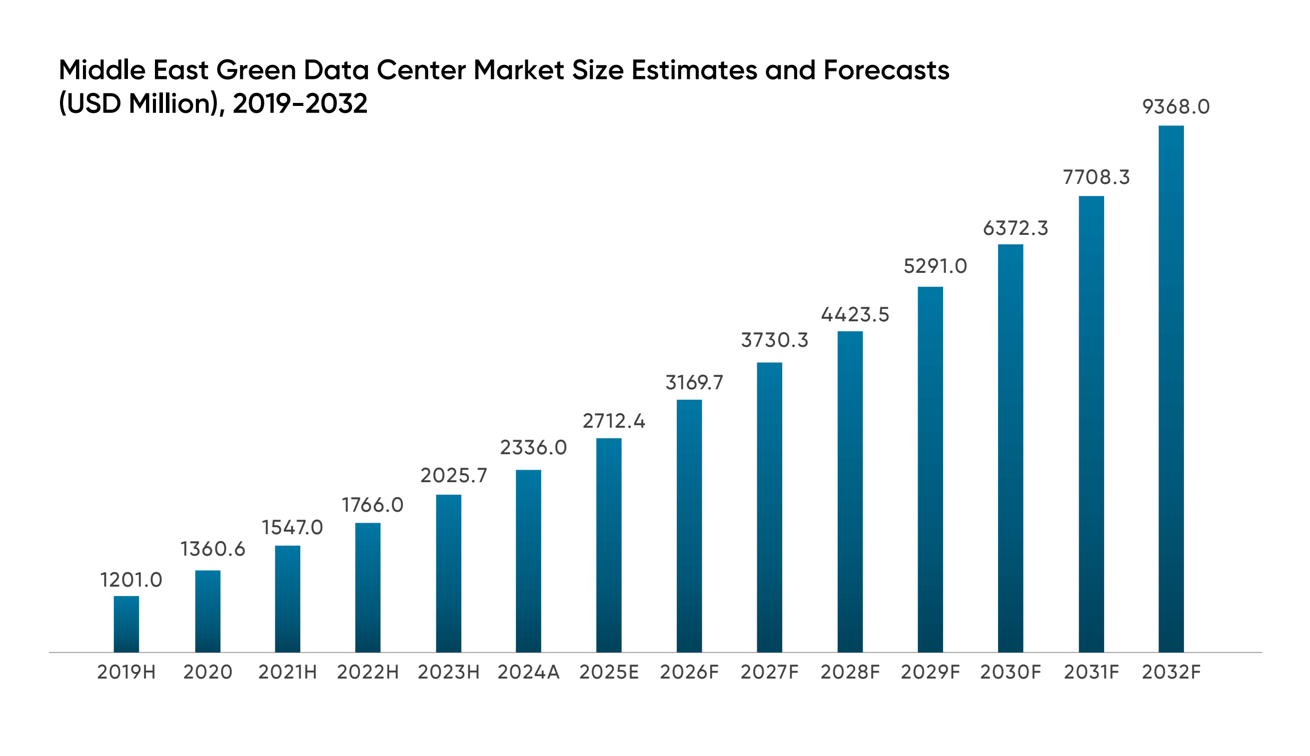


Figure [2] : Middle East Green Data Center Market Size Estimates and Forecasts (USD Million), 2019-2032

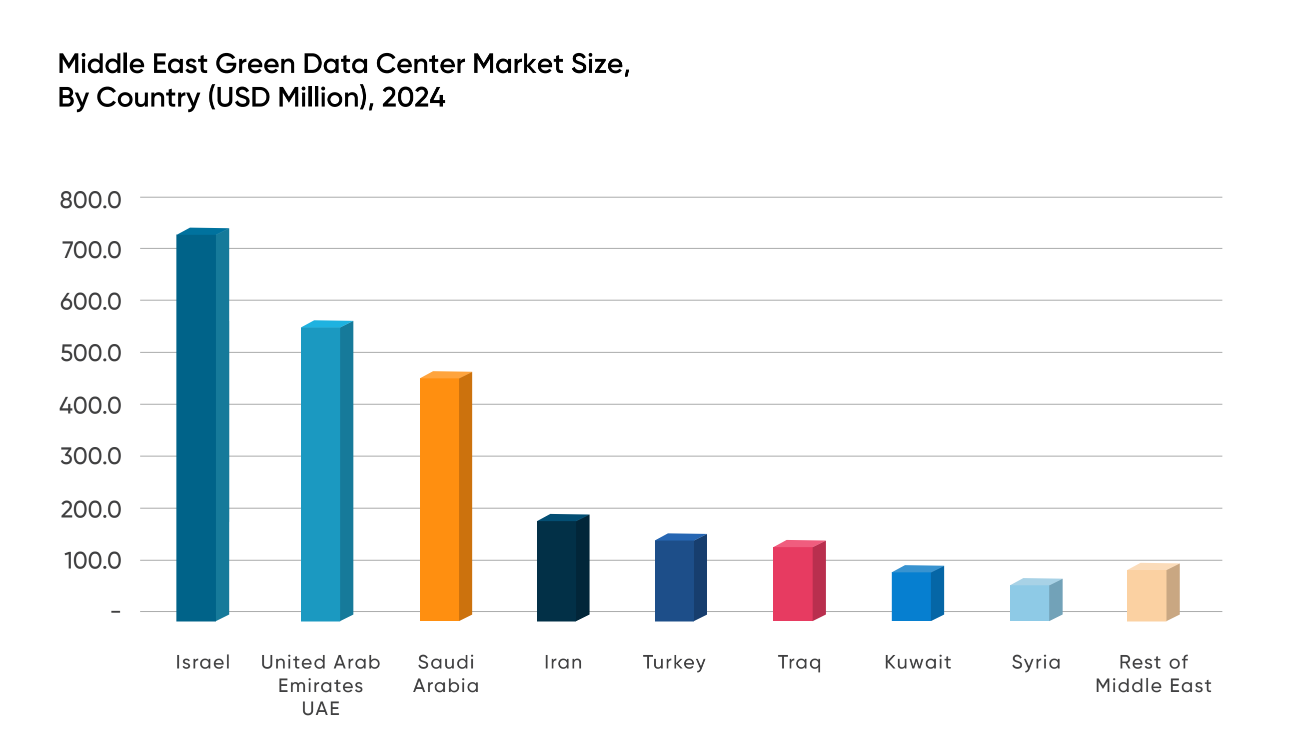


Figure [3] : Middle East Green Data Center Market Size, By Country (USD Million), 2024

SOLAR ENERGY: A STRATEGIC FIT FOR THE REGION'S SUSTAINABLE FUTURE

The Middle East is well positioned for solar energy. The region has some of the highest levels of solar irradiance and open land for big solar power setups at a large scale. This built-in advantage, coupled with rapidly falling PV prices, and better battery storage tech, makes solar energy a practical and extendable option.

By 2030, solar PV is expected to account for over 16% of the regional energy mix, underscoring its role in the decarbonization of digital infrastructure.source IEA.org

% Share of Solar PV, 2020-2030

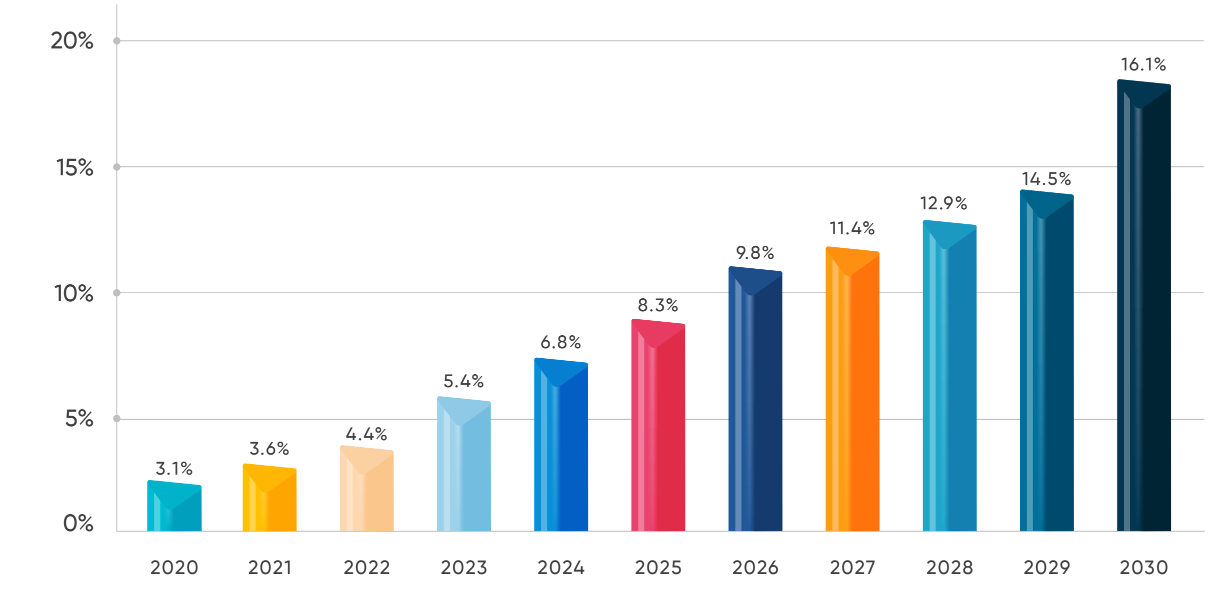


Figure [4] : % Share of Solar PV, 2020-2030. & the source

RECENT MILESTONES IN SOLAR POWERED INFRASTRUCTURE

In 2025, Emirates Group partnered with Moro Hub to utilize the world's largest solar-powered data center, located at the Mohammed Bin Rashid Al Maktoum Solar Park. This site contributes to substantial renewable energy use in data operations.

In Israel, Enlight Renewables was awarded a tender to build an integrated data and solar energy facility in Ashalim, with a planned 100 MW capacity and USD 1.1 billion investment. The site combines solar generation, battery storage, and IT infrastructure.

Qatar and Oman are competing to emerge as regional data center hubs, with Qatar targeting 18% renewable energy by 2030, and Dubai aiming for 100% renewables by 2050. In parallel, Khazna Data Centres in the UAE has launched a 100 MW AI facility in Ajman, while Saudi Arabia is pursuing large-scale AI and digital investments backed by sovereign wealth funds.

These developments signal a growing commitment to embedding solar power into the region's data center strategy.

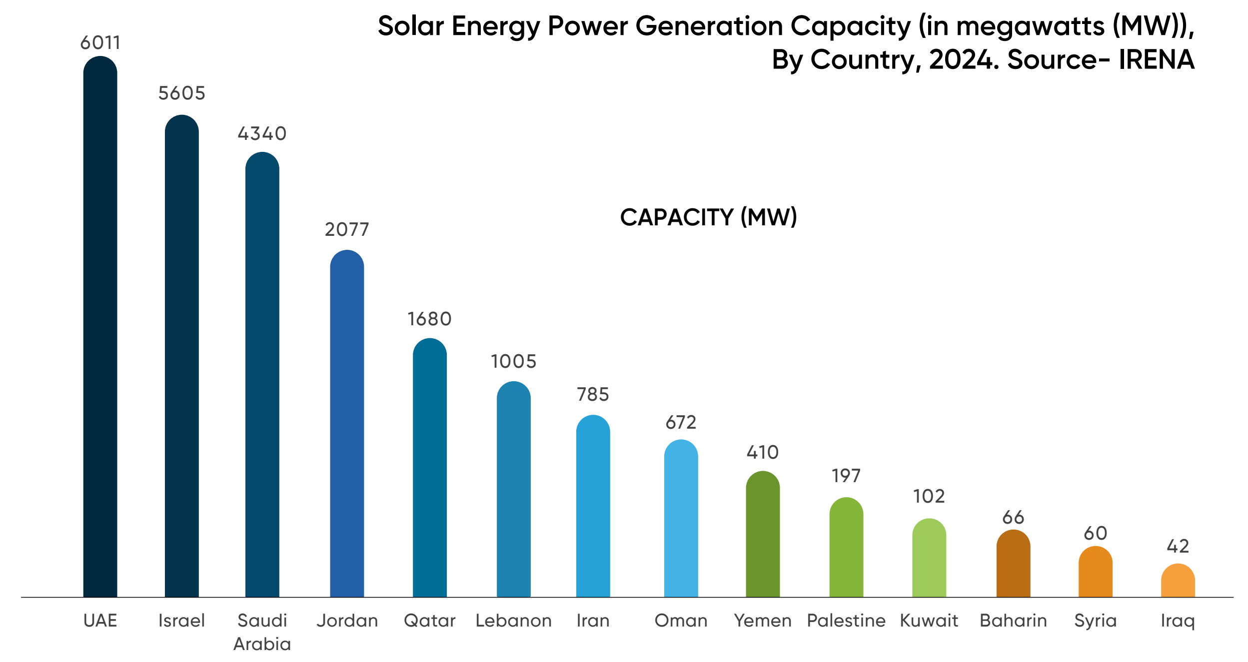


Figure [5] : Solar Energy Power Generation Capacity (in megawatts (MW)), By Country, 2024. Source- IRENA

Factors Driving Demand: **Growth Enablers and Sustainability Trends**

Growth Enablers	Description	Sustainability Trends	Description
Abundant Solar Resource	The Middle East has one of the highest solar irradiance levels globally, making solar energy a cost-effective option.	**Liquid Cooling and Energy-Efficient Design**	Adoption of advanced cooling solutions to reduce Power Usage Effectiveness (PUE).
Energy Cost Savings	Solar reduces dependence on expensive fossil fuels and lowers long-term operational costs for data centers.	**Carbon-Neutral and Net-Zero Goals**	Operators are aiming for net-zero emissions through renewable energy credits, on-site generation, and carbon offsets.
Increasing Demand for Cloud and AI Services	Rising demand for hyperscale and edge data centers from tech giants such as AWS, Microsoft, and Oracle fuels infrastructure development.	**Smart Grid and Energy Management**	Use of AI and IoT for real-time energy optimization and predictive maintenance.
Population & Urbanization	A marked increase in urbanization and population led to growing demand for digital transformation and higher regional Internet penetration.	**Integration of On-site Solar PV**	Rooftop and ground-mounted solar farms integrated with data centers, often supported by battery storage.

The major running cost for data centers is power, and the Middle East has rich energy resources, which bring them a big cost advantage. In Saudi Arabia and the UAE, electricity costs are between USD 0.05 to USD 0.06 per kWh; much more affordable than in the U.S., where it averages USD 0.09 to USD 0.15 per kWh. Renewable energy initiatives in the area present even lower rates, for instance, USD 0.014 per kWh from the Al Dhafra Solar Project in Abu Dhabi, UAE. This cost-effectiveness is critical for energy-intensive tasks like AI, which demand a lot of energy for both processing and cooling.

NAVIGATING TRADE BARRIERS

Despite regional advantages, rising tariffs on imported solar technology create challenges. Supply chain disruptions and higher equipment costs can delay deployments and elevate operational risks. To counter this, countries are investing in local solar manufacturing capacity, aiming for long-term energy security and independence.

REDUCING EMISSIONS BY 2050 THROUGH SIX TECHNOLOGICAL AVENUES

The shift to solar aligns well with broader decarbonization goals. IRENA's 1.5°C scenario calls for electrification and efficiency, supported by renewables, green hydrogen, and sustainable biomass to reduce CO_2 emissions by 37 Gt annually by 2050. Solar-powered data centers directly contribute to this systemic shift.

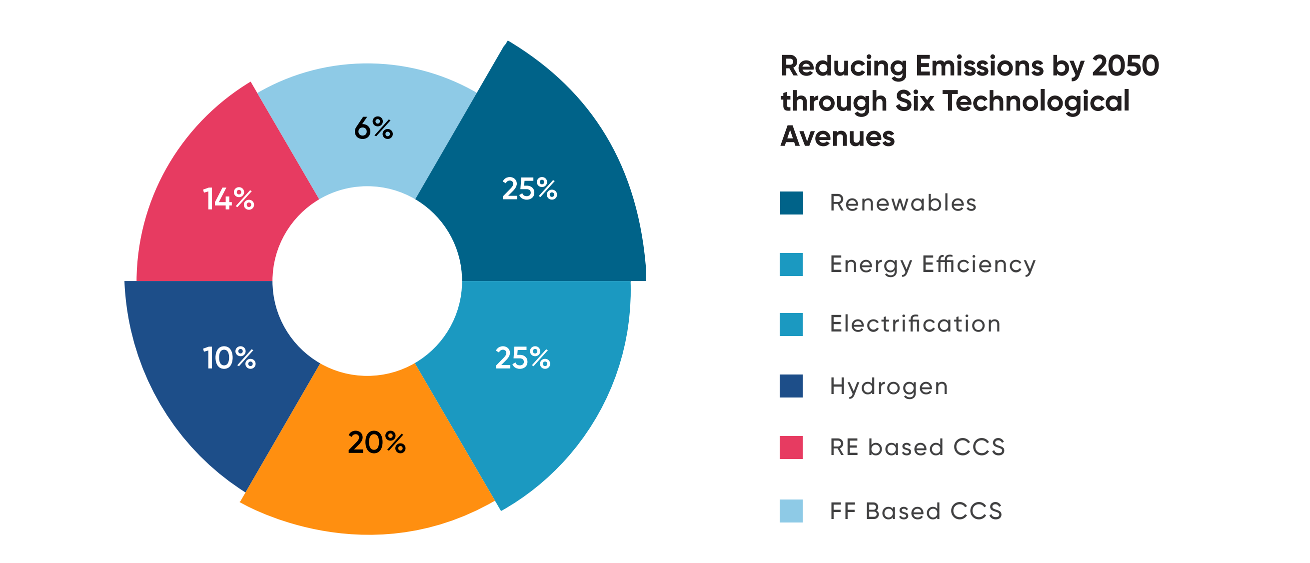


Figure [6] : Note - CCS = carbon capture and storage; BECCS = bioenergy with carbon capture and storage; $GtCO_2$ = gigatonnes of carbon dioxide; RE = renewable energy; FF = fossil fuel.

CONCLUSION

The rise of green and solar-powered data centers in the Middle East is more than just a tech jump. It is a strategic commitment to the sustainable development of the region by utilizing its abundant solar resources, transforming the energy landscape, and repositioning the region as a global player in clean, strong digital infrastructure. As demands for sustainable data solutions are increasingly prominent, the Middle East is set to play a leading role in the green digital economy.

References:

[1] *https://www.irena.org/Publications/2025/Mar/Renewable-capacity-statistics-2025*

[2] *https://www.morohub.com/en*

[3] *https://www.pwc.com/m1/en/media-centre/articles/unlocking-the-data-centre-opportunity-in-the-middle-east.html*

[4] *https://www.datacenterdynamics.com/en/regions/middle-east/*

[5] *https://www.techtarget.com/searchdatacenter/tip/Solar-shift-How-data-centers-can-embrace-renewable-energy*

[6] *https://www.lexology.com/library/detail.aspx?g=d0c5898f-09c4-4090-af0d-d52814793c1d*

[7] *https://www.iea.org/energy-system/renewables/solar-pv*

[8] *https://www.pv-magazine.com/2025/03/26/solar-adds-record-452-gw-to-global-renewables-capacity-in-2024/*

[9] *https://www.pv-magazine.com/2025/05/13/middle-east-north-africa-solar-manufacturing-capacity-to-reach-44-gw-by-2029-says-woodmac/*

[10] *https://www2.deloitte.com/us/en/insights/industry/renewable-energy/renewable-energy-industry-outlook.html*

03

STORAGE & ENERGY MANAGEMENT

AVOIDING COSTLY DEFECTS IN ENERGY STORAGE: A DEVELOPER'S GUIDE TO QUALITY ASSURANCE

Jeff Zwijack
Associate Director, Energy Storage
CEA Clean Energy Associates

Battery energy storage systems play an increasingly central role in grid reliability and renewable integration across the Middle East.Yet, behind this rapid expansion lies a less visible challenge: a significant portion of defects are introduced during final system integration, long after battery cells and modules have been manufactured.

If such issues go undetected before shipment, they can delay commissioning, reduce system performance, and create lasting operational headaches. Fortunately, they're also highly preventable if developers take the right steps at the right time.

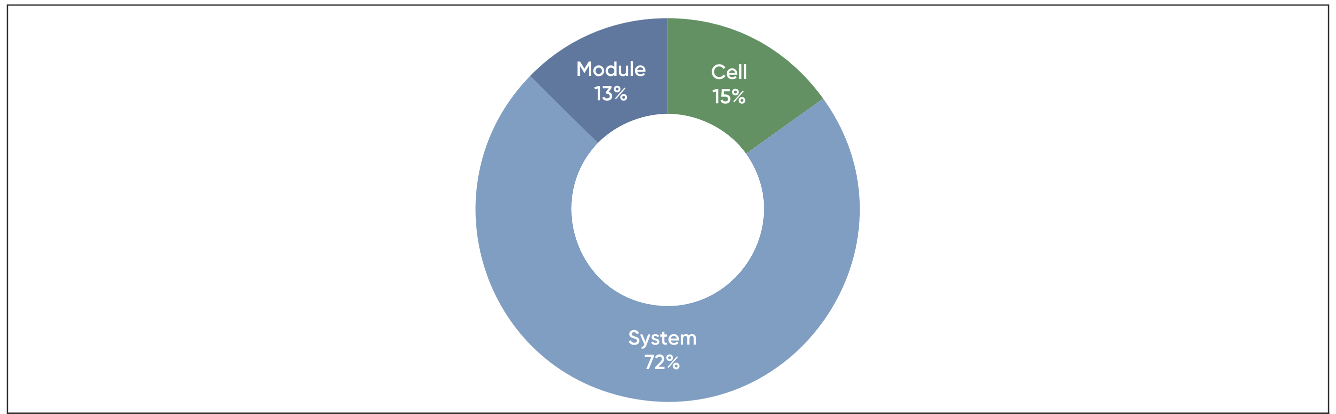


Figure [1] : Distribution of all BESS Findings

WHAT CAN GO WRONG

Inspection data from hundreds of energy storage system integration facilities worldwide reveals that a majority of quality issues, more than 70%, emerge not during cell or module production, but during system-level integration. This is the stage where battery modules are containerized and systems are assembled.

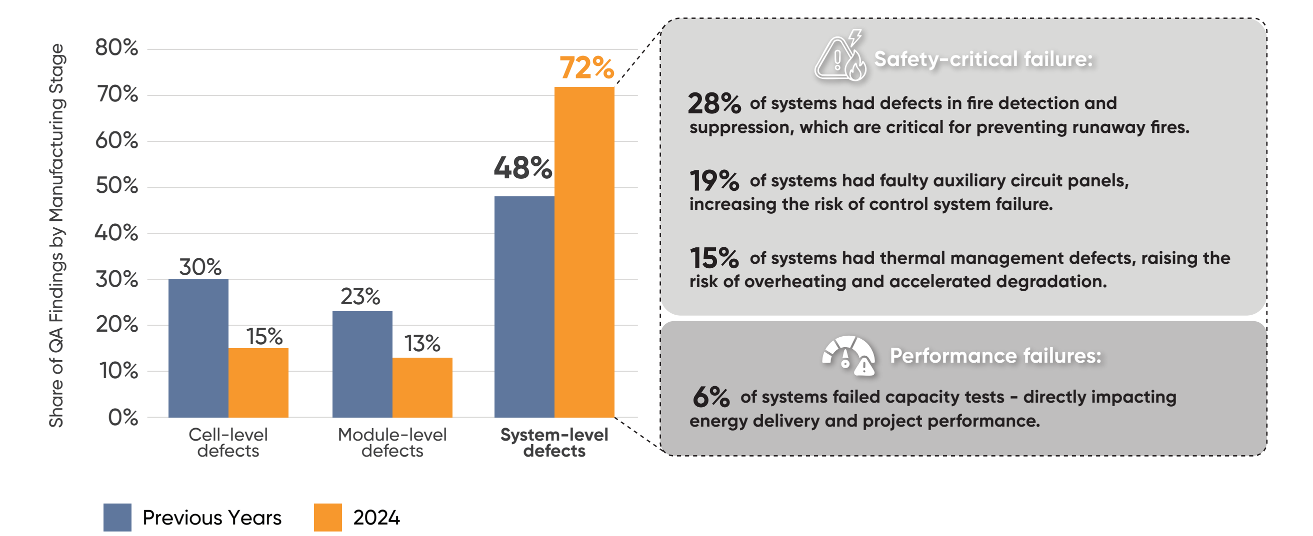


Figure [2] : Share QA Findings by Manufacturing Stage

The most frequent problems arise in key subsystems such as thermal management, fire suppression, control systems, and auxiliary circuits. Some of the most common categories of defects include:

Fire detection and suppression (28% of system-level findings): Systems failed to detect heat or smoke due to miswired sensors, while others couldn't deploy extinguishing agents when needed. In some cases, emergency abort buttons didn't function at all.

Thermal management (15%): Faulty components such as valves and compressor boards led to coolant leaks or complete system shutdowns – issues that, if missed, could accelerate degradation or trigger thermal events.

Auxiliary circuit panels (19%): Improper assembly or wiring caused failures in power distribution and communications, disrupting normal system operation.

Capacity test failures (6%): Subtle wiring issues introduced resistance that limited system output. These problems were difficult to detect without functional testing, yet have major implications for project performance and revenue.

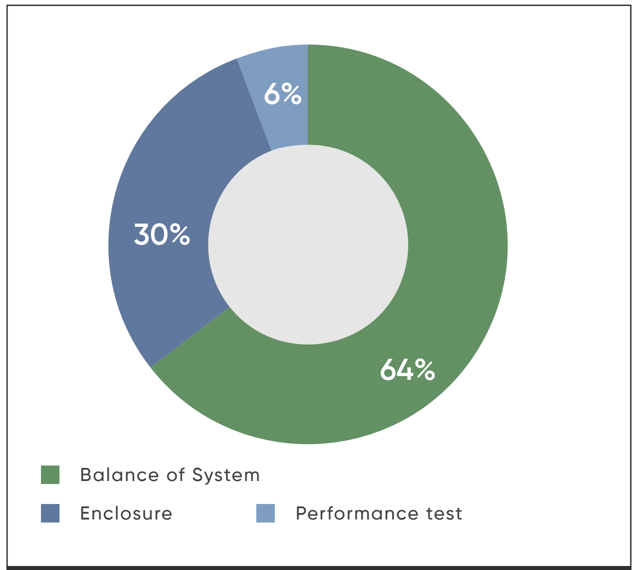


Figure [3] : Distribution of System-Level Findings

Visual caption: These issues typically stem from a combination of factors, such as rushed assembly timelines, manual labor, and inadequate documentation, rather than a single point of failure.

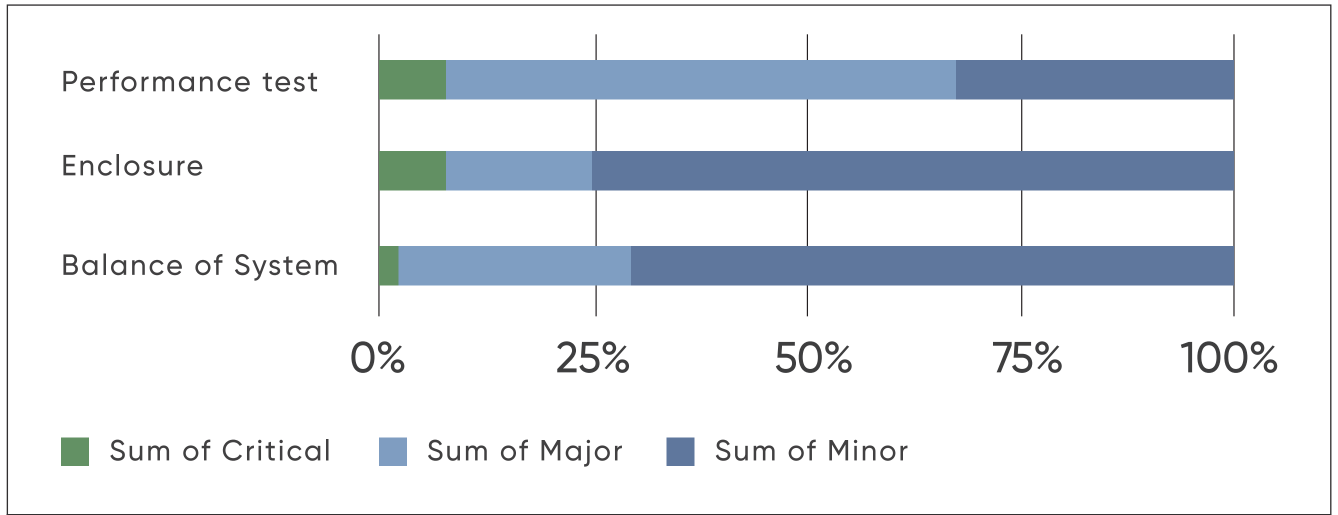


Figure [4] : Severity Scale of System-Level Findings

Visual caption: While critical defects made up a small share of systems-level issues, a majority of performance test failures were considered major, indicating that they will reduce the battery's functionality or impact safety in either short or long term.

HOW TO CATCH DEFECTS BEFORE THEY SHIP

The most effective way to prevent system integration defects from reaching project sites is to catch them during production – before the containers are even loaded for delivery. That's the role of third-party factory quality assurance (QA).

Independent inspections evaluate the actual units being built for a specific project, not just generic product samples or one-time vendor audits. Inspectors check wiring, component placement, and system functionality in real time, identifying issues that internal quality control teams may miss.

This allows manufacturers to resolve problems at the factory, rather than after delivery – when corrections are slower, more expensive, and can jeopardize project timelines or revenue.

Factory acceptance testing (FAT) adds another safeguard. Conducted just before shipment, FAT verifies the complete functionality of each system: thermal regulation, fire suppression, auxiliary circuits, and software communications. FAT gives developers a last chance to detect wiring or configuration problems that might otherwise go unnoticed until performance is impacted in the field.

Together, robust factory QA and FAT offer developers confidence that their systems will arrive on-site ready to perform – without costly surprises.

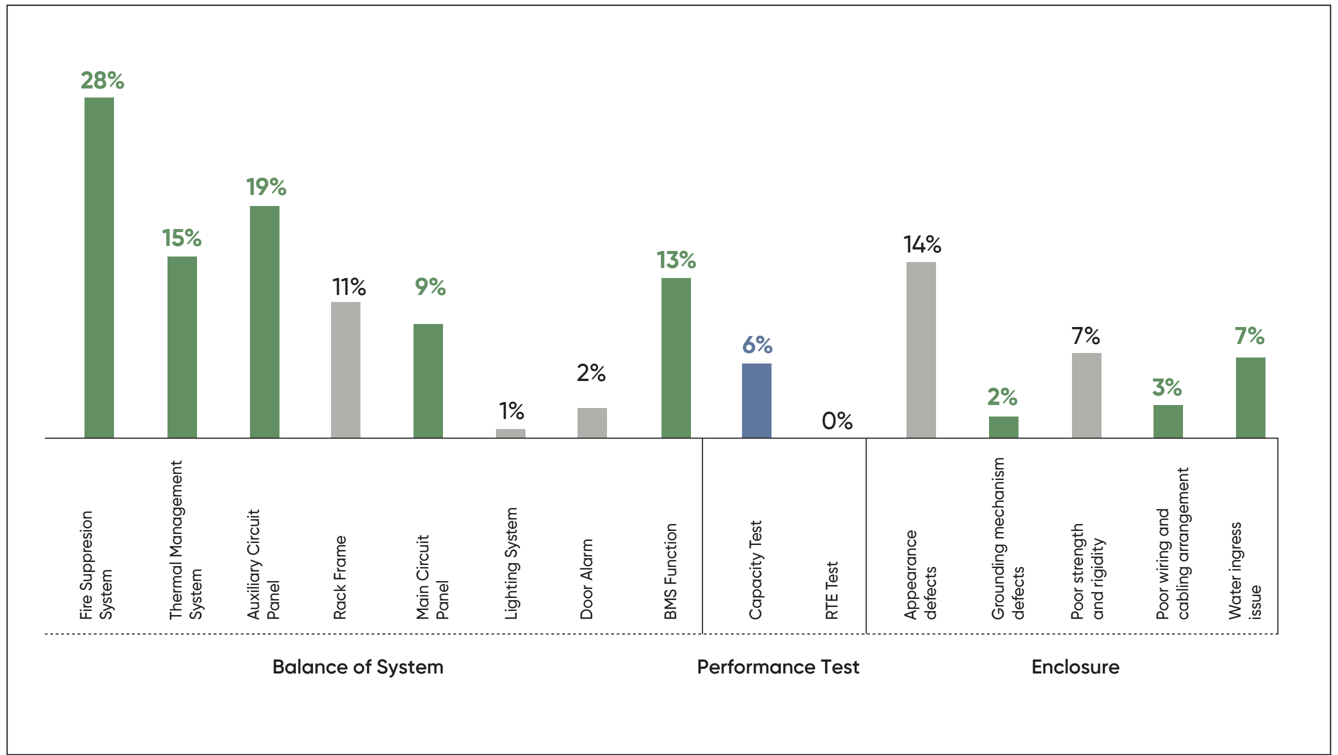


Figure [5] : Severity Scale of System-Level Findings

Visual caption: Other critical defects included main circuit panel issues, BMS functionality, grounding mechanism defects, poor wiring and cabling arrangement, and water ingress issues.

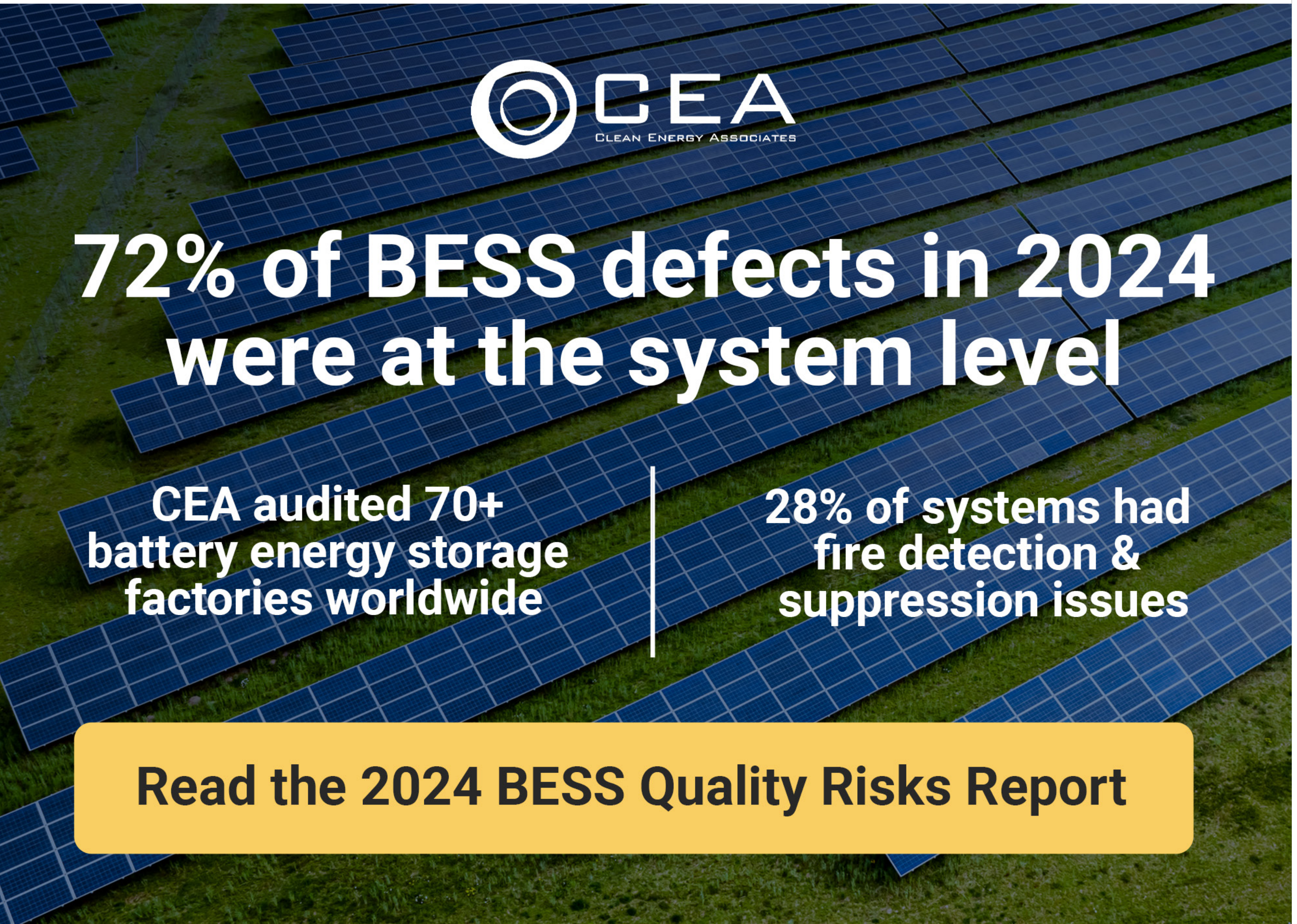
STRENGTHENING SUPPLIER SELECTION AND CONTRACTS

Preventing quality issues starts well before the factory floor. Developers who evaluate suppliers rigorously – and who structure clear, enforceable contracts – can avoid many of the integration problems that show up later in production.

Key considerations include a supplier's historical performance and quality discipline. More experienced integrators tend to have stronger process controls, clearer documentation, and more mature quality management systems (QMS). Data from third-party audits and historical defect rates can provide essential insights into real-world supplier reliability.

Clear contract language is just as vital. Vague or generic scopes leave room for misunderstanding. Developers should clearly define equipment specifications, testing requirements, acceptance criteria, and documentation obligations. Contracts should also include remedies for non-conformance, such as rework, replacement, or financial compensation.

Responsibility must also be clearly delineated. If a defect emerges during commissioning, who investigates and who pays? Ambiguity on these points often results in costly delays, strained relationships, or even legal disputes. A well-structured contract ensures accountability and enables developers to maintain quality control throughout the supply chain.



DON'T SKIP THE FINAL CHECKS

Even with a quality supplier and comprehensive QA, the final stretch of the project still carries risk. That's why developers should continue validating quality through delivery and commissioning:

- **Before shipment, review all test reports and inspection records for issues of concern.**
- **Confirm that any non-conformances found in the tests and inspections were corrected – not just noted.**
- **Upon delivery, perform inbound inspections to verify that the containers match what was approved at the factory. Examine for proper labeling, documentation, and transit protection.**
- **During commissioning, employ functional testing to confirm that each subsystem – thermal management, fire suppression, auxiliary panels – is performing as expected under real-world conditions.**
- **By staying engaged throughout the full lifecycle, from supplier evaluation to system commissioning, developers can significantly reduce the likelihood of costly surprises and ensure their energy storage investments deliver reliable, long-term performance.**

References:

[1] https://www.cea3.com/cea-blog/28-of-energy-storage-systems-show-fire-suppression-issues-during-2024-factory-inspections

[2] https://www.cea3.com/quality-control-testing-battery-energy-storage-systems-bess

[3] https://www.energy-storage.news/cea-reports-72-of-bess-defects-happened-at-system-level

[4] https://www.nacleanenergy.com/energy-storage/new-cea-report-reveals-most-common-energy-storage-manufacturing-risks

[5] https://www.cea3.com/cea-blog/cea-audit-prevents-unsafe-equipment-from-reaching-clientand-reveals-supplier-misconduct

WHAT'S THE POTENTIAL AND CHALLENGES FOR ENERGY MANAGEMENT SYSTEMS?

Rouven Lenhart
Managing Director
Romain Routtier
Regional Manager Sales
meteocontrol

CURRENT TRENDS IN THE MENA REGION

The Middle East and North Africa (MENA) region continues to experience remarkable momentum in its clean energy transition. Over the past five years, the installed capacity of solar PV and wind systems has doubled from 15 GW to 30 GW..[1] Simultaneously, energy storage is gaining traction, particularly in Saudi Arabia (KSA), which is emerging as one of the most significant global battery energy storage system (BESS) markets. Currently, 13 GWh of BESS capacity is in operation or under construction in the Kingdom, with plans to add a further 33.5 GWh by the end of 2026.

Among the notable projects is a 500 MW / 2 GWh BESS installation in Bisha, cited as the world's largest electrochemical battery storage project under construction[2]. The region's overall renewable energy ambitions are equally ambitious: the UAE and KSA aim to collectively reach 144 GW of renewable capacity by 2030, up from 9 GW today. Saudi Arabia, as part of its Vision 2030 strategy, plans to supply 50% of its energy from renewable sources by the end of the decade.[3]

NEW BUSINESS FRONTIERS: THE ROLE OF ENERGY MANAGEMENT SYSTEMS

This accelerating deployment of renewables and storage opens up new business models and opportunities for companies in the region. Hybrid power plants – PV or wind generation units plus battery storage – or standalone storage systems can only be used optimally if they are orchestrated by an intelligent energy management system (EMS). Possible strategies could be as follows:

- **Maximizing self-consumption and self-sufficiency: Advanced approaches to optimizing self-generated PV electricity.**
- **Optimization of load profiles: Intelligent control of consumption to match generation or to take advantage of favourable tariffs (demand-side management).**
- **Frequency and voltage support: Contribution of hybrid systems to grid stability (if relevant for C&I and possible from a regulatory perspective).**
- **Arbitrage and market participation: If the regulatory framework allows it, the use of storage to participate in spot markets or to provide ancillary services.**
- **Resilience and emergency power supply: Increase resilience for critical loads (by hybrid systems).**

There are already studies from remote regions that benefit from intelligent EMS. One example is a region in Spain, which is only slightly above North Africa in terms of longitude and has similar levels of irradiation. Here, hybrid solar and wind power systems have been able to reduce energy costs and increase energy independence. This is because flexible assets such as battery storage in combination with charging stations for electric vehicles improve grid reliability and reduce peak loads.[4]

A study by the Fraunhofer Institute for Solar Energy Systems (ISE) for Germany shows that there is a strong trend towards falling levelized cost of electricity (LCOE) for PV and wind energy by 2045. PV systems, especially ground-mounted systems, will become extremely competitive. Battery storage systems will play an increasingly important role and significantly improve the economic viability of PV-battery combinations due to falling prices. The LCOE for PV battery systems could fall by up to 38% by 2045. Large rooftop systems will generate electricity in 2045 at LCOE between 4.3 and 8.7 €cents/kWh.[5]

Again, it must be said that Germany is being considered here, but the developments can also be applied worldwide. Furthermore, growth in the markets can lead to increased competition and price pressure, which makes an EMS more attractive in the long term. MENA also benefits from better irradiation values.

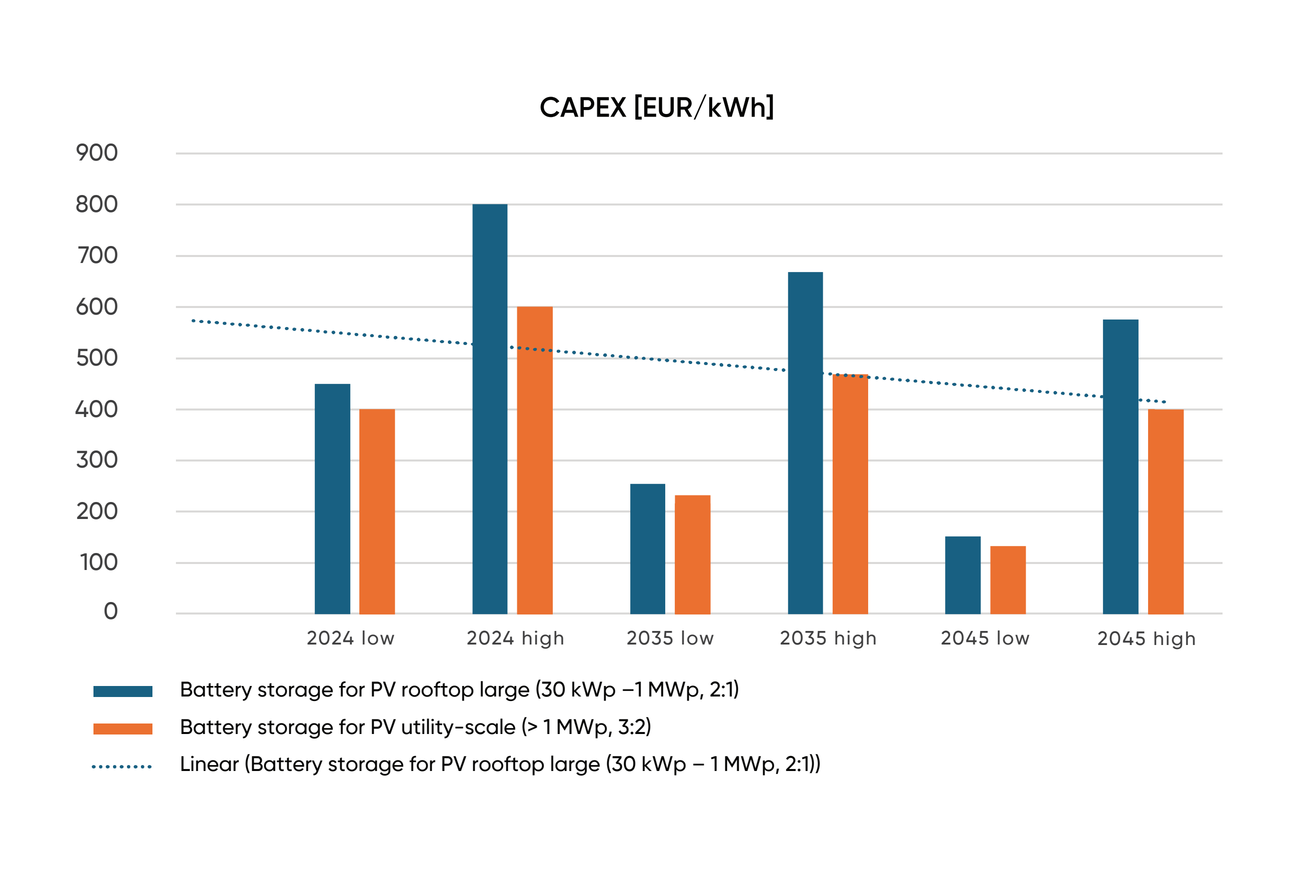


Figure [1] : Solar Energy Power Generation Capacity (in megawatts (MW)), By Country, 2024. Source- IRENA

CORE CHALLENGES FOR EMS IN MENA

An effective EMS relies heavily on seamless data exchange between generators, storage units, loads, and communication infrastructure across the network. Ensuring interoperability and reliable data transfer is paramount. Modelling uncertainties present a continuous challenge. Accurately modelling the behaviour of various components, predicting load patterns, and accounting for unforeseen events are complex tasks that require advanced algorithms and potentially machine learning capabilities within the EMS to optimize energy flow and ensure grid stability. Overcoming these challenges is vital for realizing the full potential in the global and regional energy transition.[6]

A primary hurdle lies in the unpredictable output of renewable energy sources like solar and wind. Their intermittent nature makes it difficult to reliably match supply with demand, requiring sophisticated forecasting and real-time adjustments from the EMS. The MENA region differs from other regions of the world, such as Central Europe or North America, where rainy autumns, snowy or windless winters can lead to possible longer-term 'dunkelflauten'. Nevertheless, other common problems remain: Failures of inverters, soiling due to solar modules dusted by sand, etc.

A key area in which EMS also face challenges is the technical aspects and integration. New EMS solutions often have to be integrated into an existing, diverse infrastructure. This includes a wide range of devices and systems from different manufacturers. The compatibility and interoperability of these heterogeneous systems presents a significant hurdle, which is further complicated by the use of different communication protocols.

CONCLUSION

The MENA region is undergoing an impressive energy revolution: the capacity of solar and wind energy is growing rapidly, and battery storage projects are also on the rise. This development opens up enormous business opportunities, especially for advanced EMS. They are the key to optimally controlling hybrid power plants and storage systems, whether for maximizing self-consumption, load profile optimization, grid support, market participation or ensuring emergency power supply. Initial successes from regions with similar meteorological conditions to MENA show the enormous potential of this intelligent control system.

However, the path to full potential is not without its hurdles. EMS must master the unpredictability of renewable energy and deliver accurate forecasts and real-time adjustments. Even if the MENA region is less affected by "dark doldrums", challenges such as system failures, dust deposits on solar modules or integration into existing, heterogeneous infrastructures remain.

To overcome these challenges and realize the vision of the MENA region, holistic, flexible and adaptive EMS solutions are essential. Strengthening local expertise and developing scalable solutions will also help to successfully drive the transformation of the MENA energy landscape and realize the full potential of renewable energy.

03.B ENERGY MANAGEMENT STRATEGIES FOR C&I AND HYBRID SYSTEMS IN MENA: WHAT'S THE POTENTIAL?

Award-Winning-Project Ritaj Residential Community, Photo credit by solar developer: **Yellow Door Energy**

References:

[1] *Corentin de Ricaud, The MENA region – the next hot market for energy storage, 2024, https://apricum-group.com/the-mena-region-the-next-hot-market-for-energy-storage-2/?cn-reloaded=1*

[2] *Dii Desert Energy, MENA Energy Outlook 2025 – Renewables, Hydrogen and Energy Storage Insights 2030, 2025, https://dii-desertenergy.org/publications/*

[3] *Andy Colthorpe, Saudi Arabia: 2GWh BESS project 'marks potential for energy cooperation with China', 2025, https://www.energy-storage.news/saudi-arabia-2gwh-bess-project-marks-potential-for-energy-cooperation-with-china/*

[4] *Zhan Shi, Feihong Liang, Andrea Pezzuolo, Renewable energy communities in rural areas: A comprehensive overview of current development, challenges, and emerging trends, 2024, https://www.sciencedirect.com/science/article/pii/S0959652624037855*

[5] *Christoph Kost, Paul Müller, Jael Sepúlveda Schweiger, Verena Fluri, Jessica Thomsen, Levelized Cost of Electricity Renewable Energy Technologies, 2024, https://www.ise.fraunhofer.de/content/dam/ise/en/documents/publications/studies/EN2024_ISE_Study_Levelized_Cost_of_Electricity_Renewable_Energy_Technologies.pdf*

[6] *Jhojan A. Rodriguez-Gil, Eduardo Mojica-Nava, Daniel Vargas-Medina, Miguel F. Arevalo-Castiblanco, Camilo A. Cortes, Sergio Rivera, John Cortes-Romero, Energy management system in networked microgrids: an overview, 2024, https://www.researchgate.net/publication/381995629_Energy_management_system_in_networked_microgrids_an_overview*

04

SUPPLY CHAIN & POLICY

A. Evaluating the performance of logistics supply chains in the solar industry
B. Impact of Tariffs on Solar & Renewable Energy Projects

EVALUATING THE PERFORMANCE OF LOGISTICS SUPPLY CHAINS IN THE SOLAR INDUSTRY

Pierre Holstein
Head of Global Business Development Industrials and Aerospace
KUEHNE+NAGEL

The rapid growth of solar projects, especially in the Middle East and North Africa (MENA) region, has underscored the importance of efficient and resilient solar supply chains. Spanning raw materials, manufacturing, and distribution, solar logistics networks are global in scope, with much of the production centered in Asia and shipped to demand hubs such as Europe and the Middle East. Recent disruptions like geopolitical tensions, inflation, and port congestion, have tested supply chains, revealing critical vulnerabilities. With 90% of companies facing supply chain challenges in 2024 (McKinsey), resilience has become a critical differentiator. So what defines a high-performing logistics supply chain in the solar sector?

THE HIGH-PERFORMANCE TRIAD: SPEED, COST EFFICIENCY AND SUSTAINABILITY

High-performing solar logistics supply chains must balance three competing objectives: **speed to market, cost efficiency, and sustainability.** This requires agility, full visibility, and reliable data to enable informed decisions. To be meaningful, performance data should be contextualised. Many key performance indicators (KPIs) are influenced by both controllable and uncontrollable factors. Leading companies use exception codes to flag delay causes, distinguishing between these factors and helping identify where improvements are truly needed.

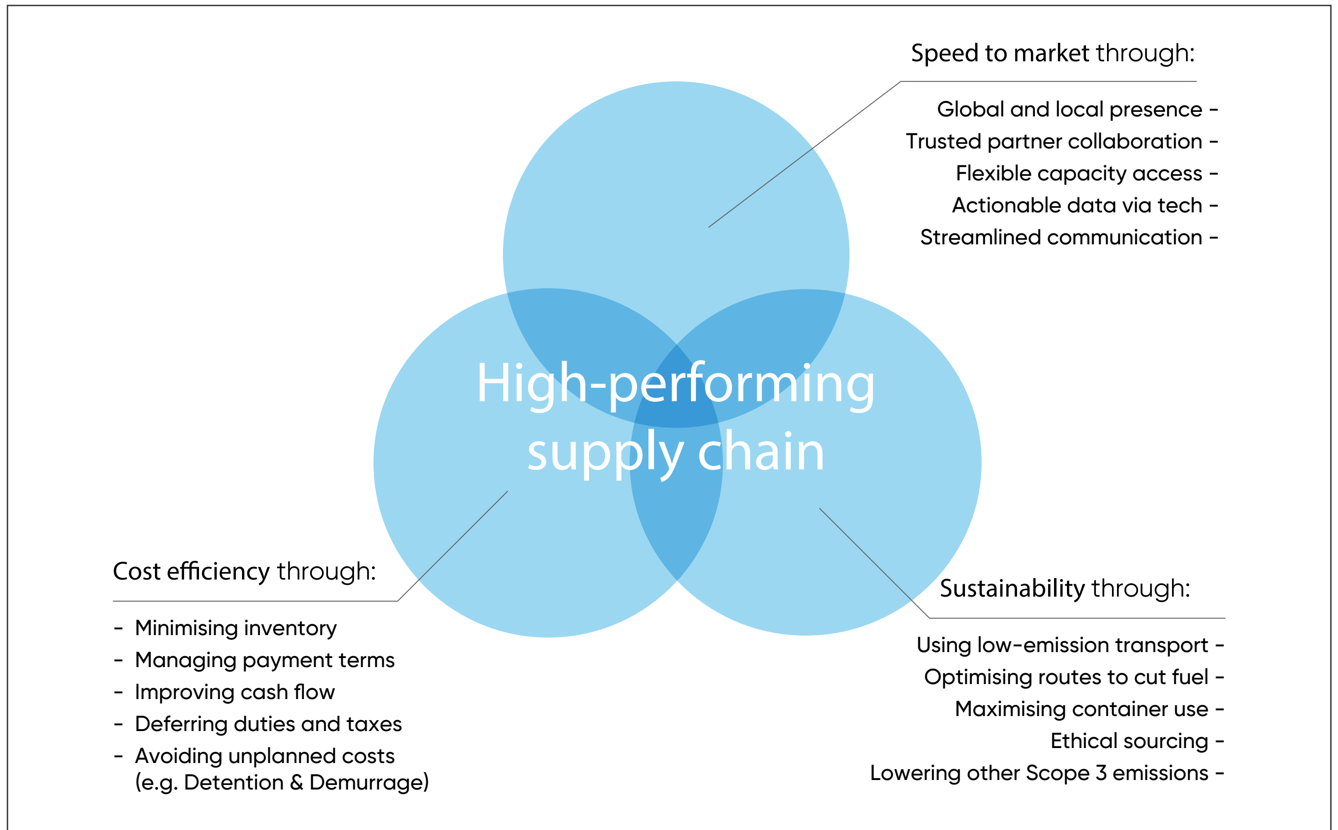


Figure [1] : The high-performance triad

SPEED TO MARKET

In a time-sensitive industry, speed is not just a competitive advantage—it's a key differentiator. Developers face auction deadlines and policy-driven delivery timelines, making on-time logistics execution crucial.

Achieving this requires early visibility into project needs, proactive sea freight booking, flexible routing, and strong relationships with logistics partners. Efficient last-mile distribution and delivery also matter, particularly in regions with infrastructure or customs challenges.

KPIs for speed:

- **On-Time, In-Full (OTIF): benchmark of 90–95% for mature supply chains; reality in solar often 80–90%**
- **Lead Time Variability: best-in-class <10%; solar averages 10-20%**
- **Freight Mode Utilisation: target mix (e.g., >90% sea for panels**
- **Forecast Accuracy: leading companies achieve 80–90%; many firms still below 75%**
- **Customer Delivery Rate & Satisfaction: ongoing metrics for improvement**

COST EFFICIENCY

Cost efficiency remains central, but aggressive cost-cutting can erode flexibility and reliability. Optimisation should focus on reducing the total landed cost while avoiding overdependence on any one supplier, route, or transport mode.

High-performing supply chains leverage scale, automation, and waste reduction. In the solar sector, recent cost gains have largely come from logistics and manufacturing optimisation. However, ongoing price compression could threaten long-term financial sustainability.

KPIs for cost:

- **Total landed cost ($/kW): a preferred metric over per-shipment cost**
- **Logistics cost as % of project cost: typically 5 to 10%**
- **Freight mode utilisation in percentages**
- **Forecast accuracy in percentages**

SUSTAINABILITY

Given the solar industry's central role in supporting the clean energy transition, sustainability is non-negotiable in high-performing supply chains. In 2025, it is fully expected that leading companies must measure and reduce their environmental footprint, source responsibly, and minimise waste. This includes choosing emissions-conscious carriers, route planning, and reusing materials. Leading supply chains embed sustainability into everyday logistics decisions.

KPIs for sustainability:

- **Annual CO_2 reductions: 5 to 10% in Scope 3 Emissions targeted by top industry performers**
- **Percentage use of Recycled Materials**
- **Supplier compliance with ESG standards**

Making sustainability a measurable logistics goal, rather than just a branding effort, strengthens both environmental impact and regulatory alignment.

VISIBILITY AND DATA INTELLIGENCE

Achieving optimal performance in speed, cost, and sustainability relies heavily on having maximal visibility. In today's complex and often fragmented solar supply chains, real-time transparency is key to managing operations. It also allows companies to anticipate risks before they escalate. With clear visibility on and data from across the supply chain, solar companies can identify gaps, prevent delays, and take early action to mitigate underperformance. Data intelligence is more than a tool, it is a strategic asset that empowers solar companies to navigate complexity with confidence. It lays the foundation for long-term innovation and continuous optimisation. Building a reliable data repository over time is essential, even if a company's data journey is still maturing. After all, the insights that are not captured today cannot be leveraged tomorrow.

FREIGHT MARKET DYNAMICS AND LOCAL EXECUTION

Solar logistics rely heavily on global sea freight. Recent changes, such as the Gemini Cooperation (an alliance between Maersk and Hapag-Lloyd) are reshaping shipping routes, improving reliability and promising schedule performance above 90%, compared to the 2024 global average of 50–55% (Hapag Lloyd).

These developments have real implications for solar supply chains. Improved schedule reliability reduces costly delays and allows for tighter project planning. Stabilised capacity and more predictable rates enable better budget control. Stronger global network resilience helps solar cargo stay on the move even in times of disruption.

But sea freight is only part of the equation. As solar equipment moves inland, the final leg can become a bottleneck if not managed carefully. Last-mile distribution, especially in regions with infrastructure constraints or regulatory complexities, is critical to ensure solar components arrive in sequence and in good condition. Coordinating inland haulage, customs clearance, and project-site delivery schedules requires close collaboration between forwarders, ground transport providers, and EPCs.

In this environment, being tuned into both global shipping trends and local delivery realities is essential. The most resilient solar supply chains are those that can navigate disruption at sea and still deliver at the project gate.

CONCLUSION

In 2025, supply chain performance is emerging as a defining factor for success in the solar industry. For companies operating in the MENA region and beyond, it's no longer enough to focus on procurement or production alone. The ability to execute logistics with precision supported by visibility, dependable partnerships, sustainable operations, and awareness of evolving freight and regulatory landscapes is what separates high performers from the rest.

Short-term cost savings may offer temporary relief, but they often come at the expense of long-term resilience. By contrast, companies that invest in end-to-end planning, data-driven decision-making, and continuous optimisation see stronger margins, greater delivery reliability, and improved sustainability outcomes.

Companies that understand and adapt to these shifts are not only mitigating risks, but also positioning themselves to lead.

Key takeaways:

- **High-performing solar supply chains are essential for business growth.**
- **Data intelligence is a strategic asset that drives supply chain performance.**
- **Efficient end-to-end integration, paired with long-term planning, enhances bottom-line results.**

TRADE TARIFFS AND SOLAR PV: LESSONS FROM EUROPE & IMPLICATIONS FOR MENA

SolarPower Europe

Trade policy remains a significant external factor influencing the solar sector's cost structures, procurement strategies, and market timelines. Europe's past experience with solar trade defence instruments, and more recent global trade tensions as a consequence of wide-ranging imposition of tariffs by the US government can both provide insights on the impacts of trade tariffs on solar and renewable projects generally. Meanwhile, markets in the Middle East & North Africa (MENA) are exposed to similar dynamics through pricing volatility and supply dependencies.

EUROPE: TARIFF HISTORY, SUPPLY CHAIN RISKS AND MARKET VOLATILITY

Between 2013 and 2018, worsening policy conditions for solar in the European Union, such as a strong decrease of German feed-in tariffs (FITs), compounded by the introduction of a minimum import price (MIP) policy on Chinese solar modules and cells raised project costs, contributing to a reduction in deployment volumes, and forcing job losses across the sector. Following the MIP's removal and coupled with improved policy conditions, solar installations in Europe have rebounded since 2018. However, the sector remains vulnerable to trade policy risks, among other challenges. In late 2023, SolarPower Europe and over 400 European companies warned against the reintroduction of trade defence measures, citing threats to job creation, energy security, and the EU's REPowerEU target of 750 GW solar installed by 2030.

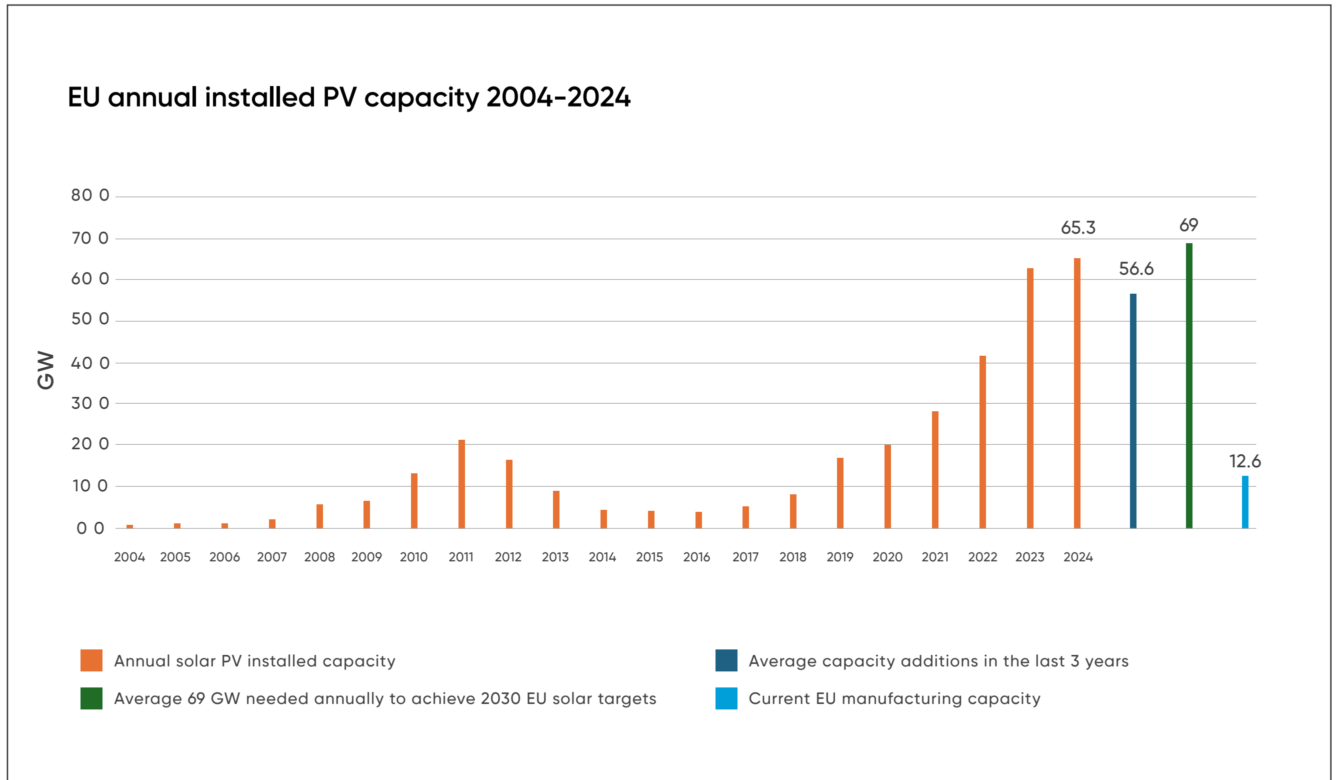


Figure [1] : EU-27 annual solar PV installed capacity 2004-2024, souce: Solar Power Europe

The recent escalation of US tariffs on Chinese clean energy products has further intensified concerns in Europe. The results of a recent survey by SolarPower Europe with its members indicate that while **direct exposure to US tariffs is limited within the EU market,** certain segments – particularly **EU manufacturers of inverters, mounting structures, and manufacturing equipment** – are significantly more vulnerable. These companies may face increased operational costs, disruptions to supply chains, and reduced competitiveness in the US market.

More broadly, **indirect impacts are seen as the most pressing concern.** General trade uncertainty and inflationary pressures, particularly from rising prices in key solar inputs such as aluminium and steel, **are undermining investment confidence, delaying decision-making, and placing long-term growth strategies at risk.**

Another key issue raised is the ongoing **decline and record low prices of Chinese modules entering the EU market.** While this trend has been offering short-term benefits to developers, it is also placing considerable pressure on EU manufacturers. Resulting in oversupply, many installers have been forced to rely on stockpiled materials, with prices in some cases approaching historic lows – further straining margins and threatening the viability of European production.

The message from the industry is clear: while direct tariff exposure may be limited in some areas, **the ripple effects are already being felt.** Continued escalation on either side of the Atlantic will only erode stability, hinder investment, and weaken the EU's clean energy ambitions. A coordinated, predictable, and proportionate trade strategy is essential to safeguard the long-term viability of Europe's solar supply chain.

MENA: PARALLEL PRESSURES AND SUPPLY DEPENDENCIES

Similarly to Europe, countries in the MENA region are looking to further develop domestic solar value chains. Across the region this manifests as either local content requirements (e.g. Kingdom of Saudi Arabia, Egypt, Tunisia, and Oman) for public procurement of solar, or as incentives for the use of local expertise and skills (e.g. Morocco, UAE, Jordan).

However, both regions remain reliant on imported solar components to drive deployment. Particularly in those markets looking to develop local value chains, prices of imported modules will have a direct impact on the competitiveness of domestic manufacturers. However, as per the European experience, imposing import duties to correct this imbalance can lead to an overall slowdown in investment in solar, due to higher component prices raising the Levelized Cost of Electricity (LCOE) of projects. Finding the right balance between creating a favourable business environment that encourages investment in solar while also promoting the involvement of domestic manufacturers will be key to increasing the rate of deployment. There have been several attempts to achieve this, which could serve as blueprints for the region: the USA's Inflation Reduction Act (IRA) and India's Performance Linked Incentive (PLI) scheme, combined with other measures, have already led to an increase in both demand and supply, while the EU's Net-Zero Industry Act (NZIA) was recently adopted by the EU Commission (May 2025).

For MENA policymakers, these frameworks could offer blueprints for balancing trade, industrial development, and clean energy deployment.

GLOBAL INTERDEPENDENCE AND REGIONAL SPILLOVERS

The interconnected nature of the global solar industry means disruptions or tariff changes in one region can have wider consequences. European and international developers active in MENA markets often rely on integrated procurement and logistics networks. European or Asian supply bottlenecks whether due to tariffs, inflationary pressures, or material shortages can directly affect project timelines, budgets, and bankability in MENA markets.

This is particularly relevant in several MENA markets where large-scale utility projects and corporate solar solutions are central to national energy transition strategies. Project timelines, financing terms, and procurement contracts must now account for growing volatility in component pricing, transport costs, and regulatory timelines.

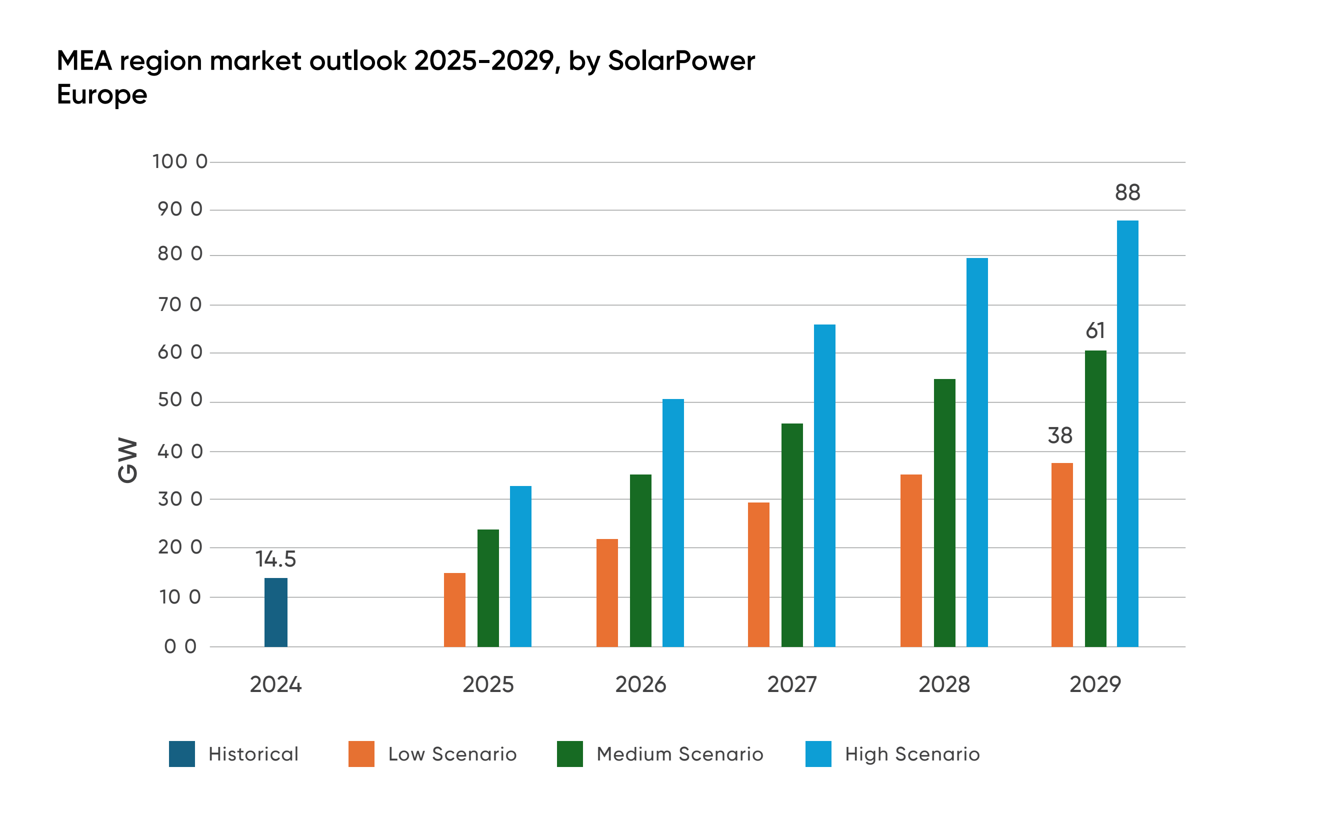


Figure [2] : MEA Region Market Outlook 2025-2029, source SolarPower Europe

MENA: PARALLEL PRESSURES AND SUPPLY DEPENDENCIES

Europe's experience highlights how trade policy and tariffs, whether imposed to protect domestic manufacturing or arising from international disputes, have immediate, tangible consequences on project pipelines, pricing, and investment confidence. Indirect effects such as material cost inflation, supply chain delays, and digital infrastructure dependencies amplify the risks, particularly for multi-regional developers operating across Europe and MENA.

SolarPower Europe expects the Middle East and Africa (MEA) region as a whole to more than triple its share in the global market, growing from 2% in 2024 to 7% in 2029, rising from a total 14.5 GW installed in the region in 2024 to 61 GW in 2029. This will be mainly driven by large-scale projects in the Middle East, while significant solar development in Sub-Saharan Africa has yet to materialise in our projections. However, our Five-year Low Scenario forecast, which underscores the risks posed in part by escalating trade conflicts, sees much slower growth in the region, reaching 38 GW in 2029.

The takeaway is clear: trade stability is now as important as policy ambition. To ensure momentum in solar deployment across both Europe and MENA, governments must resist reactive tariffs and pursue strategies that support cost-effective, sustainable, and secure solar growth.

OUTLOOK

Europe's experience highlights how trade policy and tariffs, whether imposed to protect domestic manufacturing or arising from international disputes, have immediate, tangible consequences on project pipelines, pricing, and investment confidence. Indirect effects such as material cost inflation, supply chain delays, and digital infrastructure dependencies amplify the risks, particularly for multi-regional developers operating across Europe and MENA.

SolarPower Europe expects the Middle East and Africa (MEA) region as a whole to more than triple its share in the global market, growing from 2% in 2024 to 7% in 2029, rising from a total 14.5 GW installed in the region in 2024 to 61 GW in 2029. This will be mainly driven by large-scale projects in the Middle East, while significant solar development in Sub-Saharan Africa has yet to materialise in our projections. However, our Five-year Low Scenario forecast, which underscores the risks posed in part by escalating trade conflicts, sees much slower growth in the region, reaching 38 GW in 2029.

The takeaway is clear: trade stability is now as important as policy ambition. To ensure momentum in solar deployment across both Europe and MENA, governments must resist reactive tariffs and pursue strategies that support cost-effective, sustainable, and secure solar growth.

05

NET-ZERO & SUSTAINABILITY

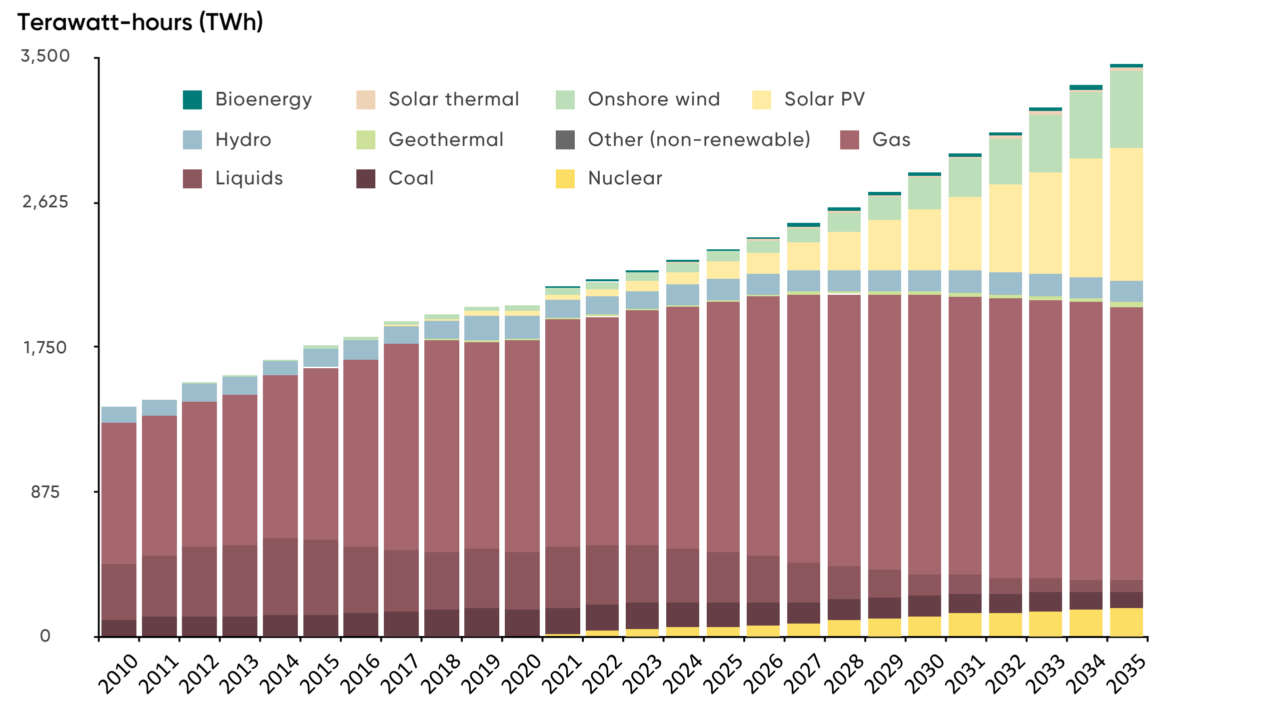
SOLAR SURGE: CATALYZING MENA'S NET-ZERO JOURNEY IN THE POWER SECTOR

Nishant Kumar
Analyst – Middle East

Nivedh Das Thaikoottathil
Senior Analyst - Africa

RystadEnergy

The Middle East and North Africa (MENA) region, renowned for its abundant oil and gas reserves, currently derives around 85% of its power from fossil fuels. Natural gas plays a dominant role in many MENA countries, accounting for more than 80% of the power generation mix in Algeria, Egypt and Iran, and nearly two-thirds in Saudi Arabia and the UAE. It also plays a pivotal transitional role in the MENA region's electricity sector as countries shift towards cleaner energy systems. While MENA is aggressively expanding its renewable energy capacity, particularly in solar and wind, natural gas remains essential for ensuring energy security and grid stability, especially given the intermittency of renewables. Gas-fired power plants provide flexible, reliable backup to balance variable renewable generation, helping to meet the region's rapidly growing electricity demand and supporting economic development. In addition to natural gas, the region also taps into other energy sources such as oil, renewables and, to a varying extent, nuclear.



*Middle East and North Africa comprises Algeria, Bahrain, Egypt, Eritrea, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, Turkiye, UAE, Western Sahara and Yemen

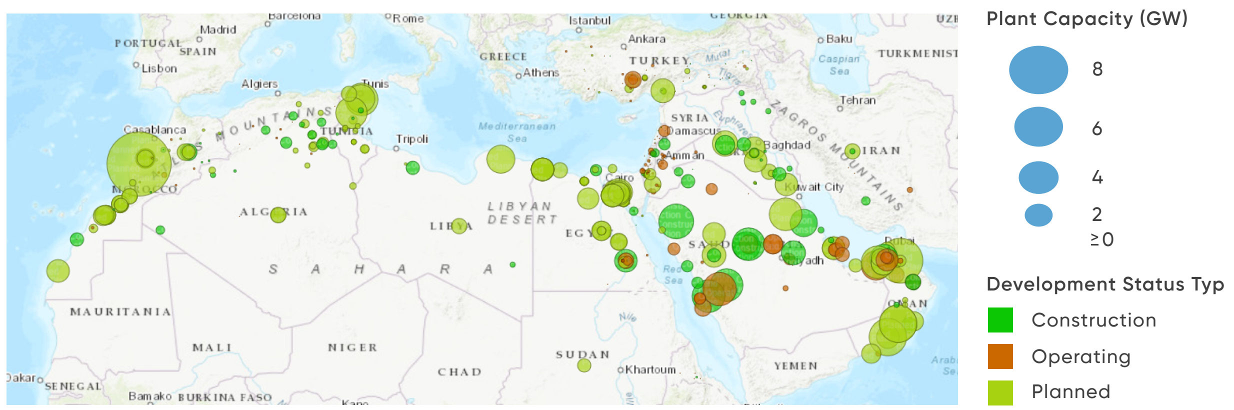
Source: Rystad Energy PowerCube

Figure [1] : Annual power generation mix in the MENA* region, by energy source

Renewables and nuclear make up the remainder of MENA's power generation mix, with renewables taking up almost 13%. Nuclear power is emerging as a key source in MENA's energy landscape, offering a sustainable alternative to conventional fossil fuels. Currently, nuclear power generation in the region is concentrated in the UAE and Iran. Turkiye leads in renewable-based power generation in MENA, contributing more than half of the total, followed by Egypt, Iran and the UAE. Hydropower currently accounts for more than 43% of the region's renewable power generation, with Turkiye, Iran, Egypt and Sudan being the primary contributors. Other significant renewable sources include solar photovoltaics (PV), which accounts for more than 26% of the renewable power generation, and onshore wind on 19%. Turkiye also takes the lead in both solar and wind power generation, followed by Morocco, the UAE, Saudi Arabia, Egypt, and Israel.

Solar and wind are rapidly reshaping the electricity landscape in the MENA region, driven by abundant resources, ambitious government targets, and falling technology costs as countries look to diversify their energy portfolios and reduce their dependence on fossil fuels. Solar and wind is expected to account for over 20% of power generation mix by 2030, up from almost 6% currently. The region also possesses one of the highest solar energy potentials globally, with average annual solar irradiance exceeding 2 megawatt-hours (MWh) per square meter per year. This results in solar power emerging as a key component in the region's push towards net zero. Countries such as Saudi Arabia, the UAE, Oman, Egypt, and Morocco are leading the way in this solar energy transition, with solar PV expected to account for 13% of the overall power generation in MENA by 2030– up from 3.3% today.

More than 18 gigawatts (GW) of solar PV and onshore wind capacity is expected to be commissioned in the region this year, with Turkiye, Saudi Arabia, the UAE, Israel, and Oman accounting for most of this. The Al Shuaibah 2 solar PV project – a 2.06-gigawatt alternating current (GW_{AC}) facility developed by ACWA Power in Saudi Arabia – was the largest utility-scale renewable asset that began commercial operations in the first half of this year. Sembcorp Utilities and Jinko Power also



Top five solar PV projects in MENA region

Project	Country	Company	Start-up year	Capacity ()
Abu Dhabi solar plus storage	UAE	Masdar	2027-2030	4.4 [d[
MBR Solar Park	UAE	ACWA Power, Masdar, EDF	2017-2027	4 [
Al Shuaibah solar PV	Saudi Arabia	ACWA Power	2024-2025	2.06
Neom solar PV	Saudi Arabia	ACWA Power	2026	2.2
Zafarana II hybrid solar PV	Egypt	Voltalia, TAQA	2029-2035	2.1

*Middle East and North Africa comprises Algeria, Bahrain, Egypt, Eritrea, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, Turkiye, UAE, Western Sahara and Yemen

Source: Rystad Energy PowerCube

Figure [2] : Annual power generation mix in the MENA* region, by energy commissioned the 500-megawatt (MW) Manah 2 solar PV project in Manah, Oman. Masdar launched the second 300-MW unit of the 1.8-GW MBR Solar Park Phase VI, increasing the total operating capacity to 600 MW. Additionally, a joint venture between AMEA Power and Sumitomo Corporation has commissioned the 500-MW Amunet onshore wind plant in Ras Ghareb, Egypt.

Turkiye, Israel, and Jordan are expected to continue adding significant distributed solar capacity in the medium term, including rooftop and commercial and industrial (C&I) solar PV. However, most capacity additions in Saudi Arabia, Egypt, Morocco, and the UAE will be driven by ground-mounted, gigawatt-scale utility solar PV projects. Earlier this year, the UAE announced a large 5.2-GW direct current (GW_{DC}; assumed 4.4 GW_{AC}) solar PV project, along with 19 gigawatt-hours (GWh) of storage, claiming to provide round-the-clock baseload power by leveraging battery energy storage. More than 18 GW of utility-scale solar PV projects are either under construction or ready for construction in Saudi Arabia, with commissioning expected within the next three years.

Significant renewable capacity additions are expected to come from green hydrogen projects in the long term, with Egypt, Morocco, Oman, and Tunisia leading the way in the green hydrogen space. There has been uncertainty surrounding most of these projects due to challenges in securing long-term offtake contracts but, if these large projects move forward, they will drive solar PV and onshore wind installations to meet the demand for hydrogen electrolysers.

These developments mark a pivotal shift in the region's energy trajectory where solar is not just an alternative but a strategic pillar of future energy systems. As solar power scales rapidly, supported by technological innovation and robust national targets, MENA is steadily positioning itself at the forefront of the global clean energy transition, catalyzing its journey toward a net-zero power sector.

06

HIGHLIGHTS IN MENA'S LEADING SOLAR PV MARKETS

A. Afghanistan
B. KSA (Kingdom of Saudi Arabia)
C. Kuwait
D. Syria
E. Türkiye
F. UAE (United Arab Emirates)

AFGHANISTAN

Source: pvknowhow, RER2032

Solar Potential	220 GW
Solar Capacity	33 MW as of mid-2024
Solar Power Target	2,000 MW by 2032

CURRENT SITUATION

Afghanistan holds exceptional solar potential estimated at over 220 GW with more than 300 sunny days per year and an average daily irradiance of 6.5 kWh/m^2. Yet, installed solar capacity remains modest at around 33 MW as of mid-2024 [1]. Only 30% of the population has access to electricity, and in rural areas, where 77% of Afghans live, this drops to just 10%. Domestic power generation is limited due to aging infrastructure, while over 77% of electricity is imported and is often unreliable and economically unsustainable[2]. However, Afghanistan's total renewable energy potential is estimated at 318 GW, far surpassing regional peers like Iran and Morocco with solar and wind resources concentrated in the south and west. Unlocking this potential will require large-scale investment in grid infrastructure to connect remote resource-rich regions with population centers and meet growing domestic energy demand.

PROJECTS

Naghlu Solar PV Project, 20 MW

The Naghlu Solar PV project owned by Da Afghanistan Breshna Sherkat with a stake of 100%, is a floating solar project.The project is expected to generate 43,000MWh electricity to offset 13,000t of carbon dioxide emissions (CO_2) a year. Once operational, it will enhance grid stability and provide clean energy to surrounding regions, supporting Afghanistan's broader transition toward renewable energy [3].

Farah Solar Project, 10 MW

Located in western Afghanistan, the 10 MW Farah Solar Project is part of a national push to diversify energy sources and improve regional energy access. The plant is expected to help reduce reliance on imported electricity and serve as a reliable renewable energy source for Farah province and its neighboring areas [4].

Uruzgan Solar Project, 3 MW

The 3 MW Uruzgan Solar PV Project, based in Trinkot, is designed to provide reliable electricity to Uruzgan province's capital and nearby communities. Developed as part of Afghanistan's efforts to promote renewable energy in remote areas, Expected to be commenced in Q4 2025 [5].

Paktika Solar Project, 10 MW

The Paktika Solar Power Plant is a phased renewable energy project targeting underserved areas in southeastern Afghanistan. With an initial phase of 2.5 MW, the plant is planned to scale up to 10 MW [6].

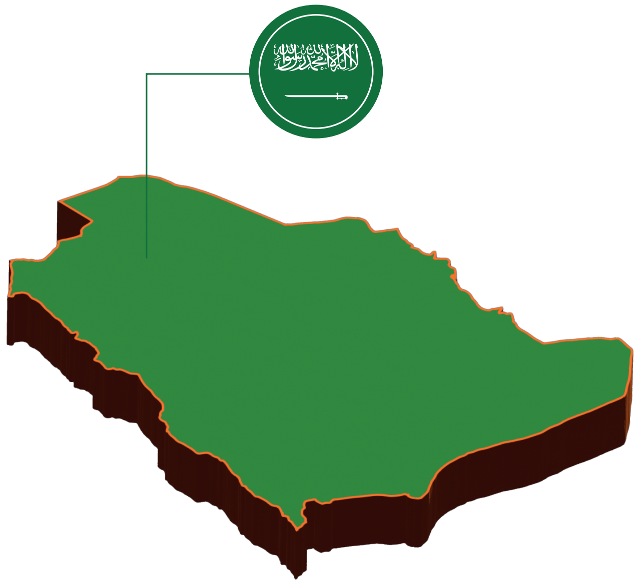
CHALLENGES & OUTLOOK

Despite its promise, Afghanistan faces structural challenges. Nearly half the population lacks reliable electricity, and the national grid is overstretched, relying heavily on imports. Political instability and international isolation—especially under the current Taliban regime—limit foreign investment and aid, while disrupting long-term policy continuity . Access to financing remains constrained due to high upfront costs and limited credit for off-grid projects. Technical skill gaps in solar installation and maintenance further slow expansion .

However, momentum is building: government incentives, policy clarity, and regional cooperation are beginning to open new pathways. If political stability improves and financing becomes more accessible, Afghanistan could significantly scale up solar capacity—potentially adding hundreds of megawatts annually—and reduce its reliance on imports.

References:
[1] *Renewable Energy Roadmap for Afghanistan (RER2032) | ESCAP Policy Documents Managment*
[2] *Power transmission in Afghanistan: Challenges, opportunities and proposals*
[3] *Power plant profile: Naghlu Solar PV Park, Afghanistan*
[4], [5] *Afghanistan Solar Panel Manufacturing | Market Insights Report*
[6] *Implementation of 3 Megawatt Solar Power Project Commences in Uruzgan | Islamic Emirate of Afghanistan, Исламский Эмират Афганистан.*

KINGDOM OF SAUDI ARABIA



Source: Vision 2030 & Solarabic Database

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

CURRENT SITUATION

Saudi Arabia's solar market in mid-2025 is defined by the simultaneous scaling of massive utility projects and a burgeoning distributed generation segment, underpinned by unprecedented investments in grid storage and modernization. The successful execution of GW-scale plants is becoming normalized, while favorable tariff policies are unlocking significant commercial and industrial rooftop potential. Backed by targeted finance and technological exploration (like FPV), the Kingdom is strategically positioned to accelerate its solar deployment across all segments in a coordinated manner, solidifying its commitment to diversifying its energy mix and reducing reliance on hydrocarbons for power generation. The market is demonstrably moving beyond ambition into large-scale, tangible implementation.

UPDATES IN REGULATIONS & FRAMEWORK

RESIDENTIAL TARIFF RESTRUCTURING

In January 2025, the Electricity and Cogeneration Regulatory Authority rolled out a two-band tariff for households: 18 hal/kWh up to 6,000 kWh per month, and 30 hal/kWh above that level. The switch replaces the old multi-tier ladder with a simpler structure aimed at cost recovery, peak demand reduction, and stronger price signals for rooftop solar and energy efficiency investments [1].

"INTENSIVE-CONSUMPTION" & C/I TARIFF REVISION – 28 MAY 2025

Starting 28 May 2025, the Saudi Electricity Company will apply a three-track pricing schedule:

Sector	≤ 6 000 kWh / month	> 6 000 kWh / month	Change vs. old rate
Commercial	22 hal/kWh	32 hal/kWh	Up from 20 / 30 hal
Agricultural	18 hal/kWh	22 hal/kWh	New two-band structure
Industrial	20 hal/kWh (flat)	–	Unified rate for both distribution & transmission connections

A new "intensive-consumption" tariff is available: facilities that apply by 30 June 2025 and meet efficiency benchmarks can retain the base rates shown above; non-qualifying users will see a surcharge of +2 hal/kWh. The measure aims to curb wasteful demand, free up capital for grid and storage upgrades, and create headroom for the record volumes of solar and battery capacity now entering service [2].

PROJECTS

Al-Mas'a & Hanakiyah 2 Solar PV, 1,750 MW

PowerChina clinched the EPC contract on 27 Jan 2025 for two Round-5 PV parks: 1,250 MW Al-Mas'a in ha'il and 500 MW Hanakiyah-2 in Madinah. Together they will deliver ≈ 4.4 TWh of clean power a year—enough for 550,000 homes—and cut 2.9 Mt CO_2 annually [3].

Shuaiba 2 Solar PV, 2 060 MW

ACWA Power declared full commercial operation on 21 Feb 2025, making Shuaiba 2 the Kingdom's largest operating solar plant. Built for SAR 8.3 bn, the facility feeds the grid under a long-term PPA with SPPC [4].

BYD–SEC Battery Storage Portfolio, 12.5 GWh

On 14 Feb 2025 BYD signed what is billed as the world's biggest single grid-scale storage order—12.5 GWh across five sites for Saudi Electricity Company. Combined with an earlier 2.6 GWh tranche, the partnership now totals 15.1 GWh, underpinning grid stability as solar output surges [5].

Al Saadawi Solar PV, 2 000 MW

Masdar and Shanghai Electric signed a cooperation agreement in Apr 2025 to deliver the 2 GW Al Saadawi IPP (Round 5). PPA terms are in place and COD is targeted for Q2 2027 [6].

Hyundai E&C HV Transmission Package, 491 km

Awarded 17 Feb 2025, Hyundai E&C will design-build two 380 kV overhead lines—311 km Medina link and 180 km Jeddah link—to evacuate electricity from new western-region solar parks. The US $389 million contracts strengthen long-haul grid capacity and unlock integration of forthcoming Round-5 PV assets [7].

NEOM–DataVolt "Green AI Factory", 1,500 MW

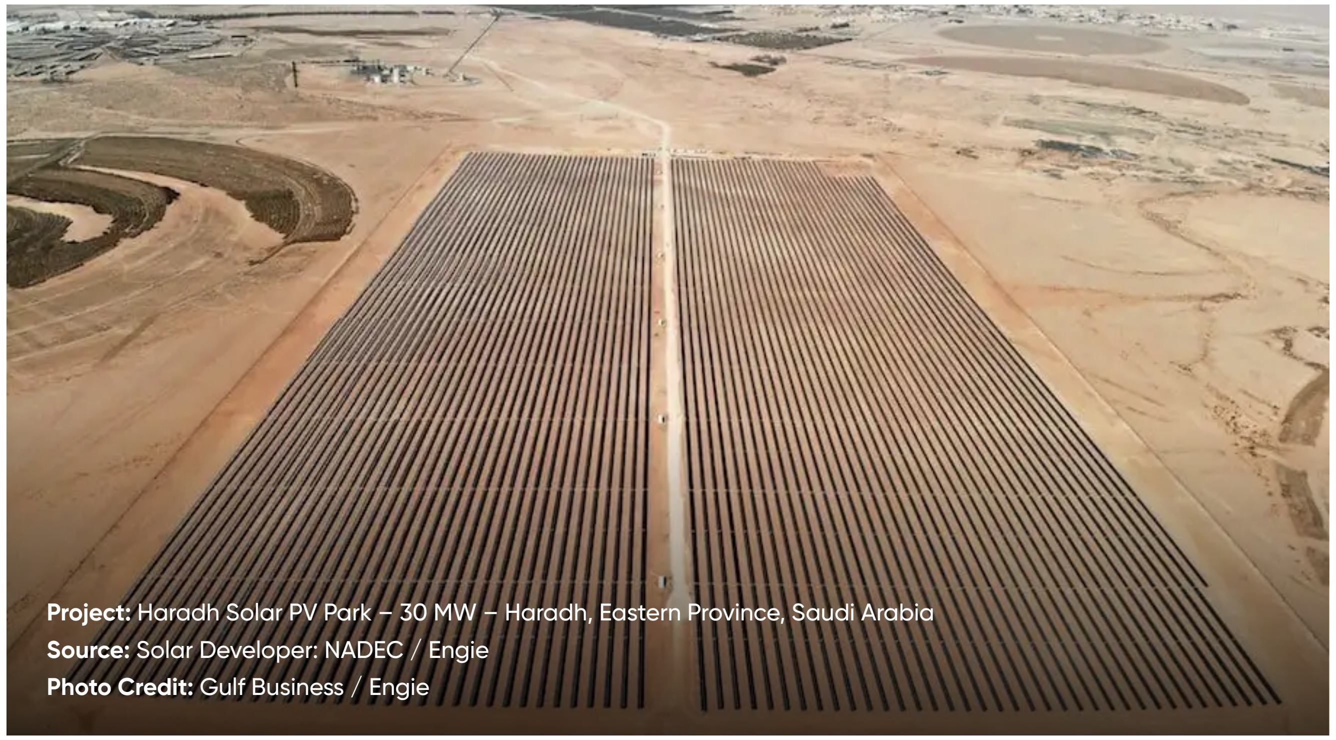
Signed 10 Feb 2025, NEOM and DataVolt will invest US $5 billion to build the world's first net-zero, 1.5 GW data-centre campus in Oxagon (COD 2028). The site will pair high-density computing with 100 % renewable power, anchoring NEOM's digital-infrastructure strategy [8].

Safeer–Golden Chicken Solar PPA, 5.18 MW

TotalEnergies/Zahid JV Safeer inked a 26 Apr 2025 PPA to install a 5.18 MWp single-axis-tracker array at a Golden Chicken site. The plant will deliver 13 GWh yr and abate 6,710 tCO^2 yr, advancing private-sector decarbonisation [9].

CHALLENGES & OUTLOOK

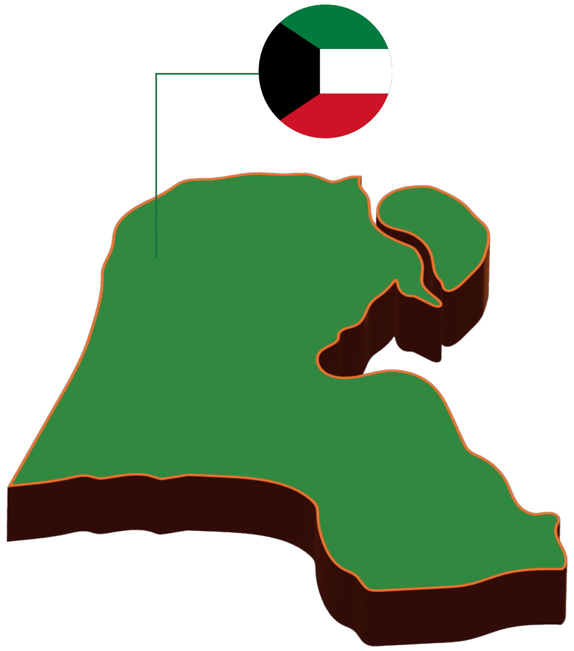
Saudi Arabia's solar market is on an irreversible upward trajectory, transitioning from ambitious targets to tangible, industrial-scale execution. While challenges around grid integration, supply chain, and regulatory frameworks require focused attention and continuous adaptation, the fundamental drivers – economic competitiveness post-tariff reform, strategic energy diversification goals, Vision 2030 imperatives, and enabling finance/technology – ensure robust long-term growth. The market is poised to become a global leader not just in deployment volume, but also in integrating massive solar capacity with storage and enabling future green industries like hydrogen. The focus is shifting from if to how fast and how smartly the Kingdom will achieve its solar ambitions.



Project: Haradh Solar PV Park – 30 MW – Haradh, Eastern Province, Saudi Arabia
Source: Solar Developer: NADEC / Engie
Photo Credit: Gulf Business / Engie

References:
[1], [2], [3], [4], [5], [6], [7], [8], [9] *https://solarabic.com/*

KUWAIT



Source: Solarabic Database

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

CURRENT SITUATION

Kuwait's renewable push accelerated in 2025. The government restarted utility-scale procurement after a two-year hiatus, resuming the long-delayed Dibdibah/Shagaya programme and requesting that the private sector bridge the looming summer supply gaps with fast-track solar and storage solutions. Parallel policy actions include a detailed rooftop-PV rulebook, accession to the International Solar Alliance, and a framework deal with China to co-develop 3.5 GW. These signal that renewables are now central to the Vision 2035 energy strategy, which targets 30 % clean power by 2030 and 50 % by 2050.

UPDATES IN REGULATION

MAR 2025 · ROOFTOP-PV CODE (MEWRE CIRCULAR 1/2025)

The new rulebook formalises grid-connected systems from 5 kW to 1 MW and introduces a clear fast-track for larger arrays (>1 MW) through the Ministry's Renewable Energy Department [1]. Key provisions:

- **IEC-compliant equipment (panels: IEC 61215/61730/61853; inverters: IEC 62109/61683/61727).**
- **Installations must be carried out by MEWRE-licensed EPCs; a blacklist mechanism removes repeat violators.**
- **ISO 17020-accredited third-party inspection is compulsory before energisation; MEWRE may reject non--conforming reports.**
- **Minimum warranties: 25 yrs performance (modules), 5 yrs materials (inverters), 10 yrs mounting structures; quarterly O&M logs to be filed online. The code is expected to de-risk rooftop finance and pave the way for commercial-and-industrial (C&I) net-metering.**

5 MAY 2025 · GRID-SCALE BATTERY-STORAGE FEASIBILITY STUDY

Citing peak-load risks for the summers ahead, MEWRE confirmed to local press that it is evaluating utility-class battery farms able to store surplus evening power and discharge during the noon-to-4 p.m. peak [2].

17 MAR 2025 · CHINA–KUWAIT 3.5 GW FRAMEWORK

An MoU signed in Beijing commits Chinese state developers and financiers to co-develop 3.5 GW (expandable to 5 GW) across Shagaya Phases III–IV and Abdaliya, accelerating EPC mobilisation and concessional funding [3].

PROJECTS

Al-Dabdaba & Shagaya-III Zone 1 Solar PV – 1,100 MW

KAPP's Higher Committee cleared release in May 2025 that includes the full RFP after pre-qualifying six consortia (including ACWA Power, EDF, Jinko Power, Masdar, Trung Nam Construction Investment Corp, and TotalEnergies Renewables SAS). The six eligible bidders are asked to submit their technical and commercial bids by Sep. 14, 2025 [4].

KOTC LNG Branch Solar – 6.9 MW

Kuwait Oil Tanker Company switched on 4.05 MW (Umm Al-Aish) and 2.85 MW (Shuaiba) rooftop arrays in May 2025, making both liquefied-gas depots self-sufficient in daylight hours and trimming corporate CO^2 by ~5 kt p.a. The project is the first large-scale solar deployment in Kuwait's oil logistics sector [6].

Fast-Track Solar Bundle (4 × ≈ 500 MW) – 2,000 MW (aggregate)

On 30 Apr 2025 – MEWRE disclosed plans for four grid-connected PV plants to be completed "within 12 months" to avert summer-peak shortages. Preferred sites are close to existing substations to cut lead times; EPCs will be let on lump-sum-turnkey terms with liquidated-damages clauses linked to the 2026 cooling season [5].

Dibdibah / Shagaya-III Zone 2 Solar PV – 500 MW

On 19 May 2025, KAPP issued the formal RFP; bids are due 24 Jul 2025. The project mirrors Zone 1's contractual structure (30-yr PPA, BOOT model) and will export via a new 400 kV spur to the national grid. EY (financial), DLA Piper (legal) and DNV (technical) are advising [7].

CHALLENGES & OUTLOOK

Peak-load risk remains Kuwait's Achilles heel. MEWRE is now evaluating grid-scale battery farms and, as an emergency back-up, powerships while it races to commission the 2 GW solar bundle. The rooftop-PV code, ISA accession, and the China framework remove long-standing policy bottlenecks, but timely land-use permits and transmission upgrades are still critical. If current tenders close on schedule and the four fast-track plants meet their 2026 target, Kuwait could add >3 GW of PV before 2028—pushing the system past the interim 30 % renewables mark and setting a clear trajectory toward the 50 %-by-2050 goal.

Project: Shagaya CSP Plant – 50 MW – Jahra, Kuwait
Source: Solar Developer: Kuwait Institute for Scientific Research (KISR)
Photo Credit: TSK

References:
[1] *https://solarabic.com/*
[2] *Kuwait explores battery storage, renewable energy to boost power supply ahead of summer - Times Kuwait*
[3] *Chinese companies to develop 3.5 GW of solar projects in Kuwait | Solar Power News | Renewables Now*
[4] *Kuwait issues RFP for 1,100 MW Solar PV IPP Project - SaudiGulf Projects*
[5] *https://solarabic.com/*
[6] *https://solarabic.com/*
[7] *Kuwait issues RFQ for 500MW Al Dibdibah Power and Al Shagaya Renewable Energy - Phase III - Zone 2 Solar PV IPP - SaudiGulf Projects*

Source: Sunevosolar

SYRIA

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

CURRENT SITUATION

Following the fall of the Assad regime in December 2024, Syria's energy governance has consolidated under a single transitional authority. This marks a major departure from the previous patchwork of control split among the regime, opposition groups, and the SDF. The new government, led by a transitional council, has pledged to unify the grid, rebuild infrastructure, and prioritize equitable electricity access across all regions.

Despite this political shift, the national grid remains severely degraded, with utility-scale capacity still hovering around 2 GW, down from 8.5 GW pre-war. Years of conflict, fuel shortages, and widespread metal theft have left most households reliant on diesel generators or small off-grid solar kits.

Solar energy is emerging as the only scalable lifeline: rooftop demand continues to rise in Damascus, Idlib, and former SDF-held towns, despite high import costs. The transitional government is also working to integrate Turkish electricity backfeeds and accelerate the 400 kV interconnection with Jordan, aiming to provide 8–10 hours of daily supply by 2026.

REGULATORY & FRAMEWORK UPDATES

U.S. SANCTIONS WAIVER – 23 MAY 2025

The U.S. State Department issued a 180-day partial waiver of Caesar Act sanctions, allowing transactions for essential civilian power projects. This includes humanitarian solar imports and grid rehabilitation equipment.

JORDAN INTERCONNECTION PLAN – 1 JAN 2025

Interim Syrian electricity minister Omar al-Shaqrouq announced a three-phase deal with Amman: repair the cross-border line within six months, restore supply to 8–10 hours/day during the emergency phase, and target 24-hour service within three years.

TURKEY SUPPLY ARRANGEMENTS – MAY 2025

Ankara confirmed it will supply 2 bcm of gas annually and up to 1.3 GW of electricity to northern Syria. Talks also include reactivating the Kilis–Aleppo gas pipeline and deploying Karpowership floating plants, with the 400 kV power line expected online by end-2025.

PROJECTS

Wadi al-Rabi' Solar PV – 300 MW

Announced by the Ministry of Electricity on 3 March 2025, the project will occupy ≈ 18 km2 of state-owned land southeast of Damascus. A gas-insulated (GIS) sub-station and a pair of 230 kV overhead lines will back-feed the capital's ring network and provide a bulk-power spur toward the Homs corridor. The tender is structured as a 25-year build-own-operate (BOO) concession:[1]

Solar Rex Twin PV Programme – 170 MW (incl. storage)

Signed 1 June 2025 between the Public Establishment for Electricity Transmission & Distribution and Solar Rex:

- **100 MW grid-tied PV plant in Rural Damascus (no storage).**
- **70 MW PV + battery system in Rural Hama, providing firm evening power and local grid support.**

Both projects target COD within 24 months and form part of a broader plan to raise renewables' share in Syria's generation mix; state utility ETD will offtake electricity under a long-term tariff [3].

Historic Energy Package" (4 × CCGT + Wadi-al-Rabi' Solar) — 5 000 MW

On 30 May 2025 the Ministry of Energy signed a US $7 billion MoU with an international consortium led by UCC Holding/UrbaCon (Qatar), Power International (USA) and Turkey's Kalyon & Cengiz Enerji.

Four combined-cycle gas-turbine plants will add 4,000 MW: Treifawi-Homs (1,500 MW), Mahrada (1,000 MW), Zeizoun-Hama (750 MW), and Deir Ezzor (750 MW).

A companion 1,000 MW solar park will be built at Wadiyān al-Rabi', Rural Damascus (separate from the 300 MW tendered earlier).

The consortium will finance, build, and operate the assets under 25-year concessions; the ministry forecasts > 50,000 direct and 250,000 indirect jobs and says the package will stabilise the grid, cut diesel use, and spur reconstruction[2].

CHALLENGES & OUTLOOK

With the Syrian pound stabilising and last year's US $25-per-panel import levy scrapped, currency volatility and equipment costs are no longer the main road-block. Today the sector's chief hurdle is access to finance: local banks have limited capital, while foreign lenders still demand political-risk guarantees that are difficult to provide in a transitional setting.

Developers also face uneven enforcement of regulations. Permit times, fees and technical requirements can vary widely between governorates because there is still no unified renewable-energy statute covering tariffs, grid-connection rules and fiscal incentives. This legal patchwork inflates transaction costs and discourages large institutional investors.

The interim Energy Council, however, is drafting a new Electricity Law that would introduce tax holidays, a single-window permitting process and transparent contract standards. Several regional green-finance funds have signalled they could enter the market once that framework is in place—potentially by late 2025. If the legislation is adopted and applied evenly, Syria could move from ad-hoc solar installations to a bankable project pipeline and become one of the fastest-growing PV markets in the eastern Mediterranean.

References:
[1], [2], [3] *https://solarabic.com/*

TÜRKIYE

Solar Energy Capacity (By end-March 2025)	21.6 GW
RE Share of total installed capacity in 2024	30%
RE Target in 2035	120 GW

Source: The Ministry of Energy, Solar Global

CURRENT SITUATION

Türkiye is undertaking an ambitious clean-energy expansion. By end-March 2025 solar PV had climbed to ≈ **21.6 GW** and wind to ≈ **13 GW,** meaning the two technologies now account for **30 % of total installed capacity.** Utility-scale growth continues to be driven by the YEKA auction scheme, while looser rules for "unlicensed" plants have triggered a boom in off-site C&I self-consumption projects. The Ministry of Energy still targets **120 GW of wind + solar by 2035** and is looking to streamline permits and shorten grid-connection queues to keep pace.

UPDATES IN REGULATIONS & FRAMEWORK

€50 M OPEC FUND–TSKB GREEN-LOAN FACILITY

The OPEC Fund signed a €50 million on-lending agreement with the Industrial Development Bank of Türkiye in 12 Feb 2025, to finance renewable energy, efficiency and circular-economy projects. It is the lender's first Turkish climate loan and aligns with Ankara's 2053 net-zero pledge [1].

PROJECTS

YEKA RES-2024 Wind Portfolio, 1,200 MW

Türkiye's first post-2021 wind mega-auction closed on **22 Jan 2025.** Five pre-permitted zones were awarded at the **price floor of USD 35 / MWh (3.5 ¢/kWh),** plus one-off contribution fees of USD 60,000-148,000 /MW:

- **Enerjisa Üretim (joint venture between German E.ON and Turkey-based Sabanci) secured the two Thrace sites – Edirne 410 MW and Balkaya 340 MW.**
- **RT Enerji won Sergen 200 MW.**
- **Efor Holding took Yellice 160 MW.**
- **ADY Akdeniz landed Gürün 90 MW.**

Winners sign a 49-year site lease, sell on the open market for six years, then receive a 20-year fixed tariff. Projects must reach COD within 72 months and meet a **55 % local-content** threshold [2], [3], [4], 5].

YEKA GES-2024 Solar Portfolio, 800 MW

Concluded **5 Feb 2025,** the solar round drew **146 bids from 67 companies** for six blocks; each cleared at **USD 0.0325 / kWh** with average CAPEX of USD 126 000 /MW:

- **Karapinar-G24 (Konya) 385 MW – Kalyon Yeka GES 5**
- **Karaman-G24 200 MW – Temmuz Güneş**
- **Malatya-G24 75 MW – Özerka Enerji**
- **Van-G24 60 MW – Chen Güneş**
- **Antalya-G24 40 MW – Erdem Soft Tekstil**
- **Kütahya-G24 40 MW – (Cumra Gunes Enerjisi)**

Developers may trade power freely for the first five years (floor price US 4.95¢/kWh), after which a 20-year fixed PPA begins. Ground-breaking is required within 24 months, with full commissioning by 2029 [6].

As Besin Agri-PV Project, 7.3 MW

Commissioned in March near Gaziantep, the farm uses locally-made **ASTRO N5 585 W TOPCon modules** to power irrigation while preserving crop yields. The dual-use array helps one of Turkey's largest food processors curb emissions and stabilise energy costs [7], [8].

CHALLENGES & OUTLOOK

Grid access and curtailment risk are rising as project pipelines swell; the ministry is therefore preparing a permitting-reform package and exploring large-scale storage mandates, with battery-sector investment already topping US$ 1 bn in 2024. Meanwhile, the oversubscribed YEKA rounds signal deep developer appetite, buoyed by local-content rules and a maturing supply chain. Delivering the 120 GW 2035 goal will hinge on accelerating transmission upgrades and finalising a clear remuneration model for hybrid PV-plus-storage plants—now under stakeholder consultation for introduction in 2026.

References:
[1] *https://solarabic.com/*
[2] *Enerjisa wins biggest two wind power projects in Turkey's auction*
[3] *Türkiye awards 1.2 GW of wind capacity in an oversubscribed tender | Enerdata*
[4] *Türkiye's 1200 MW Wind Competitions (YEKA-4 RES 2024) Completed in January 2025 - Wind Energy Turkey*
[5] *Announcements - 2024 YEKA RES Tender Announcement*
[6] *bne IntelliNews - Turkey completes tenders for 800 MW of solar*
[7] *https://solarabic.com/*
[8] *astronergy.com/astronergy-energizes-sustainable-agriculture-with-7-3mw-solar-plant-in-turkey/?utm_source=chatgpt.com*

UAE
(United Arab Emirates)

Source: IRENA, Solarbic Database

RE Target by 2030	30% by 2030
Installed Solar Capacity in 2023	6,100 MW
RE Target by 2030	14,000 MW

CURRENT SITUATION

As of February 2025, the UAE's renewable energy capacity had grown to approximately 6.3 GW, driven almost entirely by utility-scale solar PV projects. Tender activity in the first half of 2025 provided renewed impetus to the UAE's renewable energy expansion, with over 3 GW of new solar capacity including projects such as Al Ajban and Al Zaraf, and 140 MW of wind capacity at Al Sila progressing through the procurement phase. These developments indicate continued alignment with the national target of achieving 14.2 GW of renewable capacity by 2030.

The International Energy Agency's Electricity 2025 outlook foresees UAE renewable generation growing **~23% between 2025-27.** The same report notes a **20 % year-on-year jump in nuclear generation in 2024 (Barakah)** and expects gas-fired output—still the region's backbone—to grow **5.3 % p.a. in 2025-27,** nudging its share of the mix from 68 % to 73 % [1], [2].

UPDATES IN REGULATIONS & FRAMEWORK

FEDERAL DECREE-LAW NO. 11 OF 2024 ON THE REDUCTION OF CLIMATE-CHANGE EFFECTS

In force since May 2025, the decree introduces the UAE's first mandatory MRV system for greenhouse-gas emissions, requires every federal entity and large private emitter to produce reduction plans aligned with Net-Zero 2050, and empowers the Cabinet to set sector-specific carbon budgets and penalties. The measure turns earlier policy targets into legally enforceable obligations and is expected to accelerate corporates' demand for traceable clean electricity and offsets [3].

PROJECTS (MILESTONES ACHIEVED JAN – JUN 2025)

Al Ajban Solar PV – 1,500 MW

Arctech secured a pivotal contract in January 2025 to supply its advanced SkyLine II single-axis trackers for PowerChina's construction of Masdar's flagship plant. This technology deployment will optimize energy yield for the world's largest single-site solar facility, slated for 2026 commissioning. Upon completion, the project will power ~160,000 UAE households and mitigate ≈2.4 million tons of CO_2 annually through carbon-free generation [4].

Al Sila Wind Farm – 140 MW

EWEC's February 2025 RFP accelerated procurement for Abu Dhabi's second utility wind venture. This standalone IPP will leverage low-wind-speed turbine technology to boost national wind capacity to 240 MW—sufficient for 36,000 residences. It anchors the emirate's strategy to reach 2.6 GW wind capacity by 2035 [6].

ADNEC Rooftop Solar – 5 MW

Positive Zero (via SirajPower) finalized a January 2025 PPA to deploy 21,600 m² of rooftop PV across ADNEC's exhibition complex. The installation will cover ~30% of the venue's energy demand and slash 6,000 tons of CO_2 annually post-Q4 2025 commissioning, exemplifying urban decarbonization [8].

Al Zaraf Solar PV – 1,500 MW

EWEC launched the IPP tender in January 2025, advancing Abu Dhabi's utility-scale solar expansion. Structured under a 60:40 state-developer ownership model, the project attracted 16 global bidders with proposals due Q2 2025. The plant will annually displace 2.4 million tons of CO_2 while energizing ~160,000 homes upon operational launch [5].

Masdar/EWEC Solar-plus-Storage Hub – 5 GW PV + 19 GWh BESS (1 GW firm)

Announced at Abu Dhabi Sustainability Week (14 January 2025), this $6 billion flagship integrates the world's largest co-located solar array with grid-scale storage. Designed to deliver 1 GW of firm 24/7 renewable power from 2027, it sets a global benchmark for dispatchable clean energy, addressing AI-driven demand surges [7].

GEMS Education Solar Portfolio – 12.7 MW

The 13 March 2025 agreement with Positive Zero marks the UAE's largest education-sector solar initiative. The project will integrate rooftop, car-park, and bus-shelter PV across 23 Dubai schools, generating 21.3 GWh/year to cut 14,300 tons of CO_2. Completion is slated for early 2026, aligning with national climate pedagogy goals [9].

CHALLENGES & OUTLOOK

Distributed-solar growth remains hampered by low retail tariffs and rooftop constraints, yet the flurry of C&I PPAs (ADNEC, GEMS) and the expanding CEC market point to a maturing corporate-procurement channel. The momentum in utility-scale renewable energy development remains significant, with over 3 GW of solar and 140 MW of wind energy presently under active tender. However, limitations in grid flexibility have become the most critical barrier to further integration and expansion.

The 19 GWh Masdar/EWEC battery hub signals a policy pivot toward storage, but revenue rules for batteries are still nascent. Assuming a timely financial close on Al Zaraf and Al Ajban, the UAE is on track to exceed ≈ 9 GW installed renewables by 2027, keeping its 14.2 GW 2030 target within sight.

References:

[1] *UAE leads MENA in renewable installed capacity at 6.3GW*

[2] *Renewable generation in Middle East forecast to grow by approximately 14% per year during 2025-2027: IEA*

[3] *United Arab Emirates Legislations | Federal Decree-Law on the Reduction of Climate Change Effects*

[4], [5], [6], [7], [8], [9] *https://solarabic.com/*

07

10 WAYS AI IS DRIVING CLIMATE & SUSTAINABILITY INNOVATION

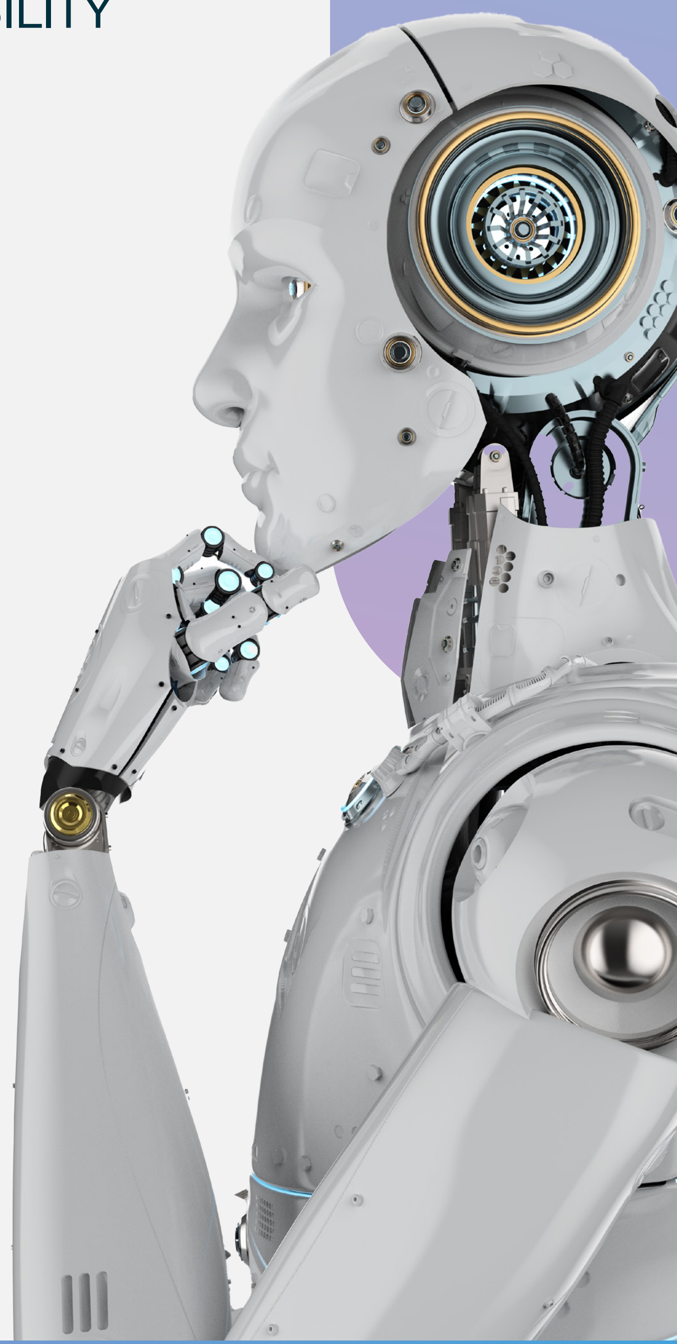
WORLD FUTURE ENERGY SUMMIT

GREENER BY THE GIGABYTE: AI SPARKS A SMARTER, CLEANER ENERGY FUTURE

10 WAYS AI IS DRIVING SUSTAINABILITY

Artificial Intelligence (AI) is fast becoming one of the most powerful tools in the global push for a greener tomorrow. From reducing emissions to safeguarding biodiversity, AI technologies are helping industries, governments, and communities tackle some of the planet's most pressing challenges.

With industry analysts predicting the **imminent tipping point of AI** (from proven use case to omnipresence) in the next few years, 2025 will be another crucial year for measuring its growing impact in the global climate and energy struggle. The widening range of areas where AI can make a positive difference demonstrates the central importance of understanding and then realising its full potential.

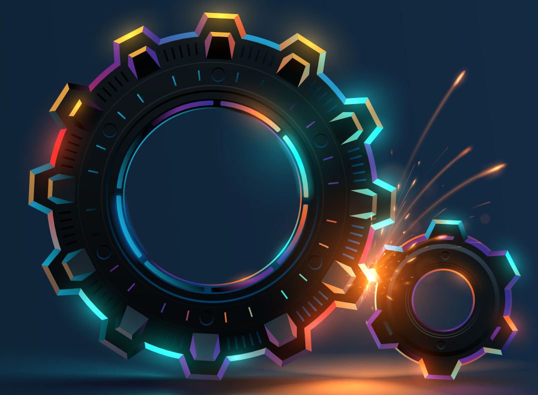


1 OPTIMISING RENEWABLE ENERGY GRIDS

AI already plays a pivotal role in improving the efficiency of **renewable energy networks**, especially as grids grow more complex. Intelligent algorithms can now predict energy demand and weather patterns, helping utilities balance load distribution and reduce reliance on fossil fuels.

Dubai Electricity and Water Authority (DEWA) uses an AI-driven platform named **Moro Hub**, which integrates cloud and data services to **enhance grid performance** and **maximise renewable energy** integration across Dubai.

2 REDUCING INDUSTRIAL EMISSIONS THROUGH PREDICTIVE MAINTENANCE



AI-powered systems are helping factories and industrial plants lower emissions by predicting equipment failure and scheduling maintenance before breakdowns occur, improving energy efficiency and cutting waste.

Saudi Aramco uses **AI systems for predictive maintenance** across its refineries, significantly reducing unplanned downtime and cutting both emissions and energy loss during production.

3 ACCELERATING CARBON CAPTURE AND STORAGE (CCS)

While the developing and upscaling of renewables will provide the greatest impetus for a complete global energy transition, AI has the concurrent role of **optimising carbon capture systems**, helping to design more effective storage solutions and track carbon leakage in real time.

UK-based company **Carbon Clean** uses AI-assisted simulation tools to improve carbon capture systems, including partnerships with Middle East oil and gas operators working to decarbonise operations.

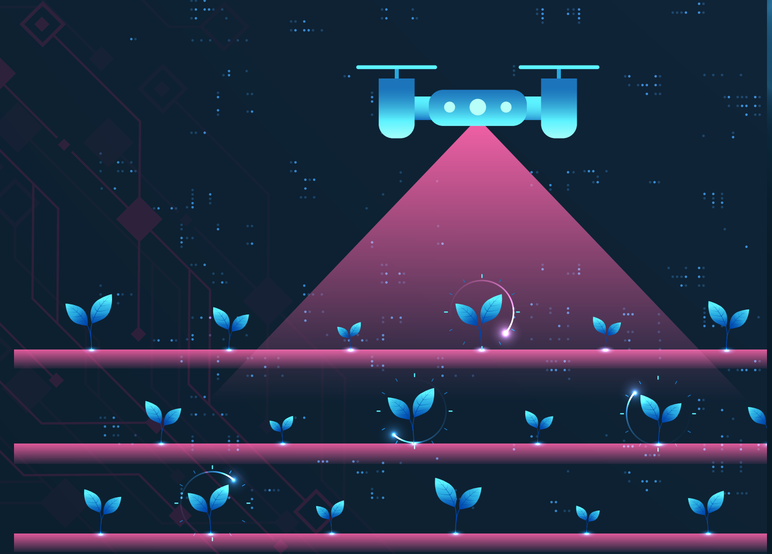
4 ENHANCING WATER RESOURCE MANAGEMENT

The Middle East is home to **15 out of the 20 of the world's most water-scarce countries**, and it's a problem that is getting worse, not better. AI systems are essential for utility firms to detect leaks, predict water demand, and manage distribution more sustainably.

Abu Dhabi's **ADNOC** uses AI to **monitor water usage** in its oilfields, optimising water recycling and reducing freshwater consumption across its operations.

5 SMART AGRICULTURE AND PRECISION FARMING

Saudi Arabia, UAE, Qatar, Lebanon, Jordan, Turkey, and Egypt all heavily rely on food imports to satisfy domestic demand. Creating a sustainable Middle East agriculture industry goes right to the heart of the food/water nexus, and AI is a vital tool for improving crop yields while reducing resource waste through precision farming techniques that monitor soil health, weather, and pest risks in real time.



UAE-based startup **Right Farm** uses AI to optimise supply chains and reduce waste in the fresh produce market, directly lowering the environmental footprint of agriculture.

6 INTELLIGENT URBAN PLANNING

Planning for the next generation of smart cities may unlock the kind of sustainable climate gains needed to stave off disaster. Aiding in this goal, AI models can simulate urban growth, traffic flows, and infrastructure stress, enabling planners to design more energy-efficient and sustainable cities.

Saudi Arabia's **NEOM** project uses AI to drive its "zero-carbon city" model, from transportation logistics to energy use, shaping a blueprint for future sustainable urban environments.

7 WILDLIFE MONITORING AND BIODIVERSITY PROTECTION

AI-powered camera traps, acoustic sensors, and satellite imagery are increasingly being used to monitor endangered species and track illegal activities like poaching or deforestation.

The Dubai Desert Conservation Reserve uses AI-enhanced surveillance systems to monitor the health of local wildlife and prevent habitat disruption.

8 GREEN LOGISTICS AND SUPPLY CHAIN OPTIMISATION

AI is streamlining supply chains by improving route planning, cutting fuel consumption, and **reducing carbon emissions** from global freight and delivery networks.

German logistics giant **DHL** is rolling out AI-powered optimisation tools in the UAE and wider GCC to cut emissions from its regional delivery fleet.

9 ENVIRONMENTAL RISK PREDICTION

'Prevention is better than cure', and prediction is an essential part of prevention. AI models are proving their increasing worth in predicting the likelihood of extreme weather events, floods, and wildfires, helping authorities and businesses strengthen climate resilience.

Qatar Computing Research Institute (QCRI) uses AI for **real-time weather modelling** and flood risk prediction, helping urban planners and emergency services prepare for climate-related disruptions.

10 ENERGY-EFFICIENT BUILDING MANAGEMENT

Smarter and more sustainable buildings (their construction, maintenance and general operations) are the key to unlocking massive CO_2 reductions as around half of the world's population now live in built-up urban areas. AI-based building management systems (BMS) allow commercial and residential properties to monitor and adjust energy use in real time, cutting both emissions and costs.

Honeywell Forge, a system used in buildings across the UAE, applies AI-driven insights to monitor heating, cooling, and lighting systems, dramatically improving energy efficiency.

AI IS CENTRAL TO THE REGENERATION OF OUR GLOBAL CLIMATE

AI is no longer a distant promise for sustainability – it's an active partner. From managing complex energy grids in Dubai to precision farming in Saudi Arabia, from carbon capture systems to wildlife conservation, AI is helping countries across the Middle East (and the wider world) lower their emissions and future-proof their nations.

With strong political backing, robust investment, and a growing ecosystem of startups, the region remains well placed to leverage AI as a means of safeguarding local ecosystems and the global climate in the coming decades.

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

The Middle East and North Africa (MENA) region is undergoing a complex but accelerating transformation in its power sector, with solar photovoltaics (PV) increasingly positioned as a foundational pillar of national decarbonisation strategies. This transition is marked by the convergence of rising renewable capacity, rapid technological advancement, evolving policy frameworks, and expanding private sector involvement. Solar power has transitioned from a supplementary energy source to a strategic asset, underpinning efforts to diversify energy portfolios, reduce fossil fuel dependence, and increase grid resilience.

Empirical data underscores the velocity of this transition. Between 2019 and 2024, the region's installed solar and wind capacity doubled, reaching approximately 30 GW. Major economies such as Saudi Arabia and the UAE are driving this growth through utility-scale solar tenders and landmark projects that incorporate battery energy storage systems (BESS), with capacities exceeding 2 GWh in a single installation. This is paralleled by increased deployment of hybrid systems, particularly in commercial and industrial (C&I) applications, where energy management systems (EMS) are proving critical to optimising load profiles, enabling self-consumption, and supporting grid operations.

Findings from the region also highlight the importance of localised technological innovation in ensuring operational viability under extreme environmental conditions. Dust accumulation, extreme heat, and soiling losses present non-trivial challenges to PV system performance. Mitigation efforts, including the use of waterless robotic cleaning systems, thermal and electroluminescence inspections, AI-driven performance analytics, and integrated digital twin platforms, are increasingly adopted to maintain high performance ratios (PRs) across diverse geographies. In parallel, the digitalisation of O&M enabled through smart SCADA, real-time diagnostics, and fault prediction models, has shifted the performance focus from component-level reliability to system-wide intelligence.

Energy management is now a central theme in MENA's solar evolution. The emergence of intelligent EMS platforms is enabling hybrid PV-storage systems to participate in demand response, arbitrage, and ancillary services, depending on local regulatory conditions. However, multiple challenges persist, particularly around interoperability, communication protocols, and forecasting precision. The region's regulatory heterogeneity ranging from supportive policy environments in the UAE and KSA to fragmented or underdeveloped frameworks in Syria and Afghanistan continue to shape deployment trajectories.

Moreover, broader global dynamics, including trade policy volatility and component price fluctuations, are beginning to affect solar project bankability in the region. Lessons from Europe's past experience with import duties on solar modules underscore the risks of misaligned policy, which can constrain local manufacturing ambitions while undermining LCOE competitiveness. These dynamics are particularly salient as MENA economies aim to localise production and integrate solar into wider industrial development plans.

Ultimately, the success of the MENA region's solar transition will hinge on its ability to operationalise advanced energy systems at scale while maintaining economic and technical viability. This will require sustained investment in digitalisation, quality assurance, adaptive policy design, and regional cooperation. As deployment expands beyond megawatts to encompass system intelligence, flexibility, and resilience, solar energy will not only support decarbonisation targets but redefine the operational architecture of MENA's power sector.

AI	Artificial Intelligence
BESS	Battery Energy Storage System
C&I	Commercial and Industrial
CAGR	Compound Annual Growth Rate
EL	Electroluminescence
EMS	Energy Management System
EPC	Engineering, Procurement, and Construction
EU	European Union
EV	Electric Vehicle
FAT	Factory Acceptance Testing
FITs	Feed-in Tariffs
FPV	Floating Solar Photovoltaic
GW	Gigawatt
GWh	Gigawatt-hour
IR	Infrared
IRA	Inflation Reduction Act
IoT	Internet of Things
KPIs	Key Performance Indicators
kWh	Kilowatt-hour
LCOE	Levelized Cost of Energy
MEA	Middle East and Africa

- **MBR** Mohammed Bin Rashid Al Maktoum Solar Park UAE
- **ML** Machine Learning
- **MIP** Minimum Import Price
- **MWh** Megawatt-hour
- **NZIA** Net-Zero Industry Act
- **O&M** Operations and Maintenance
- **Opex** Operational Expenditure
- **PLI** Performance Linked Incentive
- **PR** Performance Ratio
- **PPAs** Power Purchase Agreements
- **PUE** Power Usage Effectiveness
- **QA** Quality Assurance
- **QMS** Quality Management System
- **SCADA** Supervisory Control and Data Acquisition
- **TWh** Terawatt-hour
- **UV** Ultraviolet

BOARD MEMBERS

Abdul Aziz Abdulla Al Midfa
Chairman

Fazle Moyeen Quazi
President

Denisa Fainis
General Secretary

Khawla Albloushi
Finance, Governance and Government Relations

Moneef Barakat
Communications and Marketing

Marcelle Combrink
International Development

MESIA TEAM

Hinde Liepmannsohn
Executive Director

Zulfa Rasheed
Membership and Engagement Associate

Sol Soufan
Content and Digital Marketing Associate

Jiten Adnani
Marketing & Events Coordinator

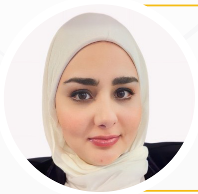
Mansi Bhalodiya
Website/Design Admin

Akhil Jajoo
MESIA Representative in India

Amine Bekhouche
MESIA representative in Morocco

Younès OUBI
MESIA representative in Morocco

REPORT DEDICATED TEAM



Ameera Al - Amayrah
Researcher Countries Section

Tannishttha Das
Editor Countries Section

OFFICE 2310, DUBAI STAR,
JUMEIRAH LAKE TOWERS,
CLUSTER L

@mesia.mena

www.mesia.com