DESERTBLUE

JA Solar Technology Co., Ltd.

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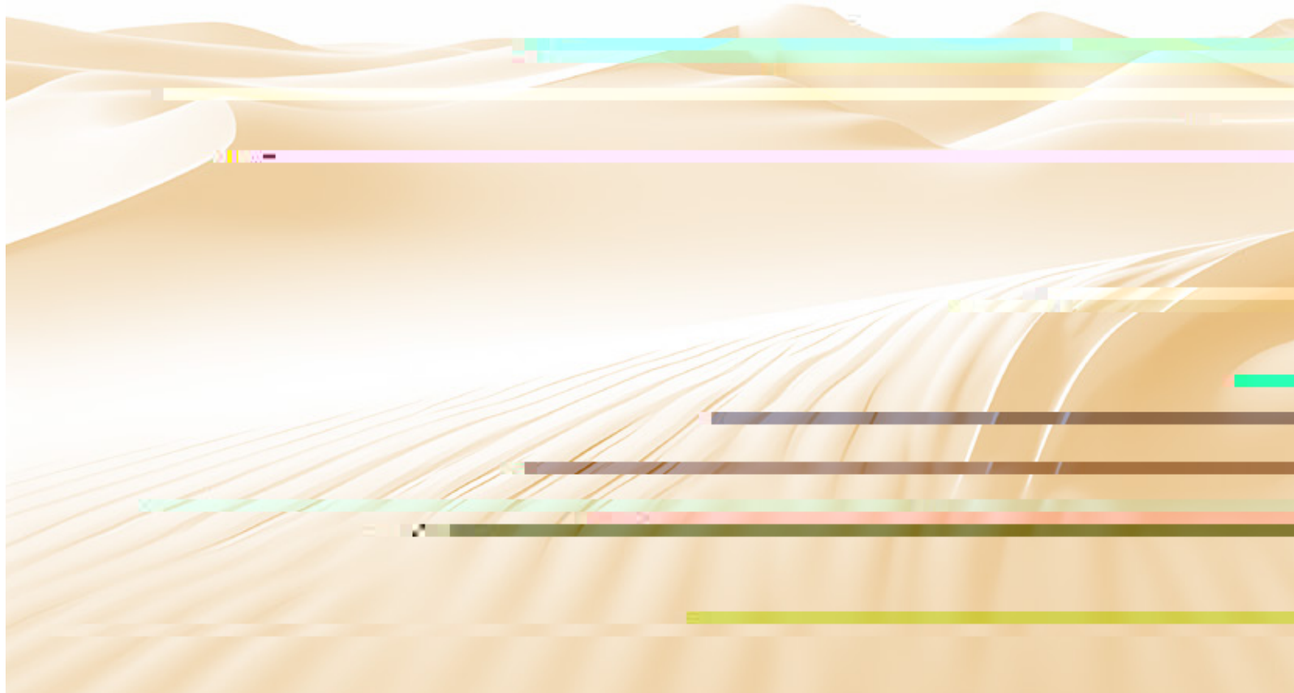


02 Desert-Gobi-Wasteland Environments and Research Background

Desert-Gobi-Wasteland environments cover nearly 27% of China's territory and approximately 25% of global land area, featuring vast but underutilized land resources that are now prioritized for development. The PV systems PV systems have become increasingly prominent in ecological restoration within desert, Gobi, and wasteland environments. Taking Phase I project of the Tengger Desert Base in Ningxia as an example, PV modules were installed with checkerboard straw barriers and drought-resistant grass seeds (such as Artemisia sphaerocephala and Astragalus adsurgens) sown underneath. Vertical sand barriers were constructed along the periphery to reduce wind-blown sand flow. This approach has achieved sand control across an area of 26,000 mu, significantly improving the regional ecological environment.

In environmental improvement, PV modules reduce sunlight exposure and lower surface evaporation rates. Additionally, the cleaning wastewater of PV modules can be used for irrigation, creating favorable conditions for vegetation restoration. The practice in Zhongwei PV Industrial Park, Ningxia demonstrates that this operating mode mentioned above significantly increases vegetation coverage, achieving synergistic effects between ecological restoration and clean energy development.

2.1 Development advantages

Abundant solar irradiation resources: Desert-Gobi-Wasteland environments feature long sunshine duration and high-intensity solar radiation, with annual average sunshine hours generally exceeding 2,000 hours, and even surpassing 3,000 hours in some areas, providing superior conditions for solar energy development.

Abundant land resources: Vast territory with sparse population and minimal shading obstacles, ideal for deployment of large-scale PV power plant.

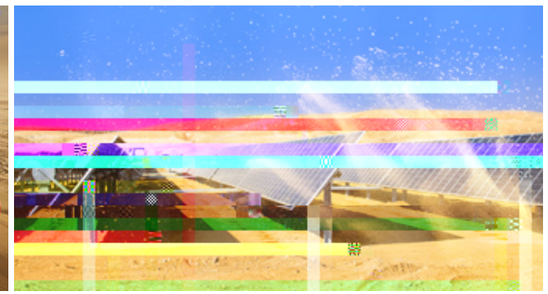
2.2 Development challenges

Dust impact: Dust accumulation causes glass surface abrasion and coating aging, reducing light transmittance and affecting power generation efficiency while increasing hotspot risks. Coupled with the fact that deserts, Gobi area, and wastelands are predominantly located in remote uninhabited areas, transportation is inconvenient, and operational maintenance (O&M) cleaning faces significant challenges with high costs.

Gusty threat: Frequent strong winds may trigger issues such as micro-cracks in solar cells, deformation or tearing of module frames, and glass breakage, severely compromising both module safety and power generation performance.

High-intensity UV radiation: Prolonged exposure to high-intensity ultraviolet rays accelerates the aging of encapsulation materials, resulting in reduced module sealing performance and light transmittance.

Large temperature variations: The actual operating temperature frequently deviates significantly from standard test conditions (25°C), leading to power output degradation, accelerated material aging, and compromised module reliability and lifespan.

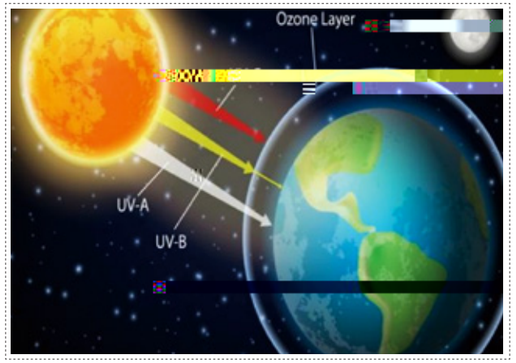


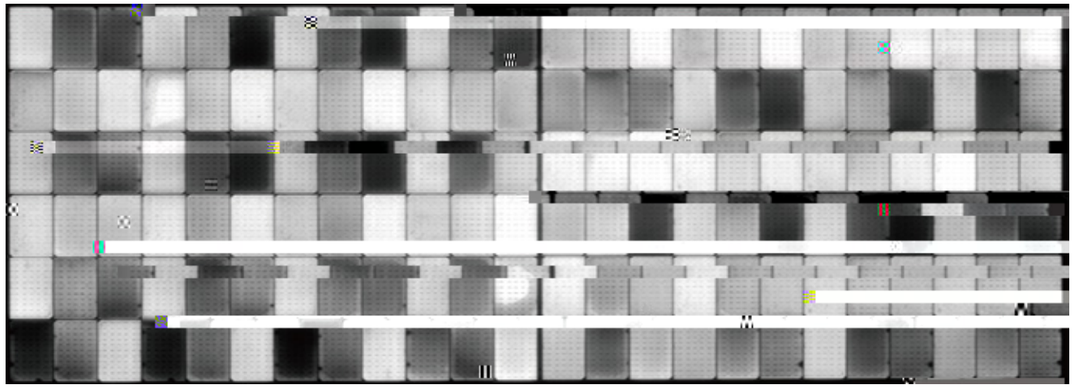
03 Reliability Risks of Desert-Gobi-Wasteland Modules

3.1 High-intensity UV radiation

Although Desert-Gobi-Wasteland regions possess abundant solar irradiation resources, excessive UV radiation can cause severe damage to PV modules. High-intensity UV radiation accelerates the aging process of encapsulation materials (such as EVA encapsulant), triggering photochemical reactions that lead to material failure, reduced light transmittance, and compromised sealing performance. Once the encapsulation materials degrade and fail, moisture and oxygen can infiltrate into the interior of PV modules, triggering oxidation and corrosion of solar cells, which ultimately accelerates the performance degradation of PV modules.

Additionally, high-intensity UV irradiation can induce the rupture of Si-H bonds in solar cells, generating excessive H atomic clusters that promote carrier recombination and degrade cell performance. Meanwhile, the generation of hot carriers may damage the passivation layer, increase interfacial state density, and further degrade module efficiency.





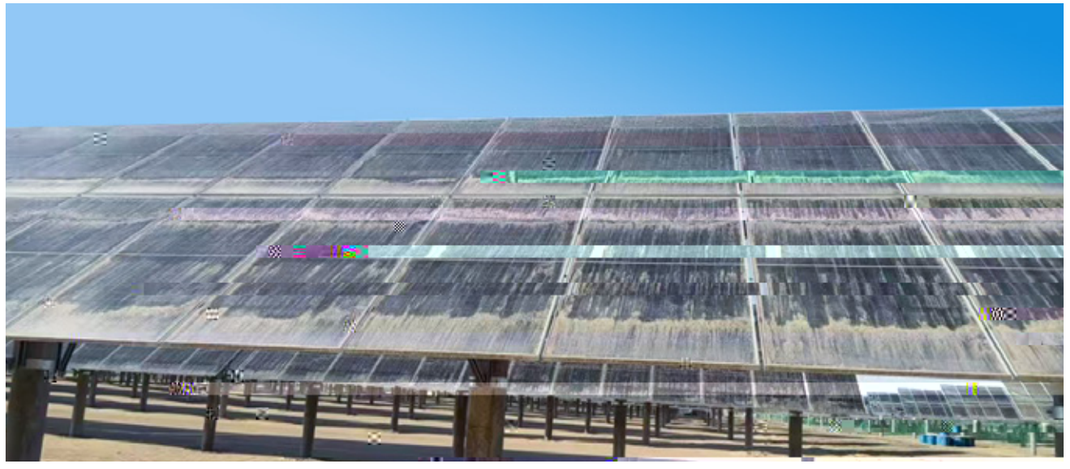
3.2 Sandstorms

PV modules operating in Desert-Gobi-Wasteland environments face unique operational challenges, with frequent sandstorms being particularly prominent. These sandstorms typically feature prolonged duration and extensive impact areas, with an annual occurrence frequency reaching dozens of times. During the active sandstorm season, visibility frequently drops below 100 meters, with suspended particulate matter (PM) concentrations in the air exceeding 10mg/m³. Such extreme weather not only triggers sharp fluctuations in instantaneous power generation but also imposes sustained adverse effects:

Strong winds accompanied by sandstorms may overturn PV mounting structures or modules, causing physical damage. A PV project in Xinjiang once suffered severe losses due to widespread module bending and mounting structure collapses caused by a Level 13 gale.

Driven by strong winds, sand and dust particles collide with PV module surfaces at high velocities, potentially scratching the glass protective layers or coatings, which reduces light transmittance and accelerates material degradation. The wind-sand environment in desert Environments further exacerbates surface abrasion of PV modules, potentially compromising the sealing performance of encapsulant materials (e.g., EVA encapsulant) and increasing the risk of moisture ingress.

Uneven dust accumulation causes localized temperature rise in modules, leading to hotspot. Hotspots not only accelerate cell aging but may also cause module burnout or even fire hazards.



PV modules face severe thermal challenges under the extreme climate conditions of deserts, Gobi areas, and wastelands. The drastic diurnal temperature fluctuations significantly impact module performance.

Ambient temperatures in Desert-Gobi-Wasteland environments can reach 0–50°C. The output power of PV onleratu with-3.208 Td[Ambie, with-a typflulantak50°C3.208 Td[A.9 (onxtref(Ambi flw 0 -. Tmodule p05er of PV)]TJ-0.0app[Ambioxthe euatt

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Excellent self-cleaning performance

The product incorporates a nano-scale self-cleaning coating, whose dense microstructure and antistatic properties significantly reduce dust adhesion, enabling effortless self-cleaning via wind force, resulting in a >32% reduction in light transmittance degradation compared to conventional PV module glass.

Enhanced weather resistance and abrasion resistance

The reliability of each aspect has been improved by at least 32%, with the service life extended by 3 to 5 years. Meanwhile, the hardness of encapsulation material has been enhanced, resulting in a 14% reduction in power loss under severe dusty conditions.

High-load design

Equipped with high-strength steel frames, DesertBlue modules withstand 6000 Pa front loading and 4000 Pa back loading, representing over 60% improvement in load capacity compared to conventional PV modules. The steel frame material combines thermal expansion adaptability with excellent conductivity, reducing grounding material requirements and carbon emissions.

Excellent high temperature performance

The temperature coefficient is optimized to -0.28%/°C. Combined with JA Solar's TOPCon cells featuring high open-circuit voltage, the power output is increased by 0.5–0.6% under desert conditions at 50°C ambient temperature and module operating temperature of 75–85°C. Compared with conventional PV modules, DesertBlue modules operate at a temperature nearly 5°C lower in dusty environments, which equates to an additional power generation capacity increase of approximately 1.5%.

Excellent UV resistance

DesertBlue modules incorporate JA Solar's proprietary n-type Bycium+ high-efficiency cells, further enhancing module performance. This cell employs technologies such as millisecond-level low-oxygen n-type silicon wafers, excellent surface passivation and passivated contact techniques, laser-enhanced contact optimization, ultra-fine grid metallization, and bifacial anti-reflective coatings. It delivers high conversion efficiency while maintaining potential for further UV resistance optimization through high-performance encapsulation technologies.

After developing solutions tailored to the complex environmental characteristics of deserts, Gobi areas, and TÜV NORD specdfic

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High temperature mechanical load performance					
MQT 20 High temperature dynamic mechanical load test		MQT 16 High temperature static mechanical load test		IEC 62938 High temperature non-uniform load testing	
MQT 01	MQT 02	MQT 01	MQT 02	MQT 01	MQT 02
MQT 03	MQT 15	MQT 03	MQT 15	MQT 03	MQT 15

MQT 18.1 Bypass diode thermal test		MQT 09 Hot-spot endurance test	
IEC 62979 Bypass diode - Thermal runaway test		-	
MQT 18.2 Bypass diode functionality test		-	
MQT 01	MQT 02	MQT 01	MQT 02
MQT 03	MQT 15	MQT 03	MQT 15

The test results are shown in the following table:

Test Item			
			Passed
		Passed	Passed
Sand-fall test0.51%	A: B: C:	A: B: C:	A: Passed B: Passed C: Passed

0.56%

0.63%

0.10%
0.11%

6.2 High-UV aging test

Given the high level of UV irradiation in Desert-Gobi-Wasteland regions, to simulate the environment where intense UV irradiation coexists with high temperatures in desert regions, this test sets the total UV radiation

the UV aging resistance performance of DesertBlue modules under high temperature conditions. Performance changes were evaluated by comparing power degradation values before and after testing. After completing the comprehensive UV aging test, the samples were immediately subjected to sand-fall test to evaluate their post-aging resistance to sand abrasion.

Given the significant diurnal temperature variations and prolonged exposure to extreme temperatures in Desert-Gobi-Wasteland environments, DesertBlue modules were subjected to rigorous combined aging tests. The test extended the duration of temperature cycling to 12 hours and 4 hours respectively (-40°C to 85°C

some areas, it may even exceed this threshold. Such extreme high temperature environments impose stringent requirements on the thermal resistance of PV modules. Furthermore, shading caused by dust and other contaminants can trigger the hotspot effect, leading to a sharp localized temperature rise in modules that severely compromises operational safety and lifespan. The module's resistance to hotspot and diode's high temperature endurance were evaluated through enhanced hotspot test, diode junction temperature, and diode thermal runaway tests.

High temperature hot-spot endurance test: The highest-temperature cell was identified using infrared screening. Hotspot test was conducted under enhanced irradiance (1300 W/m²±50 W/m²) and elevated ambient temperature (80°C ±5°C) to evaluate and verify the thermal endurance of DesertBlue modules under extreme conditions.

Bypass diode thermal test: The test conditions comply with IEC TS 63126. After obtaining the linear curve, the ambient

components used in DesertBlue modules under high temperature conditions.

Bypass diode - Thermal runaway test: Diode thermal runaway test was conducted in accordance with IEC 62979. To better simulate actual operating conditions in desert environments, the test cycle count was increased by 10 to verify the reliability of DesertBlue modules' diode components under high temperature conditions.

To simulate the mechanical stress on PV modules caused by sandstorms in Desert-Gobi-Wasteland environments, a series of test schemes combining conventional load testing with high temperature environments was designed. Considering actual operating conditions, all test samples were evaluated according to IEC 61730-2 MST 56, with an ambient temperature of 110°C during the 200-hour initial test phase.

High temperature dynamic mechanical load test: At 60 ambient temperature, 2000 Pa dynamic mechanical loads were applied to both front and back sides of PV modules for 1000 cycles to simulate frequent wind-sand impacts on DesertBlue modules.

High temperature static mechanical load test: At ed to 6000 Pa front side and 4000 Pa rear side static loads to evaluate the limits of material resistance under high temperature and extremely strong wind conditions.

		Passed	Passed
Passed	Passed	Passed	Passed
Passed	Passed	Passed	Passed

6.6.3 Empirical tests at Tengger desert post office, Inner Mongolia

JA Solar, in collaboration with **TÜV NORD** has established an empirical test platform in the Tengger Desert, a region characterized by a typical temperate continental desert climate with notably pronounced annual and

corridor, experiencing relatively high average annual wind speeds and frequent sand and dust activities. During non-sandstorm conditions, due to aerosol suspension and slight wind-induced dust lifting, the daily natural sedimentation of sand and dust can reach tens to hundreds of grams per square meter. This not only results in sustained abrasive effects on the glass surface of PV modules caused by strong winds carrying fine sand particles, but also significantly impairs the modules' light absorption capability due to dust adhering to their surfaces, ultimately leading to a reduction in power generation.

The project evaluated the actual power generation performance of dust-resistant PV modules through outdoor energy generation monitoring. The performance was comprehensively evaluated by calculating the Watt-hour power generation capacity and PR value of the modules, combined with temperature data statistics.

The project achieved grid connection on October 2025, with power generation data under continuous monitoring.

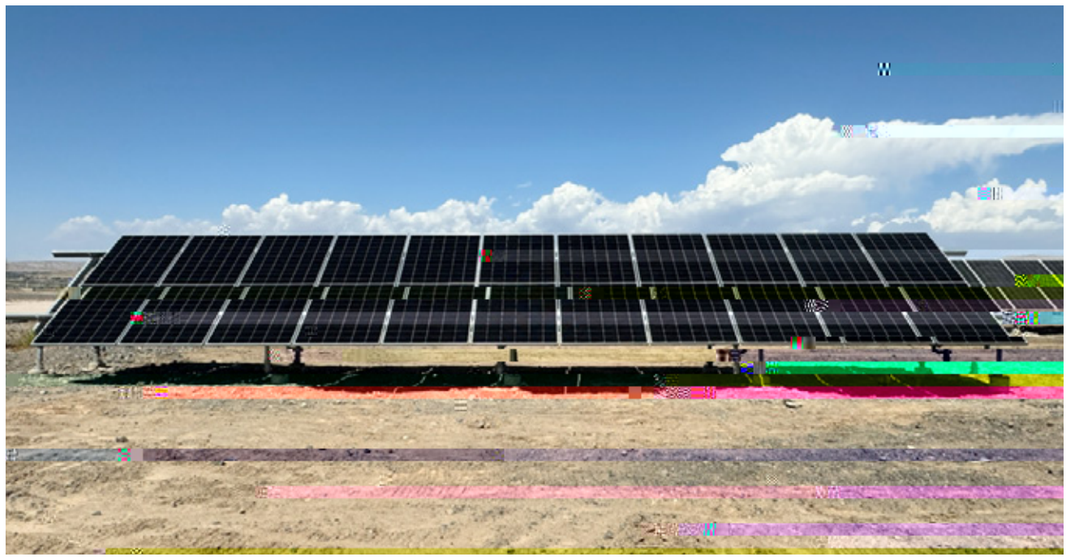
6.6.4 Xinjiang demonstration project

The Xinjiang region enjoys abundant sunshine, with an annual sunshine duration of approximately 3,000 to 3,200 hours, making it one of the regions richest in solar thermal energy resources. The Turpan region fea

16.4 mm, while the annual evaporation exceeds 3000 mm.

Xinjiang is a pivotal region for construction of China's "Desert-Gobi-Wasteland" large-scale wind and solar power bases. The empirical test data collected here can directly support large-scale PV projects in Xinjiang and across the entire Northwest region, providing precise first-hand data for site selection, design, equipment selection, and O&M. This enables power plants to achieve lower levelized cost of electricity (LCOE) and higher return on investment (ROI) throughout their entire lifecycle.

The project was completed in October 2025, with power generation data currently under monitoring.



Desert-Gobi-Wasteland Solution – DesertBlue modules deliver comprehensive value to customers across construction, operation, and power generation systems.

DesertBlue modules significantly reduce initial investment costs of projects in deserts, Gobi areas, and wastelands, achieving 0.003 CNY/W savings in grounding costs, along with 0.04 CNY/W and 0.025 CNY/W savings in cleaning robot costs for China and the Middle East markets respectively.

During the operational phase, taking a 100 MW desert power plant as an example, manual cleaning (dry brushing) frequency can be reduced by half, saving 240,000 CNY annually and 6 million CNY cumulatively over 25 years. In Northwest China and the Middle East, robotic cleaning (dry brushing) operating costs over 25 years can also achieve savings of 7 million CNY and 5.4 million CNY respectively.

In terms of power generation, the Ulan Buh Demonstration Project (Inner Mongolia Energy, IME) utilizes DesertBlue modules, which demonstrate a 4.98% increase in energy yield compared to conventional modules.

The immense customer value generated can be largely attributed to JA Solar's profound insights into the harsh environmental conditions of deserts, Gobi area and wastelands, as well as its meticulous understanding of customer-specific requirements. As a trusted green energy solutions partner for global customers, JA Solar has been deeply involved in numerous Desert-Gobi-Wasteland PV projects, identifying four major challenges: fine particulates in dust, large-particle abrasion, high load under strong wind, and extreme temperature and UV. Through technological innovation, these challenges have been systematically addressed, delivering highly reliable and high-return module solutions to customers.

JA Solar's Desert-Gobi-Wasteland Solution—the launch of DesertBlue modules epitomizes the company's deep commitment to PV technology R&D and its precise alignment with market demands in the solar energy sector.

In reliability testing, DesertBlue modules not only strictly comply with IEC requirements but also implement significantly more rigorous test conditions to validate their exceptional durability and stability in extreme environments. Specifically:

Hotspot test: T

high-temperature conditions.

UV aging test: The cumulative irradiance has been significantly increased from 15kWh/m² as required by the IEC 61215-2 standard to 220kWh/m², verifying the material's outstanding weather resistance and UV degradation resistance under more stringent conditions..

Mechanical stress test: In addition to conventional dynamic and static load tests, ultra-high limit loads of 6000/4000 Pa have been introduced, with coupled high-temperature conditions to simulate structural reliability under combined thermal-mechanical stresses in real operating environments.

Sand and dust test: By simulating the sand and dust friction caused by wind and sand, cleaning and installation, etc., the wear resistance of the front panel glass of the component is verified to ensure that it can effectively resist the loss of power generation efficiency caused by surface wear throughout its entire life cycle.

JA Solar's DesertBlue modules transcend industry benchmarks, setting a new performance standard. Their exceptional temperature coefficient and bifacial energy generation capability ensure stable and efficient power output under harsh conditions, including extreme heat, desert environments, and high-albedo surfaces. The product has successfully passed more stringent testing per IEC standards, guaranteeing over 25 years of reliable performance for solar power plants. This solution delivers an optimized LCOE and superior long-term returns, making it an outstanding choice for sustainable energy investments.

This white paper is **TÜV NORD**-certified, fully demonstrating JA Solar's global leadership in extreme-environment PV technologies. In the future, JA Solar will continue to collaborate with partners to drive i7 i7a97nutie sanp(on)TJ07.04 Tcplic (l)0.5 l

DUST OFF. POWER ON.