

TÜV NORD Authoritative Validation: JinkoSolar's Tiger Neo 3.0 Modules Lead the Industry in Shading Performance

During the actual operation of solar power plants, localized shading caused by bird droppings, leaves, dust accumulation, and building shadows is inevitable. The resulting power generation losses and hot-spot risks are increasingly becoming significant factors affecting the long-term profitability of power plants.

In March 2026, JinkoSolar commissioned TÜV NORD, a globally recognized certification body, to conduct comparative testing of three PV modules across five typical shading scenarios. Test data shows that under light to moderate shading conditions, the power degradation of the Tiger Neo 3.0 modules was significantly lower than that of the comparison modules, with power generation losses reduced by nearly 50% in some scenarios. This further validates the reliability advantages of N-type TOPCon modules in real-world application environments.

Authoritative Third-Party Testing: Comprehensive Coverage of Five Shading Scenarios

This test was conducted in accordance with the IEC 61215-2:2021 MQT 06.1 standard. The testing covered five typical scenarios: single-point shading, half-panel shading, progressive shading, multi-string shading, and short-side shading, focusing on simulating the complex operating environments commonly found in distributed rooftop, commercial and industrial, and ground-mounted power plants. Testing was performed under STC standard conditions (1000 W/m² irradiance, AM1.5 spectrum, 25°C cell temperature) using an A+A+A+ class pulsed solar simulator.

Test module information:

Sample	Module type	Pmax[W]
Sample 1	BC	650+W
Sample 2	Normal TOPCon	630+W
Sample 3	Tiger Neo 3.0	650+W

Key Test Data: Tiger Neo Leads the Industry in Shading Resistance

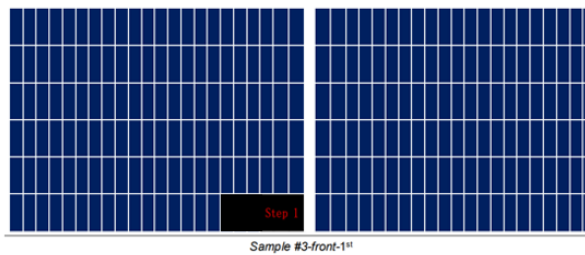
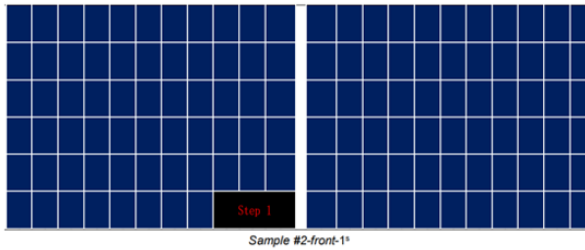
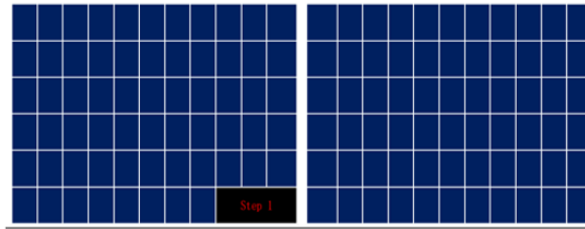
Method 1: Single-Point Shading Tests at Different Locations

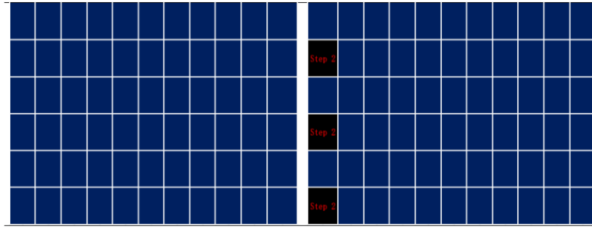
To address common issues at power plants, such as bird droppings and fallen leaves causing localized single-point shading, the tests simulated shading conditions at various locations on the modules to comprehensively verify the impact of shading points on power generation. Overall test results show that while performance differences among the three modules are minimal under edge-area shading, significant performance gaps emerge in core central shading scenarios, with Tiger Neo 3.0 demonstrating an overwhelming advantage.

Shading Position	BC Module(PL)	Normal TOPCon(PL)	Tiger Neo 3.0(PL)
Position 1	-34.14%	-34.42%	-17.50%
Position 2	-47.27%	-48.63%	-24.32%
Position 3	-45.28%	-46.30%	-43.69%

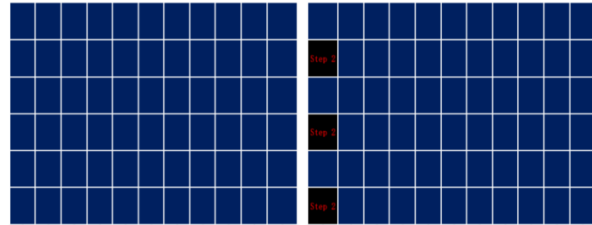
(PL-Power Loss)

Data shows that at the core shading location of the module, both BC modules and conventional half-cut modules experience power degradation exceeding 34%, resulting in significant power generation losses. In contrast, the Tiger Neo 3.0 exhibits a degradation rate of only 17.50%—a 49.3% reduction compared to the two benchmark products. This enables it to effectively mitigate substantial power generation losses caused by localized shading from foreign objects, making it ideally suited for the complex operating conditions typically encountered in residential rooftops and commercial and industrial power plants.

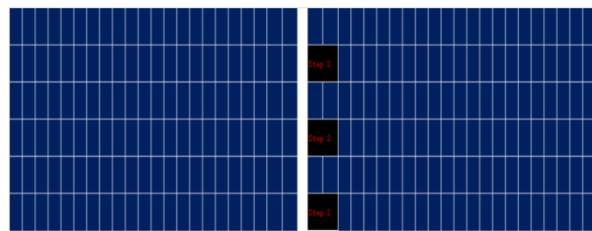




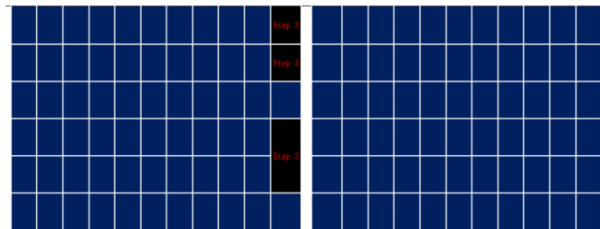
Sample #1-front-2nd



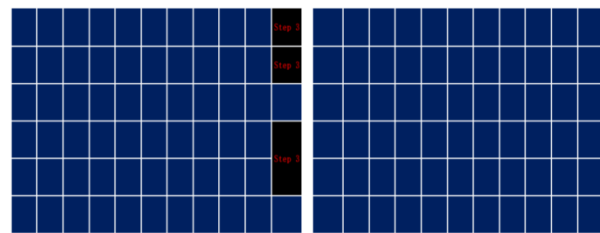
Sample #2-front-2nd



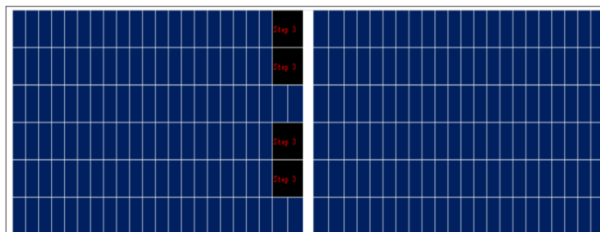
Sample #3-front-2nd



Sample #1-front-3rd



Sample #2-front-3rd



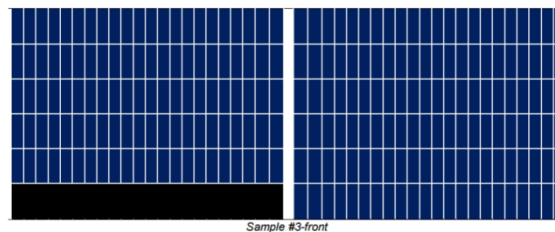
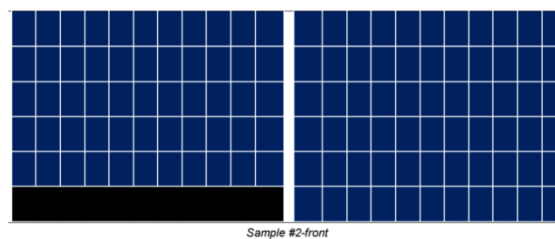
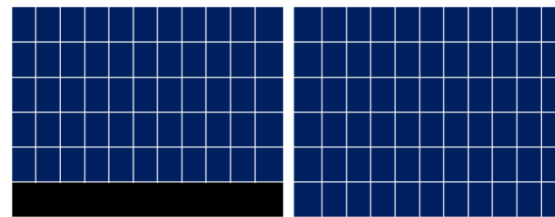
Sample #3-front-3rd

Method 2: Single-cell String Half-Area Shading Test

Single cell string half-area shading caused by building parapets and shadows from surrounding buildings is the most common shading scenario in distributed PV applications, directly affecting the stability of a power plant's daily power generation revenue. This specialized test accurately replicates this scenario to provide a direct comparison of the three module models' resistance to shading-induced power loss.

Module type	Power Loss
BC	-34.2%
Normal TOPCon	-34.4%
Tiger Neo 3.0	-17.5%

The test data clearly demonstrates the products' differentiated advantages: under these conditions, both BC modules and conventional half-cell modules experienced power degradation exceeding 34%, resulting in nearly a 50% reduction in power output. In contrast, the Tiger Neo 3.0 experienced a power decay rate of only 17.5%, representing a 48.8% reduction compared to the BC module. This helps power plants recover 16.7% of lost power generation, addressing the industry-wide challenge of shading losses in distributed rooftop systems at its root and significantly boosting daily power generation revenue.

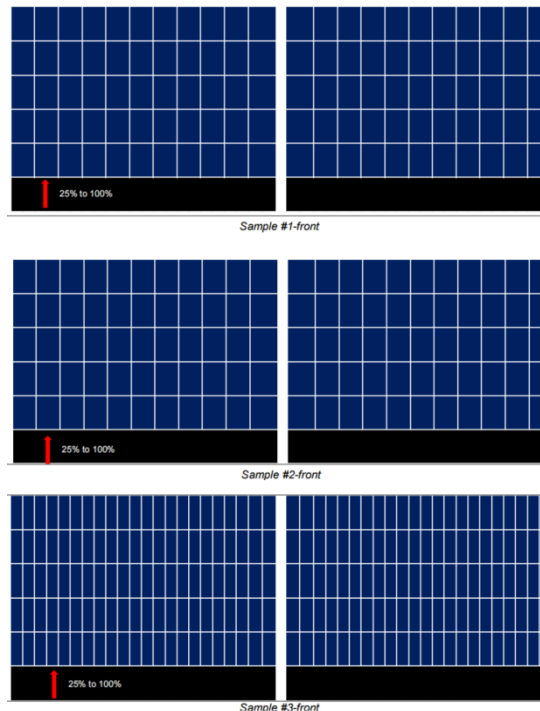


Method 3: 25% Incremental Gradual Shading Test

During long-term operation, photovoltaic modules are constantly exposed to issues such as dust accumulation and the spread of vegetation. As a result, the area of shading gradually expands, leading to progressive power loss—a key factor affecting the plant's lifetime revenue. This test employs a shading gradient ranging from 25% to 100% to fully replicate the real-world conditions of long-term, gradual shading on modules.

Shading Ratio	BC type(PL)	Normal TOPCon(PL)	Tiger Neo 3.0(PL)
25%	-13.8%	-15.2%	-7.2%
50%	-34.2%	-34.4%	-17.7%
75%	-34.3%	-34.5%	-30.1%
100%	-34.3%	-34.5%	-34.6%

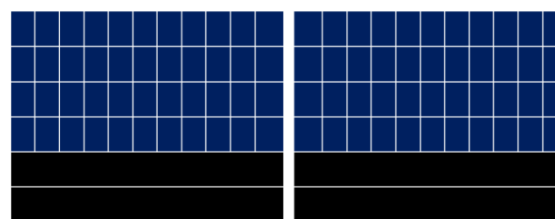
Test results show that within the 25%–75% range of light to moderate gradual shading—which accounts for the largest proportion of conditions at power plants—the Tiger Neo 3.0 consistently outperforms the two comparison products in terms of power generation stability. Specifically, in scenarios with 25% light dust accumulation and sporadic vegetation shading, the module degradation rate is only 7.2%, less than 60% of the loss experienced by BC modules, effectively mitigating the power generation decline caused by long-term dust accumulation. Even under moderate shading conditions of 50% and 75%, it maintains a significant lead in resistance to performance degradation, providing a solid guarantee for stable returns throughout the power plant's entire lifecycle.



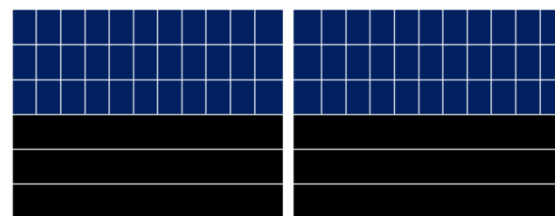
Method 4: Long-Side Shading Tests for Two-String and Three-String Configurations

To address extreme conditions commonly encountered in ground-mounted and commercial/industrial solar power plants—such as shading caused by ventilation equipment, billboards, and large structures—this test established scenarios involving extensive long-side shading of two-string and three-string configurations to verify the modules' maximum power generation capacity under severe shading conditions. Test data shows that under double-string long-side shading conditions, power generation losses for the three modules were essentially on par, with no significant differences; however, in the triple-string scenario involving extensive shading covering 75% of the module's surface area, significant performance gaps emerged.

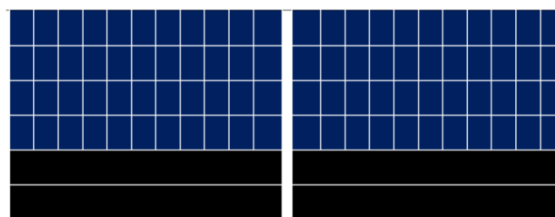
Data indicates that the BC module experienced a power degradation of -68.4%, while the conventional half-cell module degraded by -68.7%. While the Tiger Neo 3.0 recorded a degradation rate of -63.5%. Compared to the BC module, this represents a 4.9 percentage point reduction in power loss, allowing it to recover an additional 15.5% of remaining power generation capacity under extreme conditions of extensive shading. This fully demonstrates the product's exceptional adaptability in complex and extreme scenarios, enabling it to minimize revenue losses caused by severe shading.



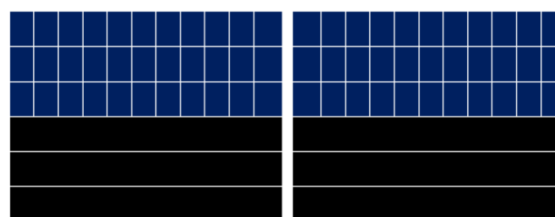
Sample #1-front-2 string



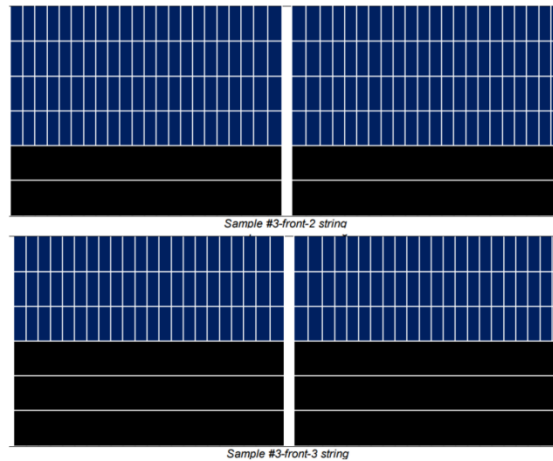
Sample #1-front-3 string



Sample #2-front-2 string



Sample #2-front-3 string

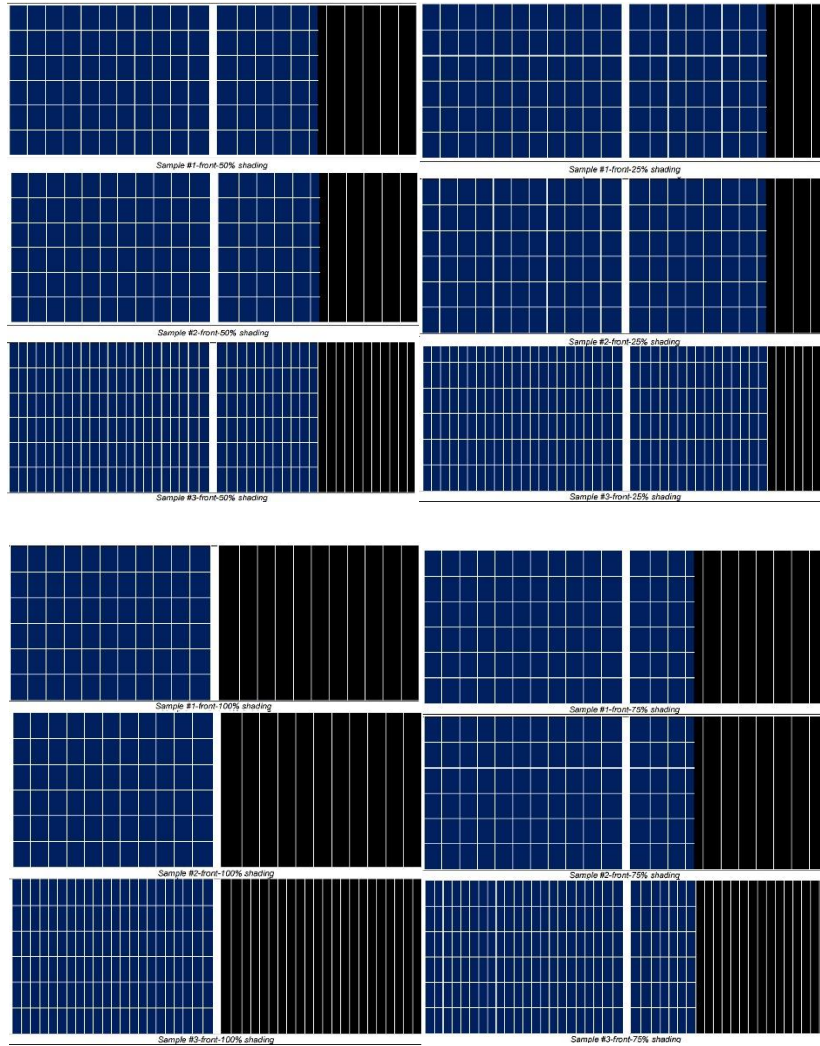


Method 5: Gradual Shading Test on the Short Side

To comprehensively cover all operating conditions, this test simultaneously simulated shading scenarios extending from the short side of the modules, such as ground reflections, snow accumulation at the base, and low vegetation. Through gradient shading tests, the performance of the three modules under these specific shading conditions was evaluated. This type of shading can easily cause overall mismatch within the solar cell strings and represents a physical performance limitation that is difficult to avoid in photovoltaic modules.

Shading Ratio	BC type(PL)	Normal TOPCon(PL)	Tiger Neo 3.0(PL)
25%	-50.2%	-50.1%	-50.1%
50%	-49.9%	-50.1%	-50.1%
75%	-49.8%	-49.9%	-49.8%
100% (half module)	-49.1%	-49.4%	-49.4%

Based on the test results, due to physical structural limitations, the three modules performed similarly under short-side shading conditions, with power degradation remaining largely consistent. Even under such conditions where there is no room for technical optimization, the Tiger Neo 3.0 continues to perform consistently, achieving comparable or slightly superior performance in scenarios with 25% and 50% moderate short-side shading. This demonstrates that the product has no performance weaknesses across all scenarios, fully highlighting its stability and reliability.



Comprehensive Comparison: Tiger Neo 3.0 Shading Performance Advantage Matrix

A synthesis of data from five specialized tests clearly demonstrates that the performance advantages of Tiger Neo 3.0 are highly aligned with the actual operational scenarios of solar power plants. It achieves significant reductions in power loss across various shading conditions commonly encountered in the industry, with the magnitude of these advantages closely matching real-world applications, highlighting its outstanding commercial value.

Test Scenario	Advantage of Tiger Neo 3.0	Application
Single-point shading	49.3% less power loss	bird droppings, fallen leaves
Single-string half area shading	48.8% less power loss	Parapet wall, neighboring building shadows
25% first row shading	47.8% less power loss	dust accumulation, sporadic vegetation
50% first row shading	48.2% less power loss	Moderate dust accumulation, partial shadows
Three-string long-side shading	7.2% less power loss	Large obstacle shading

Based on comprehensive real-world test data and categorized by shading coverage and performance degradation, the shading tolerance of the three modules forms a clear hierarchy that fully aligns with the actual operating conditions of solar power plants. Under mild and moderate shading conditions—which account for over 90% of the industry—the Tiger Neo 3.0 demonstrates a systematic performance advantage, significantly outperforming BC modules and conventional half-cell modules; Only under extreme conditions with shading coverage exceeding 75%, due to the limitations of physical shading laws, do the performance levels of the three modules converge, with no significant differences.

The overall performance ranking is clear: under light shading conditions (<50% coverage), the Tiger Neo 3.0 delivers the best performance; under moderate shading (50%–75% coverage), the Tiger Neo 3.0 continues to lead; and under severe shading (>75% coverage), the performance of the three modules converges. This means that in the vast majority of scenarios during a power plant's daily operations, the Tiger Neo 3.0 can consistently generate excess power revenue, effectively addressing the industry's core efficiency challenges.

Technical Analysis: Why Tiger Neo Performs Better in Shaded Conditions

Tiger Neo 3.0 delivers comprehensive, systematic advantages in shading resistance, stemming primarily from the underlying architectural strengths of N-type TOPCon technology. The product integrates multiple cutting-edge innovations, including multi-busbar design, HCP high-efficiency cell passivation, MAX metallization optimization, and an FP-optimized layout. By addressing industry challenges—such as power loss due to shading, high-temperature degradation, and long-term efficiency decline—at the design stage, it achieves core performance metrics that comprehensively outperform mainstream industry products.

In terms of core performance metrics, Tiger Neo 3.0 features an ultra-high bifaciality of $85\% \pm 5\%$, which is 10–15 percentage points higher than mainstream BC modules, enabling an additional 3%–5% power gain from the rear side in environments with good ground reflectivity; an excellent temperature coefficient of $-0.26\%/^{\circ}\text{C}$, effectively reducing power loss under high-temperature shading conditions; it also features ultra-low degradation characteristics with first-year degradation $\leq 1\%$ and an annual linear degradation rate of just 0.35%, ensuring stable and efficient power generation throughout the module's 30-year lifecycle while balancing short-term

shading resistance with long-term power stability.

Hot-spot effects and reverse current losses are the primary causes of significant power degradation following shading, and have long been a technical bottleneck in the industry. Leveraging N-type TOPCon core technology, Tiger Neo 3.0 employs multiple technical optimizations to suppress shading losses at their source, mitigate hot-spot risks, and establish a comprehensive shading-resistant power gain system.

By optimizing the parallel resistance structure of the cells, the product significantly reduces leakage pathways, effectively mitigating the impact of reverse current generated by shaded cells on the entire module. It also enhances the performance of the cell passivation layer to reduce carrier recombination losses, maximizing power generation efficiency in unshaded areas and achieving "minimal interference in shaded areas and high efficiency in unshaded areas." It features a refined multi-segment cell design with 264 cells (66 cells × 4), which refines current collection paths and structurally reduces the drag of local shading on overall power output. Combined with a double-glass structure and the superior thermal management characteristics of N-type cells, it optimizes rear-side heat dissipation, effectively suppressing temperature rises caused by shading and preventing overheating-induced power loss and accelerated aging. The synergy of these multiple technologies delivers the product's exceptional shading resistance.

Supported by Global Field Data: Validation Across Multiple Climate Zones

In addition to authoritative test data from TÜV NORD laboratories, JinkoSolar's Tiger Neo series modules have been deployed in large-scale projects across multiple typical climate zones worldwide. Through diverse real-world operating conditions, the products' high power generation efficiency and stable durability have been continuously validated, achieving a high degree of consistency between laboratory data and real-world performance.

At the TÜV NORD field testing site in Kagoshima, Japan, real-world monitoring data from September to December 2025 shows that under standard conditions—unobstructed with 30% ground reflectance—TOPCon modules demonstrated a significant power generation advantage over BC modules, with a power gain per watt as high as 2.51%. This fully validates the core value of ultra-high bifaciality in rear-side power generation. Additionally, in low-light conditions with irradiance below 200 W/m², TOPCon modules achieved a 12.69% power gain per watt compared to N-type BC modules, fully validating the superior low-light power generation performance of TOPCon modules.

Data Source Notes: - All shading test data in this article is cited from TÜV NORD Test Report No. TRPVP03191/26P/01 - Product parameters are cited from JinkoSolar's official product specifications - Empirical data is cited from JinkoSolar's official white papers and publicly available project data - Technical specifications have been certified by third-party institutions such as TÜV NORD and the China Certification & Inspection Group (CCIC)