

PV Module Testing and Certification.

Access world markets.
With TÜV Rheinland.



www.tuv.com/solar

 **TÜVRheinland**[®]
Precisely Right.



The supreme quality of your PV modules. We support you.

At the core of all photovoltaic (PV) systems are PV modules. Their quality and reliability are ultimately one of the key factors in the smooth and efficient operation of a PV power station during its 25-year life cycle. PV modules become key investment factors for governments, investors, and buyers worldwide.

Since its invention in 1839, PV power generation technology has undergone tremendous transformations as a result of concerted efforts by professionals worldwide, particularly in increasing efficiency and adapting the PV technology to the various areas of application. New installation markets emerge, while pressure to further reduce module prices has intensified. Challenges for the products arise and the need to accurately predict and assess performance, reliability and durability has increased. TÜV Rheinland provides up-to-date solutions to improve the safety, reliability and quality of PV modules. As the independent third party, we are well trusted by investors, owners and lenders.

We have been pioneering in the PV industry for more than 35 years, making us an undisputed authority in PV testing and certification. We provide tailor-made solutions to PV manufacturers around the world, backed by our global network. Through our world-class capabilities, we have gained a solid reputation worldwide with recognition and trust also from both overseas and domestic investors, lenders and authorities.

TÜV RHEINLAND IS YOUR RELIABLE PARTNER



INCREASE YOUR COMPETITIVENESS

We underpin your performance claim with trusted precision data and certification. We ensure that your products meet the stringent safety and performance requirements of international standards, demonstrating your commitment to quality.



TAKE ADVANTAGE OF SUBSIDY PROGRAMMES

We are accredited and listed by numerous international energy institutions including California CEC, Australia CEC, UK MCS, China Golden Sun, Middle East, Brazile INMETRO, China CQC and the like. We provide access to the large PV installation markets and niche markets alike. We help you meet local regulatory requirements and unlock incentive schemes.



MARKET LEADER

TÜV Rheinland has been actively promoting the development of photovoltaics for over 35 years. Today, we are a global market leader in PV power plant assessments and the testing of components, modules, inverters and energy storage systems.



R&D EDGE

The unique R&D competency of TÜV Rheinland is unrivaled among peers. Our PV experts actively contribute in standardization development and international peer-review conferences that define innovation directions. We aim to fill gaps in knowledge for measuring and testing of new or innovative PV technologies and applications.

Safety, reliability and performance: we make our know-how accessible to you.

Our experts test and certify PV modules based on standards including IEC 61215 series, IEC 61730-1, -2 series, UL 61730 and CAN/CSA 61730-1/-2. Our unique, customised solutions, such as our energy yield testing service, help manufacturers gain differentiated competitiveness. Globally accepted by buyers and investors, TÜV Rheinland's test mark, certificates and bankability reports are the proof of your products' trusted quality and performance, thus enabling you to gain worldwide market access.

CERTIFICATION OF PV MODULES

Certification according to the latest international standards.

PERFORMANCE CHARACTERISATION OF PV MODULES

Simulation of all performance measurements and electric characterisation.

QUALITY ASSURANCE MEASURES FOR PV MODULES

On-going production audits ensuring consistent quality.

INTERNATIONAL MARKET ACCESS

In-depth knowledge of local markets worldwide.

STRESS TESTS

The performance of PV modules faced with severe climate conditions.

DISTINCTIVE SERVICES

Customized services responding to new technologies and legal requirements.



ADDED VALUE

Unique programmes to earn advantages.

PERFORMANCE AND ANALYTICS

Diversified analytical services for innovative technologies.

BIPV - QUALIFICATION OF BUILDING-INTEGRATED PV

Evaluation of safety and reliability of BIPV modules and solar-thermal collectors.

CERTIFICATION OF PV MODULES

Proof of certification for the PV module manufacturers, retailers and EPCs is one of the most important prerequisites for a successful market development. The certification services of TÜV Rheinland consist of the following process steps:

- Laboratory tests on samples for a module family or type
- Recurring factory inspection
- Certificate and TÜV Rheinland test mark
- Certificate of conformity (CoC) or declarations for individual markets
- Bankability reports
- Multivariant precision measurement reports
- Custom performance, reliability and durability reports



QUALITY ASSURANCE MEASURES FOR PV MODULES

Quality monitoring and quality assurance are crucial in the production of PV modules – particularly as manufacturers must grant long warranty periods to remain competitive. TÜV Rheinland offers measures in parallel with development, in addition to spot-checking or regular auditing of on-going production. The following quality assurance tests offer support to manufacturers, retailers and investors, which is required for continuous quality.

- PID analysis and certification for c-Si and TF
- Electro-luminescence imaging
- Infrared imaging
- Determination of the cross-linking level of EVA
- Peel test
- RoHS conformity testing
- Identification of products and components
- Pre-/Post-shipment inspections
- Ageing of micro-cracks
- LID test (light induced degradation)
- LeTID test (Light and Elevated Temperature Induced Degradation)

STRESS TESTS

The tests according to the international and regional standards on design and safety certification include mechanical and climatic stress tests for the accelerated ageing of PV modules. These tests are intended to ensure that even after many years of operation under different weather conditions the PV modules will continue to perform reliably and safely. Depending on the installation locations, additional test conditions will be applied to ensure that the modules can also withstand severe climate conditions. In addition to the standard tests, TÜV Rheinland offers numerous other possibilities in the form of individual tests incorporating particular stress factors.

- Fire tests
- Corrosion tests (e.g., salt mist, ammonia and sulphur dioxide)
- Mechanical stress tests
- Combined sequences of environmental tests
- Outdoor long-term tests in different climate zones
- Transport and environmental simulation on PV module shipping units
- Sand abrasion tests
- Specific climate simulation (hot/dry; tropical)
- Snow load testing (non-uniform, heavy snow load)



BIPV - QUALIFICATION OF BUILDING-INTEGRATED PV

Building-integrated photovoltaics (BIPV) for solar energy applications has increased in importance. The system requirements for construction and electrical products are governed by national and international directives and standards. An identical measure of reliability and safety must be provided by BIPV modules and solar-thermal collectors. TÜV Rheinland will help you find the right measure of safety and reliability for these products and document these qualities for your customers. We provide approval-relevant testing for the following applications and functions:

- Risk analysis
- Roof integration
- Facade integrated systems
- Hail testing
- Overhead glazing
- Snow load testing
- Reflection analysis
- Many more

ADDED VALUE

Want to stand out from the tough competition? TÜV Rheinland can help you by offering unique programmes corresponding to specific markets, enabling you gain the trust of buyers and investors. In addition, the comprehensive training and education programmes offered worldwide provide you with first-hand information, with reference to standard updates and interpretation, helping you to rapidly adjust to the market.

- Quality benchmark
- Qualification Plus ("Q+") certification
- Energy yield testing under actual climate conditions in relevant target markets
- Training and education on standard interpretation



PERFORMANCE CHARACTERISATION OF PV MODULES

Precise and dependable performance information is key in differentiating a PV module manufacturer’s products in a heavily contested global market with constantly increasing requirements. Valid data gives investors and end consumers security and peace of mind in terms of yields and their return on investment.

TÜV Rheinland maintains state-of-the-art accredited test laboratories with the latest, comprehensive high-tech measuring equipment. We employ qualified class-AAA solar simulators with minimum measuring uncertainty. All performance measurements and electrical characterisations are conducted according to the most recent relevant international and national standards. Our intensive research means that you can rely on our measuring procedures and results.

- Solar simulator certification
- Measurement uncertainty analysis
- Comparison of large sample measurements against contractual guaranteed performance
- TÜV Rheinland Datapack generation
- Measurement of high-capacitance cells and thin-film technologies
- Spectral response measurements
- Calibration of reference modules

INTERNATIONAL MARKET ACCESS

China, the US, Japan and India will dominate the global PV installation also in the next years, while Germany and other European countries remain the key markets. In parallel the demand from Mexico, Australia, Brazil and the Middle East is also increasing. You can confidently depend on our global PV service team to enhance your global market access strategy with our accreditations and acceptance from local authorities, and extensive knowledge of international markets. Below is only an excerpt of the hot markets.

- | | | |
|--|---|--|
| <ul style="list-style-type: none"> ▪ Europe - Germany - UK - France - Spain - Italy | <ul style="list-style-type: none"> ▪ Asia - China - Japan - India - Korea - Thailand | <ul style="list-style-type: none"> ▪ South America - Brazil - Chile - Colombia - Argentina |
| <ul style="list-style-type: none"> ▪ META - Middle East - Turkey - Africa | <ul style="list-style-type: none"> ▪ North America - USA - Canada - Mexico | <ul style="list-style-type: none"> ▪ Oceania - Australia |

DISTINCTIVE SERVICES

New requirements, standards and innovative technologies emerge along with the industry development. TÜV Rheinland is always the pioneer to respond. Take advantage of our experience and scientific acumen to place you ahead of the competition.

- EN/IEC 61215 series
- UL/EN IEC 61730-1, -2 series
- IEC TS 62941 certification as the approval of increased confidence in PV module design and type approval
- IEC 61853-1 GTE testing and IEC 61853-2 AOI test
- Measurement and test for bifacial modules
- Energy yield simulation and real outdoor energy yield measurement
- 2PfG certificate
- IS 14286 for c-Si, IS 16077 for TF, IS/IEC 61730-1, -2. (BIS-Bureau of Indian Standards)

PERFORMANCE AND ANALYTICS

From broad solar expertise in PV modules, our analytical competencies matter when new technologies emerge, new applications arise or performance qualities are in the scope of evaluations and beyond approval testing.

- TÜV Rheinland takes the leading position in:
- Energy yield benchmarks and analytics
- Determination of influential factors for module performances
- Root-cause analysis for module failure modes
- Development of test methods
- Applied R&D activities on module level





Make a difference: Brand your products with Certipedia.

In addition to the TÜV Rheinland quality mark, the world's most recognised and trusted quality mark for PV modules, we also offer Certipedia (www.certipedia.com), a corresponding online platform serving as a brand protection mechanism by guaranteeing the authenticity of your products. Each product that passes the strict safety and quality requirements and periodic inspections of TÜV Rheinland is awarded a unique ID, thus allowing your partners and customers to search for neutral information about your PV products, to readily determine their compliance with various standards and their receipt of add-on qualifications such as power controlled, heavy snow-load tested, etc. The Certipedia platform helps users verify the origins and validity of your products, which removes the threat of counterfeit goods being sold under your brand name and reassures professional buyers and investors of the authenticity of PV products.



Moreover, our optimally organized system for issuing test marks gives you full access to your own test mark through online download, including a quick overview of all color variants and functions.

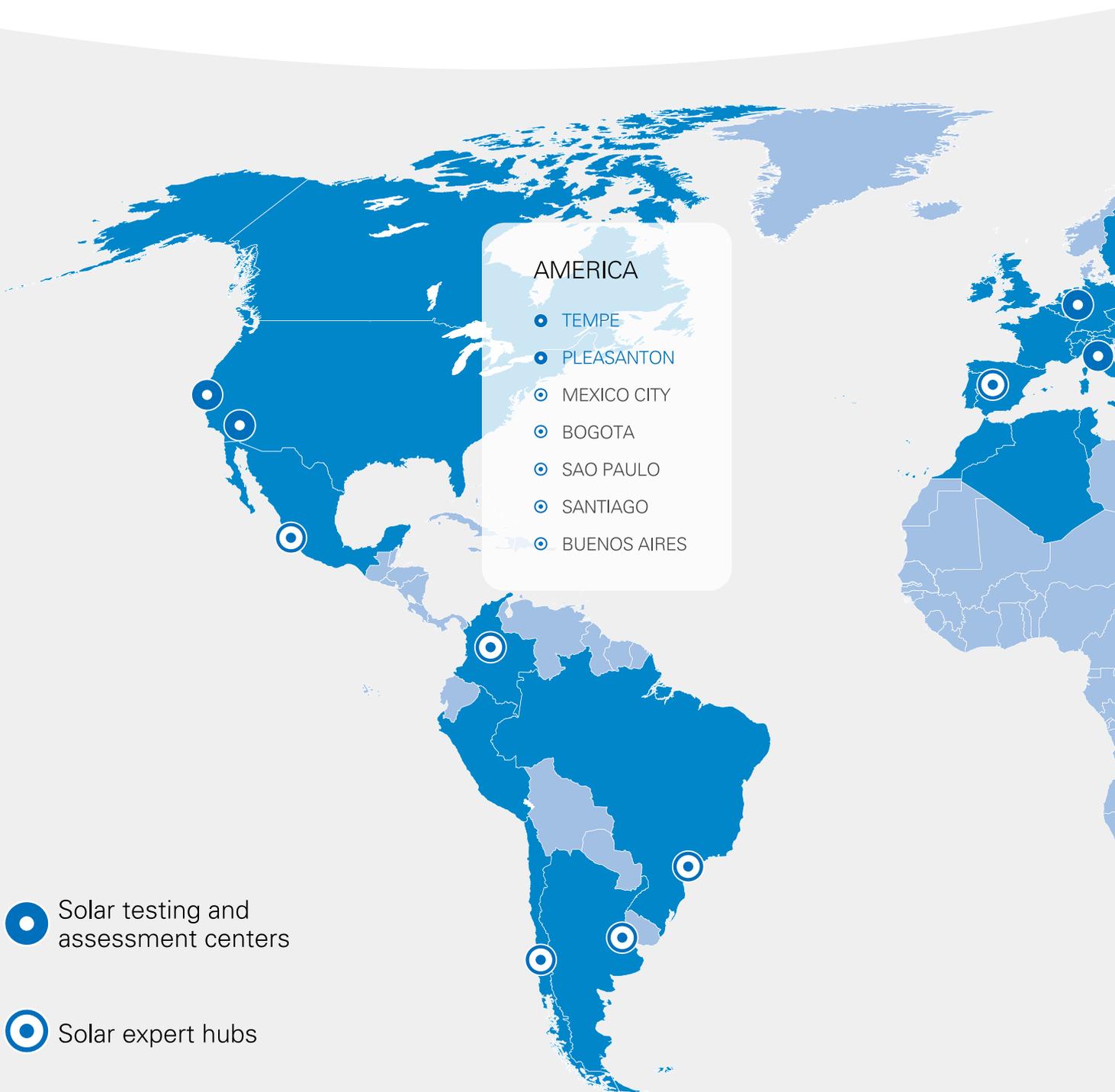
YOUR COMPETITIVE EDGE THROUGH GREATER TRANSPARENCY

We not only developed an innovative test mark, but we also have been providing a consumer-friendly reference source for the publication of test content for many years now – our certificate database Certipedia, which can be accessed at any time, anywhere in the world – combined with an individual ID number on your test mark.

That pays dividends for you. Because with us you're in a good position when it comes to transparency. Through individual test mark IDs, you make the assessment of test results clearer for consumers.

Global network, local services.

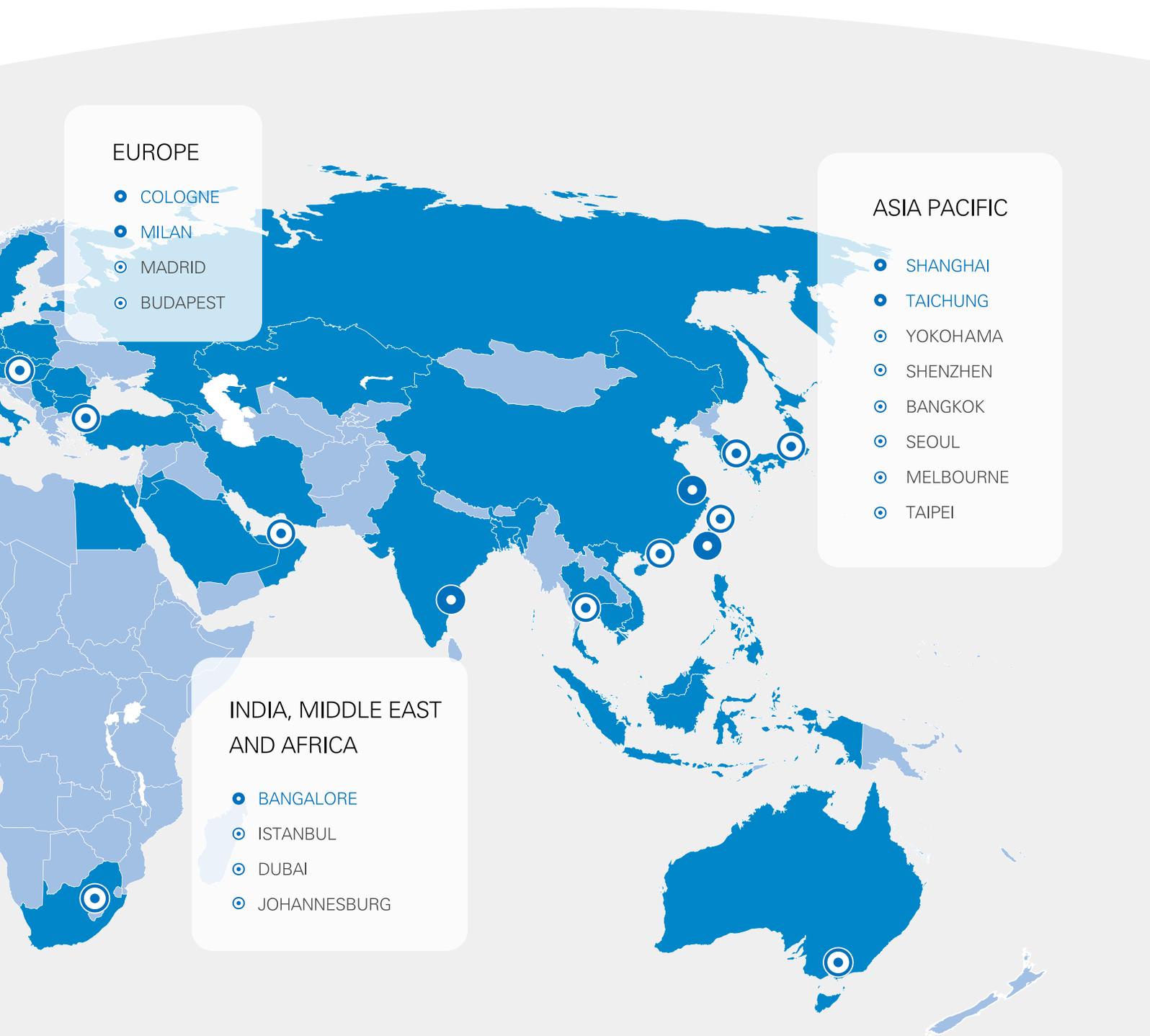
Our testing centres with multiple accreditations in Germany, Italy, China, India and the US consist of state-of-the-art equipment and sophisticated engineering teams. Additionally, a number of outdoor measurement sites under various conditions, including dry & hot, tropical and moderate climates, ensure a wide range of assessments on the performance of PV modules. As the premier third party certification institution for the PV industry, over 250 experts of TÜV Rheinland worldwide can rapidly respond to the local needs of manufacturers, retailers and investors, offering value beyond expectations. The combination of different competences makes us a trustworthy partner, able to advise you and play an active role in helping you achieve success in a wide range of global markets.



250+ experts **35+** years of experience

500 locations

No.1 in PV products testing and certification



EUROPE

- COLOGNE
- MILAN
- MADRID
- BUDAPEST

ASIA PACIFIC

- SHANGHAI
- TAICHUNG
- YOKOHAMA
- SHENZHEN
- BANGKOK
- SEOUL
- MELBOURNE
- TAIPEI

INDIA, MIDDLE EAST
AND AFRICA

- BANGALORE
- ISTANBUL
- DUBAI
- JOHANNESBURG

TÜV Rheinland AG
Am Grauen Stein
51105 Cologne,
Germany
Phone +49 221 806-0
info@tuv.com

www.tuv.com/solar



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