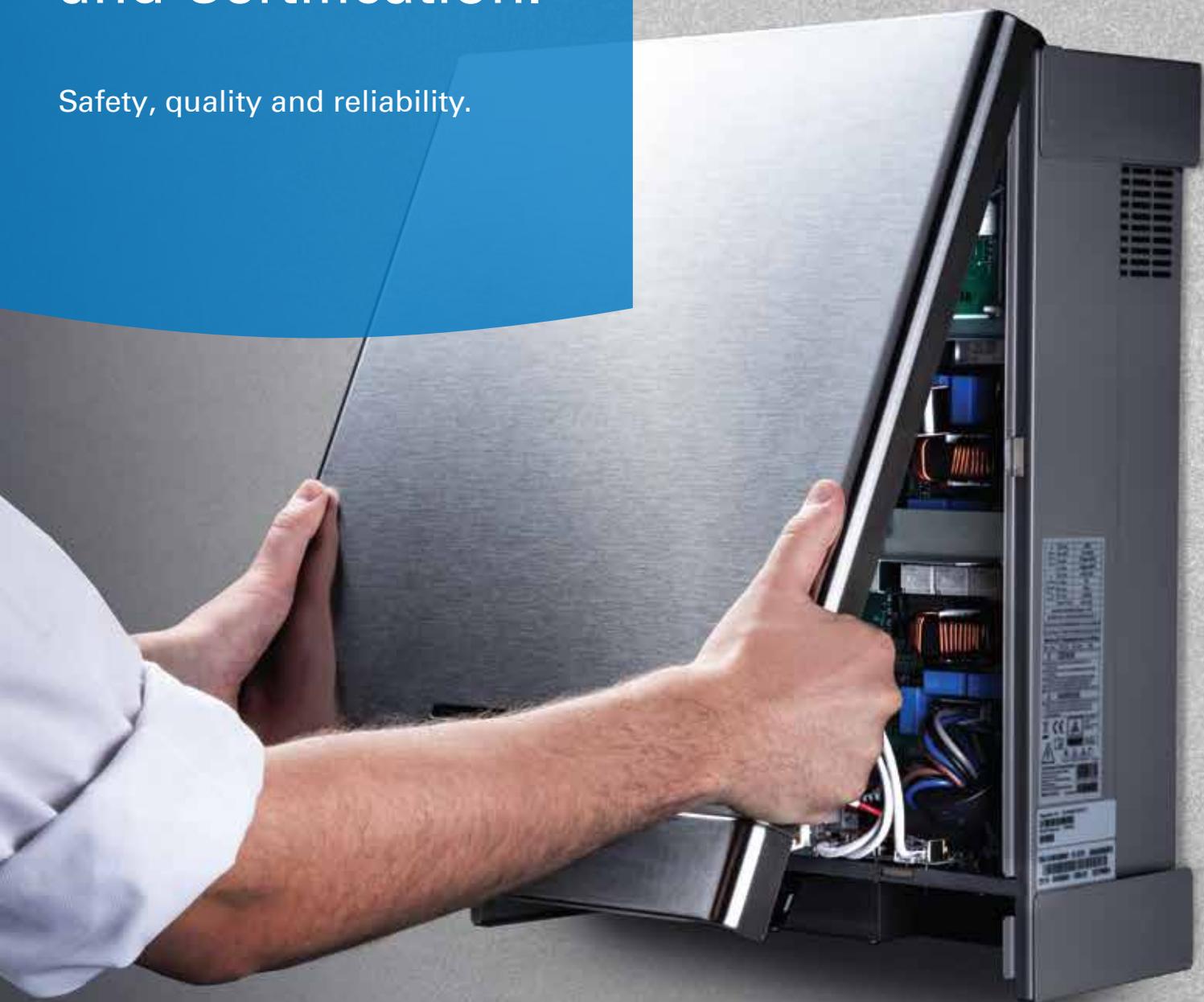
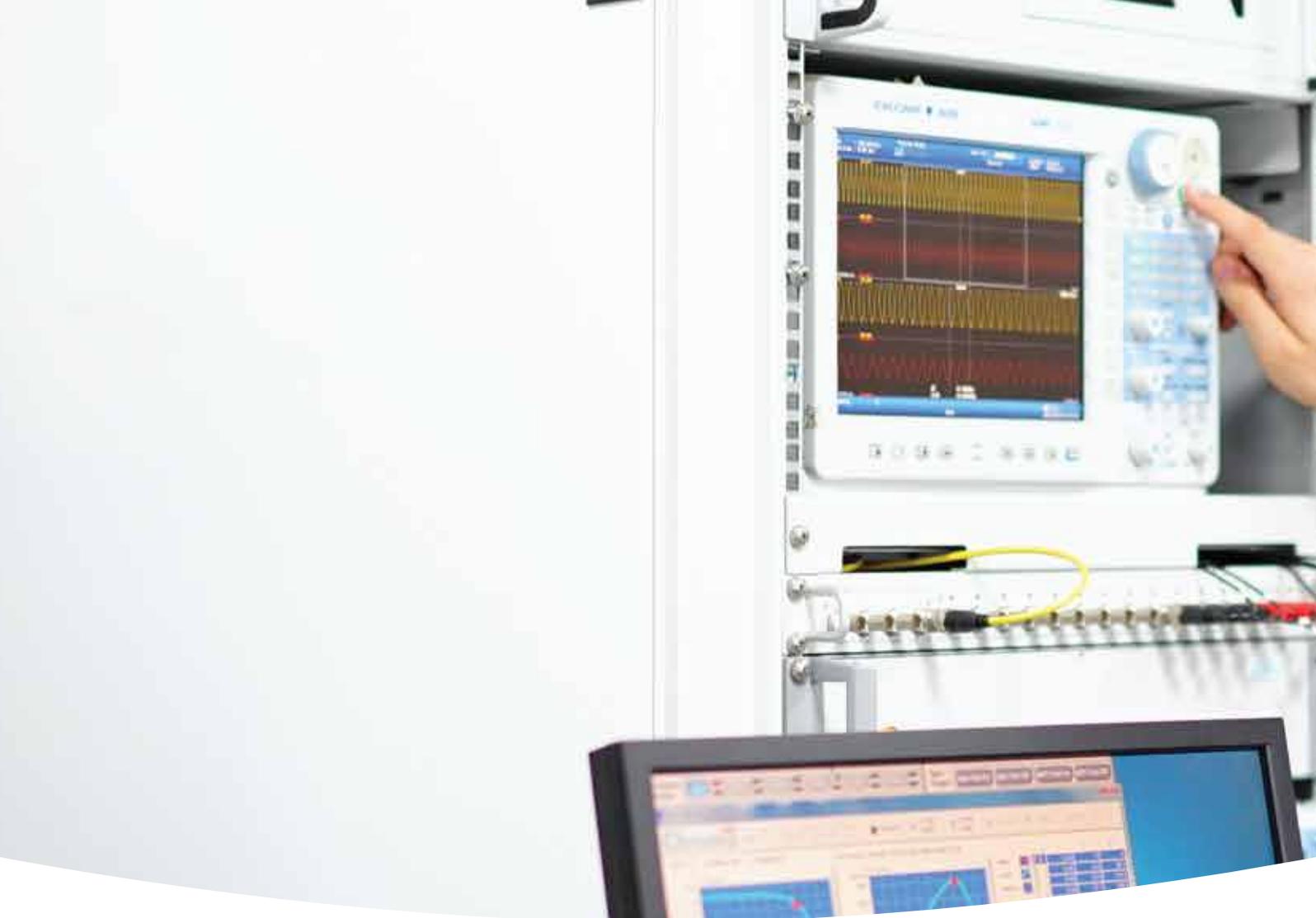


# PV Inverter Testing and Certification.

Safety, quality and reliability.





## As vital components of PV systems, PV inverters must be safe and reliable.

PV inverters are critical components of PV power systems, and play a key role in ensuring the longevity and stability of such systems. The relevant standards ensure that your inverters perform safely, efficiently and with wide applicability. TÜV Rheinland's one-stop testing and certification services will improve the quality of your PV inverters and help you to access global markets.

### **TÜV RHEINLAND IS YOUR RELIABLE PARTNER**

TÜV Rheinland is a world-recognised leader in the provision of testing and certification services for PV products. We boast over 35 years of experience and a unique global network backed by more than 250 PV experts, enabling us to provide professional services worldwide.

Not only is TÜV Rheinland accredited by CBTL, CNAS, NRTL, DAkkS, TAF, CGC and more, but we provide first-class solar energy assessment with the strongest testing capabilities and greatest capacity in mainland China, Taiwan, Germany, the US, Japan, Italy and India. Locally, our advanced automatic equipment ensures that testing is fast, efficient and professional.



**OUR COMPLETE SERVICE PORTFOLIO MEETS YOUR REQUIREMENTS FOR SAFETY,  
HIGH PERFORMANCE AND RELIABILITY**

|  |   |  |
|--|---|--|
|  <b>Worldwide market access</b> | <ul style="list-style-type: none"><li>• Safety / Functional safety</li><li>• Grid codes</li></ul>                                       | <ul style="list-style-type: none"><li>• Wireless</li><li>• EMC</li></ul>                 |
|  <b>Performance</b>             | <ul style="list-style-type: none"><li>• Power quality testing</li><li>• Efficiency testing</li></ul>                                    | <ul style="list-style-type: none"><li>• Environment testing</li></ul>                    |
|  <b>Value added</b>             | <ul style="list-style-type: none"><li>• Benchmark testing</li><li>• Reliability testing</li></ul>                                       | <ul style="list-style-type: none"><li>• Quality mark</li><li>• Cybersecurity</li></ul>   |
|  <b>Supply chain</b>            | <ul style="list-style-type: none"><li>• OEM assessment</li><li>• Factory acceptance testing</li><li>• Site acceptance testing</li></ul> | <ul style="list-style-type: none"><li>• OND files</li><li>• Laboratory testing</li></ul> |

# Worldwide market access

To guarantee the safety, efficiency, reliability and wide applicability, PV inverters should conform to relevant international and regional requirements. We have the most comprehensive testing and certification services that help to ensure the quality of your PV inverters and thus assist you to become a global player in diversified markets.



## GRID CODES

Compliance with global grid codes is one of the most efficient ways of ensuring the safety, stability and reliability of a power supply. TÜV Rheinland has in-depth knowledge and experience of global grid code connection, offering one-stop service and helping you to overcome challenges in this area.

- IEC 61727
- EN 50438
- IEEE 1547.1
- UL 1741 including SA
- VDE 0126-1-1
- VDE-AR-N4105
- BDEW TG3/TG4/TG8
- VDE AR-N 4110
- VDE AR-N 4120
- CEI 0-16 / CEI 0-21
- G83/G59
- AS 4777.2
- GB/T 29319
- GB/T 19964, etc.

## SAFETY / FUNCTIONAL SAFETY

Our electrical safety labs are accredited by global organisations such as CNAS, CBTL, DAkkS, TAF, NRTL and CGC/CQC. We offer testings to ensure that products meet market requirements based on various standards, such as IEC/EN/UL 62109-1/-2, UL 1741, C22.2 No. 107.1, NB/T 32004, IEC 61508, IEC 60730 Annex H, etc.

## WIRELESS

Wireless products are required to conform to national and international standards before they go to market. We provide a range of wireless testing and certification services accredited in Europe, the US, Brazil and Japan to help our clients to meet these standards.

## EMC

Electrical products must comply with EMC directives before entering the market. TÜV Rheinland is a Notified Body under the EU's EMC Directive and an FCC-accredited audit institute. Its efficient and high-quality testing services will help you to rapidly reach your target markets.

# Performance

PV inverters play a critical role in ensuring the longevity and stability of PV power systems. To maximise the power generation of PV systems, high-quality PV inverters must be selected to provide the maximum power output.



## EFFICIENCY TESTING

Efficiency is the core index of the performance of a PV inverter; it is closely related to the power generation capability of the overall PV system. We provide customers with the most comprehensive efficiency testing services according to standards such as CEC, IEC 61683, IEC 62891, EN 50530, CGC/GF 035, etc.

## POWER QUALITY TESTING

Power quality is an important index of the performance of grid-connected PV inverters. It affects not only the safety and stability of a power grid, but also the operational stability and service life of electric equipment. TÜV Rheinland's PV inverter laboratory boasts advanced equipment and staff with many years of testing experience, who can quickly and accurately measure PV inverter voltage flicker, voltage harmonics, current harmonics, DC components and other power quality indicators.

## ENVIRONMENT TESTING

To verify the reliability of PV inverters in diverse application scenarios, such as hot, cold, damp, high-altitude and offshore environments, a variety of extreme harsh environmental conditions can be simulated in our laboratory for testing and verification in accordance with IEC 60068-2 standards. Only validation through environmental testing can ensure that PV inverters perform well in the future.



# Value added

Market competition is becoming more and more severe and the market environment is becoming increasingly complex. TÜV Rheinland helps you to stand out and maintain your competitive edge by offering unique programmes corresponding to specific requirements.

## RELIABILITY TESTING

The reliability of a PV inverter has two main dimensions. First, PV inverters should be able to operate in all of the environments allowed by product design, such as natural environments characterised by high temperatures, low temperatures, high humidity, sand and smoke. Electromagnetic compatibility and power grid impact should also be considered in electric power environments. The second dimension of reliability is life expectancy. PV inverters should have long service lives, i.e. maintain a high degree of reliability within their design lives. Our laboratory, with its professional testing capability and advanced testing equipment, accurately simulates and verifies the highly reliable operation of PV inverters throughout their lifecycles.



### QUALITY MARK

A tested quality mark applies to TÜV Rheinland-tested products that offer both safety, quality and good performance. The safety test is the basis for all further tests. The product's quality and performance features are then subjected to stringent testings. Criteria such as MPPT tracking range, power quality, input/output capability, efficiency, stability, durability, environmental categories are key factors. The catalogue of basic requirements is based on IEC 62093, as well as our long-term experience of product quality assurance.

### CYBERSECURITY

As PV inverters are designed with increasing connectivity, security weaknesses may arise unless careful attention is paid to cybersecurity during design and validation. TÜV Rheinland's portfolio of cybersecurity services spans strategic consulting, design and process optimisation.

Penetration testing provides a detailed overview of PV inverter security issues. The analysis is conducted by simulating a real hacker attack during the prototype development phase. The results indicate both weaknesses, including the potential for unauthorised parties to gain access to the system's features and data, and strengths, enabling a full risk assessment to be completed.

### BENCHMARK TESTING

Benchmark testing will help you to assess the performance of your PV inverter relative to its competitors' performance in a number of areas, such as functionality, durability and quality. We will work with you to create a testing programme specific to your needs and goals. The results will help you to determine how your PV inverter fares against products already on the market. The testing data will also help you to make informed decisions on price points and product design and shape your performance claims.



# Supply chain

We have decades of experience providing supply chain services for PV projects with different levels of capacity. We have built a global network of laboratories designed to meet new challenges and work closely with specialists who support and advise our clients.

|  | Development   | Pre-production   | Production   | Post-production  |
|--|---|--|--|--|
|  <b>TÜV Rheinland expert team</b>      | <ul style="list-style-type: none"> <li>▪ Supplier evaluation</li> <li>▪ Technical advisory</li> </ul> |  |  | <ul style="list-style-type: none"> <li>▪ Quality insurance advisory</li> </ul>                     |
|  <b>At factory</b>                    | <ul style="list-style-type: none"> <li>▪ Factory audits</li> </ul>                                    | <ul style="list-style-type: none"> <li>▪ Manufacturing capability assessment</li> <li>▪ Pre-production factory inspection</li> </ul> | <ul style="list-style-type: none"> <li>▪ DuPro factory inspection</li> <li>▪ Inline quality assurance</li> </ul> | <ul style="list-style-type: none"> <li>▪ Factory acceptance testing (FAT)</li> </ul>               |
|  <b>In TÜV Rheinland's laboratory</b> | <ul style="list-style-type: none"> <li>▪ Benchmark tests</li> </ul>                                   | <ul style="list-style-type: none"> <li>▪ Performance tests</li> <li>▪ Safety tests</li> <li>▪ Reliability tests</li> </ul>           | <ul style="list-style-type: none"> <li>▪ Fast verification sample tests</li> </ul>                               | <ul style="list-style-type: none"> <li>▪ OND files</li> <li>▪ Final random sample tests</li> </ul> |
|  <b>On construction site</b>          |   |  |  | <ul style="list-style-type: none"> <li>▪ Site acceptance testing (SAT)</li> </ul>                  |

**FROM SUPPLIER SELECTION TO FINAL INSTALLATION, TÜV RHEINLAND PROVIDES ALL-AROUND SUPPORTS ALONG THE ENTIRE SUPPLY CHAIN**





## 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, we also offer Certipedia ([www.certipedia.com](http://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. 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.

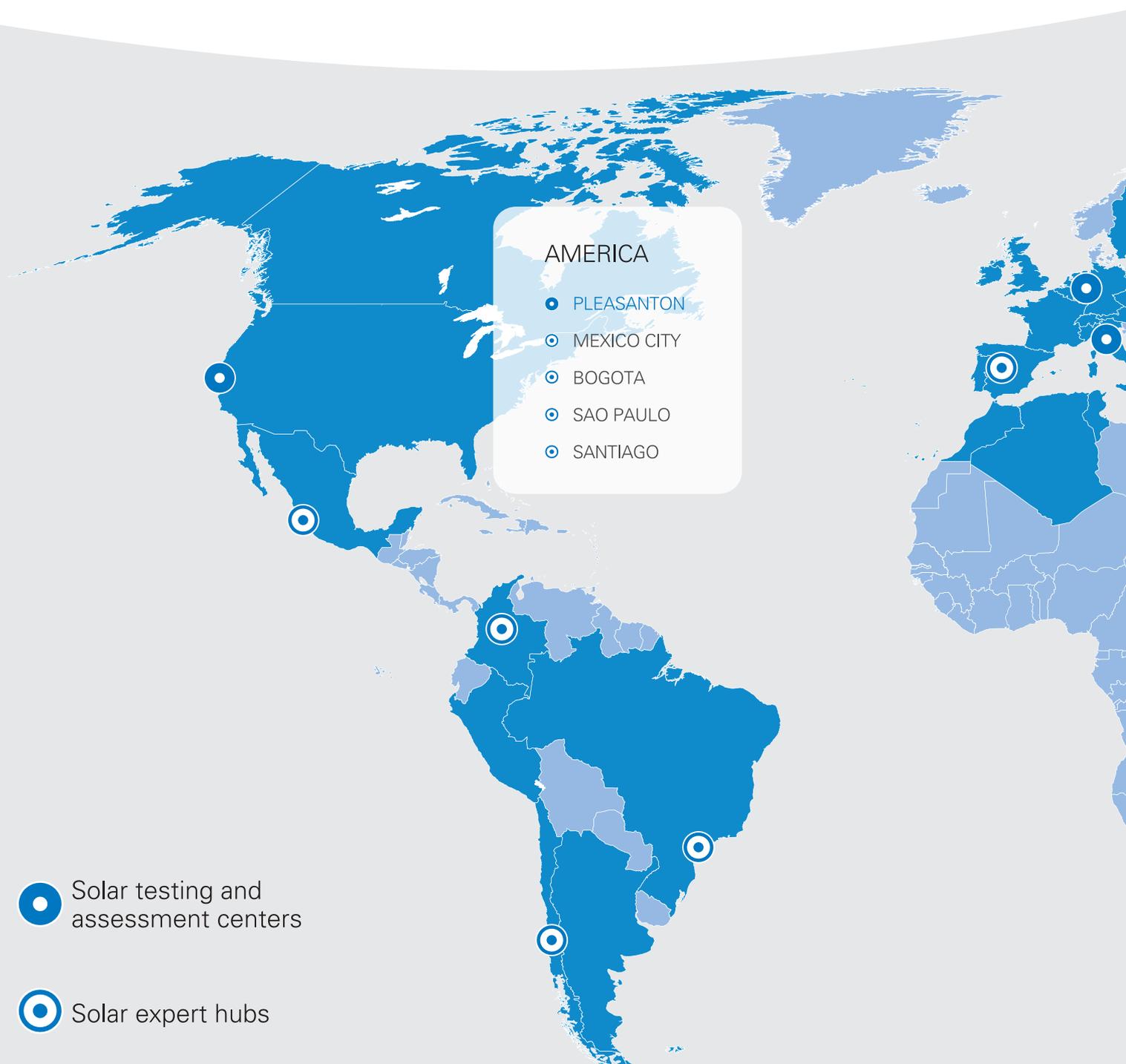
Our testing centres with multiple accreditations in Germany, Italy, China, India and the US consist of state-of-the-art equipment and sophisticated engineering teams. As the premier third party certification institution for the PV industry, over 250 experts of TÜV Rheinland worldwide can rapidly respond 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.

## AMERICA

- PLEASANTON
- MEXICO CITY
- BOGOTA
- SAO PAULO
- SANTIAGO

● Solar testing and assessment centers

○ Solar expert hubs



**250+** experts

**35+** years of experience

**No.1** in PV products testing and certification

EUROPE

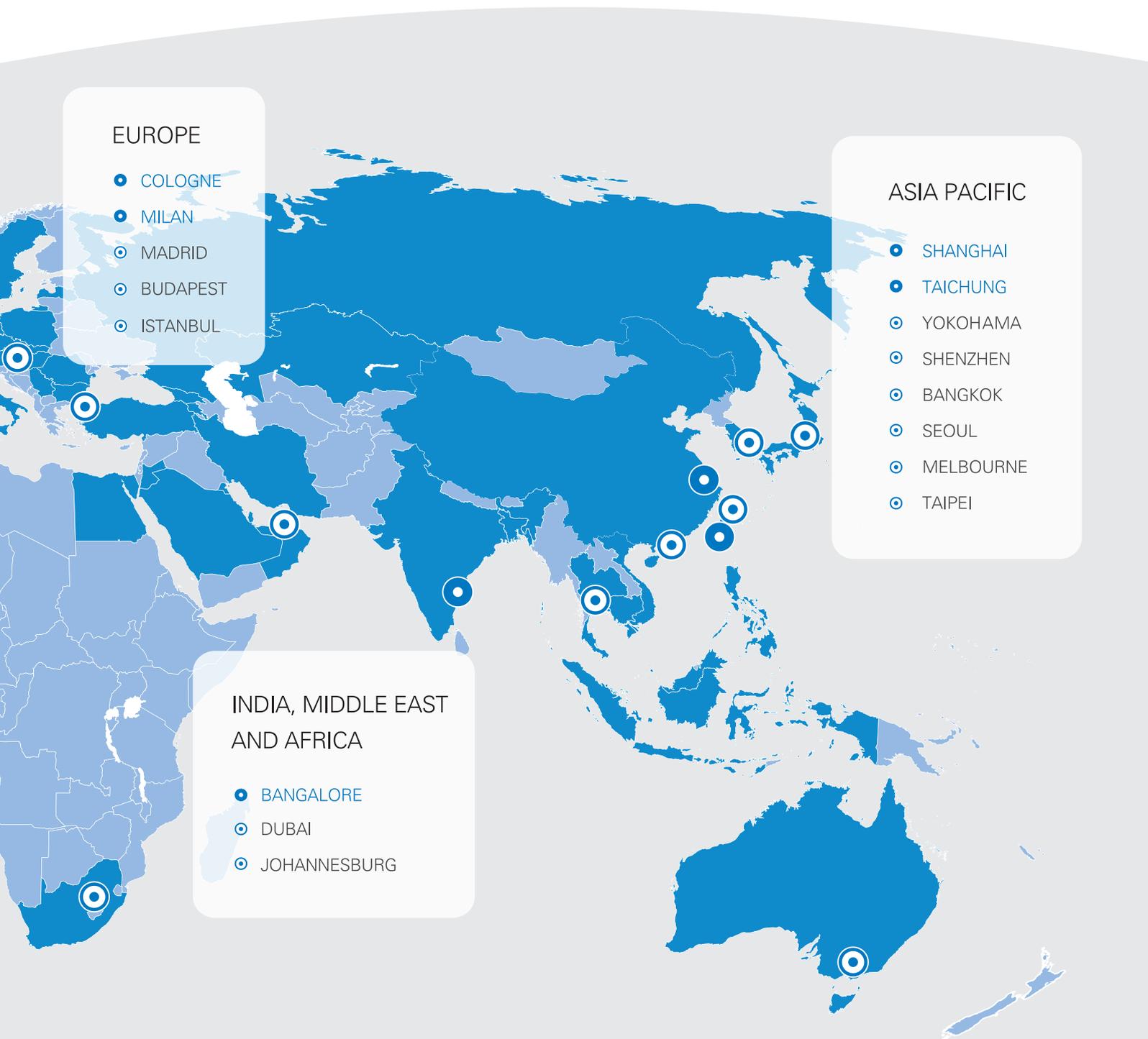
- COLOGNE
- MILAN
- MADRID
- BUDAPEST
- ISTANBUL

ASIA PACIFIC

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

INDIA, MIDDLE EAST  
AND AFRICA

- BANGALORE
- DUBAI
- JOHANNESBURG



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