



Good practices in testing and certification for PV systems in Asia

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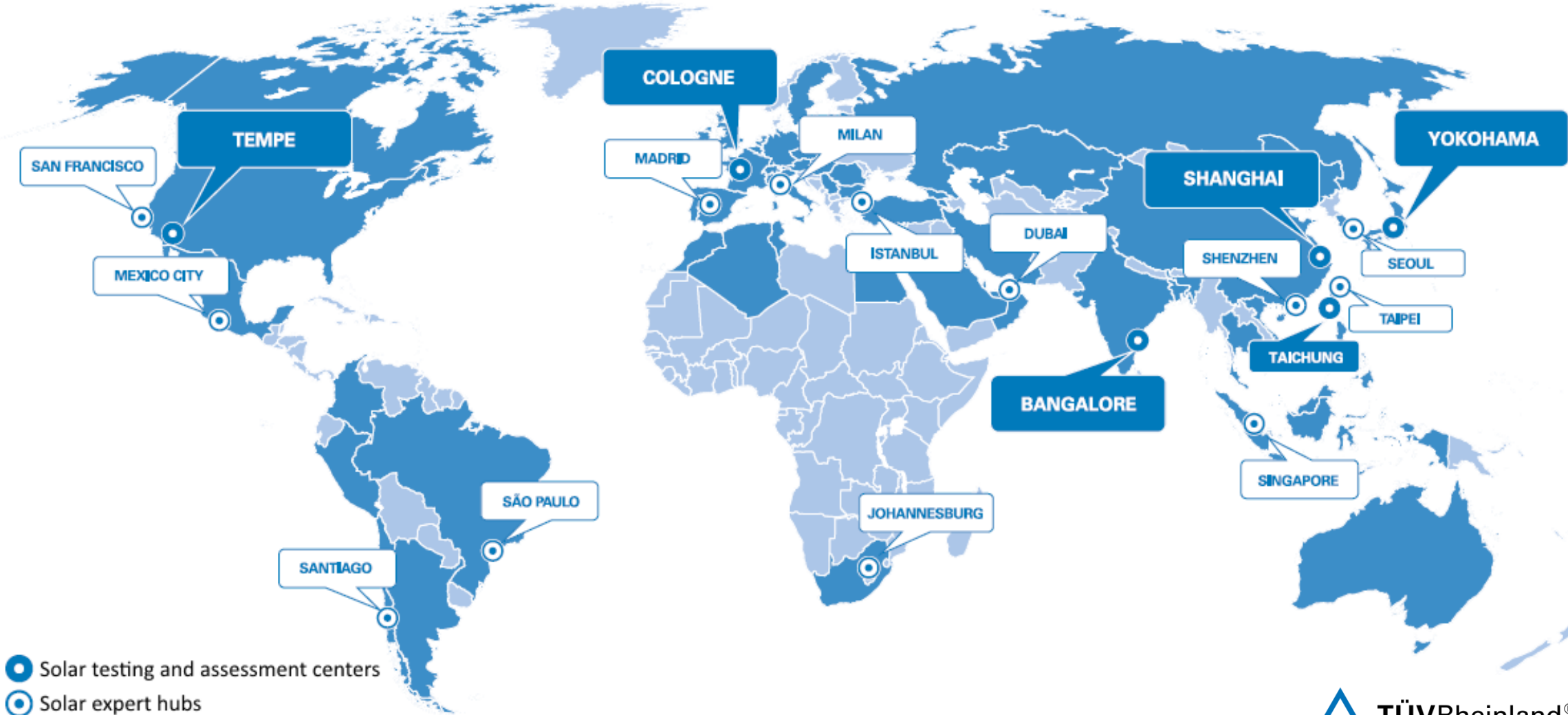
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TÜV Rheinland Global PV Network

We're always focusing on quality and safety



Basis of the study:

- TÜV Rheinland has more than 12 GW (in 2015, today around 25 GW) plants inspected world wide (Europe, North America, South America, Central America, Asia and Africa)
- Basis of the study are
 - > 100 plants (100 kWp - 30 MWp)
 - (Main regions: Germany, Europe, RoW)
- Two periods (2012 – 2013 / 2014 - Q1. 2015)

Categorization:

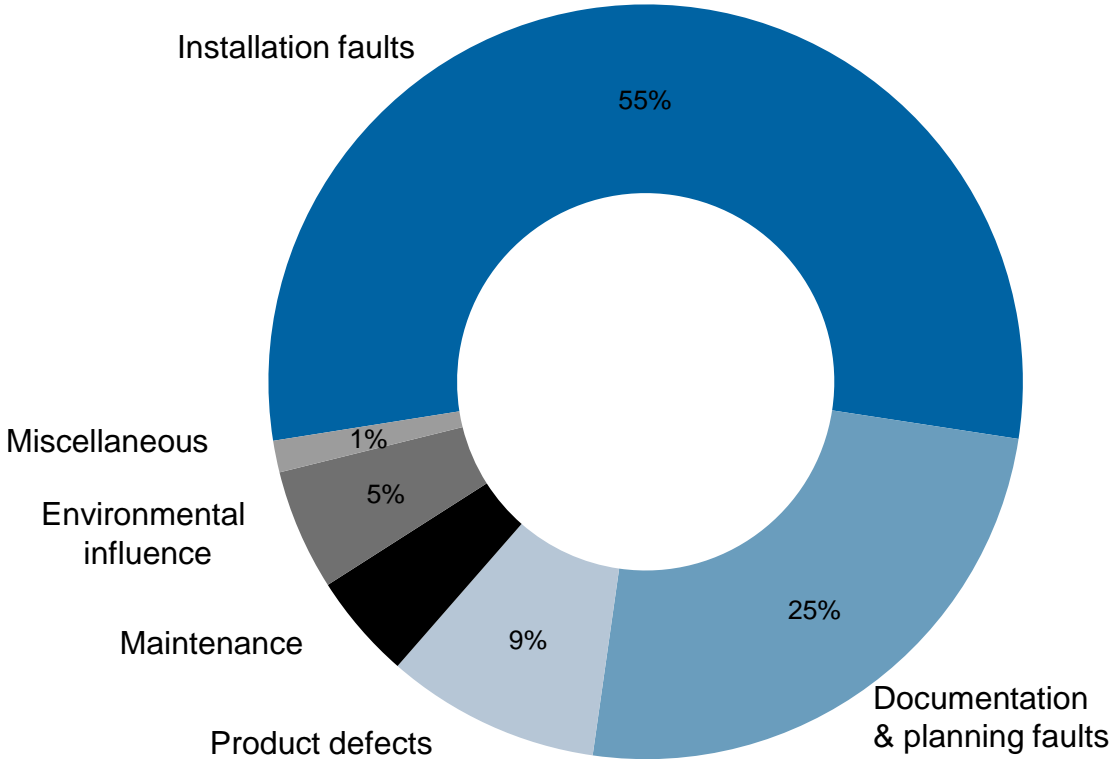
- **Particularly Serious Defects (PSD)**
Immediate action to prevent plant breakdown is required
- **Serious Defects (SD)**
Plant operation is possible but defects must be repaired
- **Less Serious Defects (LSD)**
No compelling need for action but monitoring of development is recommended

Cause of Defects in PV Power Plants – TÜV Rheinland Data 2014/ Q1. 2015

Main findings:

- 30 % of power plants show particularly serious and serious defects (incl. safety issues) or large number of issues
- > 50 % of defects are caused by installation errors

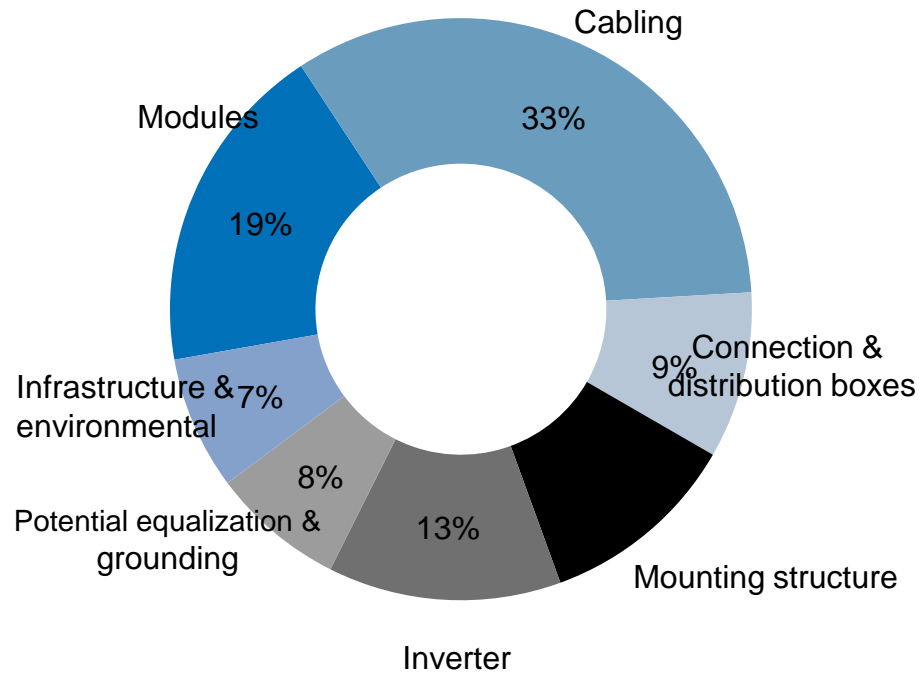
2014/ Q1.2015



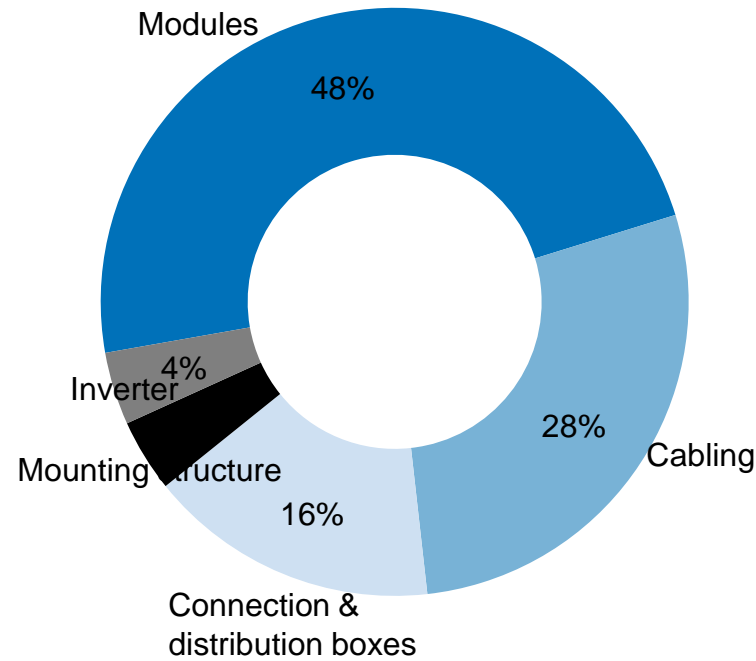
Systematic quality assurance is required
Plant inspections and maintenance are imperative

Particularly Serious Defects in PV Power Plants

2012 / 2013



2014 / Q1. 2015

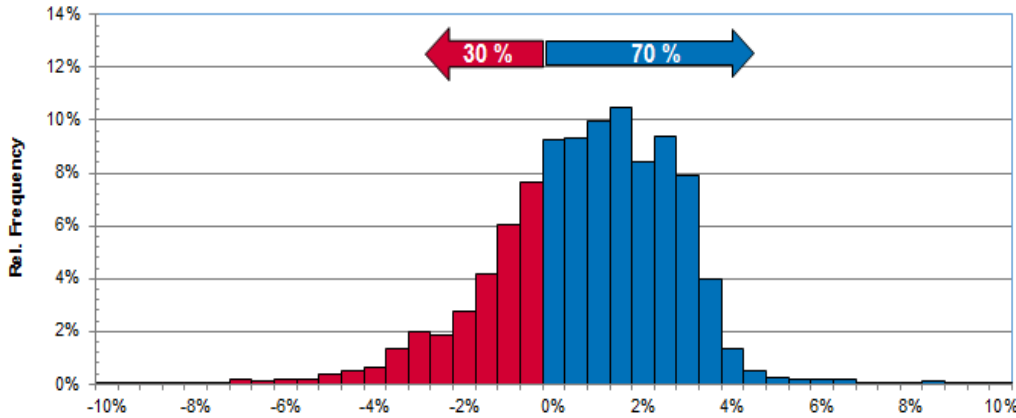


The study shows that Particularly Serious Defects are usually based on issues in relations to PV modules and Cabling.

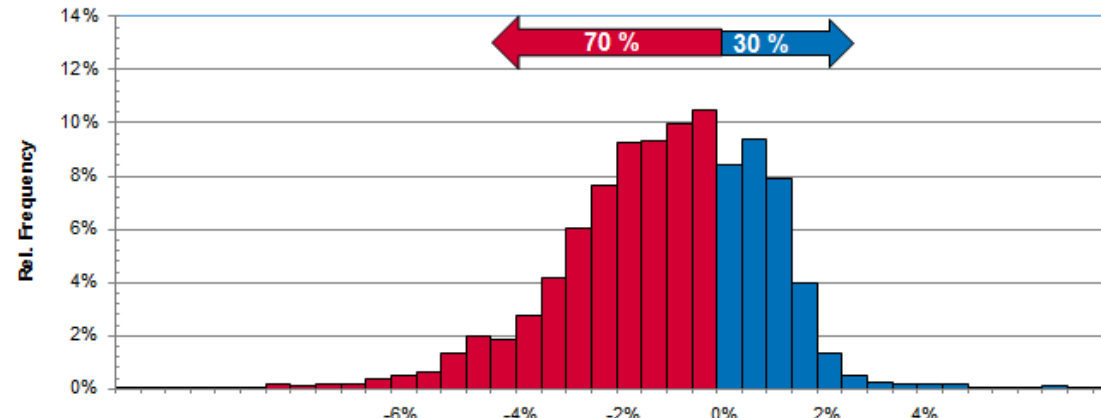
Comprehensive Quality Assurance for PV Modules required. For cabling appropriate designing and installation is crucial.

Risk analysis and control in PV systems

Technical Risks – Quality of PV Modules



**PMAx Deviation to Low Tolerance Limit [%]
before LID**



**PMAx Deviation to Low Tolerance Limit [%]
after LID**

Unique SNs: 7179
 Unique module classes: 935
 Unique manufacturers: 190
 Test period: 2015-2016



Source: Bloomberg Q1 2016 PV Market Outlook Report

“...We strongly recommend that module purchasers and banks do not use this list [TIER list] as a measure of quality, but instead consult a technical due diligence firm...”

	MW/year
Trina Solar*	4,700
Hanwha Q CELLS*	4,300
JA Solar*	4,000
Jinko*	4,000
Canadian Solar*	3,800
First Solar	3,000
Zhongli Talesun*	2,800
Risen Energy	2,600
Suntech/ Shunfeng	2,400
Chint/ Astronergy	2,000
Eging	1,600
SolarWorld*	1,500
REC Solar*	1,300
SunPower*	1,300
Seraphim*	1,250
Hareon	1,200
LG*	1,100
Solar Frontier	1,050
ZNShine*	1,000
ET Solar*	1,000
BYD*	1,000
HT-SAAE	1,000
Hyundai Heavy*	600
Sharp	500
Phono Solar*	450
AUO/ BenQ*	435
Heliene	250
Winaico	150
Total	50,285

Source: Bloomberg New Energy Finance. Note: Methodology.

Risk Management for Investors and Lenders

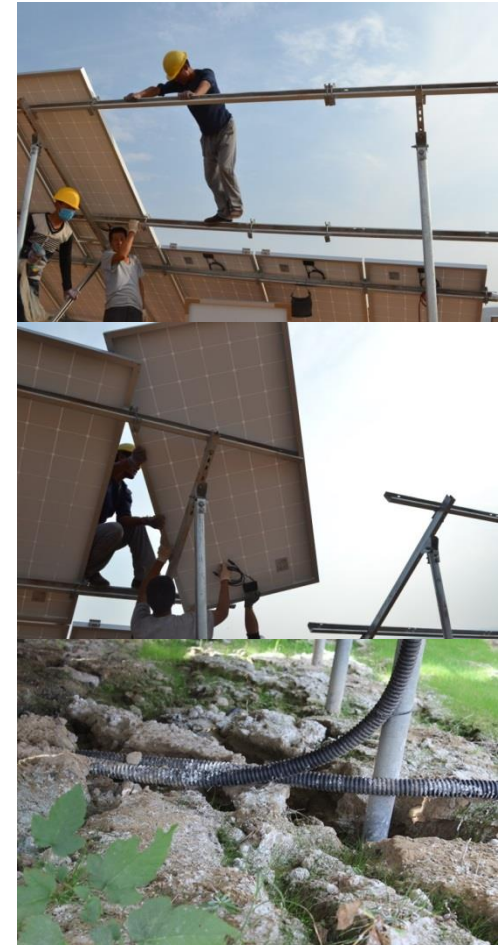


Individual solution

- Rather for bigger PV Power plants (typically > 3 MW)
- Technical Due Diligence with flexible Scope of Work and individual Quality Assurance Program

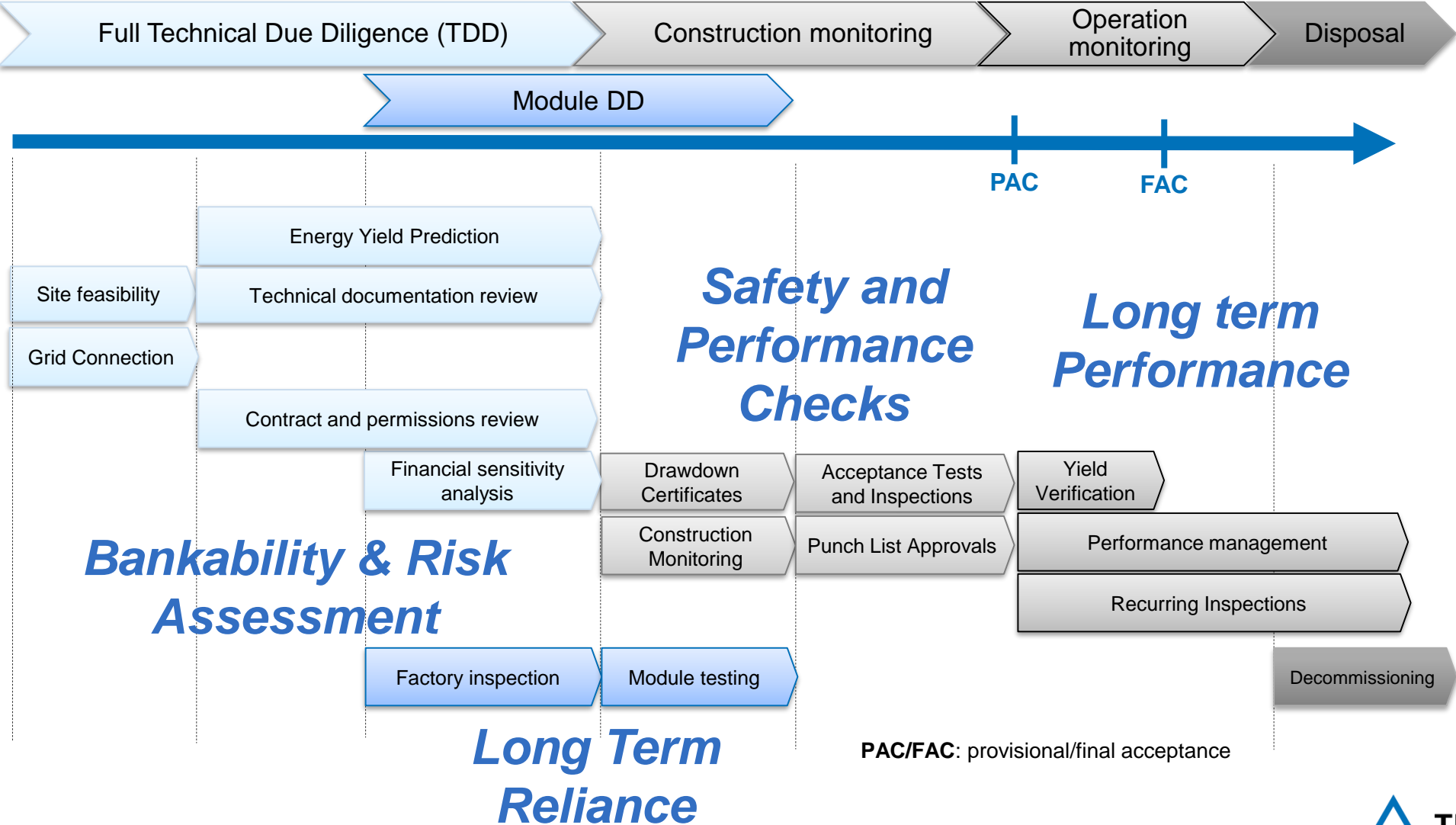
Standardized solution

- Rather for smaller PV Power Plants (typically < 3MW)
- Standardized solution is more cost-effective for small plants



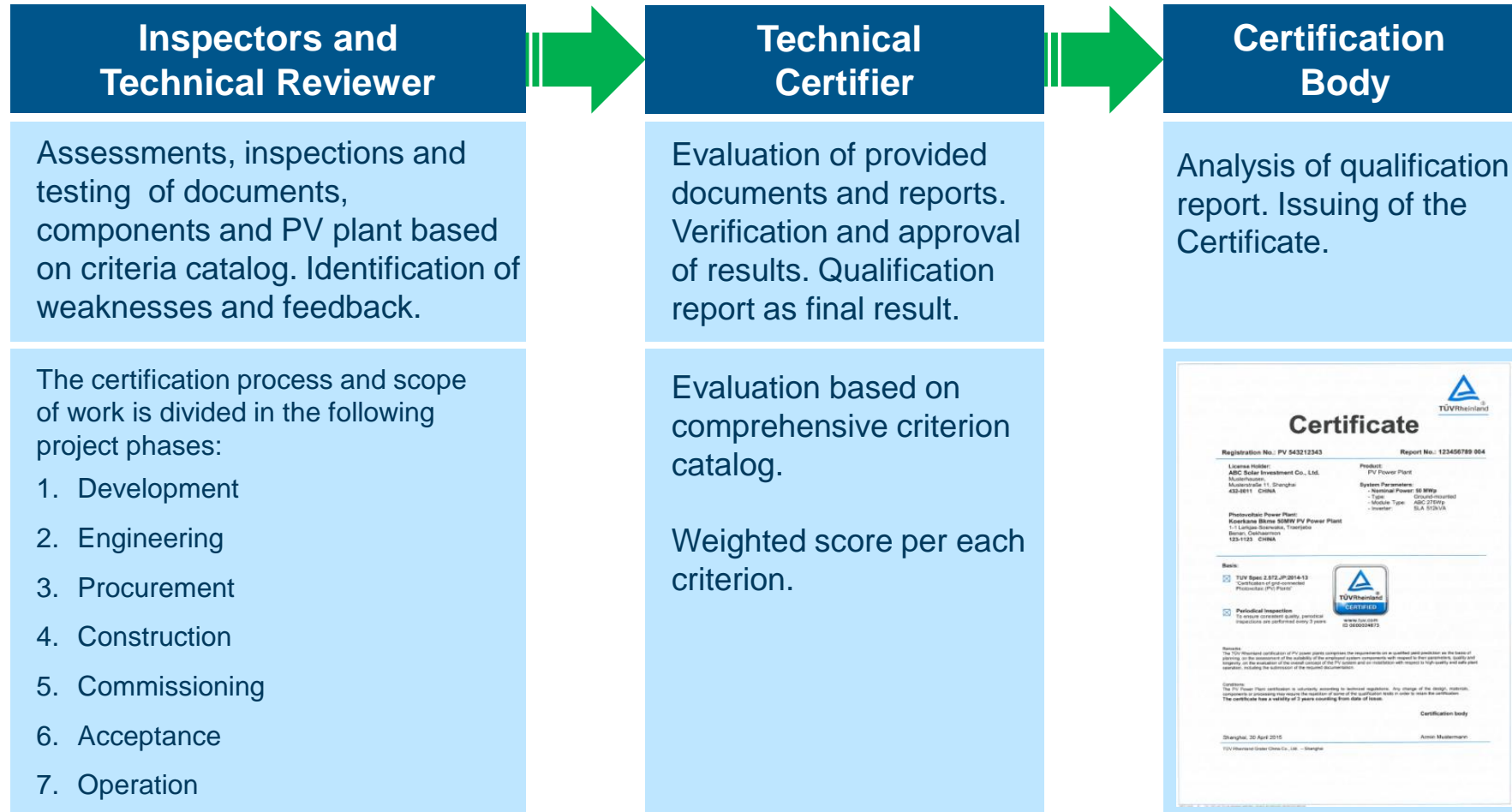
Technical Due Diligence

Project Phase – Lender Perspective



PAC/FAC: provisional/final acceptance

PV Power Plant Certification



Thanks for your attention

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