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A holistic view of quality: building quality infrastructure for solar PV

INTERSOLAR

Munich, Germany
1 June 2017

1 PV deployment

Growth in PV deployment

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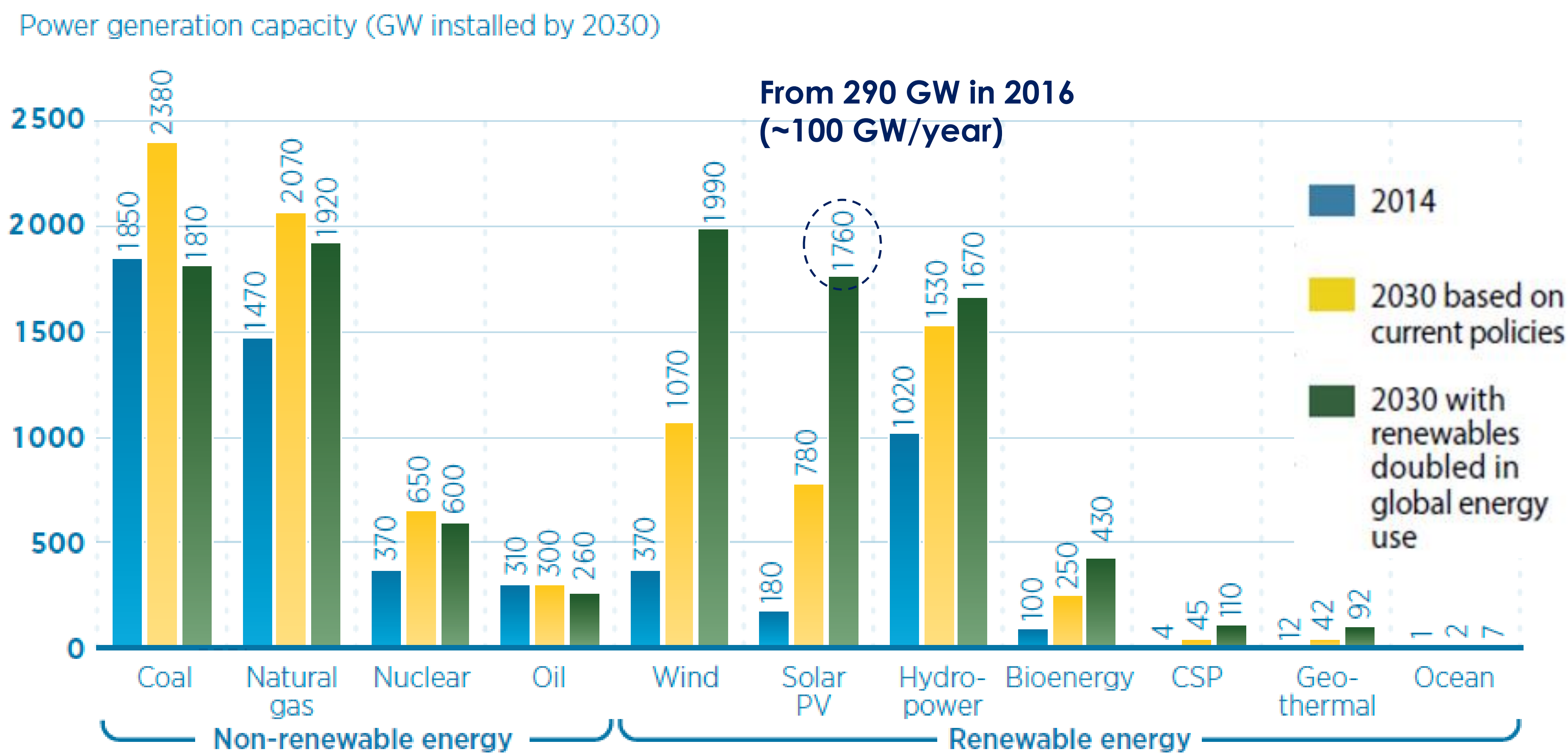

Source: IRENA Remap 2016

Global solar power investments

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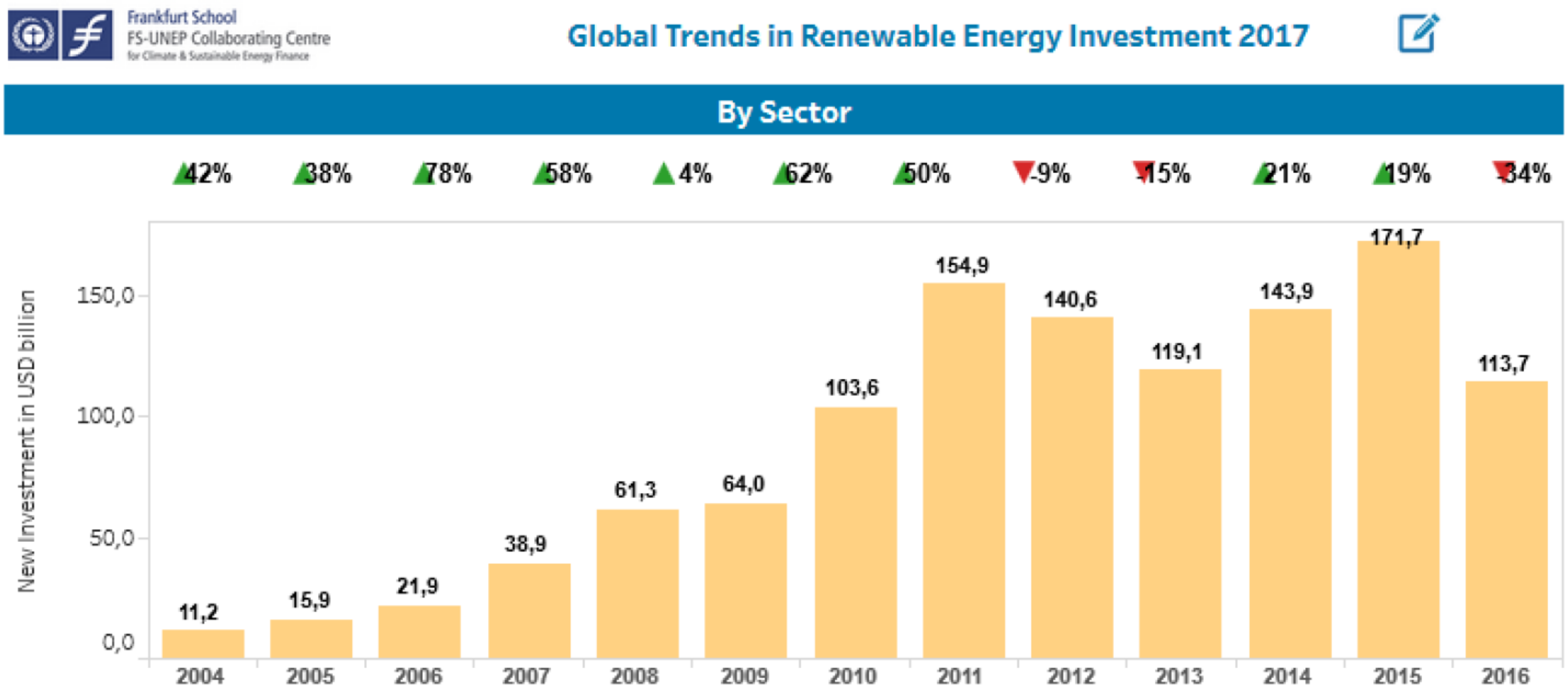


Source: Frankfurt School-UNEP Centre/BNEF. 2017.Global Trends in Renewable Energy Investment 2017, http://www.fs-unep-centre.org

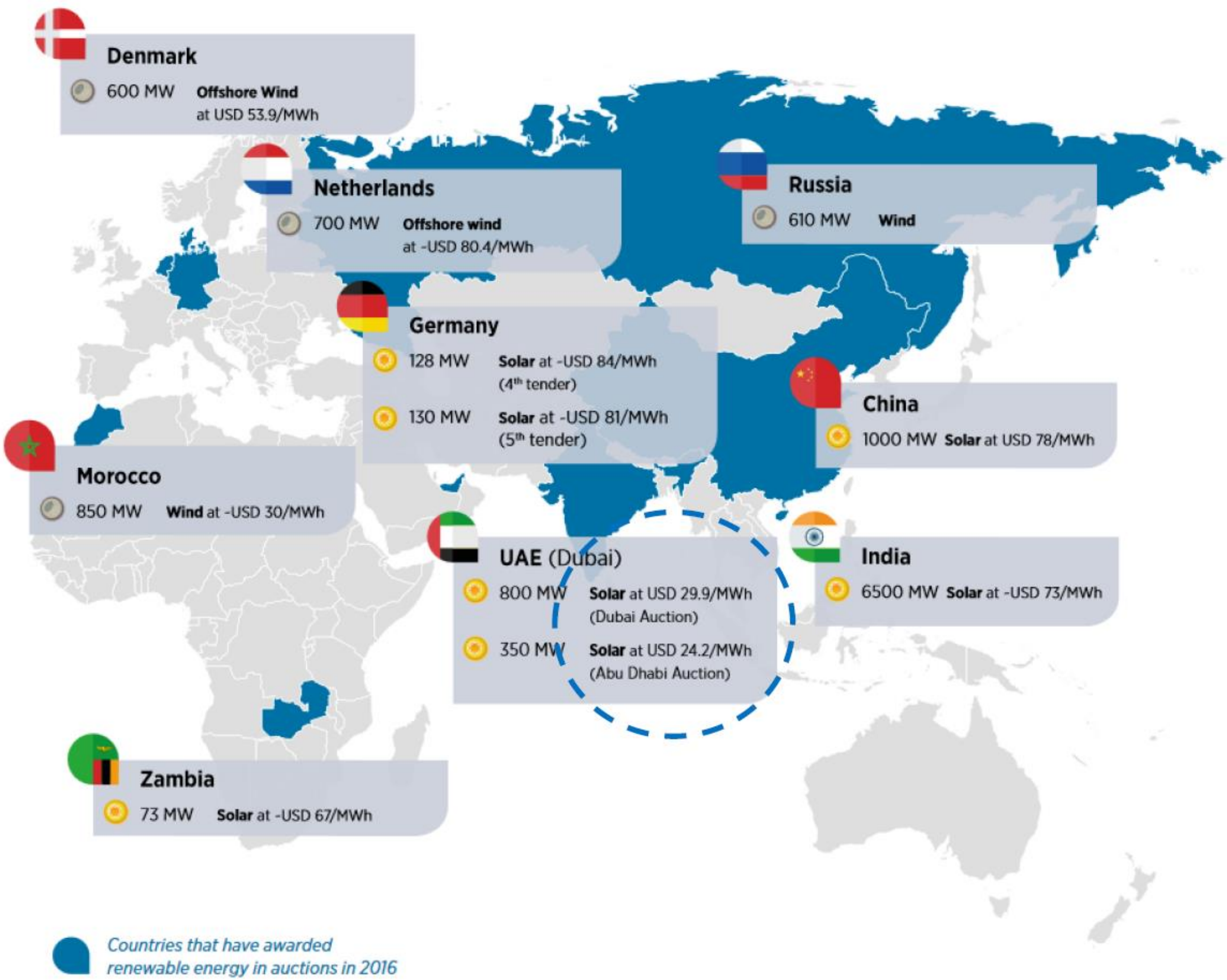
Note: Investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

2016: **113 USD billion**

2030: **2.7 trillion USD in 15 years** | 186 billion USD/yr (1 800 GW)

2 Risk management

Record PV prices



Source: IRENA (2017) RENEWABLE ENERGY AUCTIONS: ANALYSING 2016

Failure risks present in their majority at early and mature stages

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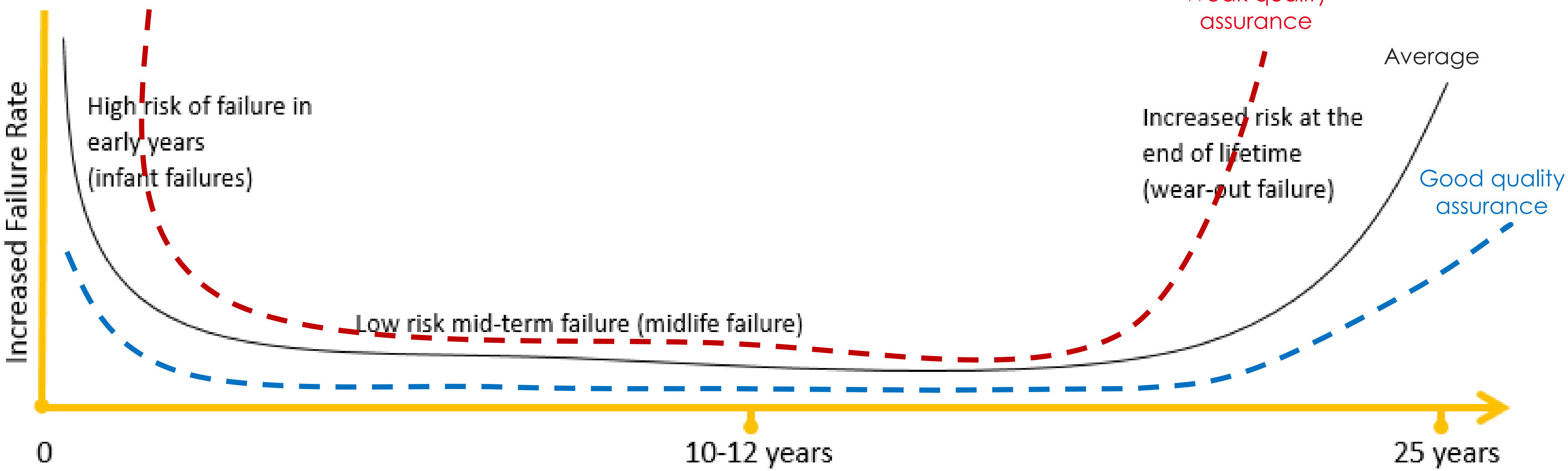
Life expectation of modules is 25+ years, however they have to deal with failure PV curve



Source: Adapted from Solar World 2016

Lenders' perspective: revenues only important during first 10-15 years

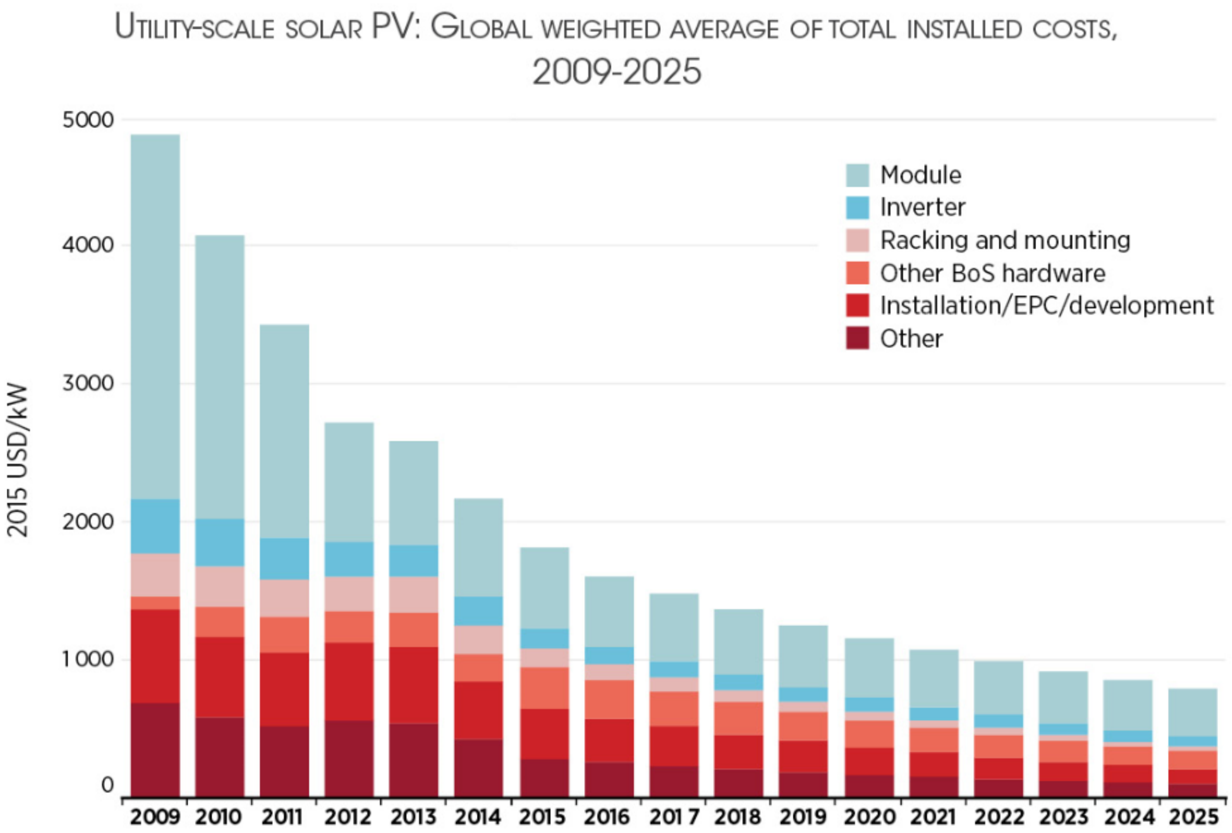
- Risk of infant failures are passed to EPC
- Bankability assessments further minimize risks of midlife failure
  - ✓ Valid renown certifications
  - ✓ Track record of company and modules
  - ✓ Quality of manufacturing facility
  - ✓ Warranty conditions

Equipment selection considering quality aspects

PV Modules represent around a third of PV installed costs

Performance of PV modules is dependent to:

- Module technical characteristics
- Quality of materials used
- Testing procedures
- Quality of manufacturing facility
- Manufacturing process

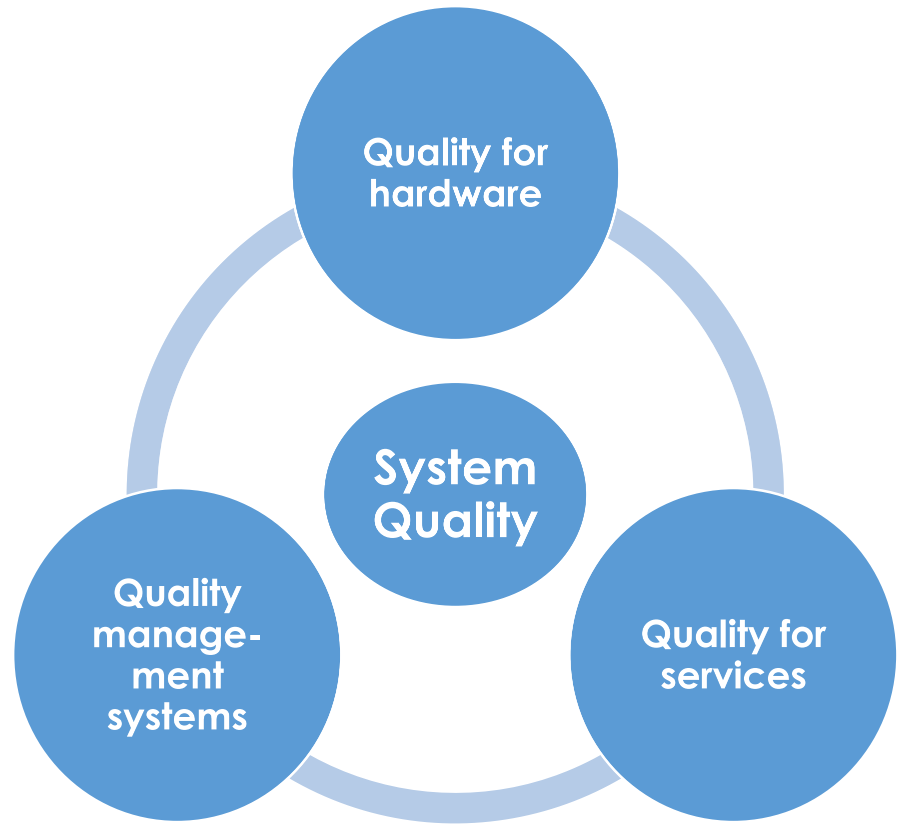


More than half of non schedule hardware repairs happen due to equipment selection

Source: IRENA (2016) Power to Change

Holistic View - Quality Covers the Whole System, not Hardware only

Implementation of Quality Schemes covers not only equipment but whole systems
Including Design, Installation, O&M services



TÜV Rheinland

"Every other fault that we detect is due to incorrect installation."

Source: TÜV Rheinland

IRENA (2013) "International Standardisation in the Field of Renewable Energy"

3 Quality Infrastructure

Quality Infrastructure

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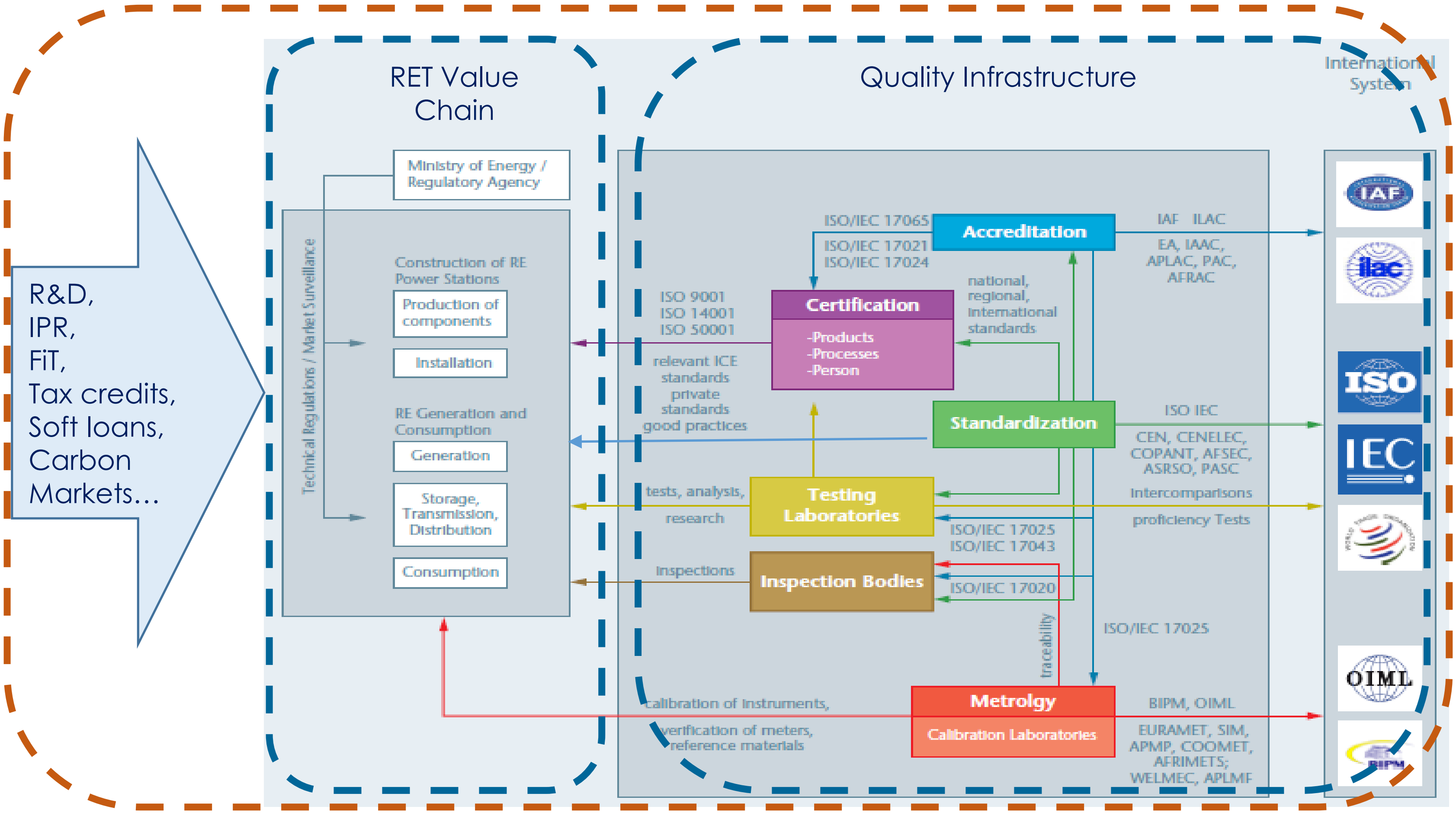
Which **instruments** do we have to mitigate technical risk, attract investment and public acceptance, and meet expectations by all stakeholders in a USD trillion market?

International standards and conformity assessment schemes



Source: Physikalisch-Technische Bundesanstalt

Standards for PV systems

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System component manufacturing	System design and equipment selection	Installation and commissioning	Performance and operation & maintenance (O&M)	End-of-life
• Internationally IEC 61730, IEC 61215, IEC 62109 and IEC 62093 • IEC 61215, IEC 61646, UL 1741 and IEC 62109 • USA / UL 1703 • China has developed its own standards	• IEC 62548 (international) • IEC 62738 for large (utility) scale project • IEC 62257 for off-grid • IEC 62116 for grid-code related regulations, which is typically country specific • NEC Article 690 (USA), AS/NZS 4777,3100 (Australia) and GB 50797-2012 (China) • Rollout of national standards for installations and certification of installers	• IEC 62446 and 61724 (international)	• IEC 61724, 62446-2 (international) • ASTM E2848 (USA)	• Decommissioning and waste management options need yet to be properly addressed in international standards. • Directives, like the European Waste Electrical and Electronic Equipment (WEEE) directive, are implemented awaiting transposition into national laws and standards.

Source: IRENA (2017) Quality infrastructure for PV systems

The benefits of QI services outweigh their costs – QA in EPC contracts

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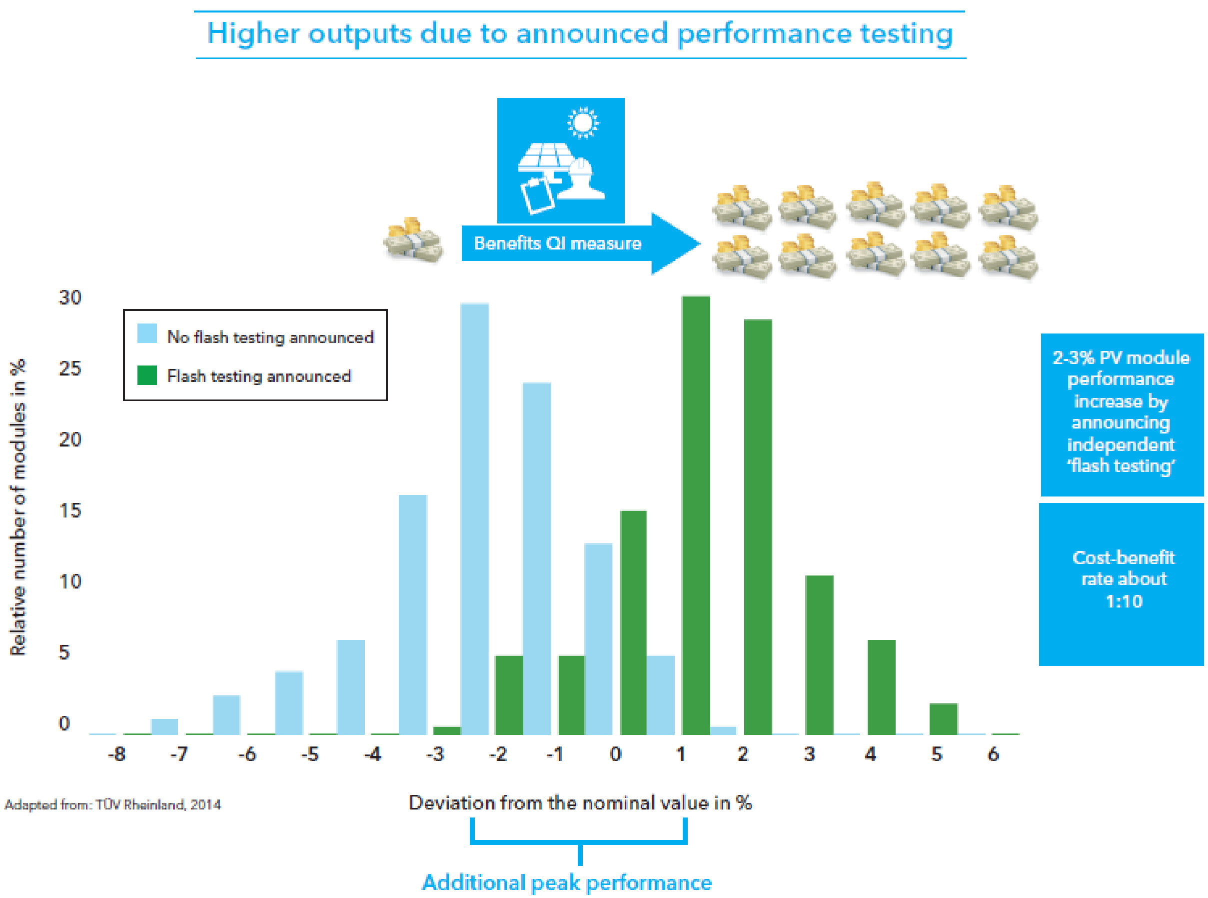
Example: Higher plant outputs due to module performance testing



Adapted from: TÜV Rheinland, 2014

Monetary case

- 20 MW PV plant in southern Europe
- kWh-sales price of 10 ctEUR
- 2-3% higher performance
- Measurement cost 5 – 10 kEUR
- Annual revenue increase 75 – 115 kEUR

IRENA uses a five-stage approach for the development of QI

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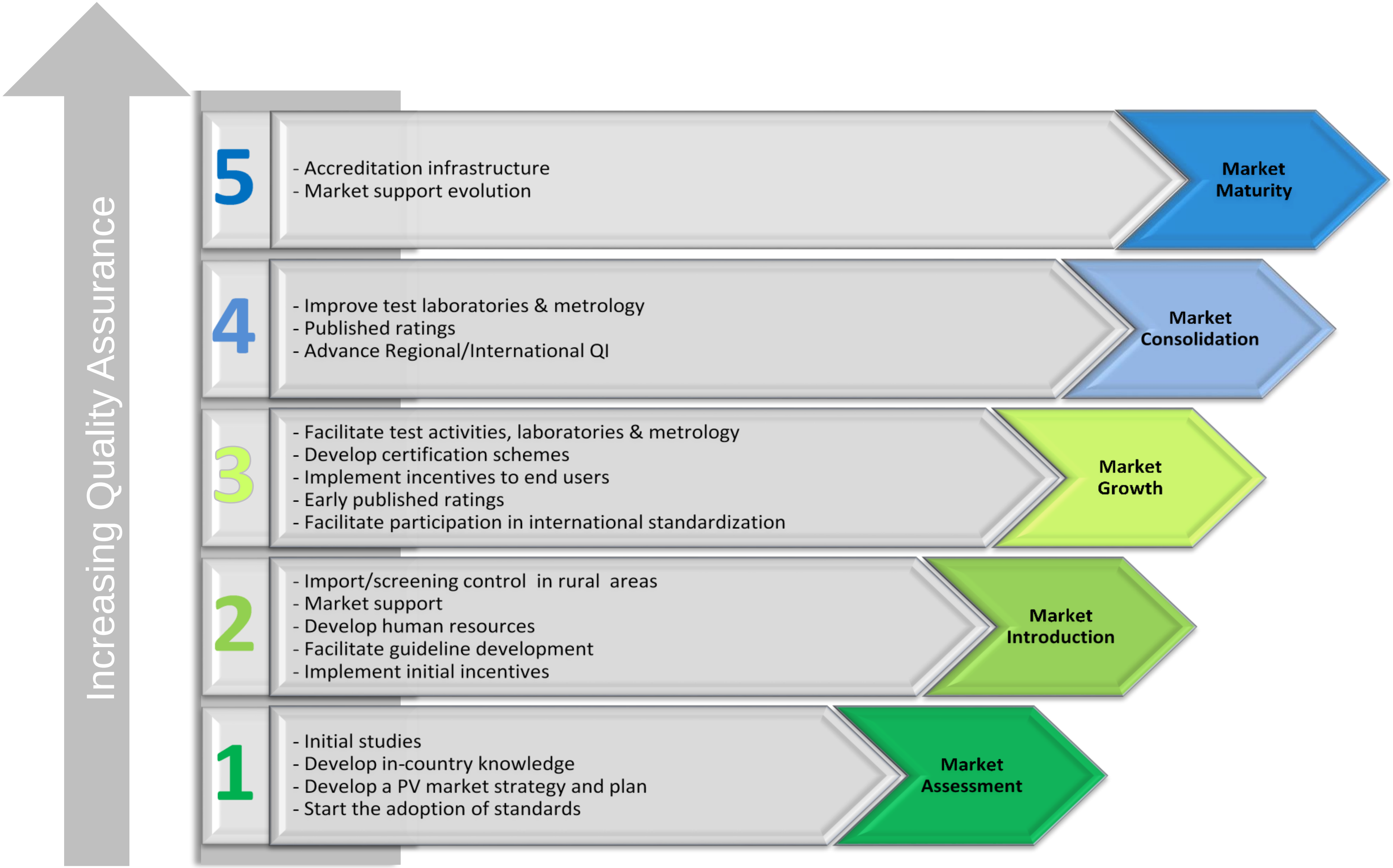

4 Emerging challenges

What is coming next in QI for PV systems

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Engagement from all stakeholders in PV markets

- Bankability – durability tests
- Life cycle aspects
- Extreme weather condition
- New applications
- Grid integration

Work-in-progress at international level

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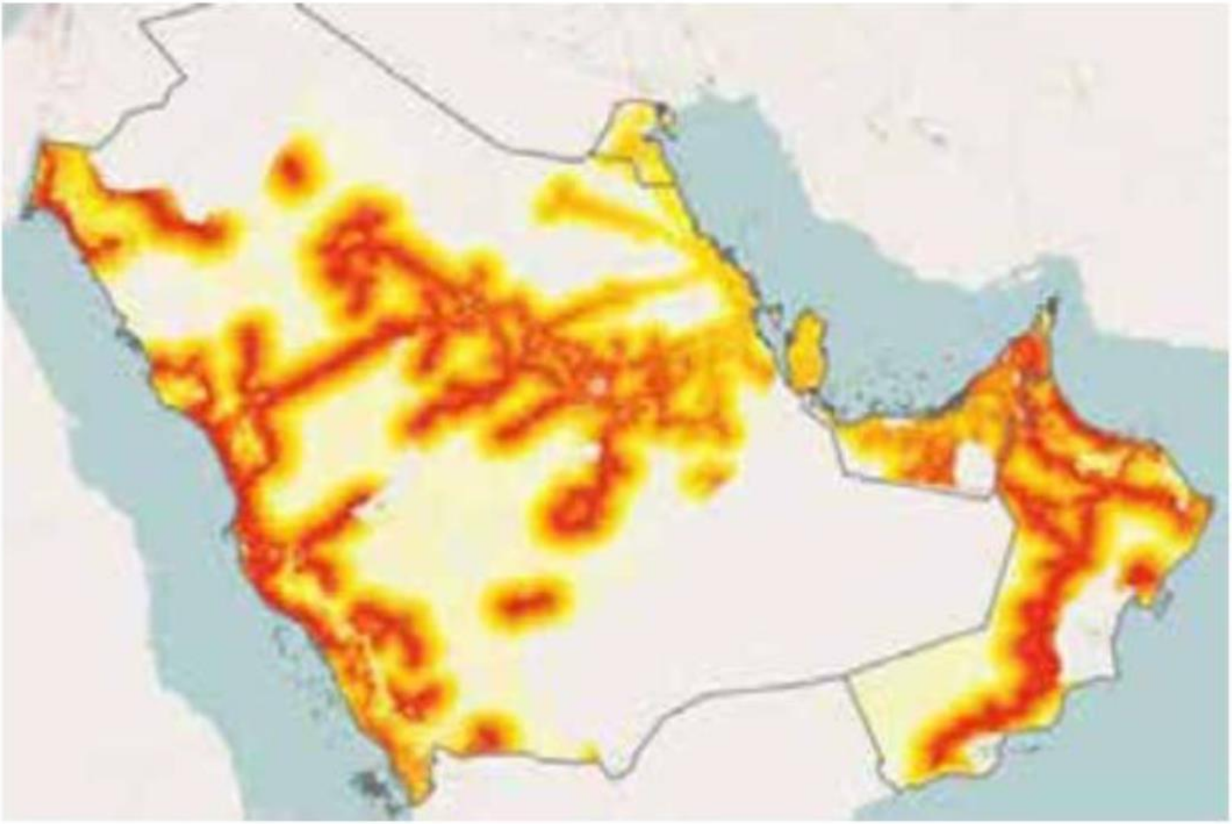
	Durability Testing	Value Chain
Gap	Not assure PV systems last as long as **expected project lifetime** (20+ years)	**Further International standards** in installation, operation, maintenance, documentation and decommissioning, end of life.
Possible Solution	**Stringency** of test methods? Private sector can incorporate **batch acceptance testing** in large wholesale procurements or utility scale projects.	Encourage QI addressing the **entire PV life-cycle**

Source: IRENA (2017) Quality infrastructure for PV systems

Extreme weather conditions: Example – GCC region

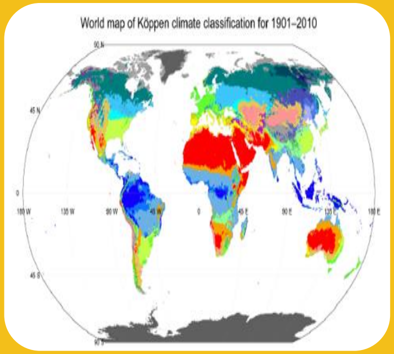
~60% of the GCC's surface area has excellent resources for solar PV
Just 1% of this area represents ~470 GW of additional capacity

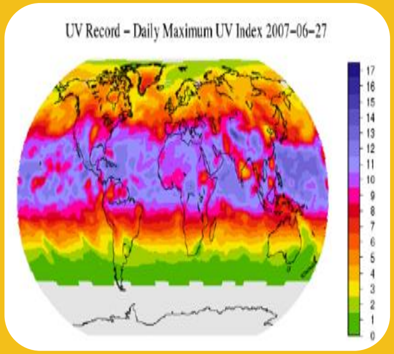
- Source: IRENA (2016) RENEWABLE ENERGY MARKET ANALYSIS: THE GCC REGION



Source: (IRENA, 2016) (http://irena.masdar.ac.ae/?map=2146)

GCC's local conditions





Temperature: IEC open air conditions (-40oC - +40oC) | GCC -20oC - +55oC high humidity

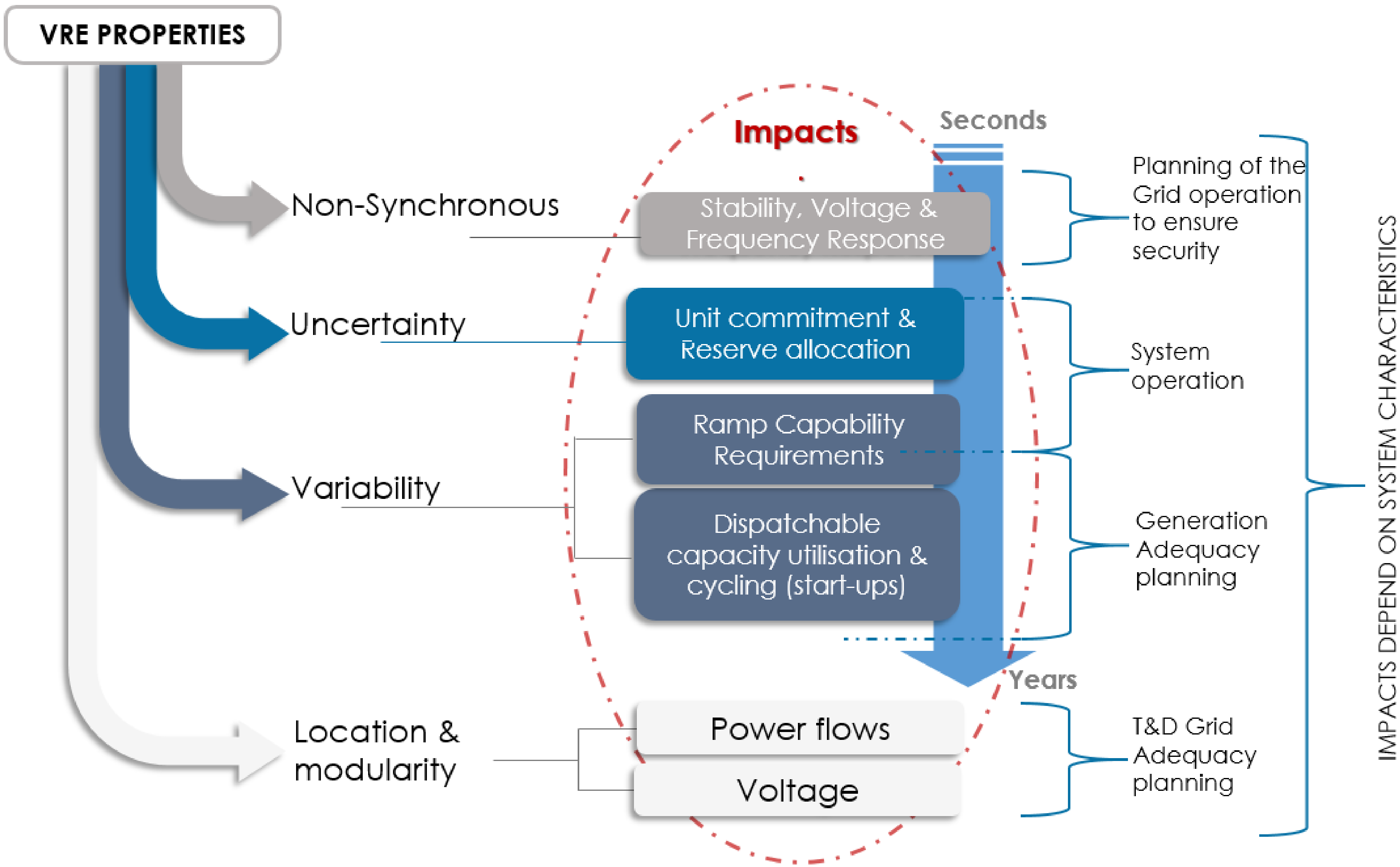
Annual irradiance: Germany ~1 200 kWh/m2 | GCC ~2 300 kWh/m2 – UV double

Hail: IEC 25mm Ø | GCC 44mm Ø

Sand: no international test methods – different types of sand

Sources: hanschen.org; promote.fmi.fi; arabnews.com; KACST

Standards for grid integration – Grid codes



Source: IRENA

New applications

BIPV

BS EN 50583-2:2016

Photovoltaics in buildings

Part 2: BIPV systems

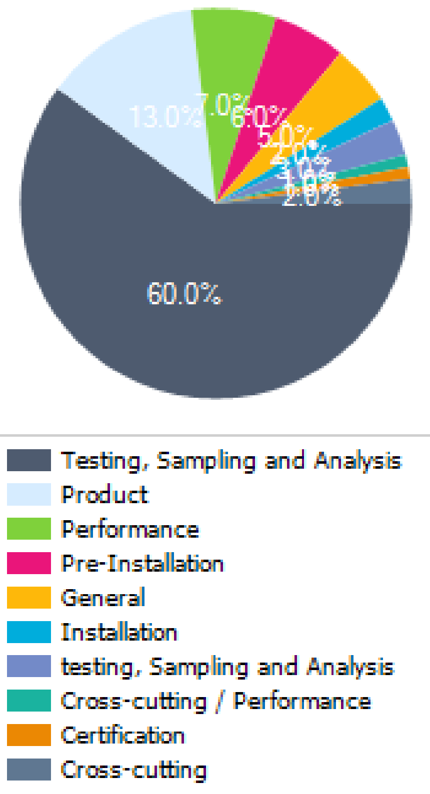
Floating PV

Table 2 — Mounting categories A – E

Category A:	**Sloped, roof-integrated, not accessible from within the building**	
	The PV modules are mounted in the building envelope at an angle between 0° and 75° (see Fig. 1) with a barrier underneath preventing large pieces of glass falling onto accessible areas below	
Category B:	**Sloped, roof-integrated, accessible from within the building**	
	The PV modules are mounted in the building envelope at an angle between 0° and 75° (see Fig. 1)	
Category C:	**Non-sloped (vertically) mounted not accessible from within the building**	
	The PV modules are mounted in the building envelope at an angle of between and including both 75° and 90° (see Fig. 1) with a barrier behind preventing large pieces of glass or persons falling to an adjacent lower area inside the building.	
Category D:	**Non-sloped (vertically) mounted accessible from within the building**	
	The PV modules are mounted in the building envelope at an angle of between and including both 75° and 90° (see Fig. 1)	
Category E:	**Externally integrated, accessible or not accessible from within the building**	
	The PV modules are mounted onto the building and form an additional functional layer (as defined in 3.1) exterior to its envelope (e.g. balconies, balustrades, shutters, awnings, louvres, brise soleil etc.).	

5 IRENA Contribution

INSPIRE Platform - Search of International Standards

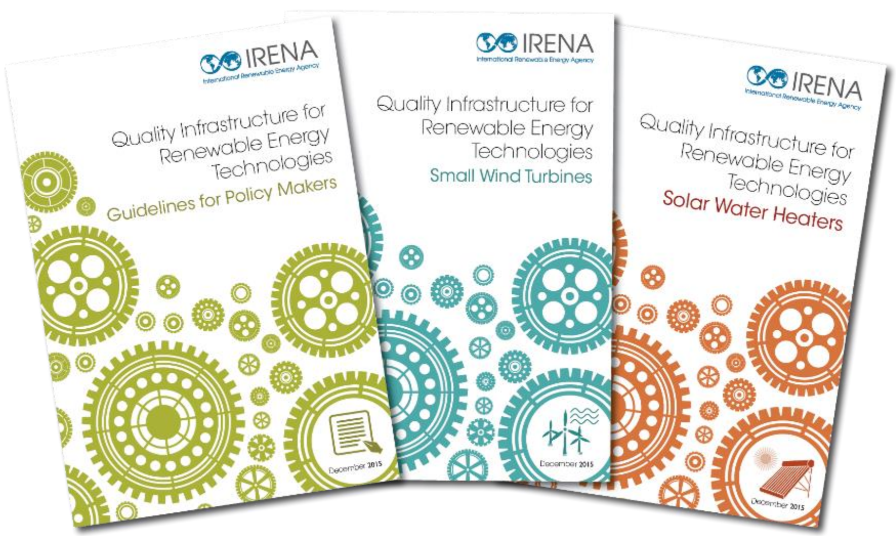


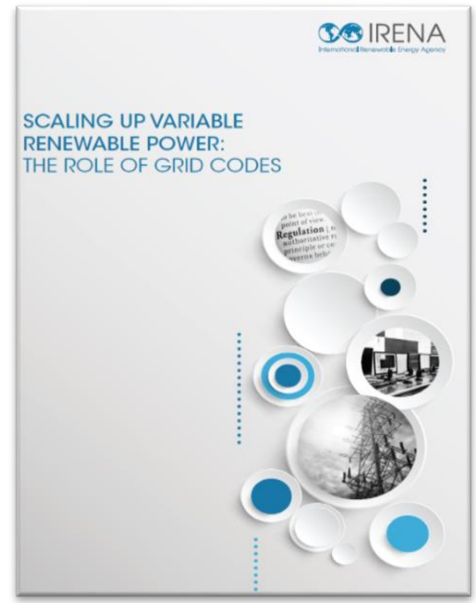
Access for free:
www.irena.org/inspire

Webinar about INSPIRE:
https://www.youtube.com/watch?v=O2AOwZH5sxM

INSPIRE facilitates in a simple way a catalog of the applicable standards for Solar Technologies

Supporting countries to develop and implement QI for RET





IRENA - Cooperation in Quality Assurance & Standards

Requests

- **China:** Technical standards for Offshore Wind technology
- **Japan:** quality control for PV and Wind technologies in extreme weather conditions
- **Latin American region:** In cooperation with PTB, quality control for solar thermal and PV systems
- **MENA region:** In cooperation with EU GCC testing for PV systems
- **UAE:** International Standards for PV systems
- **Mauritania:** Request for support on grid connection codes
- **Colombia:** Grid codes
- **Tanzania:** Solar thermal

- **International Electrotechnical Commission - IEC:** Workshops for Countries on use of standards, INSPIRE
- **German Metrology Institute- PTB:** Quality infrastructure support, Workshop in Costa Rica, Green climate dialogue in Germany
- **ENTSO-E, SolarPower Europe and Solar United**: PV and grid codes

- **IEA PVPS Task 13:** Solar Bankability
- **WWEA:** Standards in small wind technologies

- **EU GCC Clean Energy Technology Network :** GCC Inception meeting & training-Solar Photovoltaic Testing Centres Network

6 Final remarks

Take away

- ❖ We entered into an era of low equipment cost | quality infrastructure is critical to mitigate risks and achieve the **expected LCOE**

- ❖ **Quality is not about hardware only**, but a system approach is needed

- ❖ Progress on standards and conformity assessment schemes need to **accelerate the pace** to meet the existing and NEW markest needs

- ❖ **Cost – benefit** ratio of assuring quality is positive

- ❖ International and regional **cooperation networks** strengthen and accelerate the development and implementation of QI for PV systems

Quality pays!

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