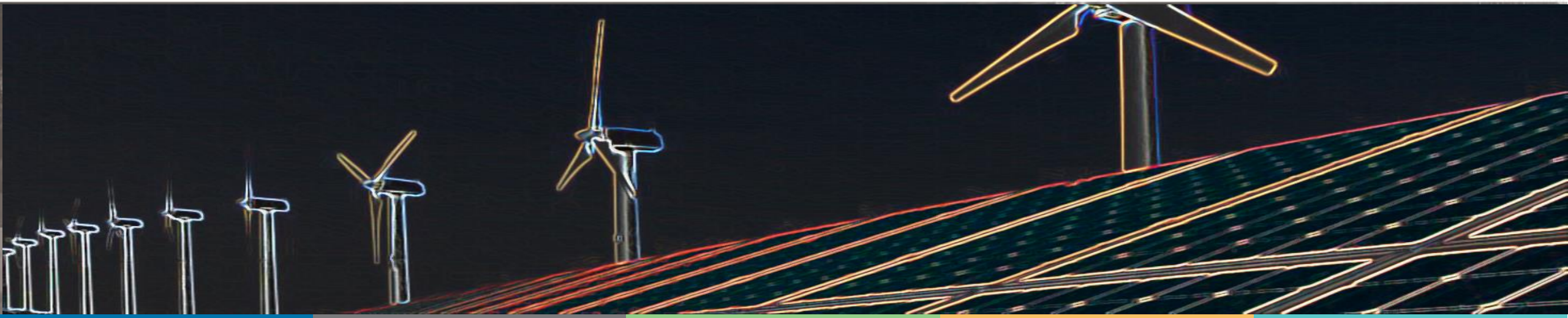
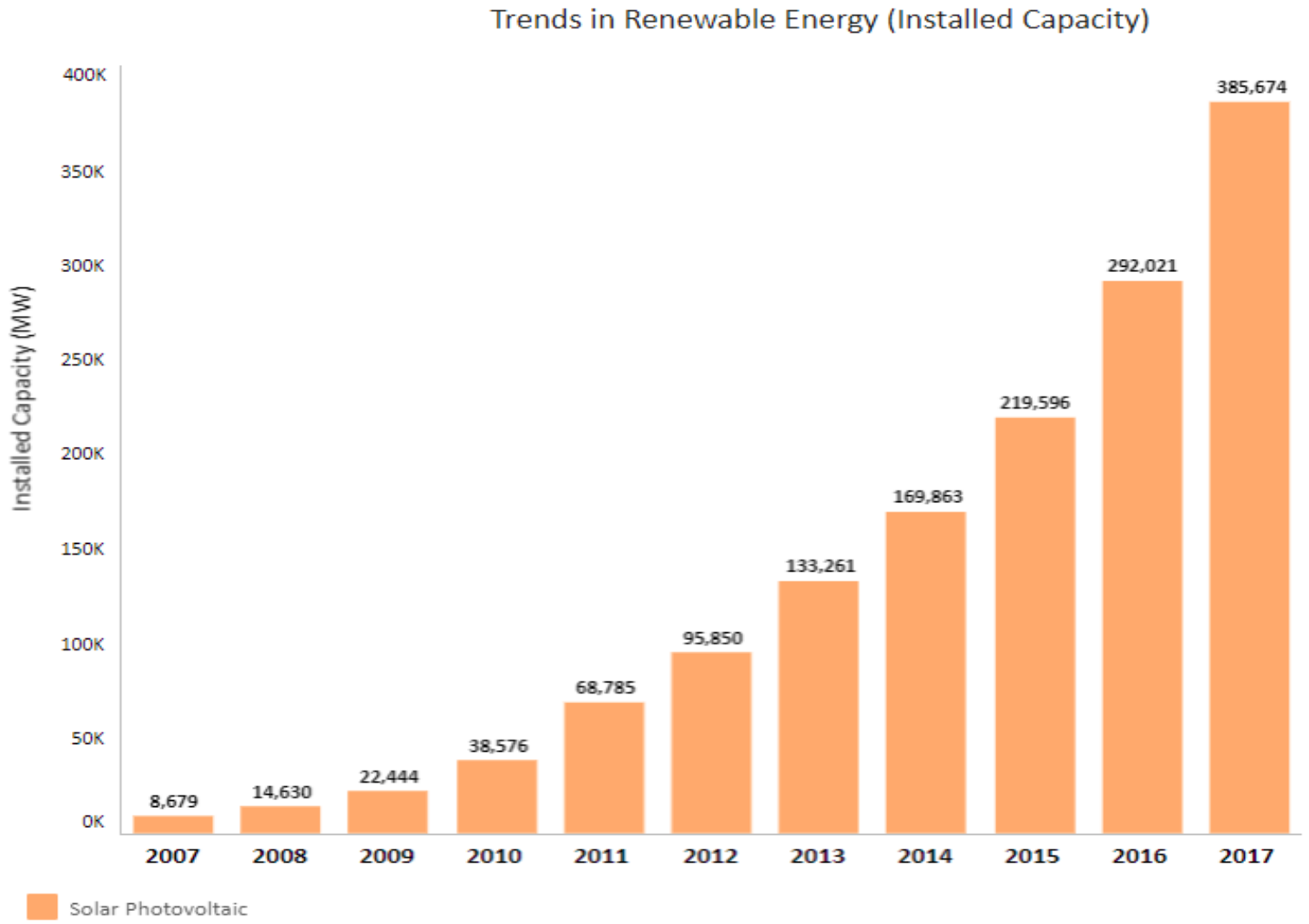
IRENA
International Renewable Energy Agency



Boosting Solar PV Market – The role of Quality Infrastructure

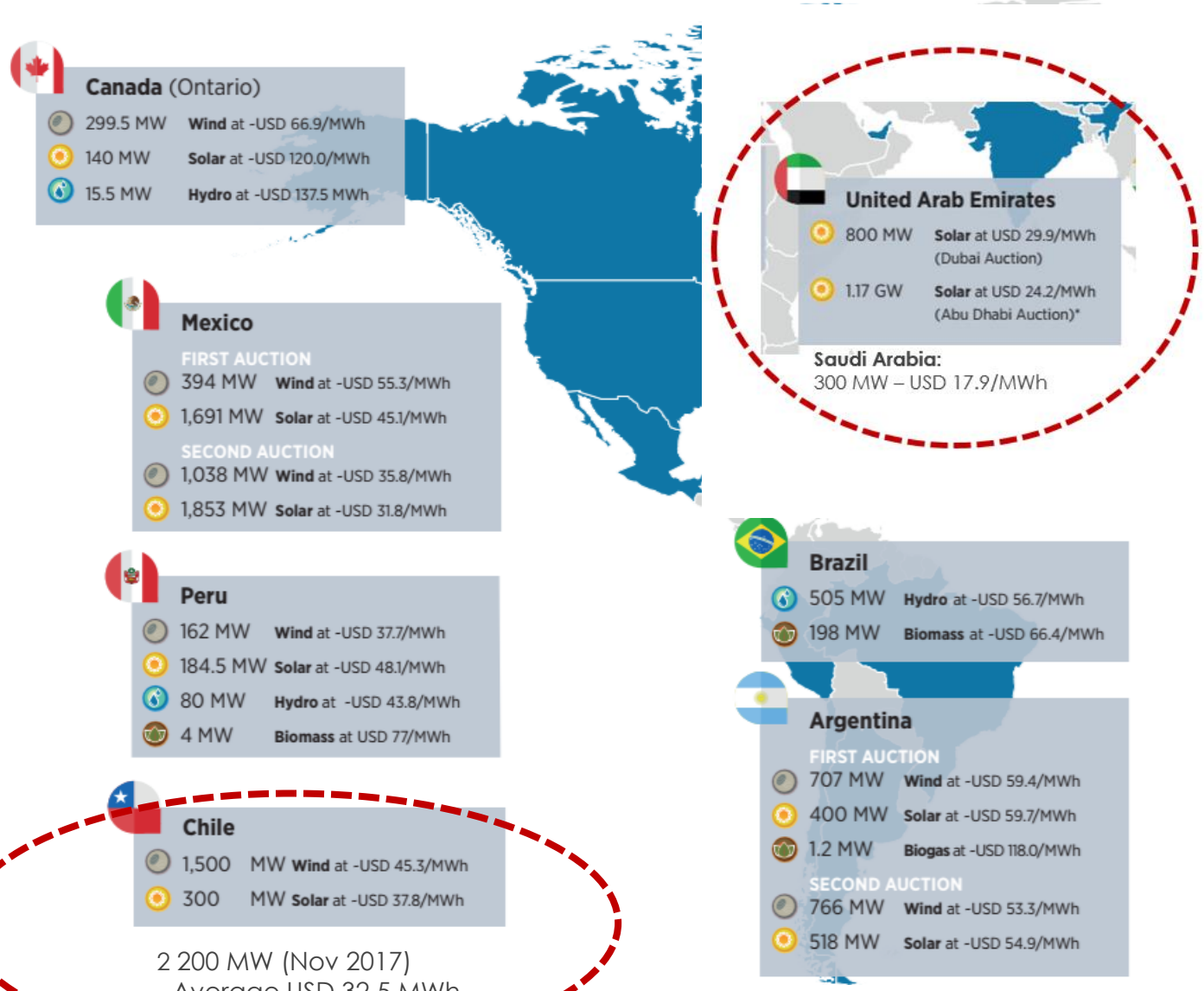
QUALITY AND SUSTAINABILITY OF PV SYSTEMS CONFERENCE
Brussels, Belgium
3 May 2018

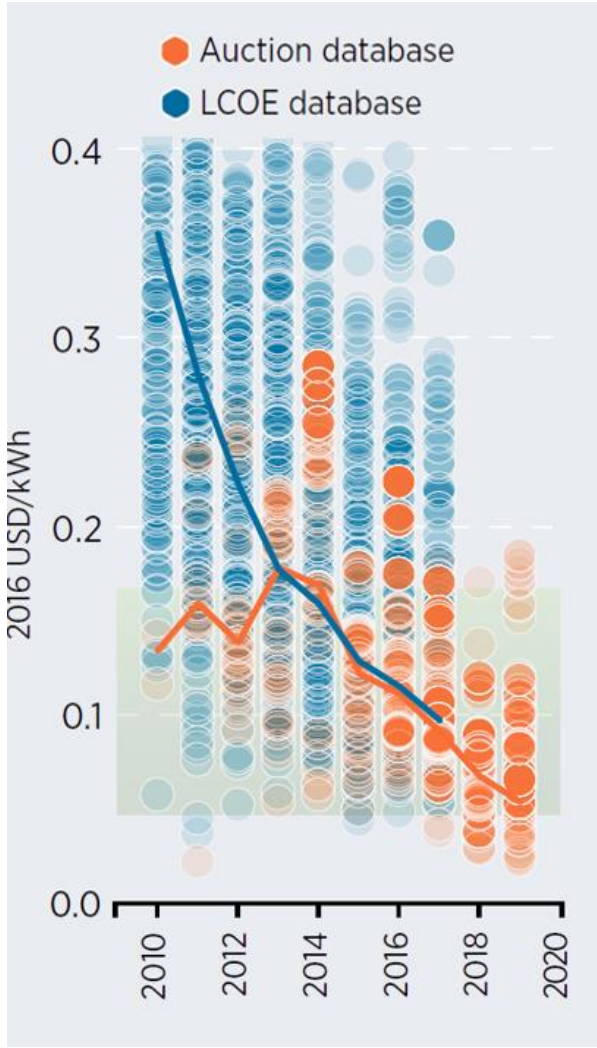
Global solar power investments



2017: 161 billion USD 2030: > 2.5 trillion USD | > 200 billion USD/y

Record PV auction prices – what will be delivered?

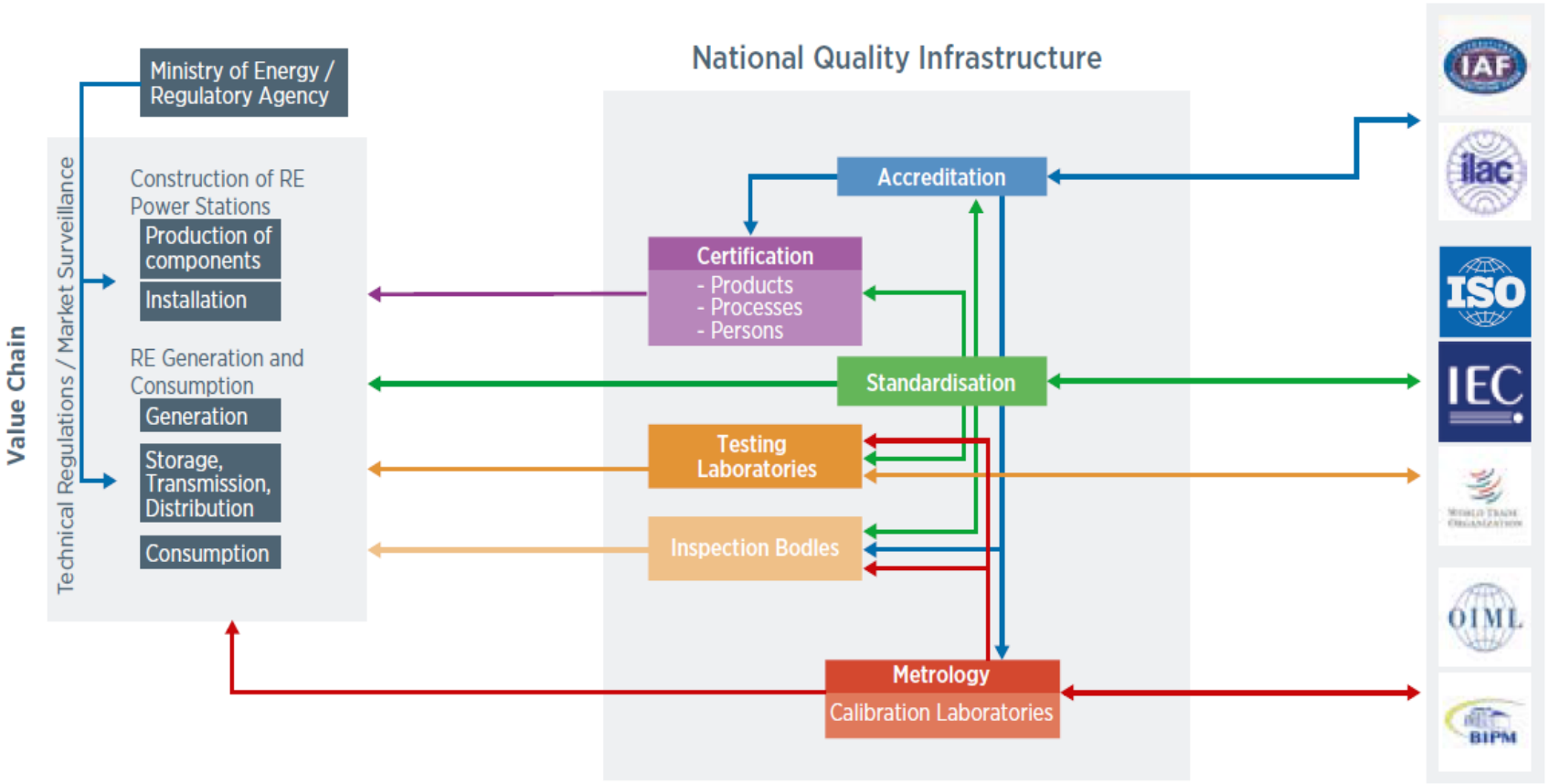




Sources:
IRENA (2018), Renewable Power Generation Costs in 2017
CNE Chile

Quality Infrastructure to mitigate technical risk

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?



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

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"

QI supporting policy-makers

1

POLICY OBJECTIVES

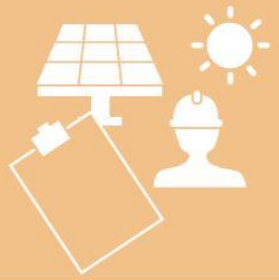
- Economic and affordable photovoltaic systems
- Support development goals
- Reliable photovoltaic systems
- PV integrated in power systems

2

HOW QUALITY INFRASTRUCTURE SUPPORTS THE POLICY OBJECTIVES

- Attracts investment through risk mitigation
- Increases public acceptance
- Encourages efficient services
- Fosters good practices
- Promotes consumer protection

3



WHERE TO APPLY QUALITY INFRASTRUCTURE

- White papers
- Guidelines
- Regulations
- Incentives
- Industry guidebooks
- Vocational training

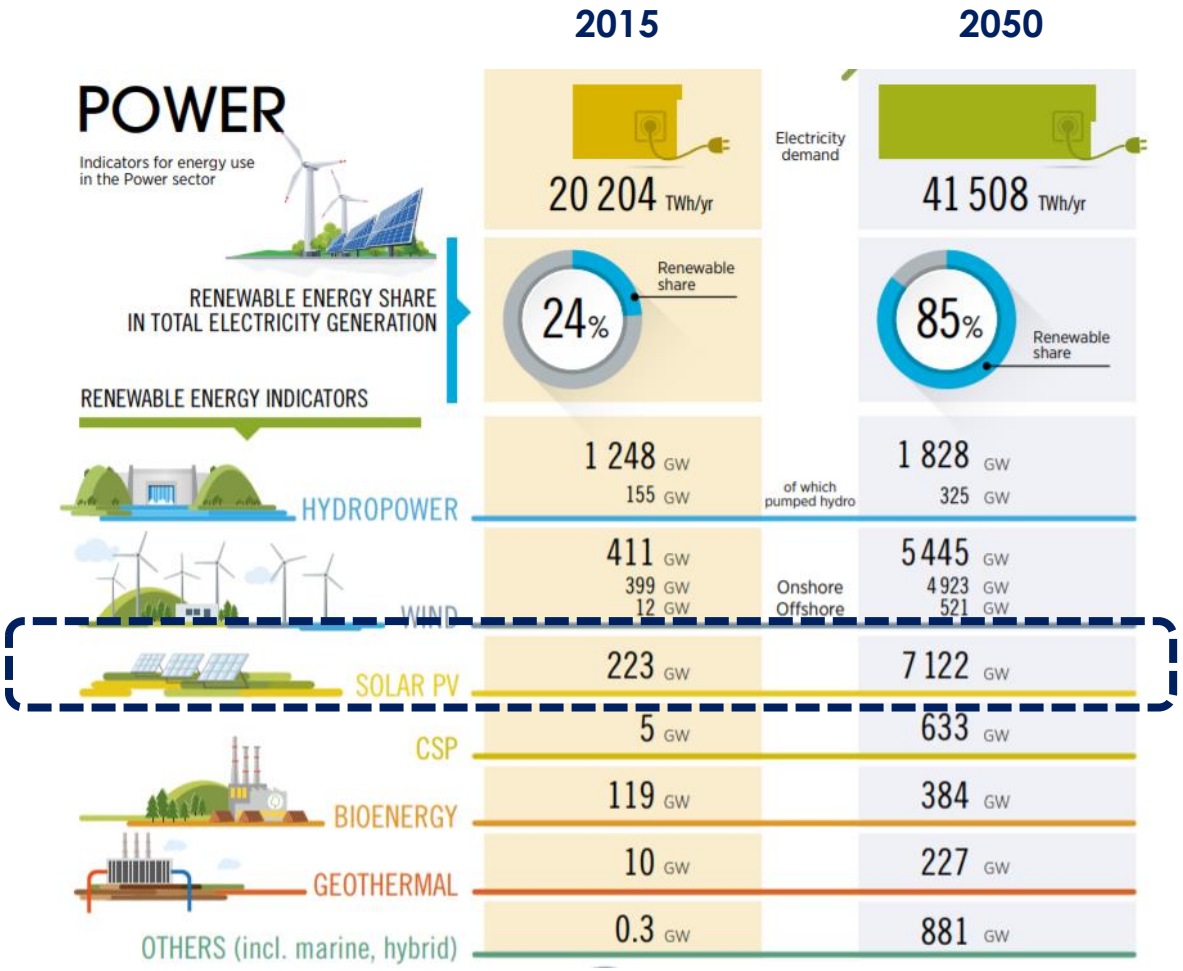
The benefits of QI services outweigh their costs

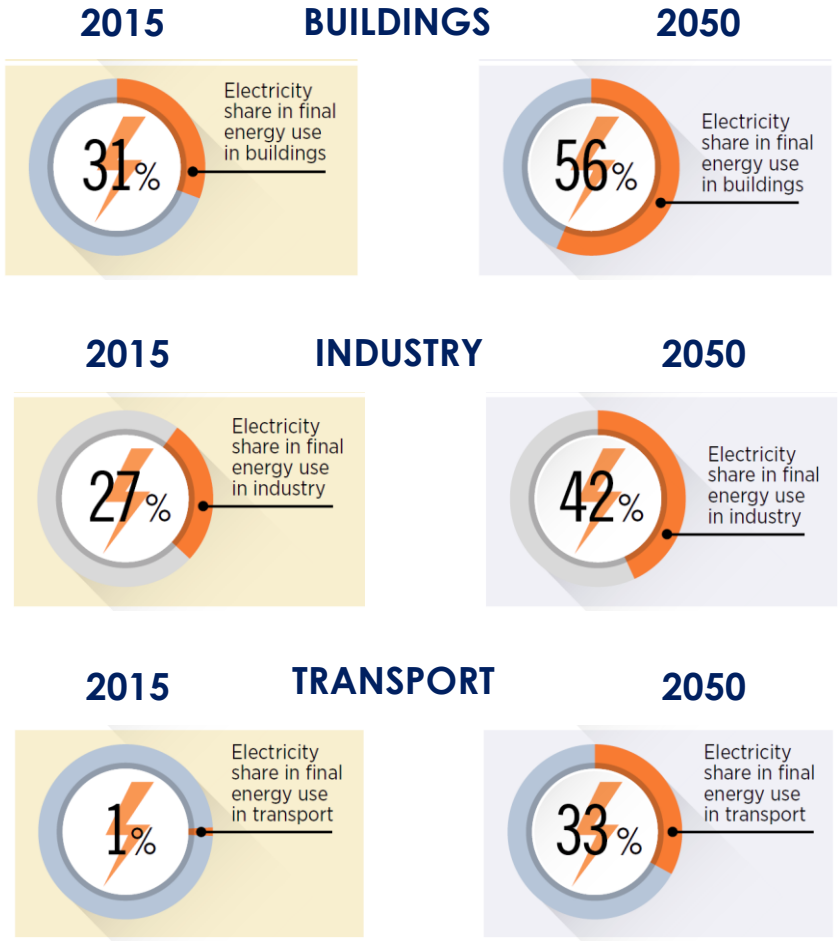
Quality infrastructure service	Cost	Benefit
Development: Solar resource and yield uncertainty		
Energy Production Assessment (EPA) based on measured irradiance data	Measuring local irradiance for at least one year	Reduction of uncertainty in EPA from 8% to 6% leads to an increase in P90 values by 3%. Rewarded through improved loan conditions.
Preconstruction: Prevention of low plant yields		
Batch acceptance testing for wholesale and utility projects	The cost of a batch acceptance test (Typically USD 50 000-55 350 for a 20 megawatt (MW) plant)	A reduction of the degradation rate from 0.75% a year to 0.4–0.6% a year in a project's financial model (Resulting in USD 450 000–1 000 000 of increased revenue over 25 years for a 20 MW plant)
Construction: Performance testing		
Includes independent testing in engineering, procurement and construction contracts on photovoltaic systems performance	The cost of batch testing for a 20 MW plant is USD 276.75– 553.50/MW	Photovoltaic module manufacturers deliver modules exceeding contracted performance by 2–3% when batch testing is announced. (Earning an additional EUR 4 000–6 000/MW a year increased generation for a 20 MW plant) (USD 4 428–6 642/MW/year)
Operation and maintenance		
Potential induced degradation (PID) reduction. Inspections to detect, classify and mitigate PID effects	Cost of inspection and corrective actions (for a 6 MW plant in Western Europe: EUR 2 500-–4 000/MW) (USD 2 767.5–4 428/MW)	Tackling PID reduces underperformance of 3–5%; however, recovery is not immediate (for the 6 MW plant, EUR 6 000–10 000/MW/year) (USD 6 642–11 070 MW/year)

Source: IRENA (2017) Boosting Solar PV Markets: the role of quality infrastructure

Global electricity sector for the energy transformation

Share of electricity in TFEC needs to double between 2015 and 2050 with renewables generating 85%
Solar PV highest installed capacity: Global 7 000 GW by 2050
EU28 650 GW by 2050 (270 GW by 2030)





Source: IRENA (2018), Global Energy Transformation: A roadmap to 2050

Weather conditions in LAC affecting PV systems

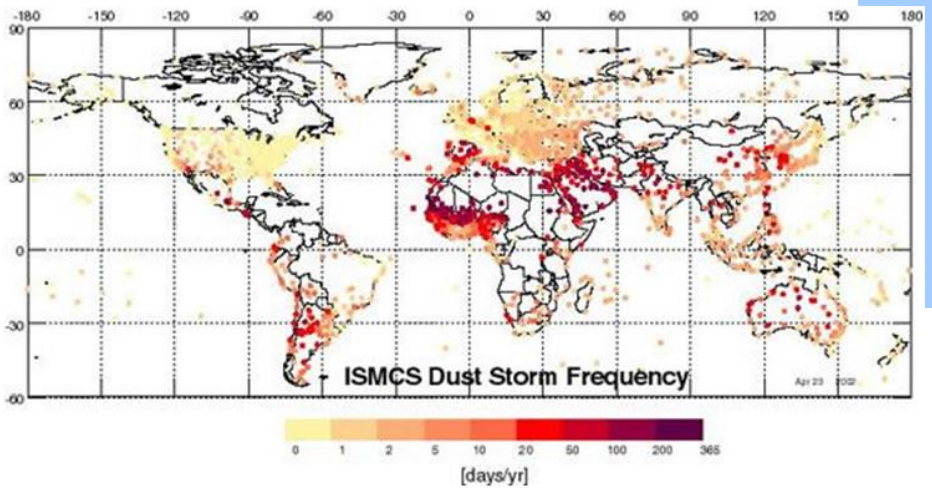
High irradiation level and temperature variations in Chilean Altiplano and northern México:

DNI up to 3800 / 3000 kWh/m^2/year

UV-A/B up to 190 / 150 kWh/m^2/year

Temperature variations:
Up to 45° C

Frequent dust winds (soiling!) in Atacama and Sonoran Desert



Caribbean: risk of hurricanes and tropical storms, causing inundations, erosion, etc.

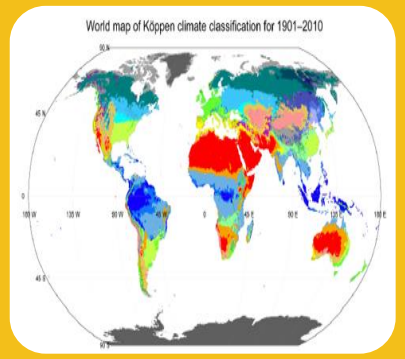
High humidity and atmospheric corrosion on the NE Brazilian coast and the Caribbean

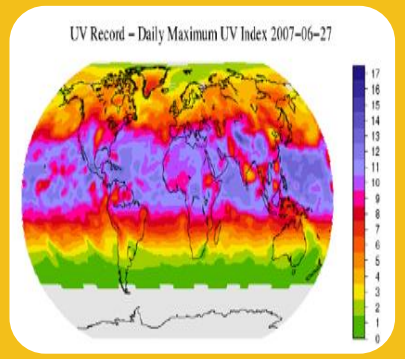
(SolarGIS, 2017)

(Wiki-Solar, 2017)

Weather conditions Middle East

http://www.eugcc-cleanenergy.net/Solar_Photovoltaic_Testing_Centres_event





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

International Standards addressing climatic conditions

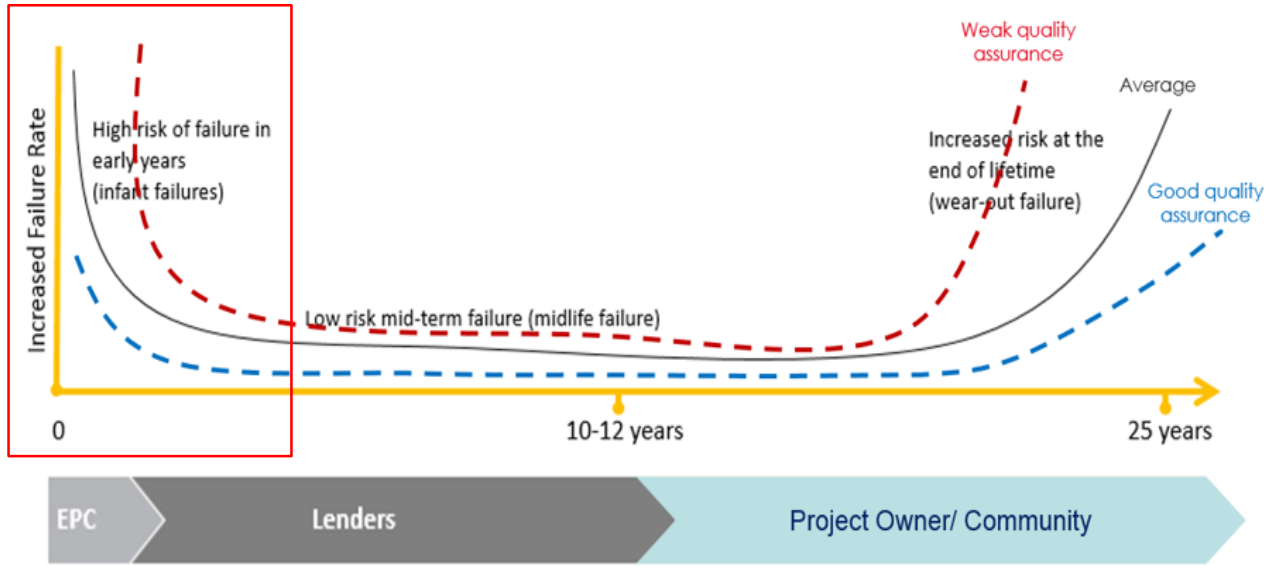
Module classification:

- IEC 61215 (examples)
  - 60 kWh/m^2 irradiation
  - 15 kWh/m^2 UV-A/B
  - -40 to 85° C (200 cycles)
  - 1000h: 85° C / 85% hum.
  - 20h: 85° C / 85% hum. -> -40 ° C
  - 3 cycles of 2400 Pa
  - Ice balls with d=12,5 mm and v=35 mm/s to 27,2 m/s

BOS classification:

- IEC 62093
  - Test similar to IEC 61215

IEC 61215/61730



Based on Solar World, 2016
Note: EPC = engineering, procurement and construction.

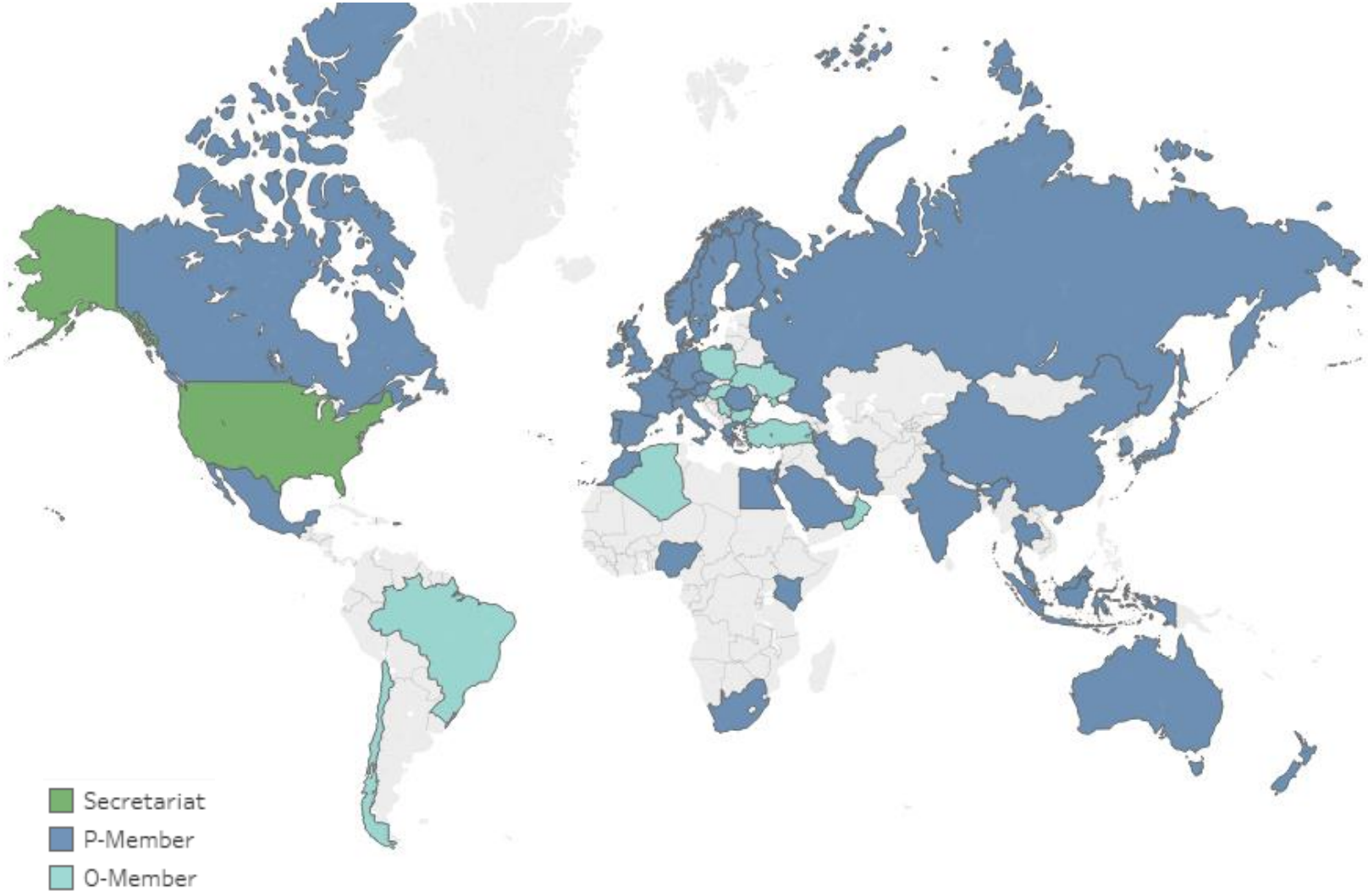
Specific tests:

- IEC 61701/62716 (salt/ammonia corrosion)
- IEC TS 62782 (mechanical load)
- IEC TS 62804 (PID)
- DIN 52348 (sand abrasion test)

Under development:

- IEC 62892: Additional tests to reflect different climates and applications (thermal stress, UV, high humidity); expected in 2018

Europe's engagement in international standardization IEC TC82



-Limited engagement from emerging markets

-Need for engagement in relevant international platforms

- IEC / IECRE
- PVQAT
- IEA PVPS (T13, T12)
- IRENA
- Others

-Work together

- Industry (SolarPower Europe – SolarBankability, SolarUnited)
- R&D institutes
- Financial institutions
- Commercial banks
- Insurance companies
- Policy-makers and regulators
- Communities and final consumers

Source: http://inspire.irena.org/Pages/default.aspx

Take away messages

- We entered into an era of low equipment cost and higher pressure on marginal profits | quality infrastructure is critical to mitigate risks and achieve the **expected LCOE**
- **Cost – benefit** ratio of assuring quality is positive
- **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 markets needs
- Need to **engage emerging markets** and work closer with project developers and R&D bodies to adapt technology and technical requirements
- International and regional **cooperation networks** strengthen and accelerate the development and implementation of QI for PV systems. Leverage on existing initiatives
- **QI supports effectiveness of policies** for PV markets – all white papers should include the role of QI

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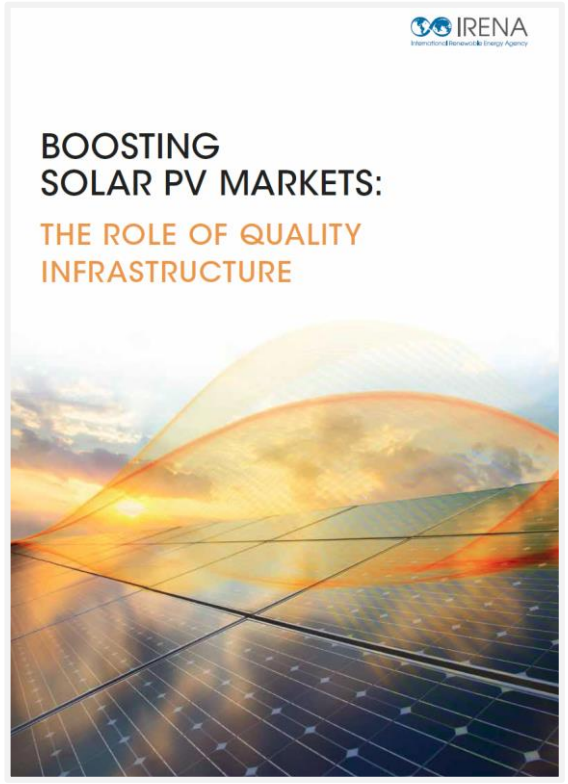

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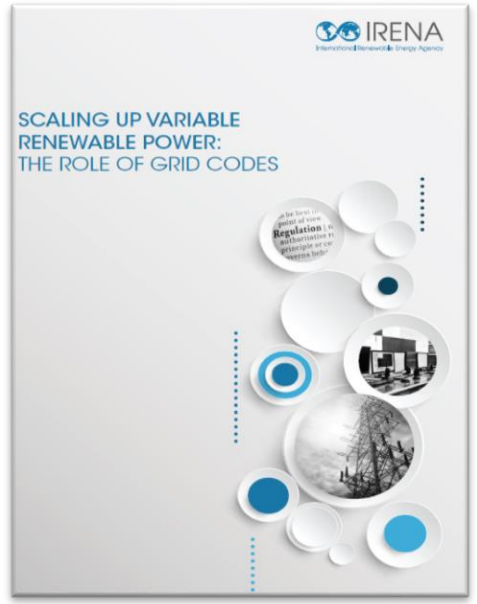

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