



IRENA Innovation Week  
Session: Advancing the frontiers of reliability and quality  
Bankability of PV projects: mitigating technical risk

# TÜV Rheinland 2015 – Facts & Figures.



# Overview – Solar Energy

- More than 30 years experience in the field of solar energy
- Global network of more than 200 solar experts
- More than 12 GW inspected PV plants world Wide (Europe, North America, South America, Central America, Asia and Africa)
- Research and development in the area of power plant optimization and module qualification (characterization and life time assessment)
- Active participation in the important standardization committees



Quality Assurance and Risk  
Management of Photovoltaic Projects

# Quality Weaknesses in the PV Market

**Product quality is often not given**  
due to the market situation (high competition, low financial recourses, personnel fluctuation, change of suppliers, lack of quality assurance, differences among certifiers and labs)

**Low quality of planning and installation**  
use of sub- and sub-subcontractors, high competition, lack of knowledge and experience, tight commissioning deadlines, weak quality assurance during construction

**How to solve these problems?**

**Project assumptions and feasibility are imprecise**

energy yield prediction too optimistic, cleaning concept missing or insufficient, lack of fixed contract requirements, lack of experience,

**Bankability of involved parties often not given**

unstable market situation, choose of Tier-1 manufacturers is not only a criteria for bankability, warranties are often not reliable

# Quality Monitor 2015: Basis and Results of TÜV Rheinland Study

## Basis of the study:

- TÜV Rheinland has more than 12 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

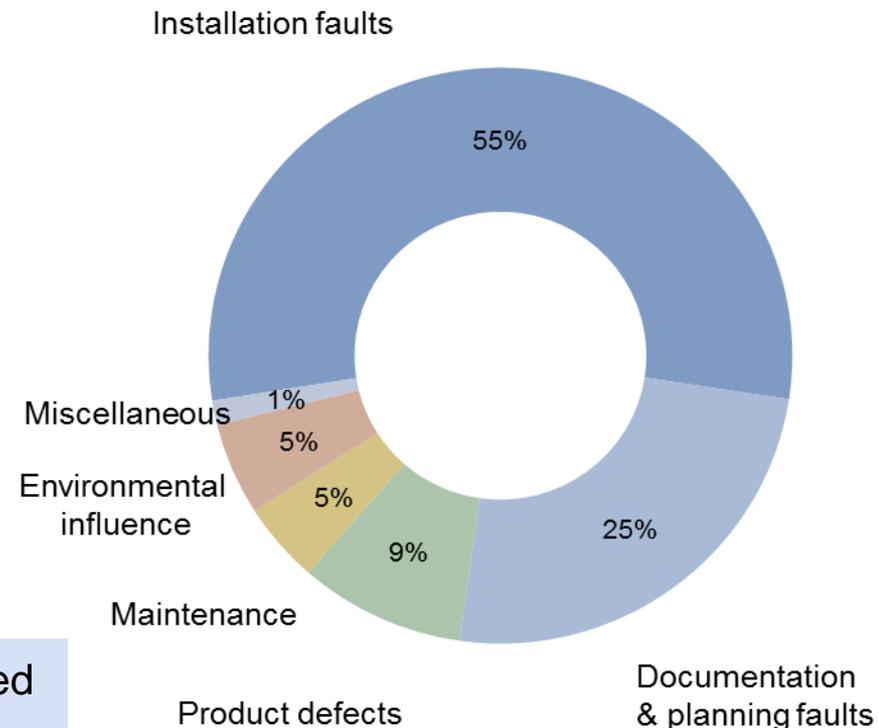
# Cause of Defects in PV Power Plants

Results of TÜV Rheinland internal Study Data (2014/ Q1. 2015)

2014/ Q1.2015

## Main findings:

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

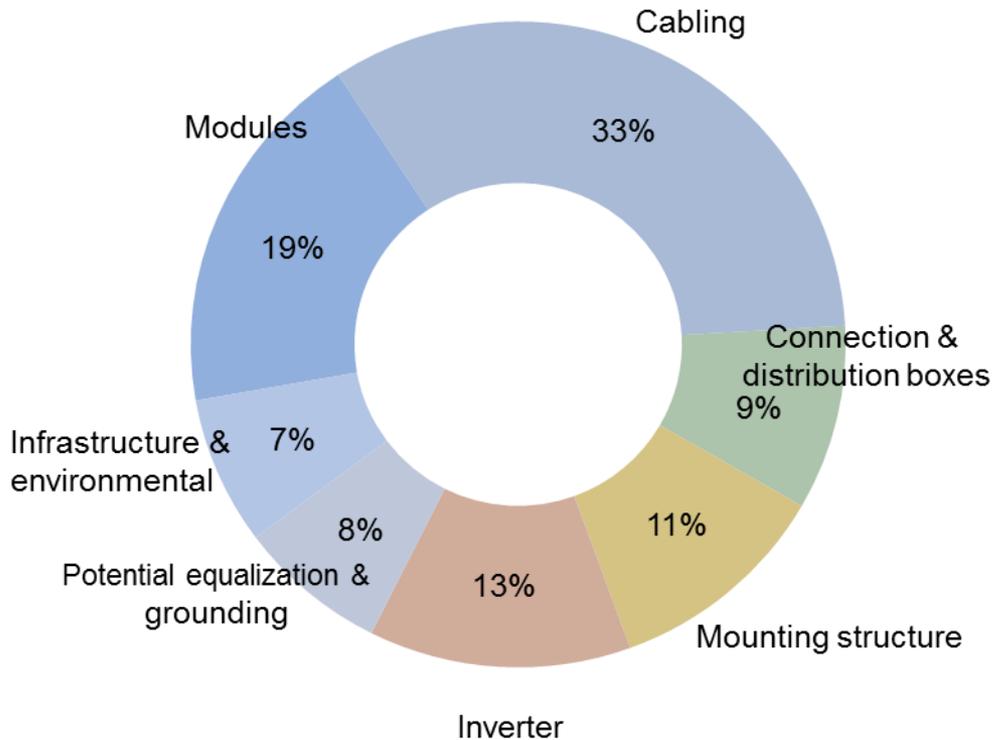


- Systematic quality assurance is required
- Plant inspections and maintenance are important

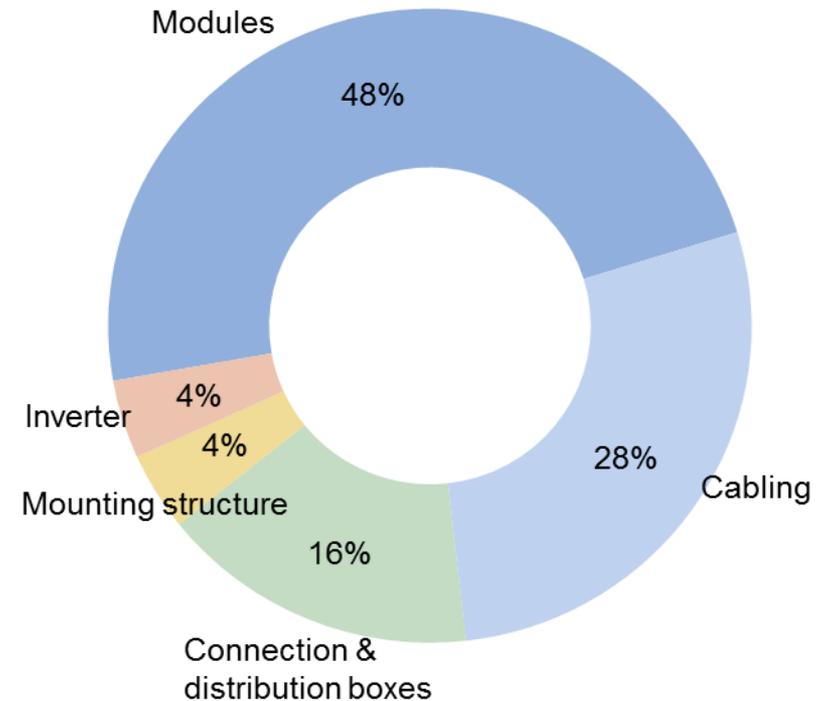
# Particularly serious Defects in PV Power Plants

"Immediate Action to prevent Plant breakdown is needed"

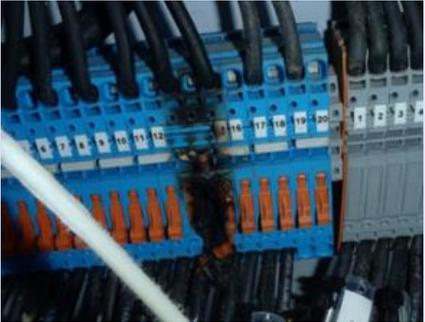
2012 / 2013



2014 / Q1. 2015



# Examples for Particularly Serious Defects (PSD), Serious Defects (SD) and Less Serious Defects (LSD)

Components	Category	Defects	Example
Modules	PSD	PID – Potential Induced Degradation Undervalued power, glass breakage, delamination	 <p>Delamination</p>
	SD	Burned junction box Defective backsheet	
	LSD	Browning, serious micro cracks Module frame damaged Snail tracks	
Inverter	PSD	Out of operation	
	SD	Insulation faults Not suitable for local environmental conditions	
	LSD	Inverter door without filter	
Connection & distribution boxes	PSD	Missing Cover	 <p>Burned Connection</p>
	SD	Burned connection, surge protector out of operation Water in distribution box Wrong fuse rating	
	LSD	Missing labels Dirt inside	

# Examples for Particularly Serious Defects (PSD), Serious Defects (SD) and Less Serious Defects (LSD)

Components	Category	Defects	Example
Mounting structures	PSD	Unstable, damaged	 <p>Bad foundation</p>
	SD	Weak anchorage Missing edge protection Screw not fixed in place Module clamp not fixed	
	LSD	Corrosion	
Cabling	PSD	Connector charred/burned	 <p>Corroded socket/plug</p>
	SD	Damaged cable Different connector type Not UV resistant Improper insulation Wrong dimensioning	
	LSD	Not fixed (loose) routing	
Potential equalisation & grounding	SD	Missing or improperly secured potential equalisation	
	LSD	No corrosion protection	

# Examples for Particularly Serious Defects (PSD), Serious Defects (SD) and Less Serious Defects (LSD)

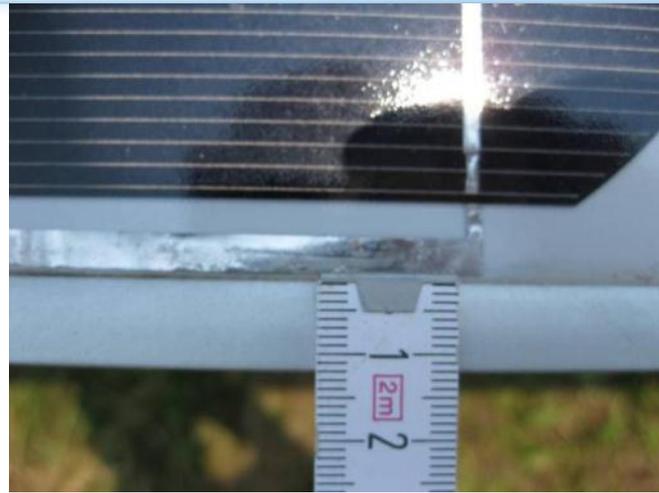
Components	Category	Defects	Example
Weather station	LSD	No maintenance or calibration logs Wrong location or orientation of sensors	
Infra-structure, environmental influence	SD	Shading	
	LSD	Land-slide due to bad drainage system Fence damaged Refuse at the plant	
Communication & monitoring	SD	No communication link to inverter	
	LSD	Incorrect data transmission	
Transformer station	PSD	Panic lock blocked	
	SD	Insecure access Improper cooling system	
	LSD	Refuse in station	

Shading by vegetation

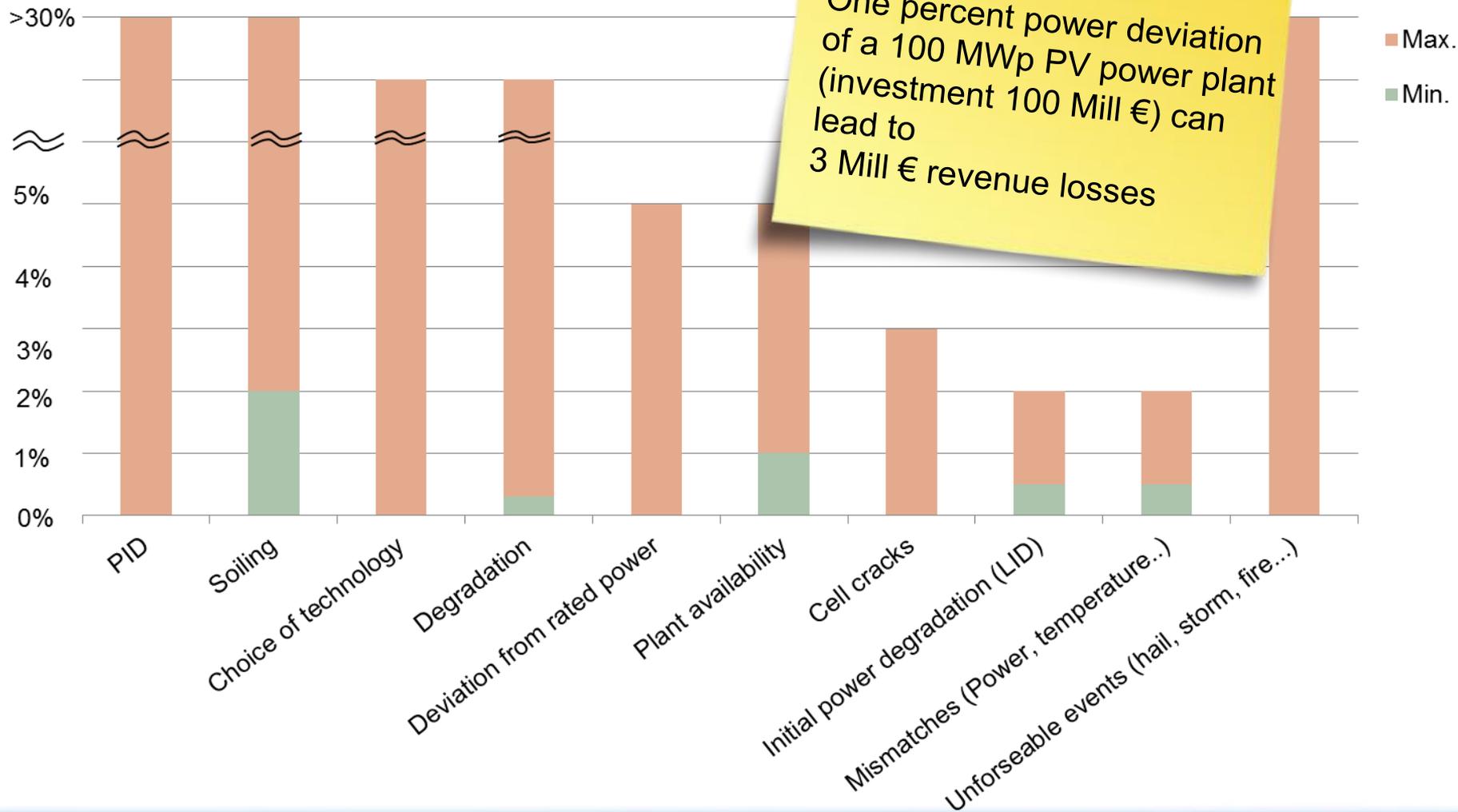
# Failure Examples in PV Systems (O&M, Installation, Foundation, Planning)



# Failure Examples in PV Systems (Product)



# Examples of Yearly Loss of Revenue Factors, Risks



# Technical Risk Quantification and assessment



The background of the slide is a photograph of two children standing on a grassy hill at sunset. The child on the left is holding a large, dark balloon that is illuminated from below, making it glow. The child on the right is holding a smaller, dark balloon. The sky is a mix of deep blue and orange from the setting sun.

Thank you for Attention !

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Selected reference cases: [www.tuv-e3.com/solar](http://www.tuv-e3.com/solar)