

# How to draw a correlation between financial yield improvements, extending system life, standardization, risk mitigation, and rating



**Lakewood, CO • February 27, 2020**

- Who is EXXERGY ?
- Does the general perception correlate to reality?
- Results from insurance claim case study
- Case study I: Financial consequence from deteriorating performance
- Talking about risks and risk mitigation
- Proposed solution: IECRE rating standard
- Case study II: Exemplary financial benefit from rating
- Conclusions

## Acknowledgements

- George Kelly (ARESCA)
- Roger Taylor (EXXERGY)
- Masaaki Yamamichi (RTS)
- ...and all supporters from the PV sector, SolarPower Europe, IEC, and several banks and surety/insurance companies

# EXXERGY is a consulting firm offering a wide range of comprehensive services

Solar power	Power storage	Glass and specialty chemicals	Industrial and specialty gases	Corporate Strategy	<ul style="list-style-type: none"> <li>• Marketing and sales strategy</li> <li>• M&amp;A: Buy Side / Sell Side advisory</li> <li>• Organizational development and structuring</li> <li>• Business due diligence</li> </ul>
				Markets	<ul style="list-style-type: none"> <li>• Market research and analysis</li> <li>• Product development</li> <li>• Sales effectiveness optimization</li> <li>• Operational market entry support</li> <li>• Operational procurement support</li> </ul>
				Finance	<ul style="list-style-type: none"> <li>• Project bankability</li> <li>• Business planning</li> <li>• Financing structures &amp; fund raising</li> <li>• Business assessment</li> <li>• Performance warranty insurance</li> </ul>
				Human Resources	<ul style="list-style-type: none"> <li>• Management assessment</li> <li>• Performance management</li> <li>• Training programs</li> <li>• Recruitment</li> </ul>
				Technology Processes	<ul style="list-style-type: none"> <li>• Manufacturer audits / technical DD</li> <li>• Technology transfer</li> <li>• Product development</li> <li>• Process optimization</li> <li>• Technical feasibility assessments</li> </ul>

EXXERGY ...

... supports / cooperates with several NGO / non-profit organizations



SolarPower Europe



TEXSECURE

Rating Foundation



... etc.

... is active in:

- Europe
- North America
- China
- Japan
- APAC

...soon, also in the Middle East, and...

...later in Central Asia and in Latin America

# On the way from ~2% to 20+%\*, questions on value generation, consolidation pressure and the resulting sustainability continue

- For the past 20 years, the PV sector has enjoyed tremendous volume growth...
- While the first decade (2000 – 2010) showed quality growth, critical undesirable developments have taken place since 2008

Financial crisis 2008  
with default of businesses



Effects remain within the PV industry

Massive risk aversion by all  
businesses on all levels



Continuously increasing  
control over cash flows

Bad reputation of renewable  
industry as “cash burner”



The profitability of most players falls significantly short of  
expectations  
Cash is burnt on several levels throughout the value chain

Extremely cyclical markets  
Unsustainable price declines  
Unexpected performance gaps  
Business insolvencies  
Risk of fading PV-project bankability



**SOLUTION ???**

\* Of worldwide electricity production

# Do stakeholders share a common perception of their part of the overall deal?

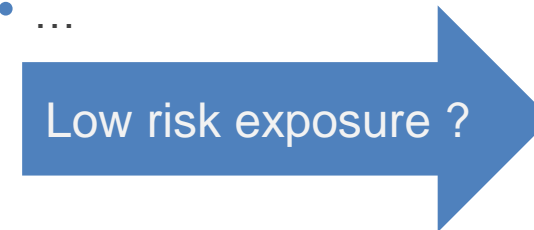
## Possible perception of (some) PV park investors

- PV is a blue chip investment delivering “automatic”, reliable, long term returns
- Quality meets industrial standards
- Business plans are “a sure thing”
- Deal flow is of the essence
- The project will be “flipped” soon, anyway
- ...



## Possible perception of (some) banks

- Typical non-recourse financing structure is non-investment grade
- Risk exposure is mitigated by
  - warranties
  - contingency reserve requirement
  - leverage limits
- ...



## Possible self-perception of (some) manufacturers

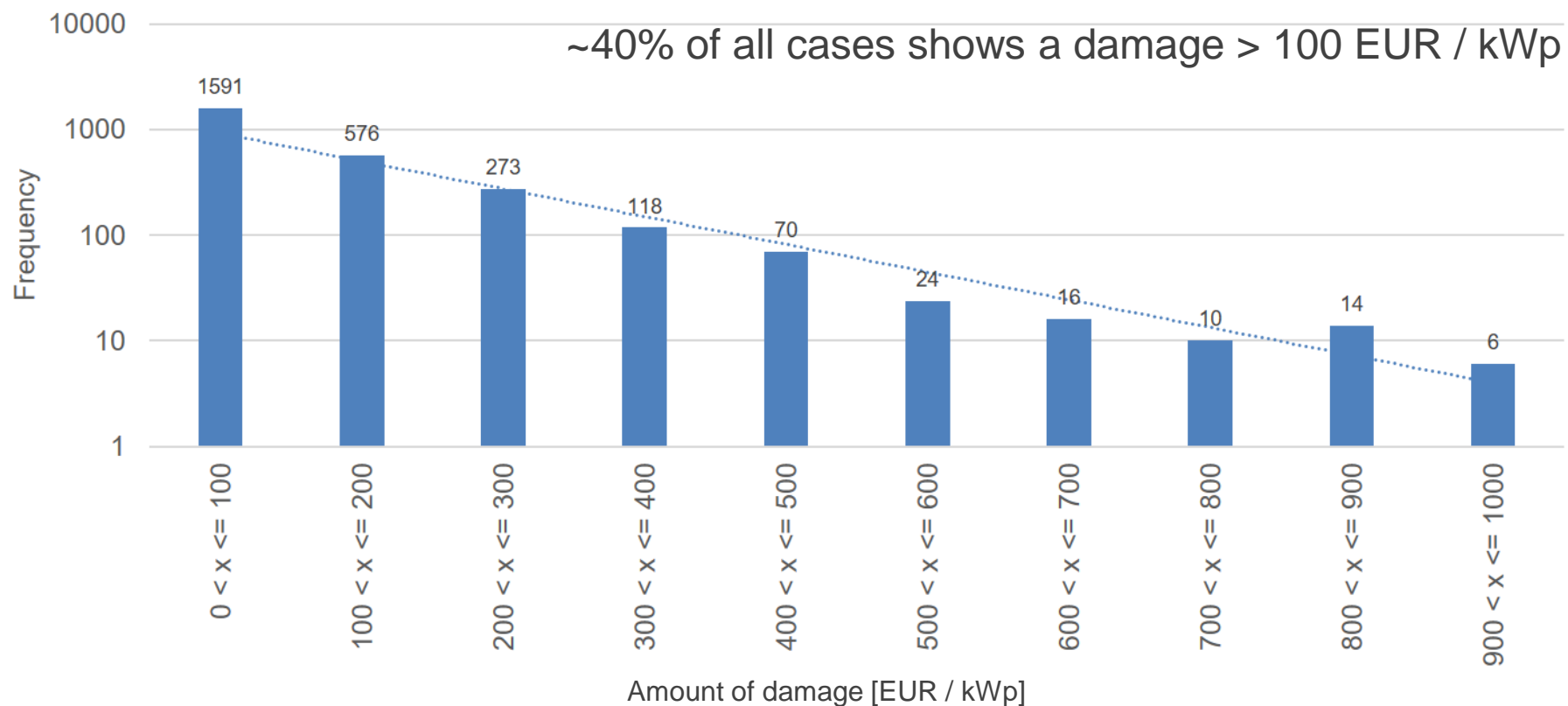
- Price matters, and so does size
- The quality level that the customer accepts is sufficient
- Certificates, warranties, and insurance covers are essentially a marketing tool
- ...

## Possible perception of (some) insurance companies

- Cover may be avoided, e. g.
  - Exclusion clauses (e. g. conforming components)
  - Delayed start of coverage
- Risk mitigation by principle of large policy numbers vs. quality control
- ...

# An insurance claim cases study identifies damage amounts that can be more significant than calculated for...

- More than 3.600 insurance claim cases have been analyzed in total
- Generally, the relative amount of loss trends to decline with increasing system size
- The mainstream amounts of loss spreads over 2 orders of magnitude
- Outliers range up to 3.500 EUR / kWp (incl. consequential damage)

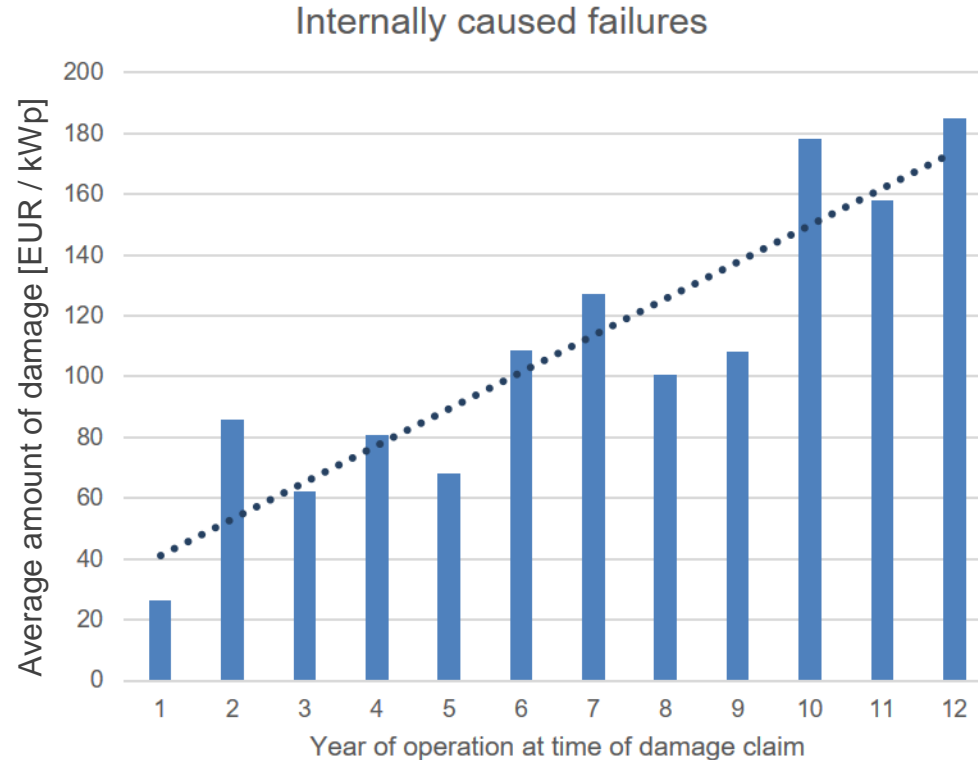
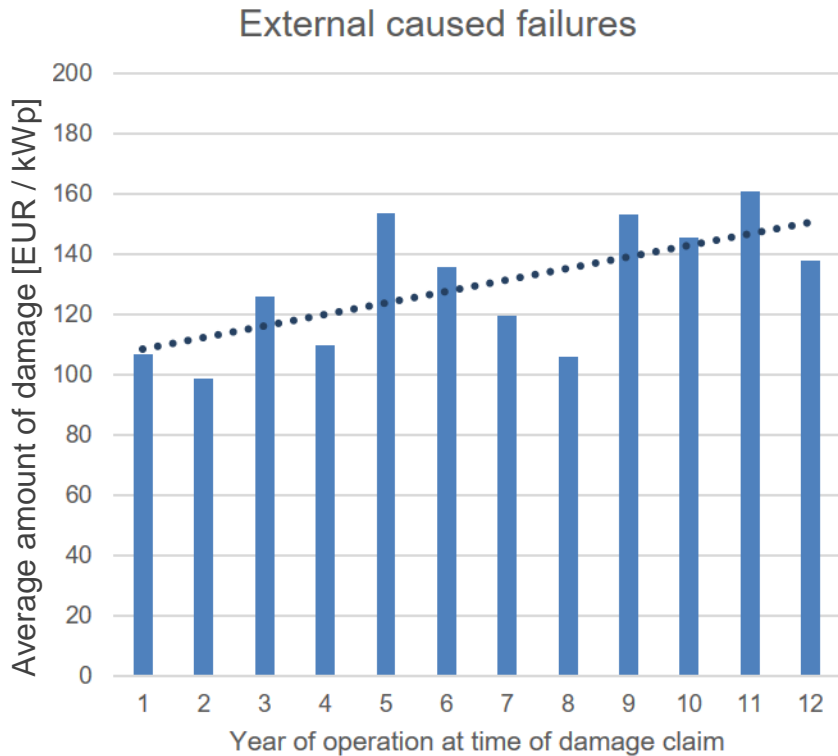


All claim cases Jan 2012 through June 2017 for which amounts of damage have been available

Source: EXXERGY analysis on >3.600 insurance claim cases 2012 - 2017

# ...and for the ~20% of claim cases associated with internal failures, a rising trend correlated to service life seems to be evident

## Average amount of damage over service lifetime



- Externally caused failure: Damage is caused by external factors (hail, lightning strikes, snow loads, theft, marten bites etc.)
- Internally caused failure: Damage is caused by the PV system (20.13% of all cases)

The graphs only reflect such claim cases for which

- (1) the service age of the PV power plant was known at the date of claim and max 12 years and
- (2) the amount of damage covered was >0.

PV power plants with a service life >12 years have not been listed because the data pool did not offer a statistically relevant number of cases.



# As PV cost reductions have slowed down, any equity cash drain caused by corrective actions can no longer be compensated for by lower prices

## PV-park investment:

### Case study I:



- Investment (Capex) 750 US\$/kWp (EPC share, only)
- Power purchase price: 0,125 US\$/kWh
- Assumption on cost for repair reflects estimate on future price reduction of components that is significantly lower than in the past.

Sources: TÜV Rheinland, EXXERGY financial model

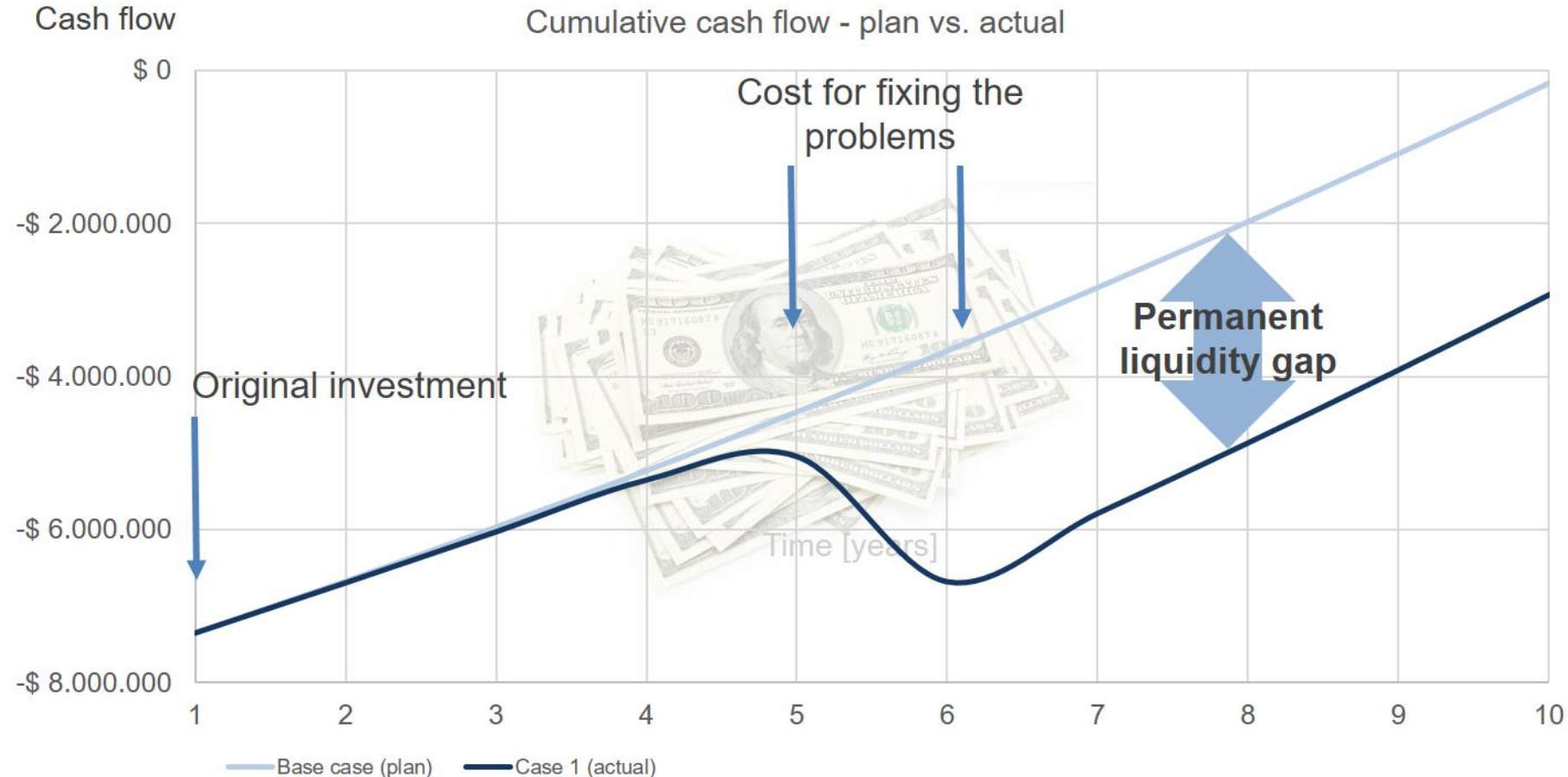
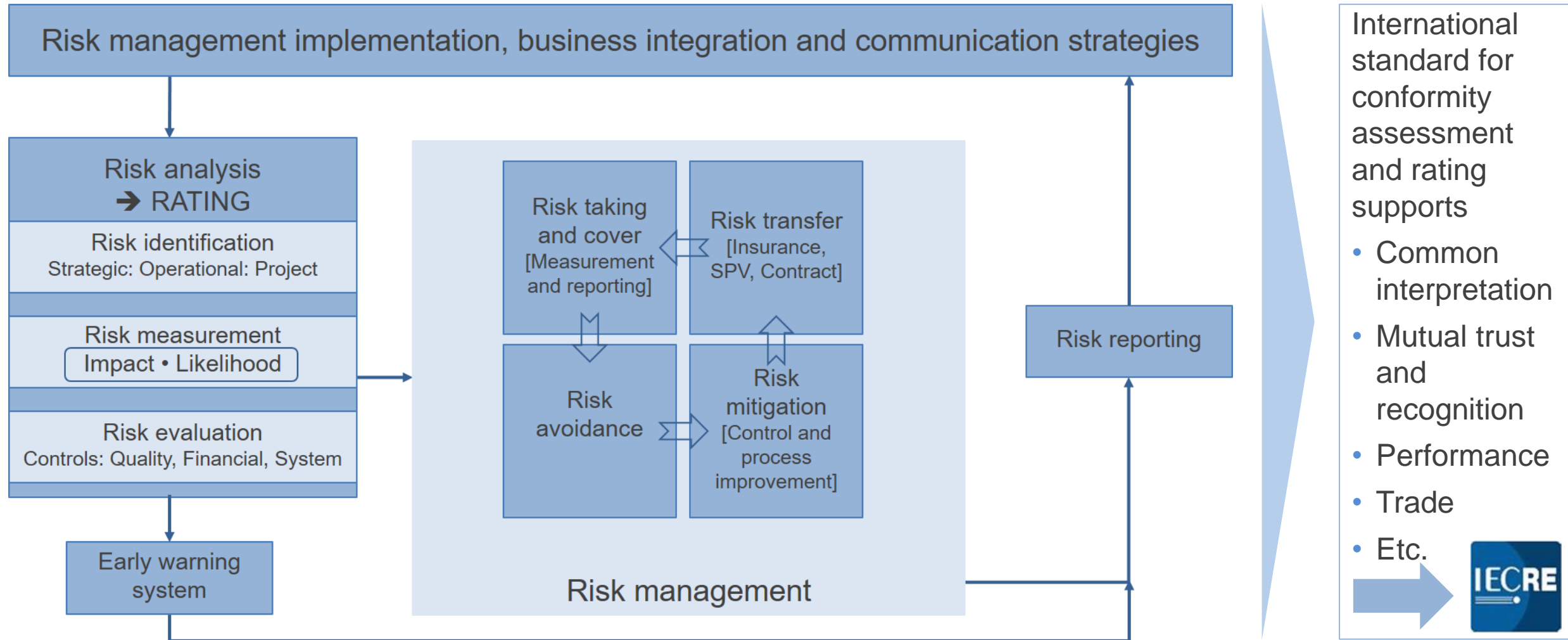


Chart data is illustrative based on a real case

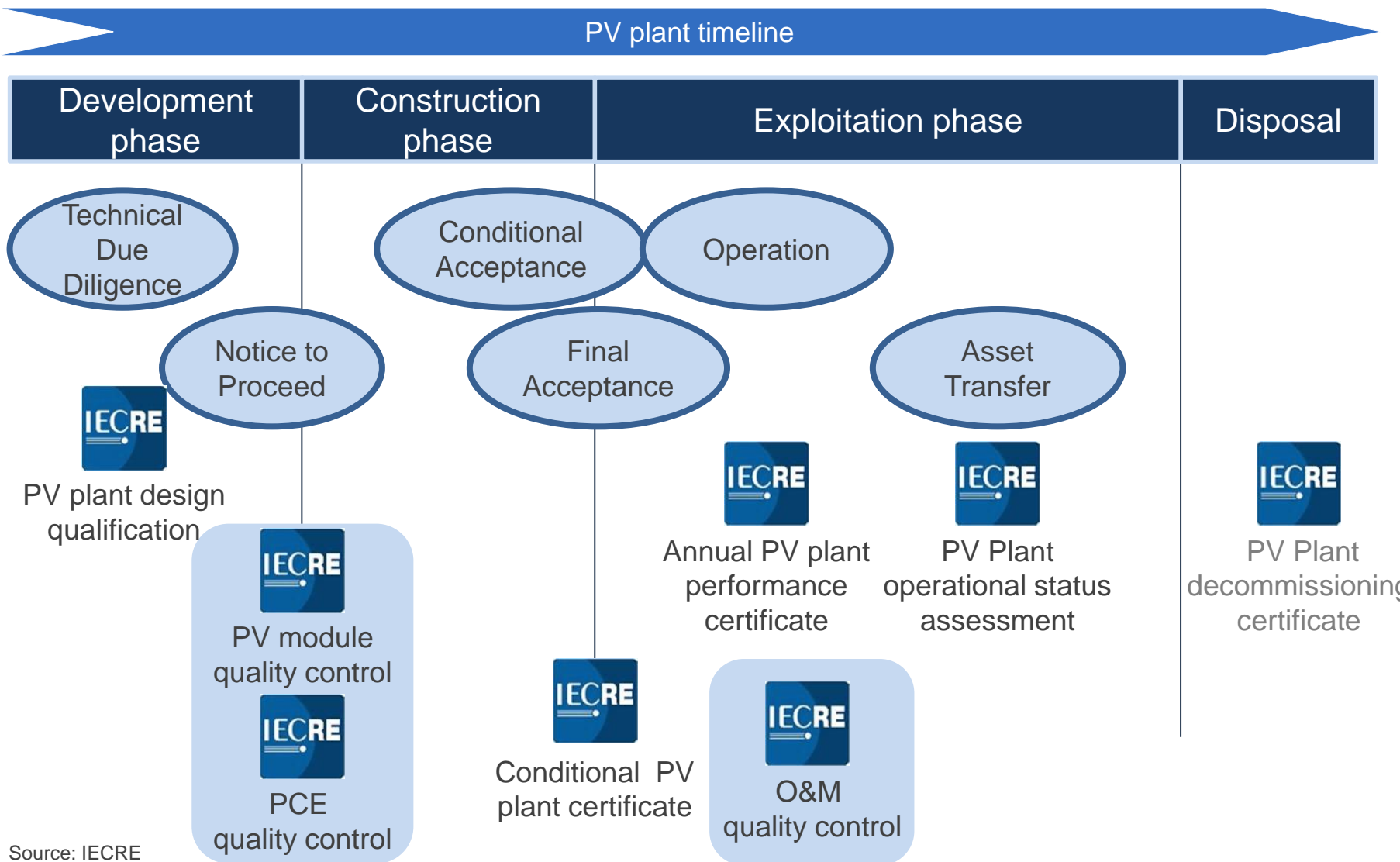


# All this begs a fundamental question: Does the solar sector (and/or the financial sector) need to shift paradigms...?

A solid risk management strategy requires a viable toolset for risk analysis and a basis for common understanding



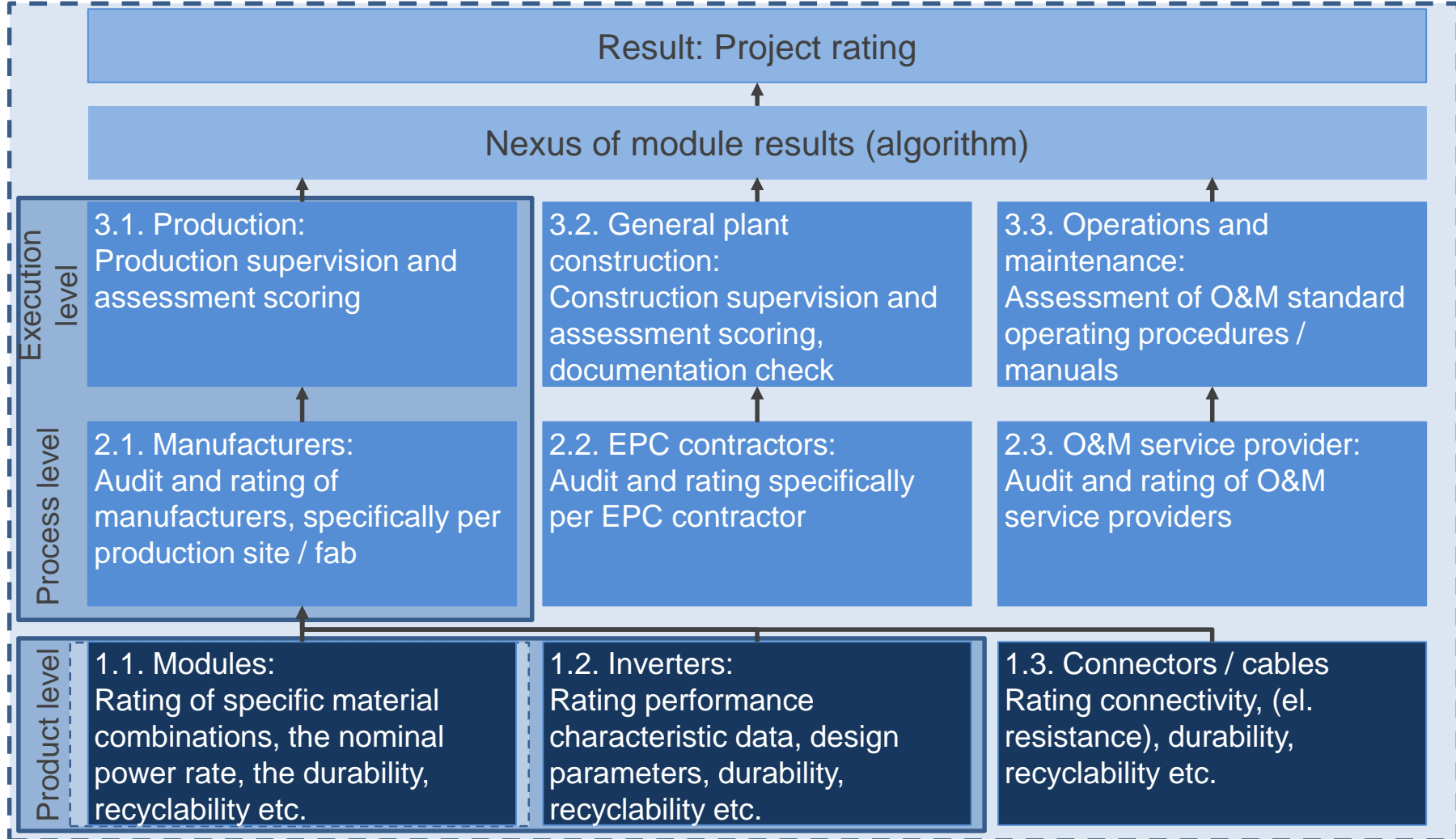
# Responding to quality issues in the field, IECRE was formed to develop and establish an international standard conformity assessment system



- The concept is to offer certification throughout the lifetime of a PV power plant
- Operational documents (ODs) offer a full range of certifications under the IECRE scheme
- IECRE itself does not certify, but administers the system
- Qualified registered IECRE participants are competent to assess RE equipment and projects

Source: IECRE

# To effectively enable managing risks, TEXXECURE is currently developing a rating system within the framework of IECRE



Proposal to EU Commission:

- ➔ Min. BBB-
  - Ecodesign
  - Energy label
- ➔ Min. AA-
  - Ecolabel
  - GPP

- ➔ IECRE is referenced in recent EU commission reports
- ➔ Provisional assignment: IECRE OD-411 series

# The rating points are transformed into a risk exposure which may trigger the calculation of financing and/or insurance premium conditions

## Currently discussed rating ranges, subject to possible adjustments

Rating	Point range		Short description (proposal)
	From	To	
AAA	981	1000	Benchmark standard
AA	921	980	Meets high quality standards
A	861	920	Meets essential quality standards
BBB	801	860	Meets standards to an acceptable level
BB	741	800	Meets standards to a moderate level
B	681	740	Meet standards to a minimum pass level
C	621	680	Fails to meet standards to a major extent
D	≤	620	Completely fails to meet standards



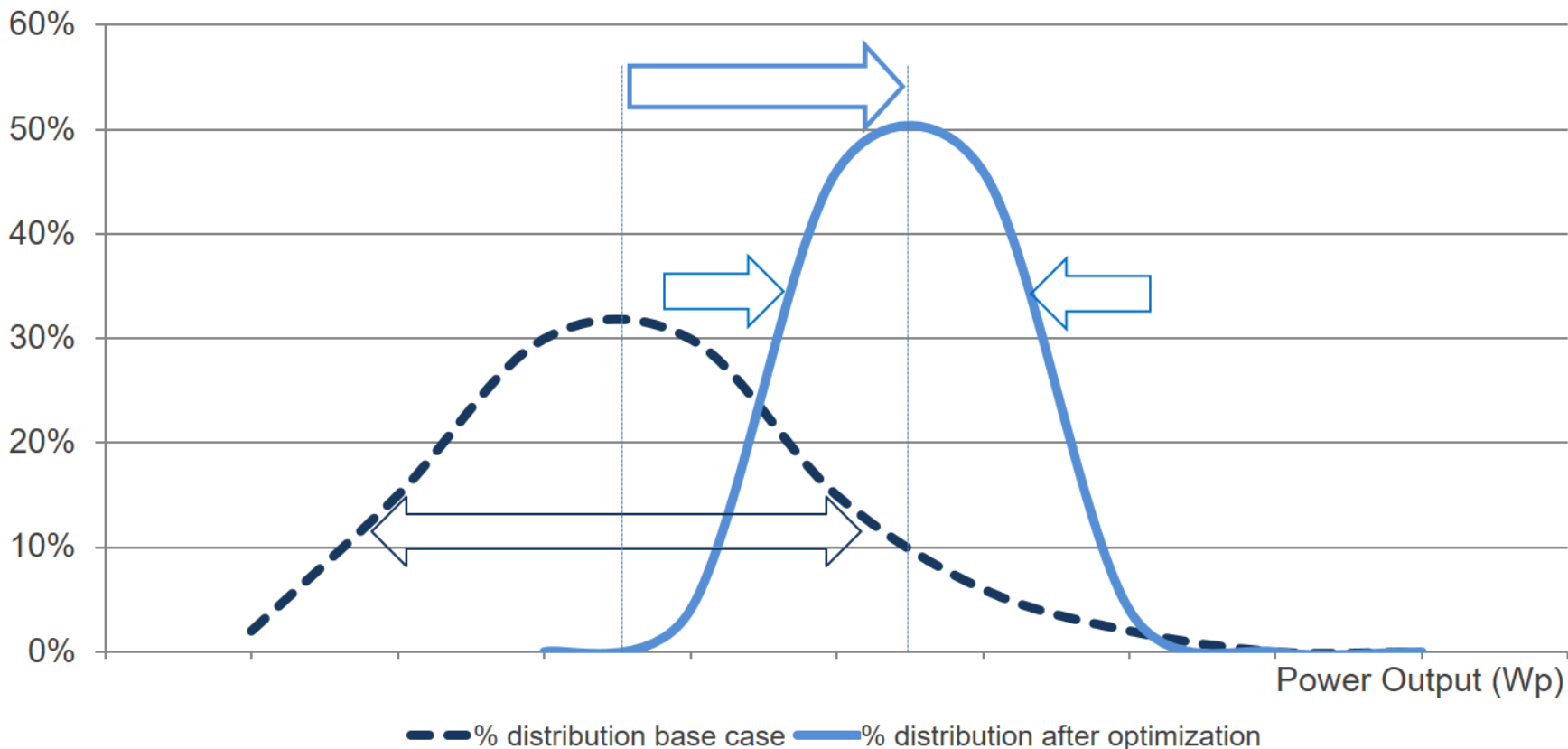
Attracts low risk investors (Investment grade) →	AAA	981	–	1000	"Pass"	Risk low →
	AA	921	–	980		
	A	861	–	920		
Attracts medium risk investors →	BBB	801	–	860	"Conditional pass"	Risk medium →
	BB	741	–	800		
Attracts high risk investors (Non-investment grade) →	B	681	–	740	"Fail"	Risk high →
	C	621	–	680		
No certificate issued (report, only)	D	≤		620		No acceptance Risk too high →

# Besides just costs, conducting a thorough rating project during the inception phase can result in significant yield improvements

- Rating round 1: BB+ → Shortfall identification during unbiased production / construction situation and lower rating
- Rating cycle 2: Work process improvements resulted in better system performance and in improved rating → A

## Case study II:

PV module power output distribution in % before and after corrective actions following a rating and re-rating project

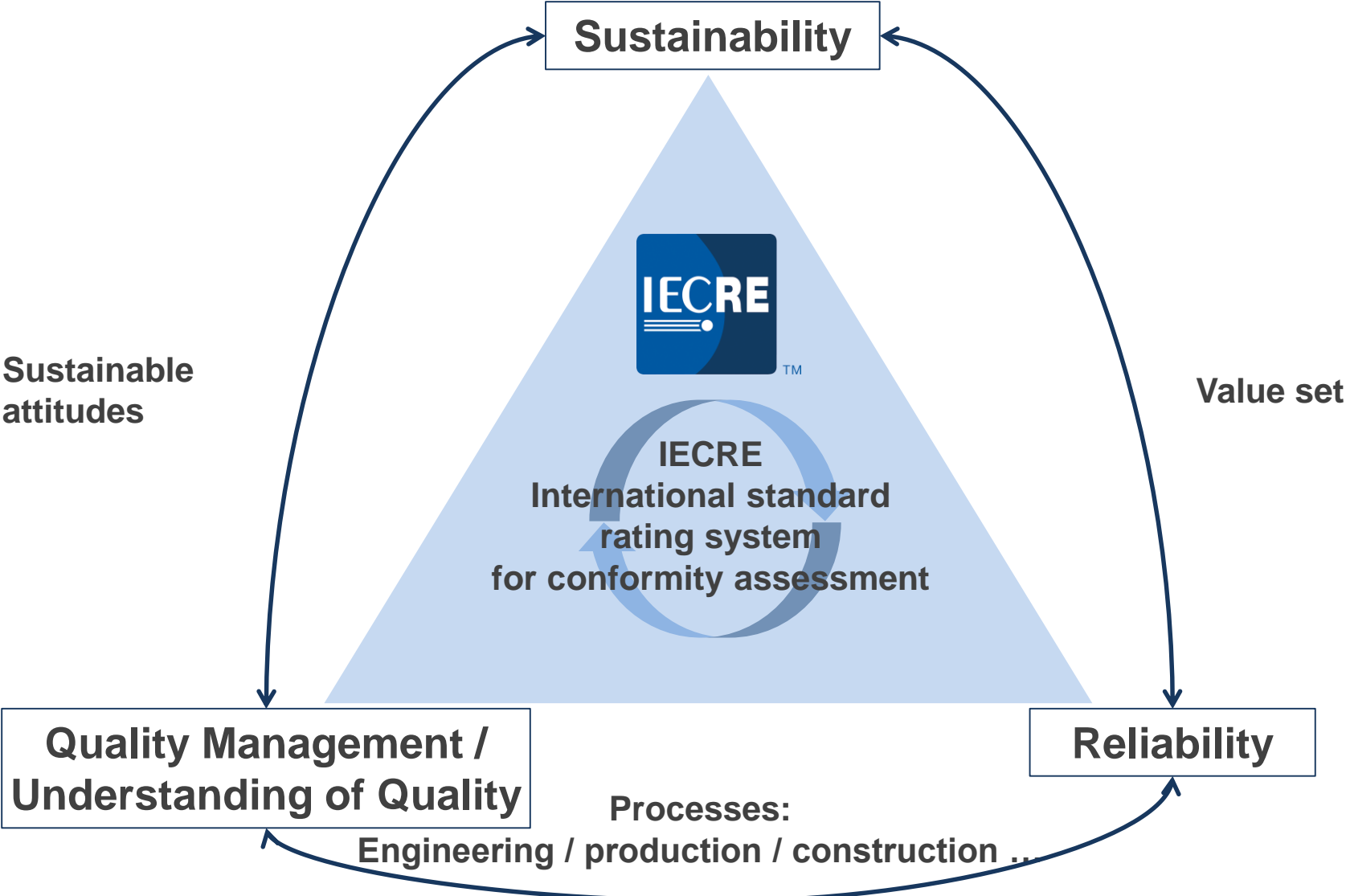


### Results:

- ~ 550,000 modules measured (~160 MWp)
- Rating improved from BB+ to A
- Productivity improved by >5%!
- Enhanced project bankability

Chart data is illustrative based on a real case

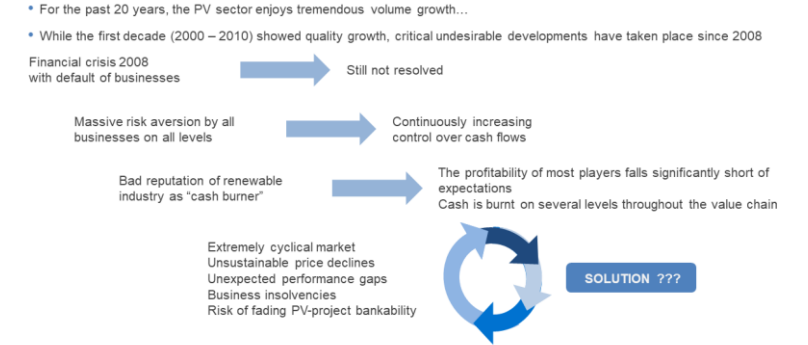
# In a nutshell, the rating system will become an integral component to the “magic triangle”



# Changing to a quality and value paradigm will enable the PV sector to pave the way in pursuit to grow towards the next order of magnitude

- The PV sector is facing constant, recurring, critical pressure points
  - Market cycles
  - Price races to the bottom and resulting cost cutting on projects
  - Constant dashes to meet critical timelines
  - Resulting quality issues
  - Etc. ...

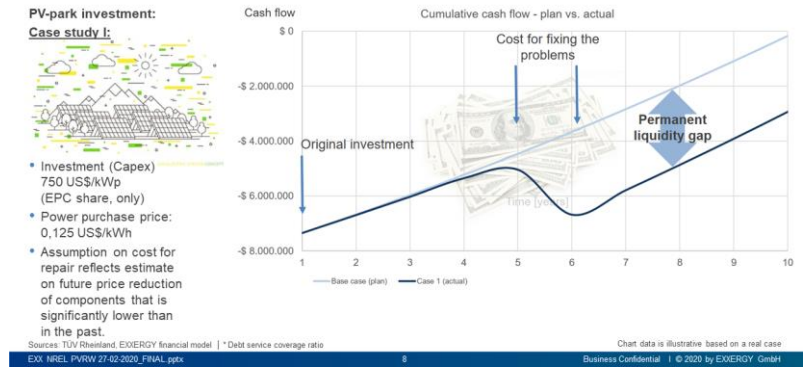
## The PV sector grows in volume – while questions on value generation and the resulting consolidation pressure continue



## Reality check

- Plan is never actual – however, increasing performance gaps in PV threaten the viability of the sector ...as well as the success of the energy transition towards affordable power
- LCOE is already lower than for thermal power plants or for wind turbines
  - ➔ Tapping real cost reduction potential is generally good
  - ➔ Business health is vital
  - ➔ **There is no real need for a continued price race to the bottom at the expense of reliability and sustainability**

## As the cost reductions from the past have slowed down, any equity cash drain resulting from corrective actions can no longer be compensated for





# Risk mitigation by applying a thorough rating system and yield optimization turn out to be two sides of the same coin

The rating points are transformed into a risk exposure which may trigger the calculation of financing and/or insurance premium conditions



Currently discussed rating ranges, subject to possible adjustments

Rating	Point range	Short description (proposal)
AAA	981 - 1000	Benchmark standard
AA	921 - 980	Meets high quality standards
A	861 - 920	Meets essential quality standards
BBB	801 - 860	Meets standards to an acceptable level
BB	741 - 800	Meets standards to a moderate level
B	681 - 740	Meet standards to a minimum pass level
C	621 - 680	Fails to meet standards to a major extent
D	≤ 620	Completely fails to meet standards

Attracts low risk investors (Investment grade)	→	AAA 981 - 1000	Risk low
Attracts medium risk investors	→	AA 921 - 980	"Pass"
Attracts high risk investors (Non-investment grade)	→	A 861 - 920	Risk medium
No certificate issued (report, only)	→	BBB 801 - 860	"Conditional pass"
	→	BB 741 - 800	Risk high
	→	B 681 - 740	"Fail"
	→	C 621 - 680	No acceptance
	→	D ≤ 620	Risk too high



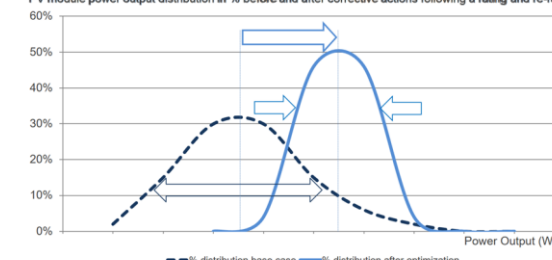
Besides just costs, conducting a thorough rating project during the inception phase can result in significant yield improvements



- Rating round 1: BB+ → Shortfall identification during unbiased production / construction situation and lower rating
- Rating cycle 2: Work process improvements resulted in better system performance and in improved rating → A

### Case study II:

PV module power output distribution in % before and after corrective actions following a rating and re-rating project



- Results:
- Rating improved from BB+ to A
  - Productivity improved by >5%!
  - Enhanced project bankability

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## Solution

- **Consistent, quantifiable classification** of the risk exposure and the expected performance of a PV power plant
- The costs of **thorough quality control** easily pays back through improved lifetime performance
- Improvements resulting from applying the rating system approach can result in **significant yield improvements**
- Current status of the rating system development status:
  - TEXSECURE Rating Foundation continues to raise funds and the development process has started → **Sponsors are welcome**
  - Expected timeframe for market introduction of first elements: Q1/2021

# Risk mitigation by applying a thorough rating system and yield optimization turn out to be two sides of the same coin

**Solid rating enables high quality oriented investors to leverage their competitive advantage because it is predictive...as opposed to finding out problems later**

- Alignment of the technical assessment quality:
  - Clearly defined requirements, policies, and procedures for certification bodies (CB) and inspection bodies (IB)
    - Consistency and comparability → Mutual recognition
    - Credibility of the standardization effort
- Acceptance by the financial sector:
  - Selected players are involved in the rating system development process
  - Increased confidence
    - Better access to capital and to viable insurance solutions
  - Investor groups with different risk appetites may be addressed
    - Rating will allow differentiation as it provides risk assessment guidance
  - Rating system supports investors focusing on the secondary market
    - Clear guideline towards the (technical and financial) performance and risk profile
- High quality stakeholders can leverage part of the net present value advantage to demand better selling prices
  - Healthy business
  - **Healthy and sustainable development for the solar PV sector**



# Thank you for your attention !

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## Funds & contributions welcome:



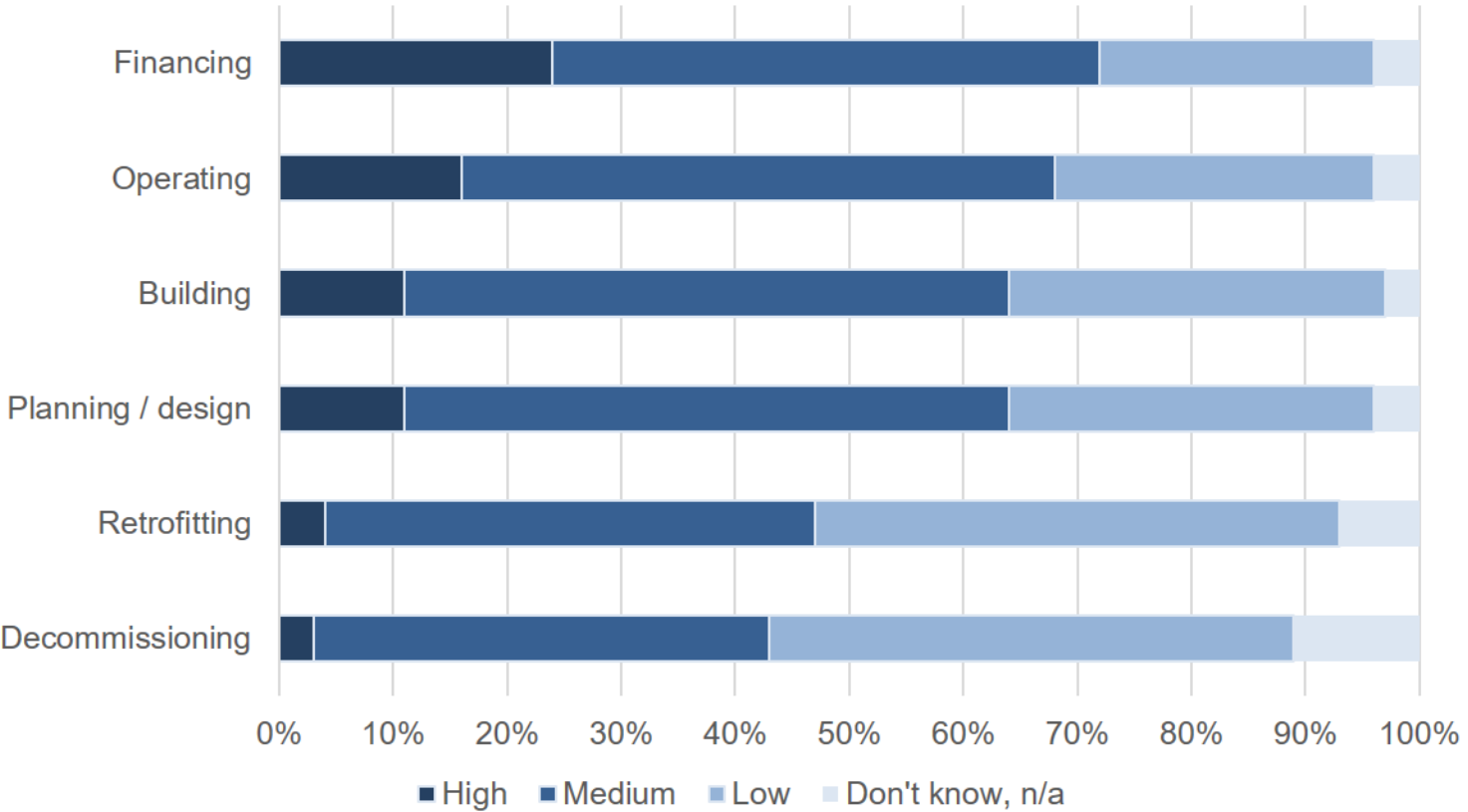
## Thank you for your attention ! ... Questions... ?

# Investors are naturally assessing risks involved in any financial engagement – are these sufficient to ensure solid investment returns?



## Question:

As a general matter, how would you assess the overall degree of risk associated with each of the following stages of building and operating a RE power plant?



**Not specifically mentioned:**

- Procurement
- Supply chain management
- Quality assurance

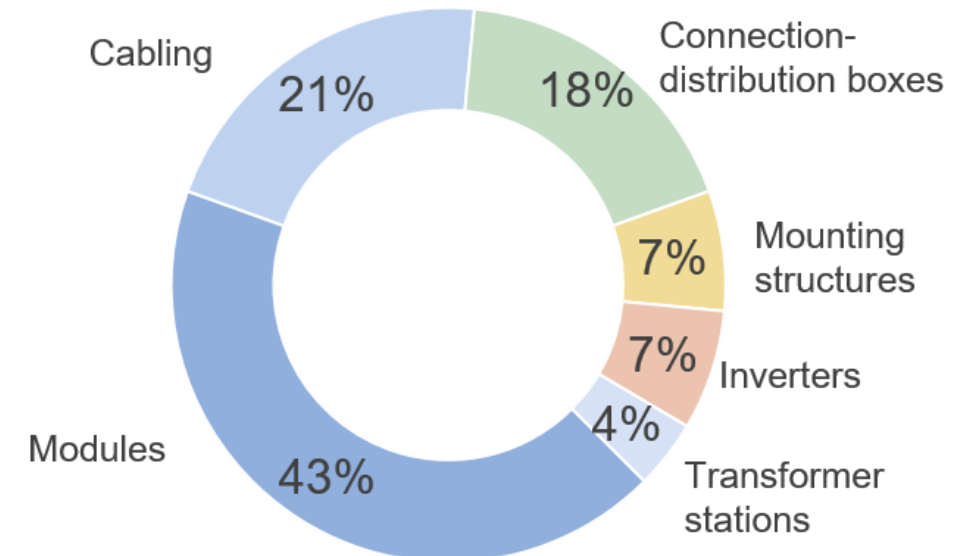
Source: The Economist Intelligence Unit, sponsored by SwissRe

# Does a correlation between the complex challenges in the PV sector and the observations of deteriorating performance exist?

Type of mistake	Description	Yield reduction
Planning mistake	Important design criteria are disregarded or have not been appreciated	≤ 40%
Component mistakes / problems	Components don't meet name plate functionality	≤ 60%
Mounting errors and mistakes	Quality issues during mounting and construction	≤ 20%
Lack of monitoring	Inoperative situation or performance issues are not detected at all or detected too late	≤ 70%

- 30% of inspected operating PV power plants show serious defects requiring immediate corrective action
  - Most prevalent causes for defects are related to production of components and installation
- Extent of performance assessments:  
More than 1,5 GWp inspected

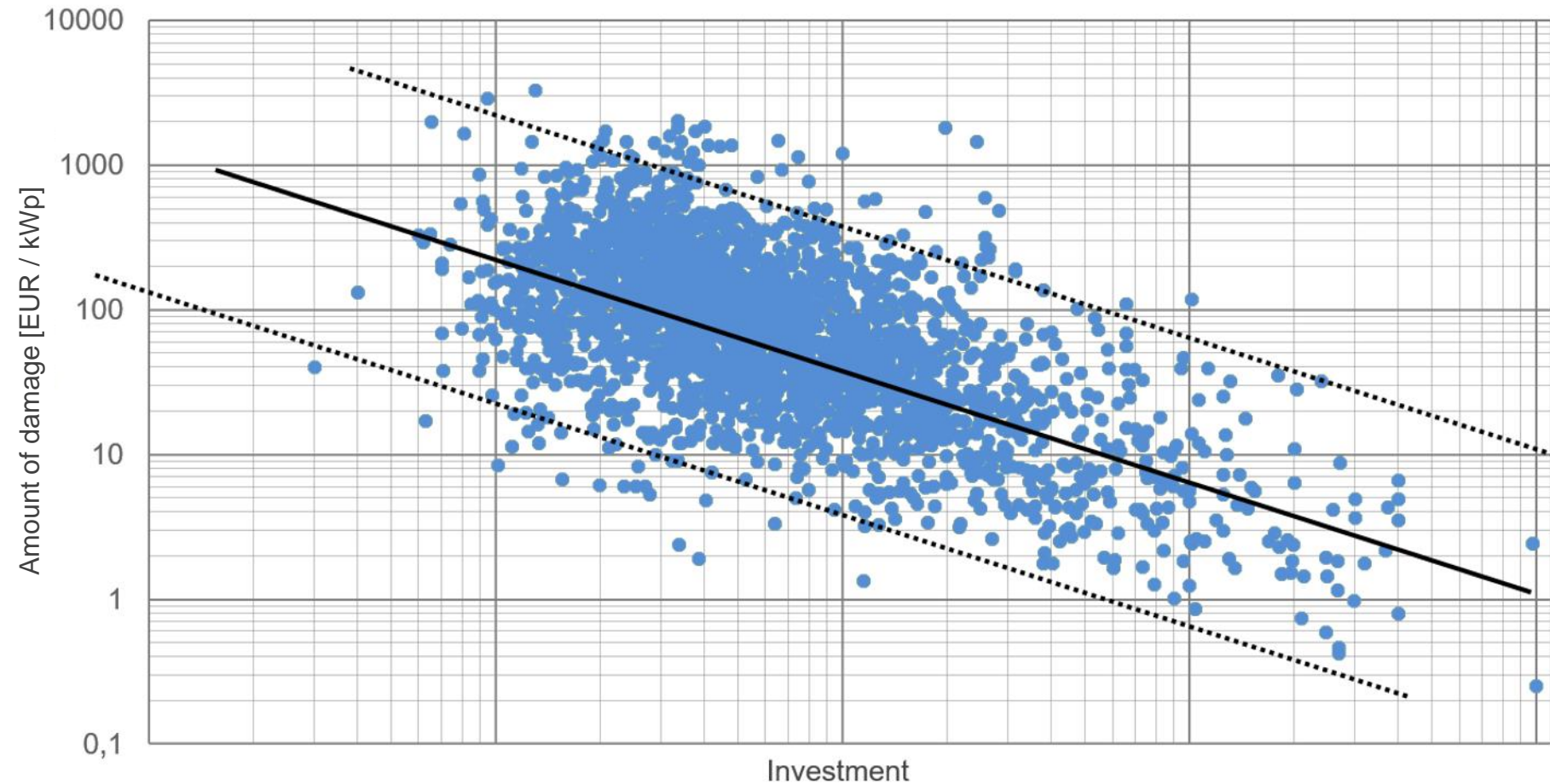
**Sources of poor performance**





# An insurance claim cases assessment suggests that amounts of damage can be more significant than calculated for...

- More than 3.600 insurance claim cases have been analyzed in total
- Generally, the relative amount of loss trends to decline with increasing system size
- The main stream amounts of loss spreads over 2 orders of magnitude
- Outliers range up to 3.500 US \$ / kWp (incl. consequential damage)

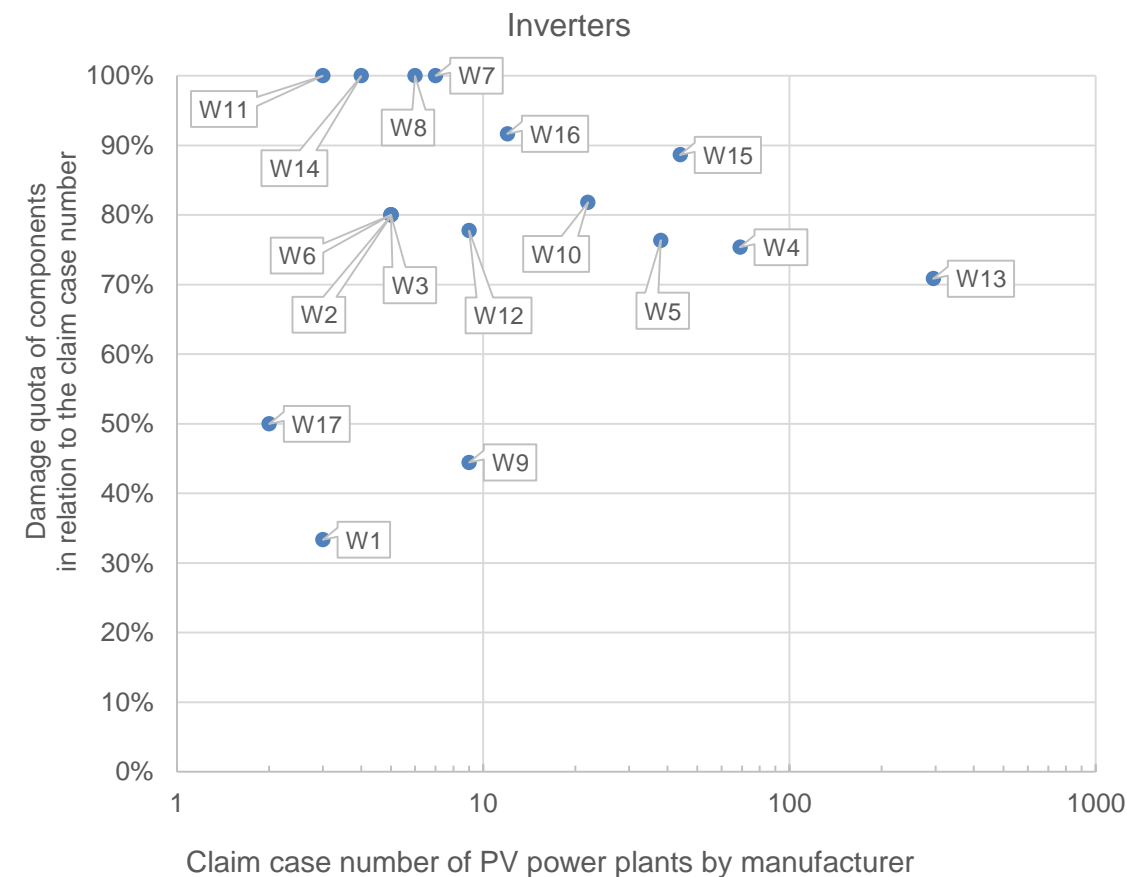
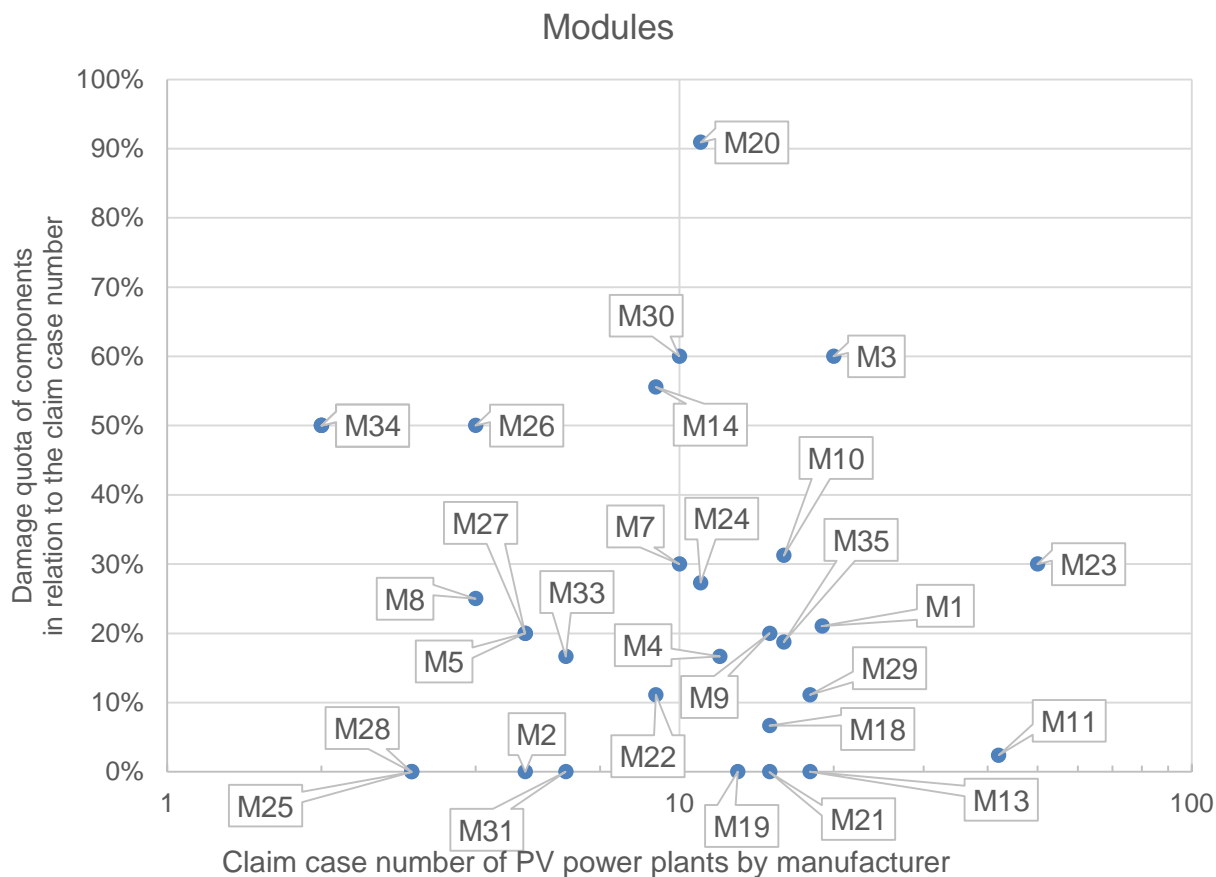


3503 claim cases Jan 2012 through June 2017 for which amounts of investment and of damage have been available

Source: EXXERGY analysis on >3.600 insurance claim cases 2012 - 2017

# Clustered by manufacturer reveals an interesting correlation, however, the ratio between damages on inverters vs. modules may be misleading

Ratio of internal damages by manufacturer in relation to total number of damages



Source: EXXERGY analysis on >3.600 insurance claim cases 2012 - 2017



# Many investors take financial performance from PV power plants for granted – a realistic assumption?

## PV-park investment:

### Case study I:

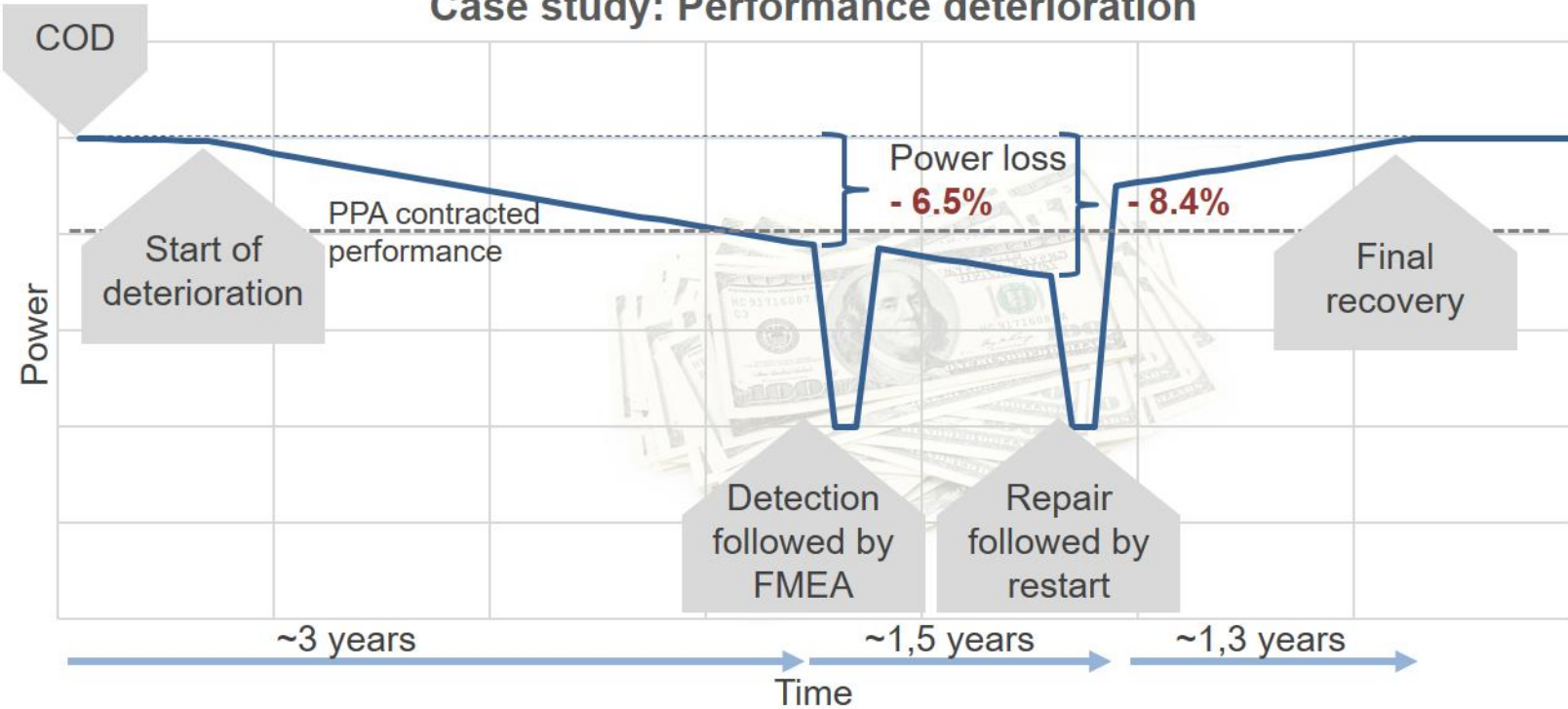


### Basic information:

- PV power plant approx. 10 MWp
- Ground mount
- Investment (Capex) approx. 750 US\$/kWp
- Power purchase price: 0,125 US\$/kWh

Sources: TÜV Rheinland, EXXERGY financial model

## Case study: Performance deterioration



### Impact on financials and other resources (excerpt)

- Reduced revenue streams
- Costs for detection (FMEA) and definition of corrective action
- Cost for repair
- Penalties from bank
- Liquidated damages for non-performance on PPA
- Human resources for fixing issues
- Material resources (replacements)
- ...

Chart data is illustrative based on a real case

# The previous case was financially a challenge but not a disaster... What if the PIRR reduces to below 11%...?

## PV-park investment case



### Basic changes on "today projection":

- Investment (Capex) 750 US\$/kWp
- Power purchase price: 0,125 US\$/kWh
- Assumption on cost for repair reflects estimate on future price depression for modules

Today projection @ <11% PIRR	Plan (base) case	Case 1: Actual performance case	Case 2: Investment to match case 1 PIRR	Case 3: Solid quality investment case
Total Capex initial investment [kUS\$]	7.350	7.350	+38,5% → 10.180	+10% → 8.090
Cost for FMEA <sup>1)</sup> [kUS\$]	-	+38,2% 260	-	-
Cost for repair [kUS\$]	-	(activated) 2.400	-	-
Compensation for electricity supply [kUS\$]	-	150	-	-
Cumulative EBIT <sup>2)</sup> 20 years lifetime [kUS\$]	25.150	22.120	22.320	24.410
Project DCF <sup>3)</sup> 20 years [kUS\$]	7.580	6.200	7.830	7.640
PIRR <sup>4)</sup> (unlevered)	10,6%	4,6%	4,6%	8,7%
20 years equity IRR <sup>4)</sup> @60% leverage for 12 years, 9,5% interest	23,7%	14,3%	12,9%	20,2%
DSCR <sup>5)</sup> range	1,65..3,08	Fatal default 1,13..3,24	Requires ≥55% equity 1,23..2,30	1,51..2,83
Payback year	5,7	10,0	7,7	6,2

US\$ numbers commercially rounded to 10 kUS\$

Sources: TÜV Rheinland, EXXERGY financial model | <sup>1)</sup> Failure mode and effect analysis | <sup>2)</sup> Earnings before interest and taxes | <sup>3)</sup> Discounted cash flow | <sup>4)</sup> (Project) internal rate of return | <sup>5)</sup> Debt service coverage ratio

# Well...what happens when planned PIRR further drops to 7% - a number that is increasingly seen in the region

## PV-park investment case



### Basic changes on "today projection":

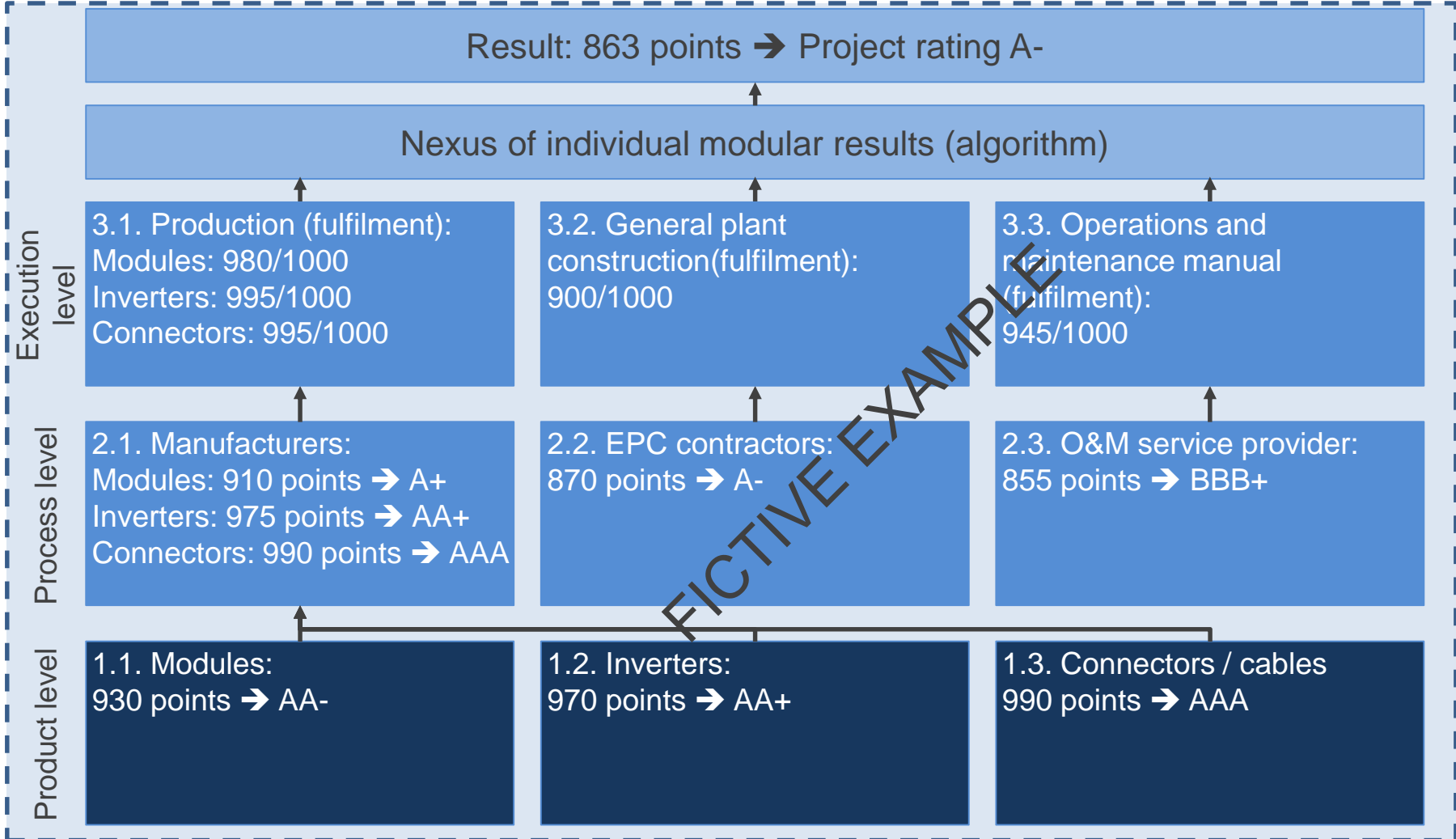
- Investment (Capex) 750 US\$/kWp
- Power purchase price: 0,106 US\$/kWh
- Assumption on cost for repair reflects estimate on future price degression for modules

Today projection @ 7% PIRR	Plan (base) case	Case 1: Actual performance case	Case 2: Investment to match case 1 PIRR	Case 3: Solid quality investment case
Total Capex initial investment [kUS\$]	7.350	7.350	+38% → 10.140	+10% → 8.090
Cost for FMEA <sup>1)</sup> [kUS\$]	-	+38,2% (activated) 260	-	-
Cost for repair [kUS\$]	-	(activated) 2.400	-	-
Compensation for electricity supply [kUS\$]	-	150	-	-
Cumulative EBIT <sup>2)</sup> 20 years lifetime [kUS\$]	19.610	16.640	16.820	18.880
Project DCF <sup>3)</sup> 20 years [kUS\$]	6.400	5.060	6.650	6.470
PIRR <sup>4)</sup> (unlevered)	7,0%	1,5%	1,5%	5,3%
20 years equity IRR <sup>4)</sup> @60% leverage for 12 years, 9,5% interest	17,2%	8,5%	7,9%	14,2%
DSCR <sup>5)</sup> range	1,39..2,60	Fatal default 0,92..2,76	Requires ≥60% equity 1,05..1,96	1,28..2,39
Payback year	6,8	11,7	9,0	7,4

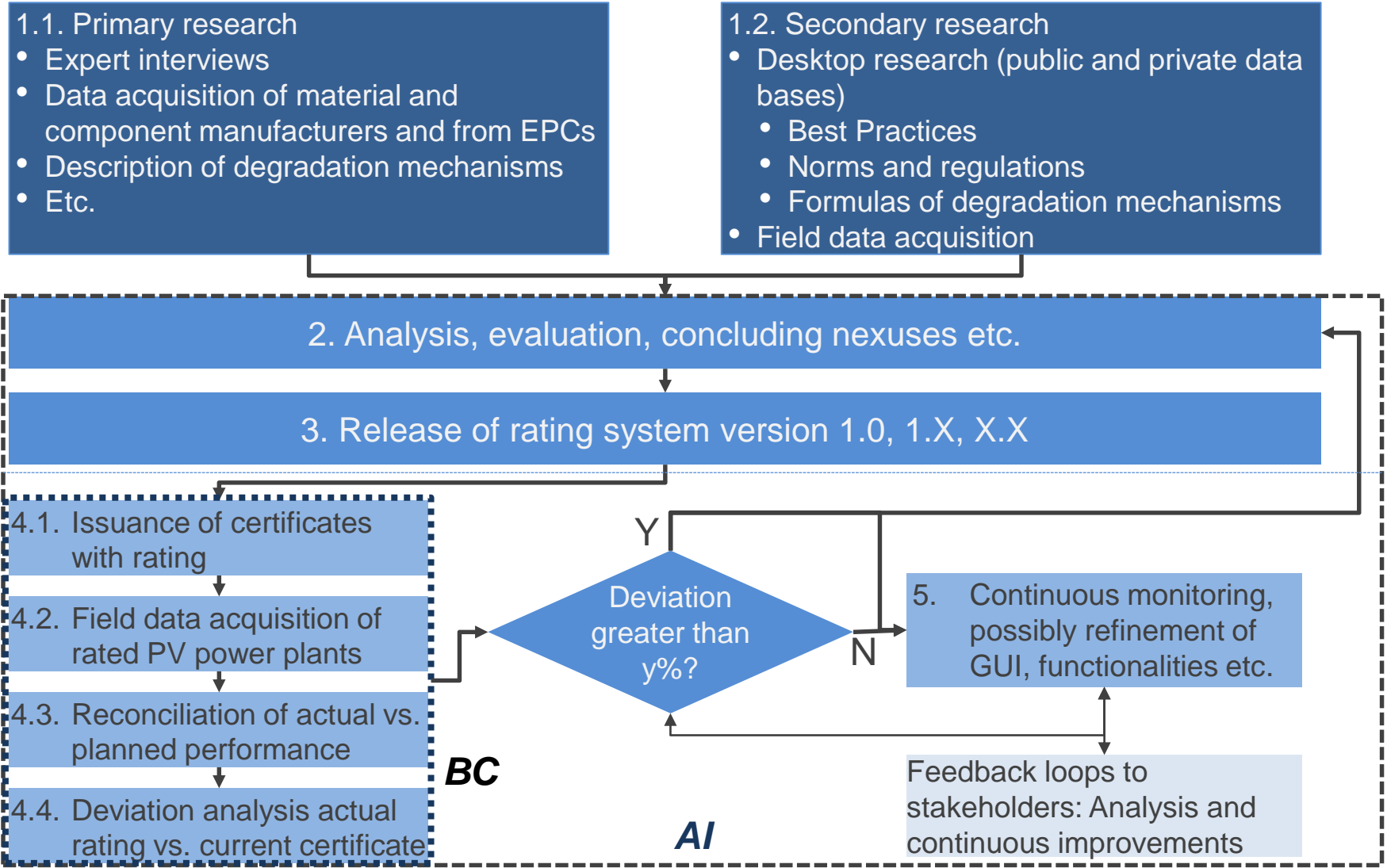
US\$ numbers commercially rounded to 10 kUS\$

Sources: TÜV Rheinland, EXXERGY financial model | <sup>1)</sup> Failure mode and effect analysis | <sup>2)</sup> Earnings before interest and taxes | <sup>3)</sup> Discounted cash flow | <sup>4)</sup> (Project) internal rate of return | <sup>5)</sup> Debt service coverage ratio

# ...that will allow an individual rating for each category and the aggregation of these category results into a final project rating



# Applying artificial intelligence will amplify the usefulness of the TEXEXECURE / IECRE rating system



\* Abbreviations:  
BC: Blockchain  
AI: Artificial intelligence



# The triangle of standardization, conformity assessment, and rating system enables furthering healthy LCOE reductions

- **Several initiatives are crucial to further the reduction of LCOE**
  - PV is on a continuing trajectory reducing LCOE significantly
  - The trajectory for LCOE reduction for wind is relatively marginal
  - **Quality concerns can jeopardize LCOE projections**
- **Crucial initiatives are about standardization**
  - IECRE issues standards for RE power plants
  - The “Orange Button” initiative is about data taxonomies
    - for financial reporting (historical data)  
→ XBRL data system
    - **To manage larger technical performance data volumes, a more efficient taxonomy is required**



# Risk mitigation by applying a thorough rating system and yield optimization turn out to be two sides of the same coin

Cooperation level	Platinum	Gold	Silver
<b>Contribution USD</b>	<b>300,000</b>	<b>120,000</b>	<b>60,000</b>
One (1) advisory committee position	X		
Personalized free copy of the EXXERGY insurance claim case report (pitch see attached document “PVS Insurance Report Pitch EUWW 01-03-2019.pdf”) *	X	X	
Participation in IECRE or TEXXECURE end user group (first annual fee (either for 2019 or 2020, depending on when the end user group is set up) waived, thereafter annual fee)	X	X	
Participation in IECRE or TEXXECURE end user group (for additional annual fee)			X
Participation in selected project work groups sessions	X	X	X
Consortium partner to TEXXECURE: Provision of neutralized information, data, and knowledge deemed essential to the PV Rating System 1.0 development	X	X	X
TEXXECURE to consortium partner: Specific provision of neutralized information, data, and knowledge deemed necessary to the PV Rating System 1.0 development	X	X	X
Provision of progress reports	X	X	X