



SolarWorld AG
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Quality Challenges for Solar Markets

Green Quality Dialogue – Bonn

SolarWorld at a glance



Location

- >> Headquarters in Bonn/Germany
- >> Production in Freiberg/Germany, Arnstadt/Germany and in Hillsboro/U.S.
- >> Sales offices in Germany, U.S., France, Italy, UK, South Africa, Singapore and Japan

Established/ IPO

- >> Established in 1998
- >> IPO in 1999 (Düsseldorf Stock Exchange)
- >> listed on the Prime Standard of the Frankfurt Stock Exchange since 2003

Market position

- >> Global producer of high quality crystalline solar solutions with a strong brand
- >> Leading manufacturer of PERC technology worldwide
- >> Vertically integrated production in Germany and the U.S.
- >> Broad customer base in quality segment (B2B partner installer networks in Europe and the U.S.)

Nameplate capacities

- >> 1,500 MW ingots
- >> 1,500 MW wafers
- >> 1,500 MW cells
- >> 1,500 MW modules

Shipments

- >> Shipments 3Q 2016: **1,027 MW**
 - >> Revenue 3Q 2016 : **€ 639m**
- | | | | |
|---------------------|-----|------------|-----|
| ▪ U.S.: | 52% | ▪ Germany: | 15% |
| ▪ Europe (w/o GER): | 21% | ▪ ROW: | 12% |

Employees

- >> 3,073 employees *(as at September 30, 2016)*

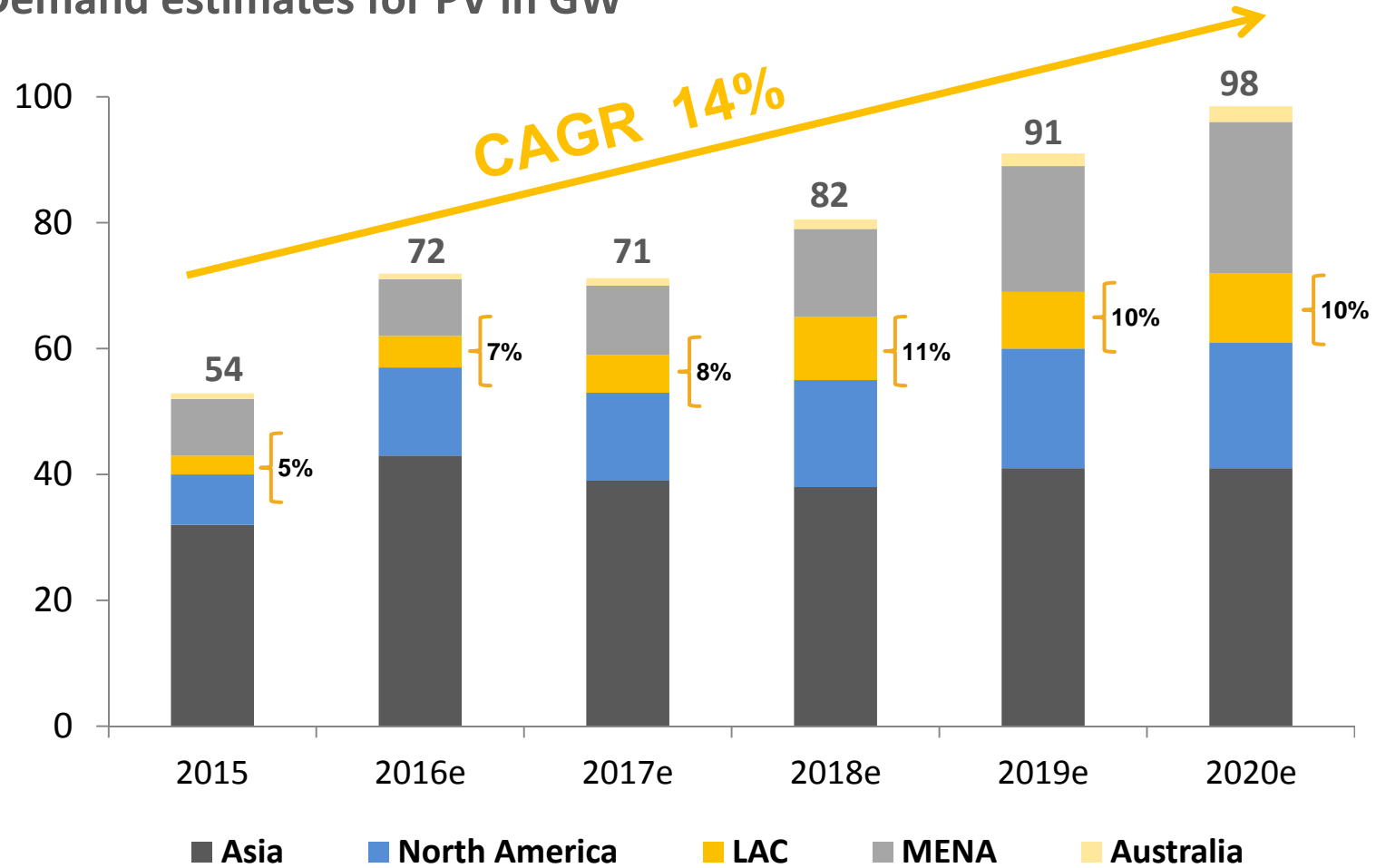
MARKET ENVIRONMENT



Global solar market development



Demand estimates for PV in GW

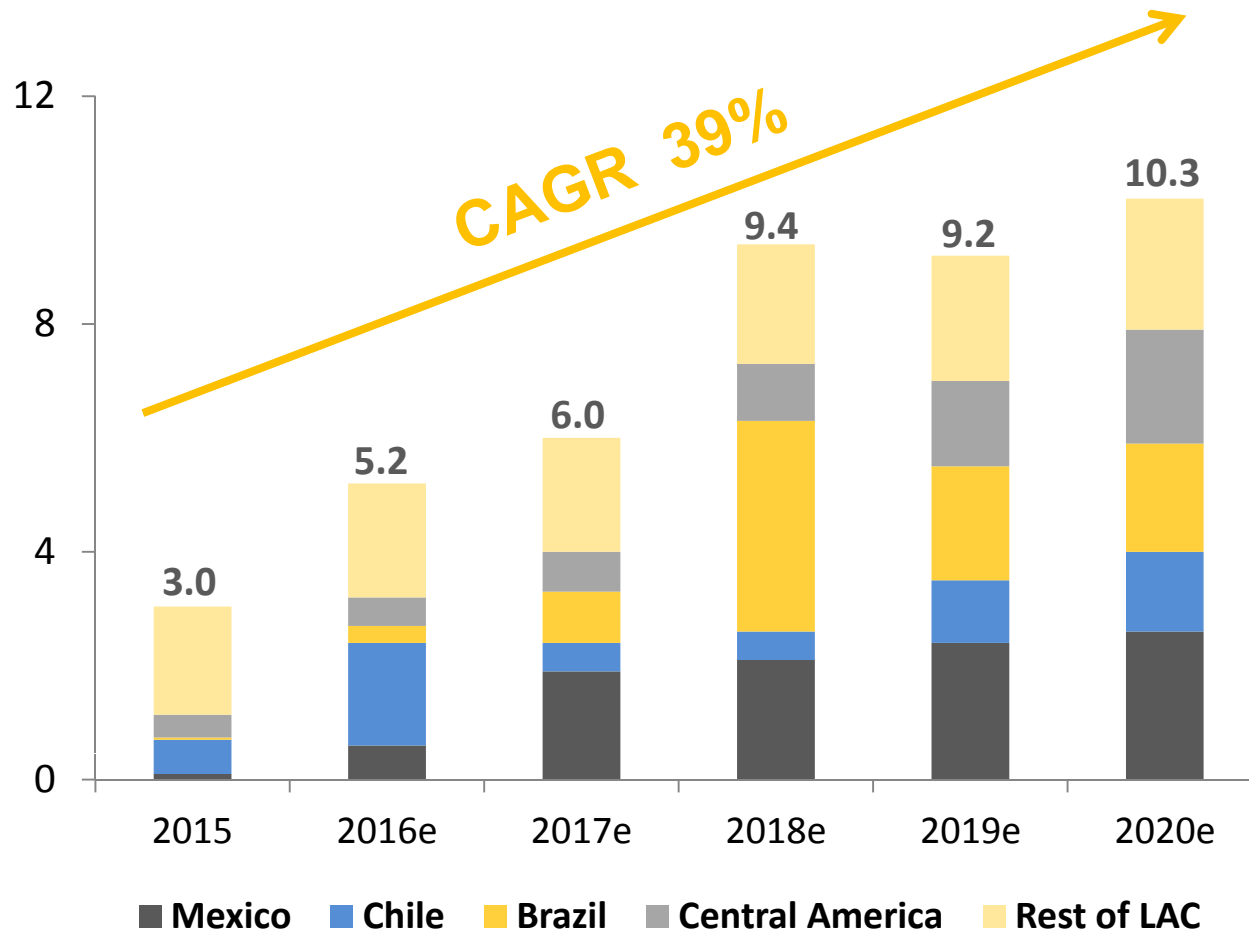


Source: Deutsche Bank, October 2016

Development in Latin America and Caribbean



Demand estimates for PV in GW



CAGR 2015–2020e

Mexico	+2,450%
Chile	+154%
Brazil	+4,120%

Source: Deutsche Bank, October 2016

QUALITY CHALLENGES



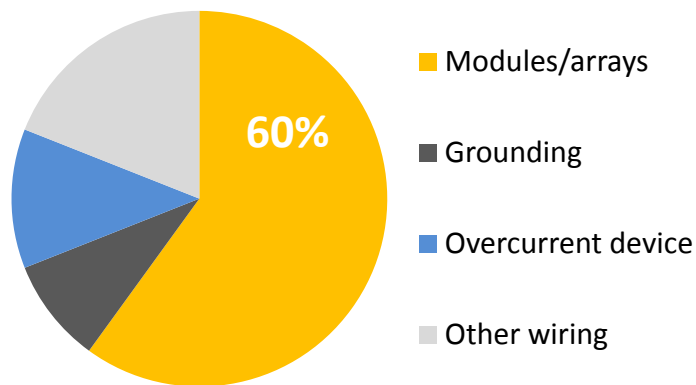
Equipment selection – why is QA important?



- >> High maintenance costs
- >> Unscheduled downtime



Threats to project financials!



Source: Massachusetts Production Tracking System

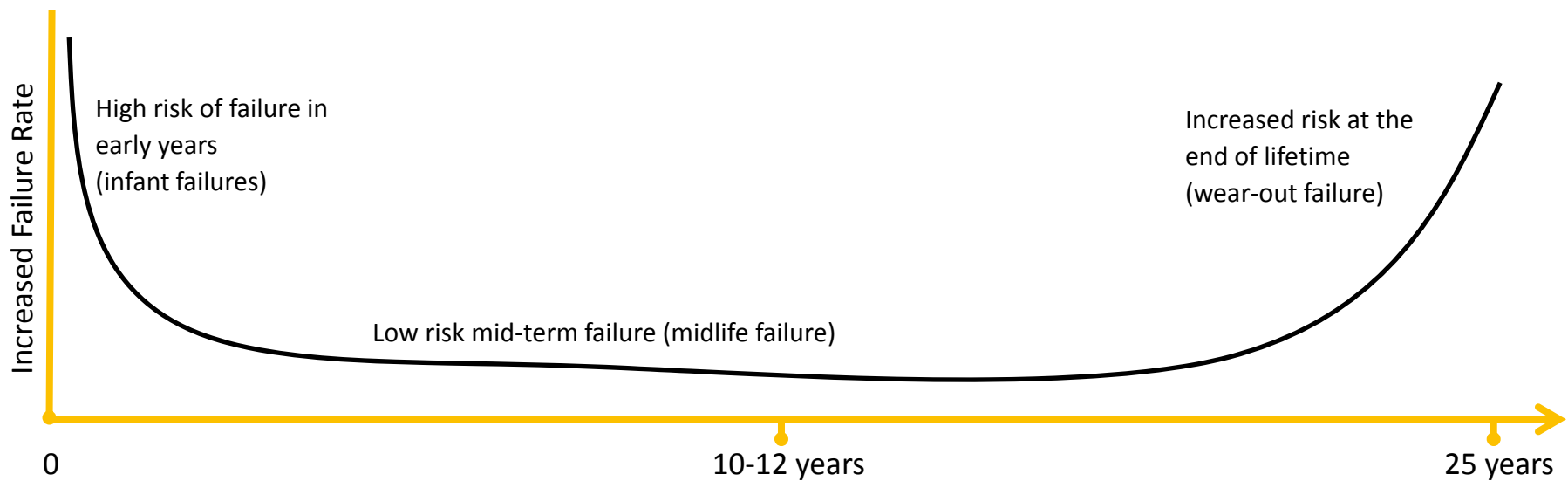
- 60% of unscheduled PV plant repairs are related to equipment selection
- Maintenance has little effect on the degradation rate/yield/lifetime of modules
- Module performance is predominantly dependent on:
 - ✓ Module technical characteristics
 - ✓ Quality of manufacturing facility
 - ✓ Manufacturing process
 - ✓ Quality of materials used
 - ✓ Testing procedures

PV plant risk allocation (1)

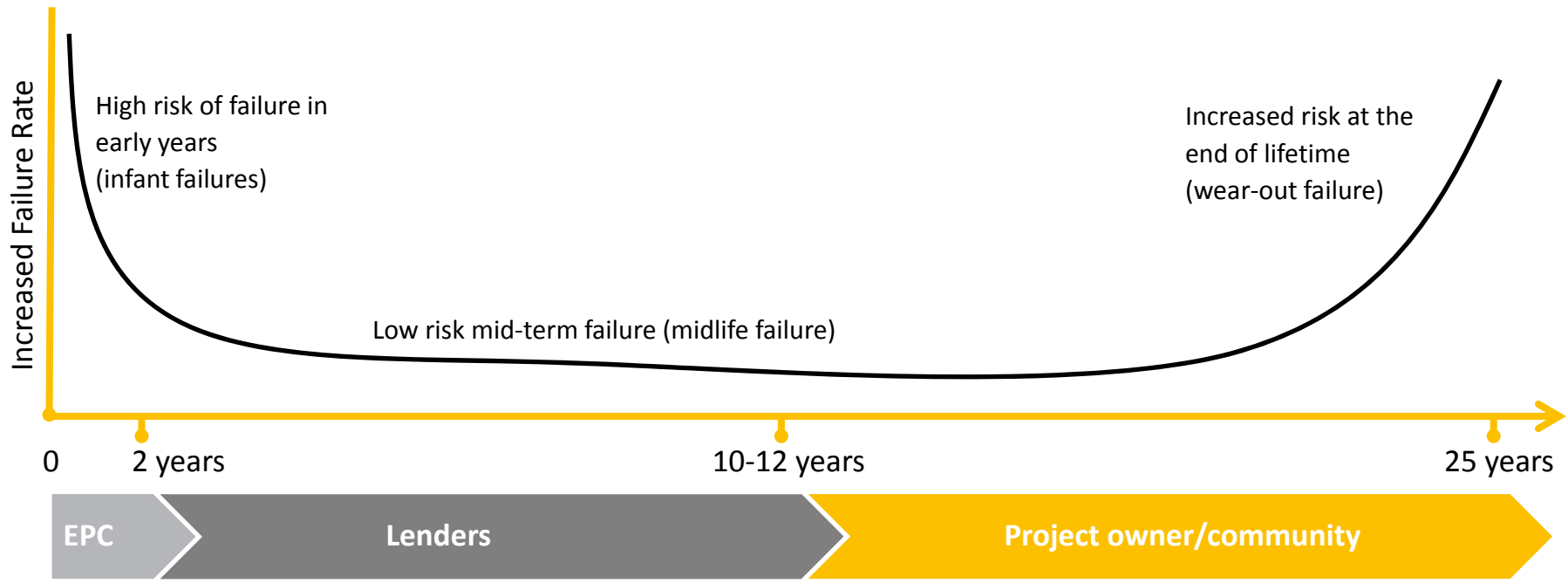


- >> PV modules typically account for about 50% of total system costs for a PV power plant
- >> When calculating energy yield of PV plants, modules are expected to last more than 25 years

BUT: PV modules typically have a bath-tub failure curve



PV plant risk allocation (2)



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
 - ✓ Track record of company and modules
 - ✓ Valid renown certifications
 - ✓ Quality of manufacturing facility
 - ✓ Warranty conditions



Owner/community carry risk burden of wear-out-failure ahead of time!

Environmental impact of low quality PV



Energy balance/Payback

Energy consumed during production

Energy used compensation

Positive energy balance → Energy produced during PV plant lifetime



Carbon Footprint/Payback

Emissions during production

Emissions compensation

Positive climate impact → Emissions additionally avoided by substituting GHG-intensive sources of energy and improving efficiency during PV plant lifetime



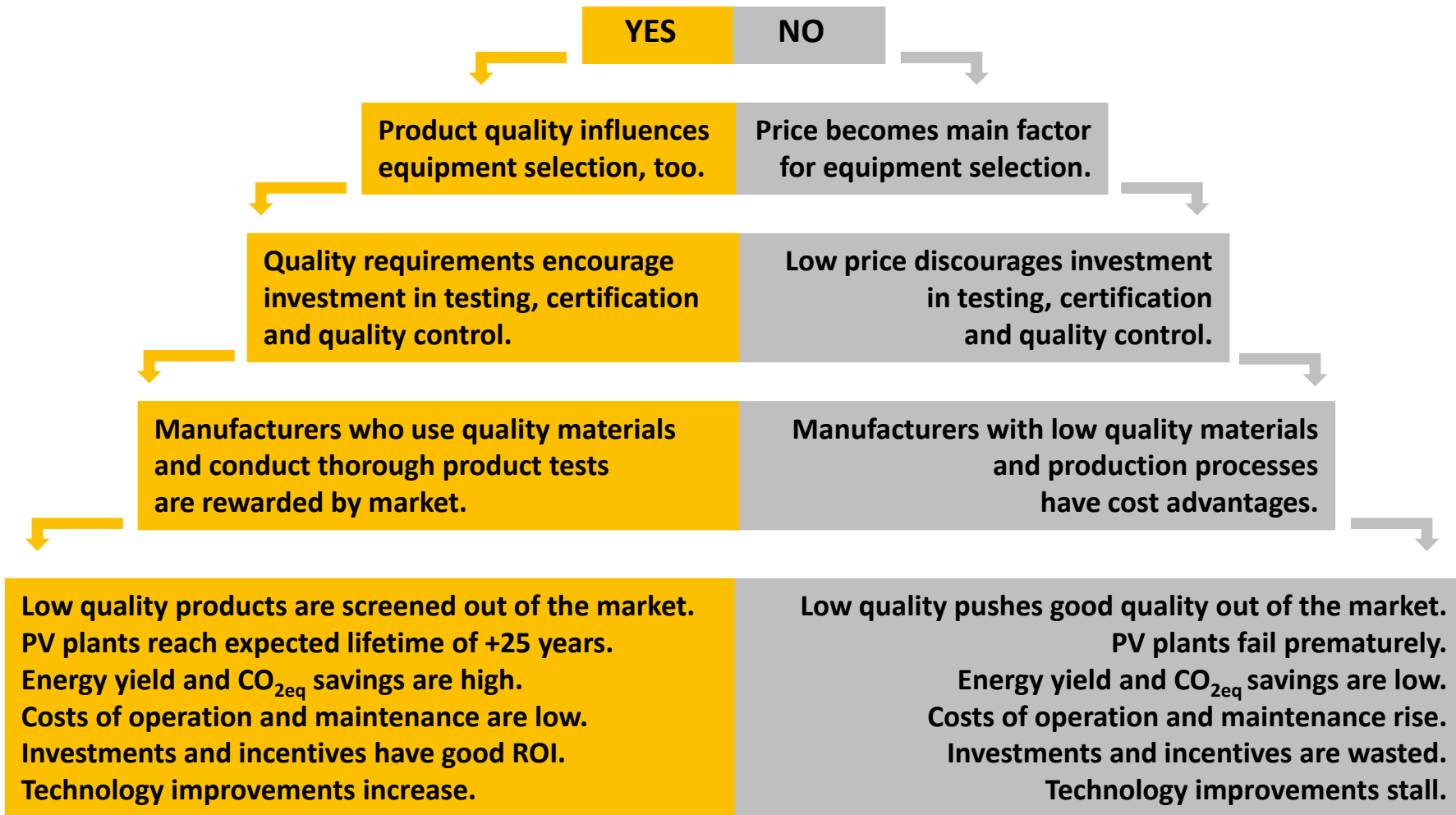
Increased waste

Rule of thumb: 1 MW of solar PV = 100 tons

In Germany: Current installed capacity is 40 GW = 4 million tons
➡ app. 1% failure = 400,000 t/a to be disposed

Low failure rates only possible with good QA/QI ➡ The higher the failure rate, the higher the amount of waste.

Advantages of QA/QI



Furthering common interests



IMPORTANT: Policy makers, owner and community should think long-term!

lowest module costs \neq lowest LCOE



Policy makers should **put incentive mechanisms in place that:**

- >> encourage long-term benefits
- >> protect the interests of the community
- >> reduce investment risks for owners/community
- >> increase market attractiveness for serious manufacturers
- >> minimize environmental impact and reduce waste
- >> help avoid market failure

THANK YOU ! FOR YOUR ATTENTION

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