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# Current Photovoltaic Reliability Challenges and the Role of the IC FA Community

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***With acknowledgements to: Jack D. Flicker, Kenneth M. Armijo, N. Rob Sorensen***

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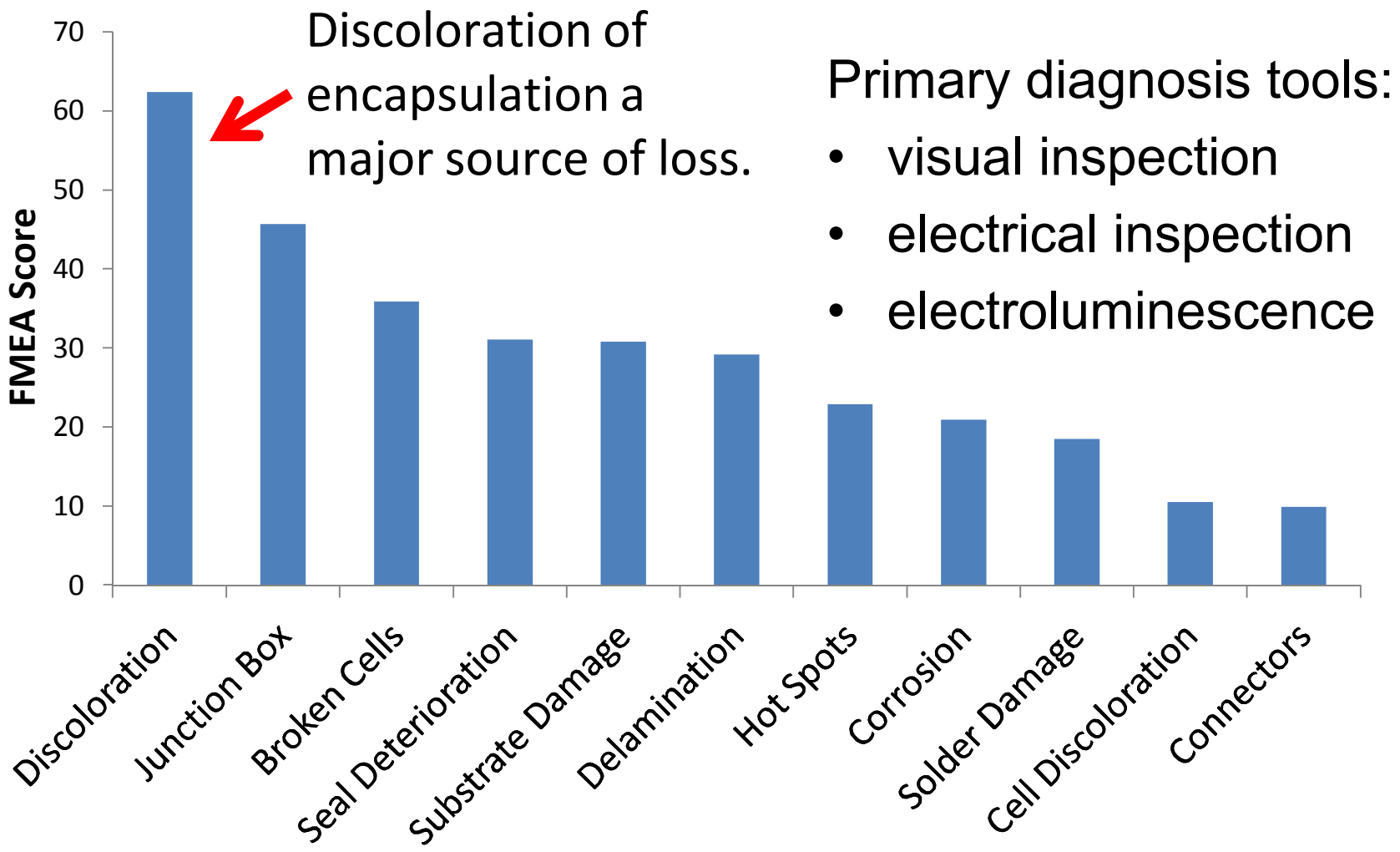
# Summary of PV Challenges

- Reliability concerns shifting from PV modules to Balance of Systems (BOS) components.
- PV industry under intense cost pressure
- Opportunity:
  - Reliability aspects of industry immature compared to IC industry
  - Industry is maturing to become more “IC-like”

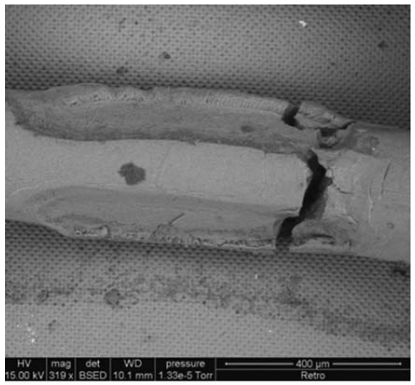
# PV Module Failure Modes

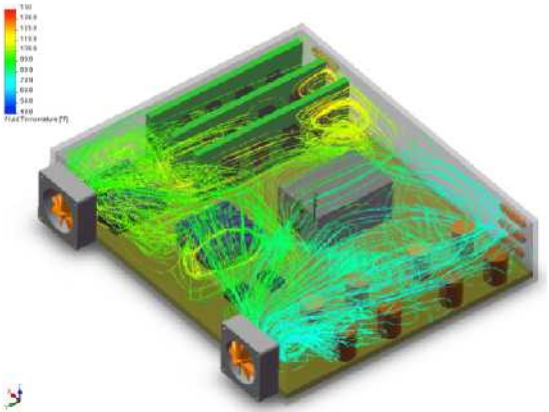



A. Golnas, "PV System Reliability: An Operator's Perspective," in 38th Photovoltaic Specialists Conference, June 2012, pp. 1–32.

# What about “everything else”?

## Balance of System = all non-PV-panel components





Solder Joint Degradation

Connector Reliability

Inverter Thermal Performance

Advanced Inverter Function

Ground Fault

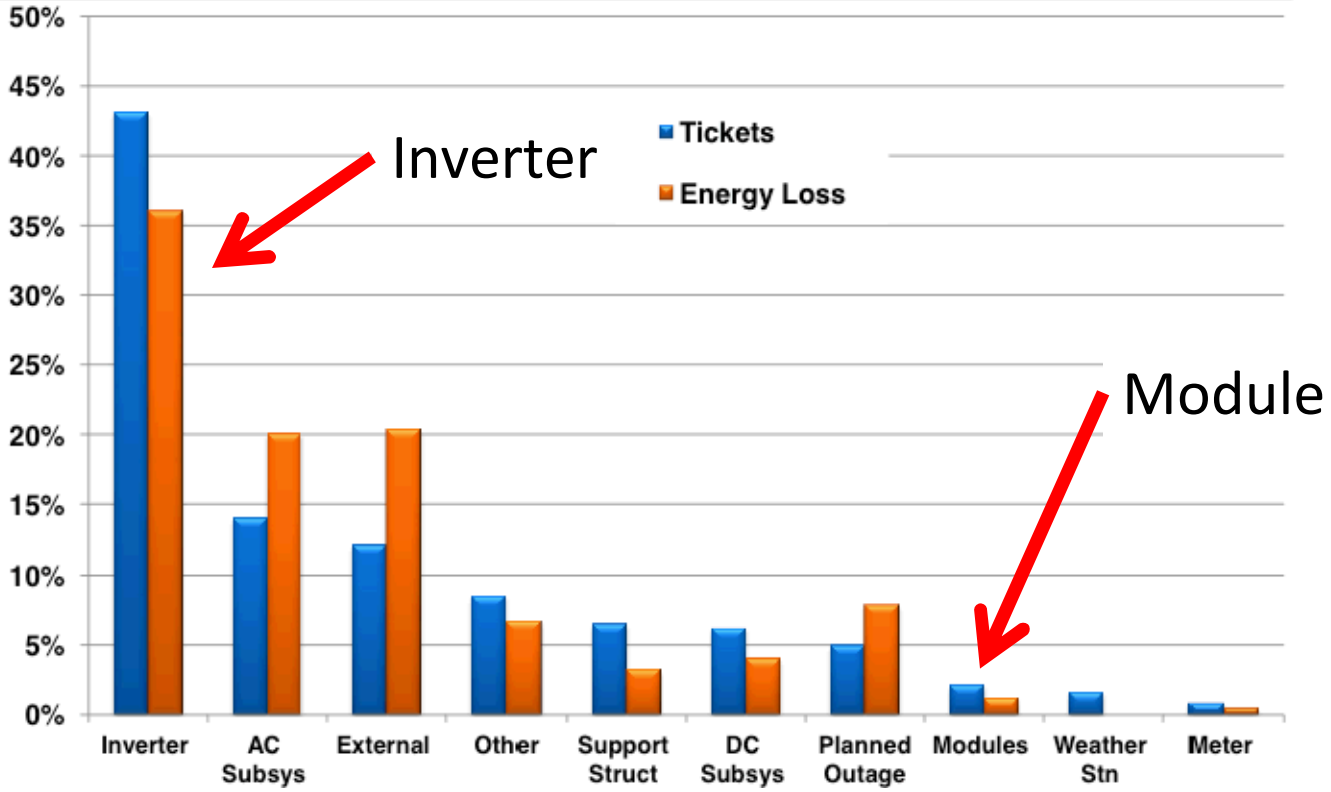
Arc Fault

O & M

Materials — Components — Sub-system — System

Capacitor, IGBT, WBG

# Cost of Balance of System Failures

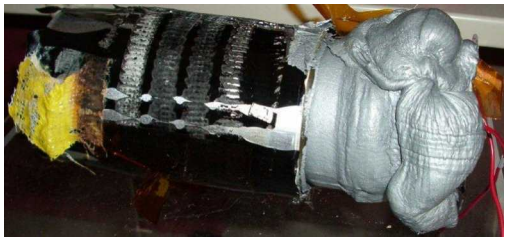



- Module MTBF > 500 Years
- Inverter MTBF ~ 1-16 Years
- SunEdison says inverter accounts for 36% energy losses.
- Power electronics now 8%-12% lifetime PV cost ($0.25/W) (DOE Sunshot goal $0.10/W by 2017)

A. Golnas, “PV System Reliability: An Operator’s Perspective,” in 38th Photovoltaic Specialists Conference, June 2012, pp. 1–32.

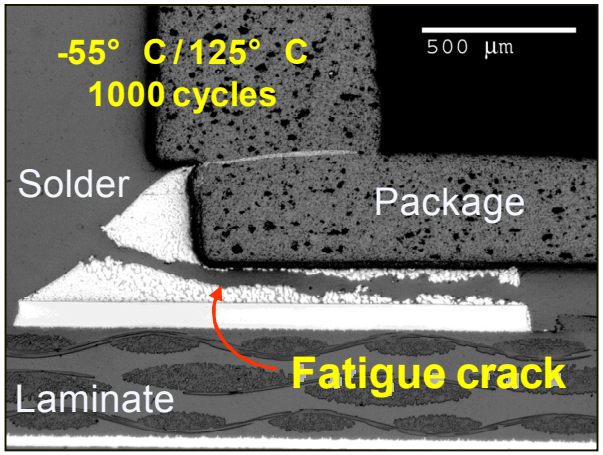
# Some Trends in BOS Reliability

- Capacitor reliability [1]
  - Move towards thin-film, reliability unknown.

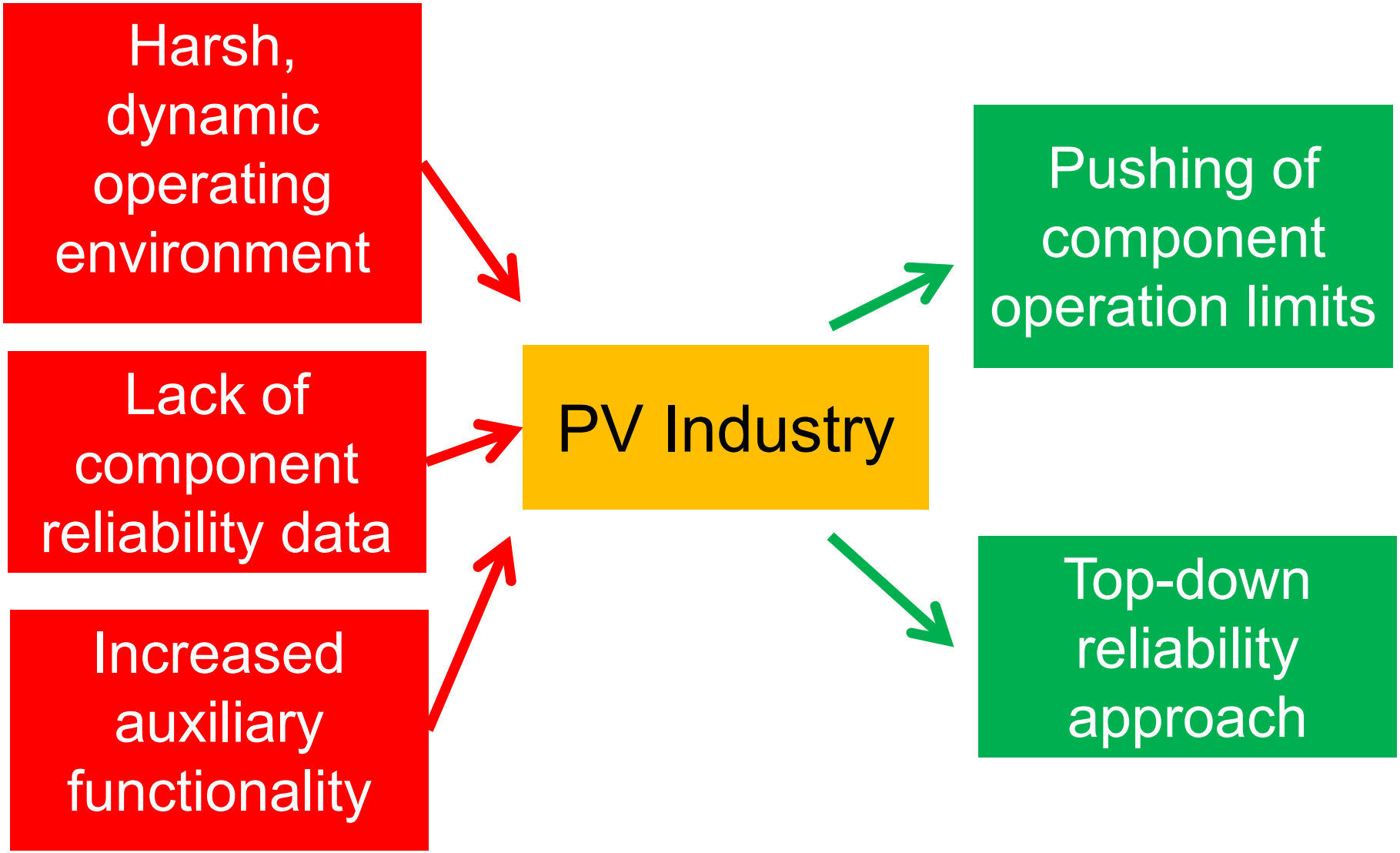
- Soiling (up to 7% annual loss) [2]

- BOS connectors [3], solder joints [4]

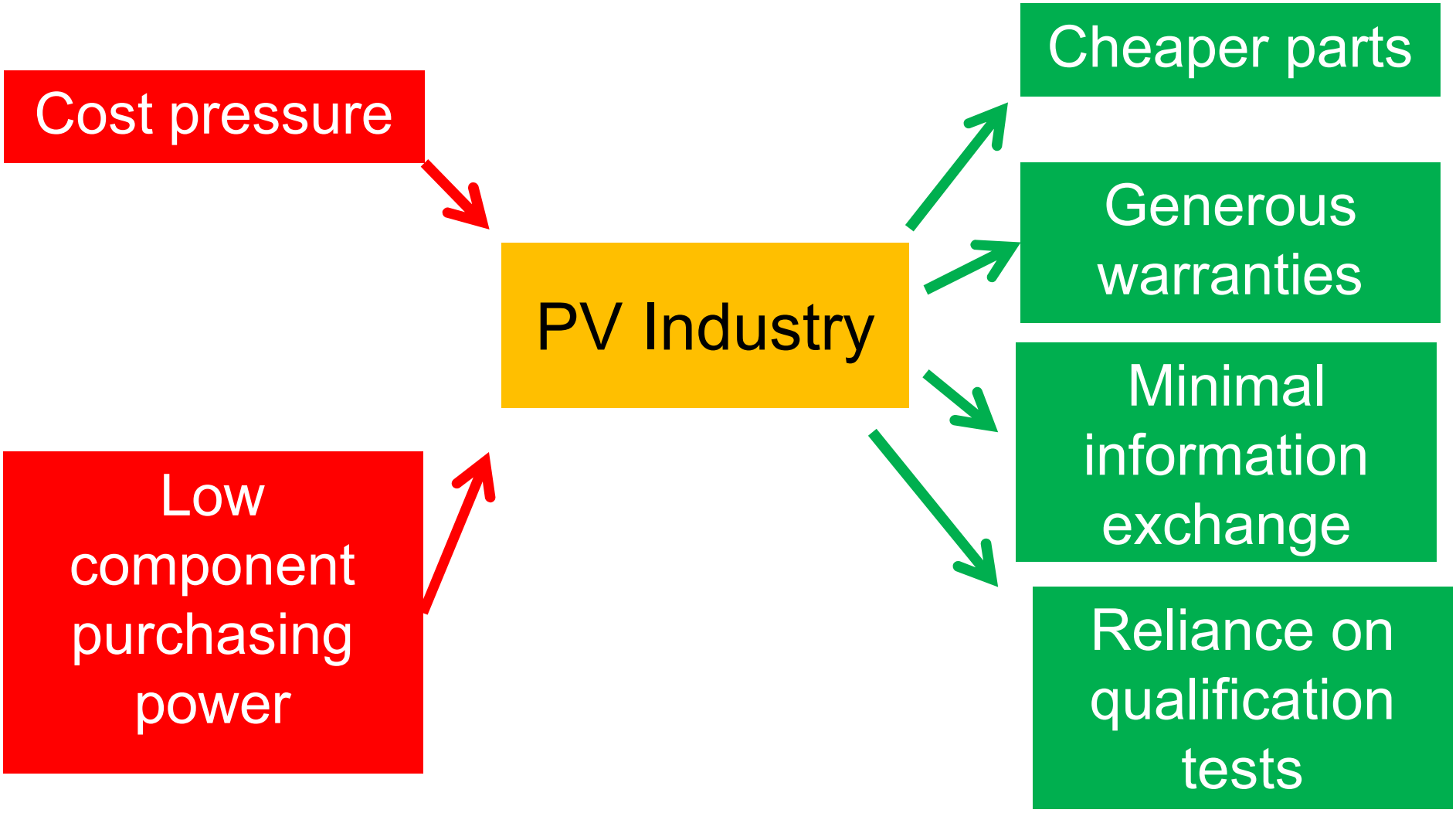



[1] J.D. Flicker, *et. al.*, in the 39th IEEE Photvoltaics Specialists Conference, 2013.
[2] T.U. Townsend, *et. al.* in Annual Conference of the American Solar Energy Society, 2000.
[3] P.D. Burton, and B.H. King, Journal of Photovoltaics, 2013
[4] P. Vianco, *et. al.*, in the 39th IEEE Photvoltaics Specialists Conference, 2013.

# PV Industry Technical Challenges

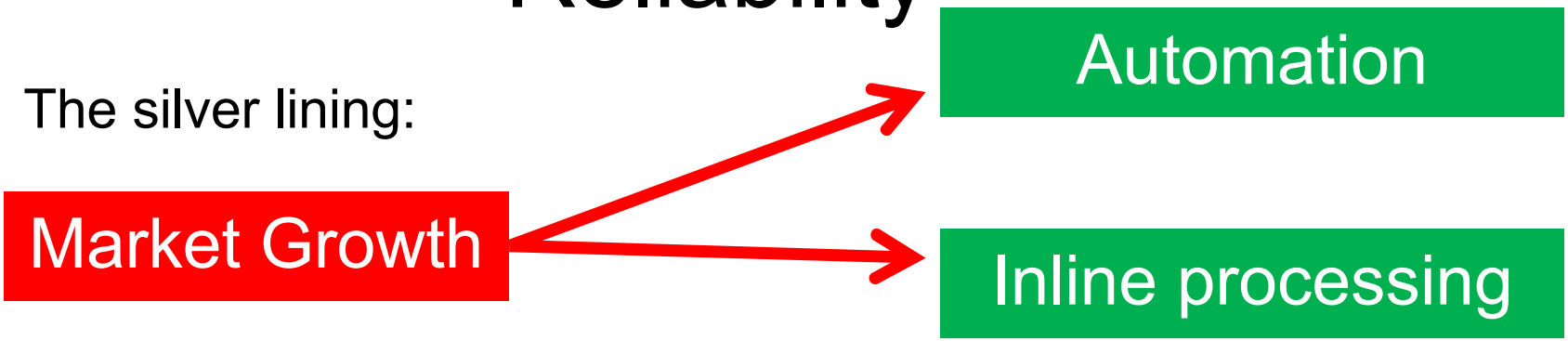


# PV Industry Business Challenges



# Areas of Opportunities for FA and Reliability

- The silver lining:




- What is the quickest path to developing reliability models for PV BOS components, given the current industry status?
- What can the IC industry provide as a model to mature PV reliability?
- What does the IC industry suggest as an example for information exchange regarding failure analysis and reliability?