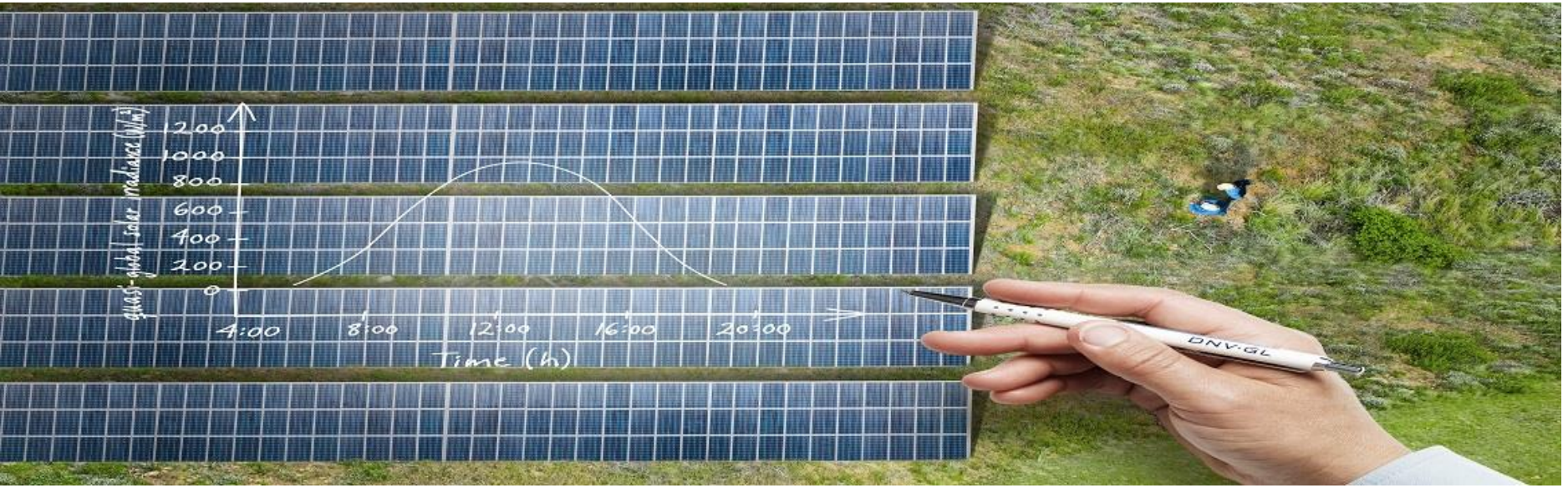
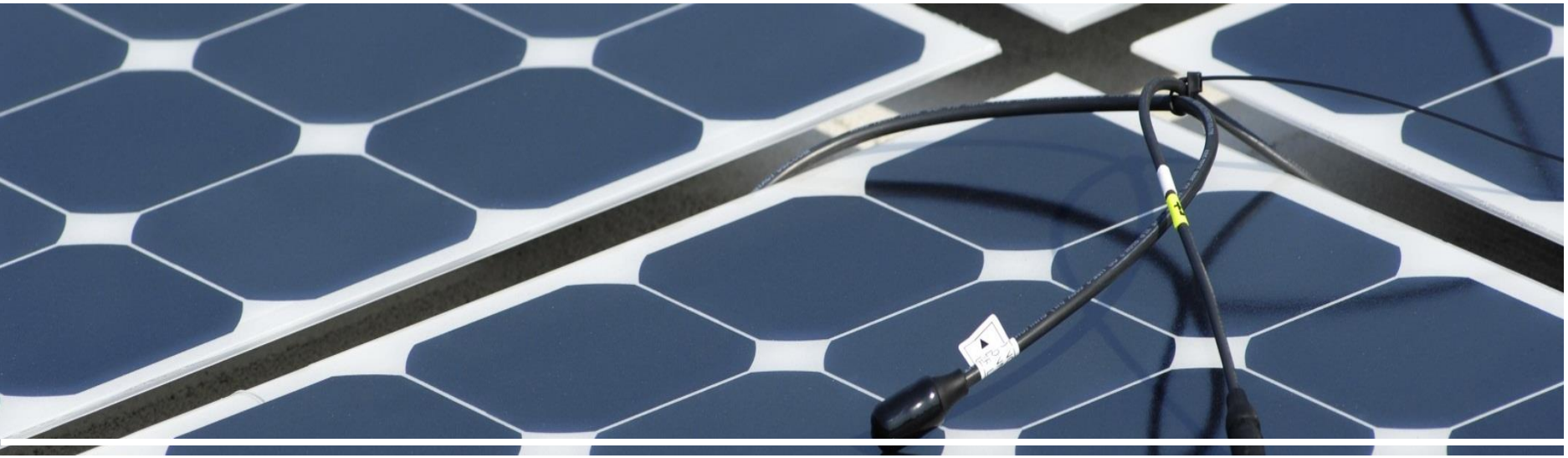


PV Equipment Diligence Best Practices

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- Firms such as DNV GL that provide solar Independent Engineering services are called on by financiers, investors, insurance companies and ratings agencies to provide a 3rd party expert opinion on technical risks

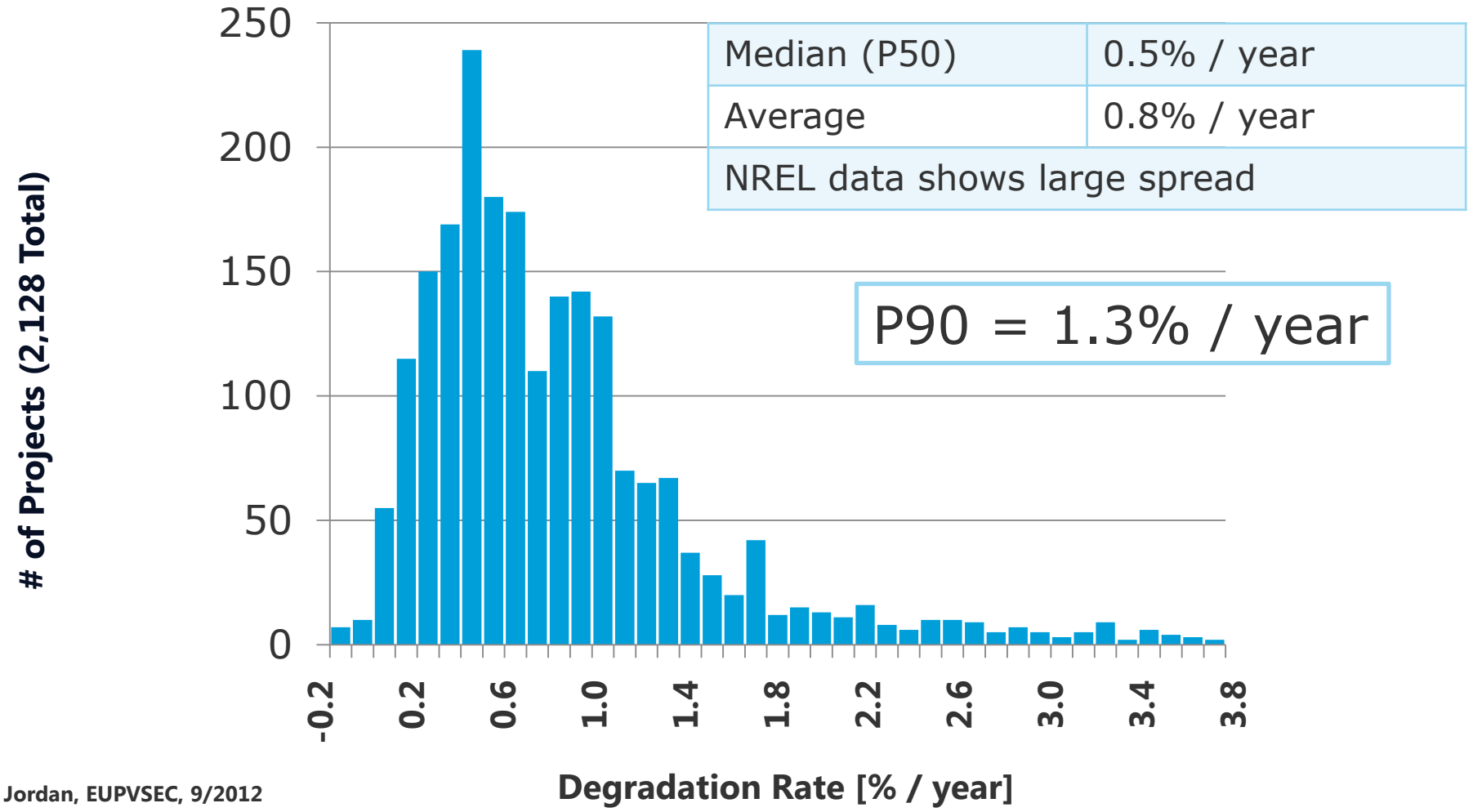
- The selection of equipment used in a PV plant is critical in managing the project risks

- In the absence of compelling and detailed information, IEs rely on broad industry averages and historical precedent

- Data on your equipment is (almost) always better than no data!

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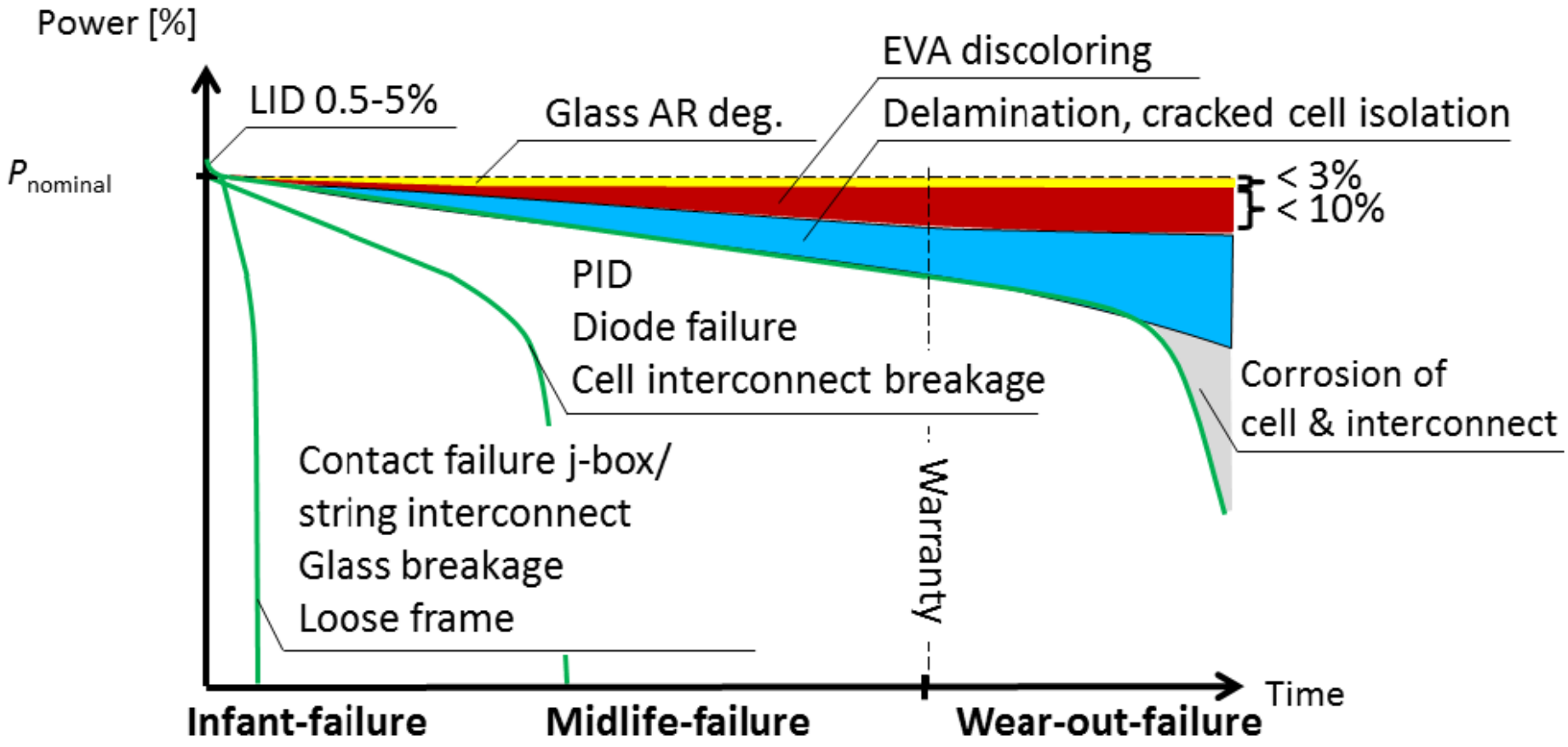
National Renewable Energy Lab (NREL)



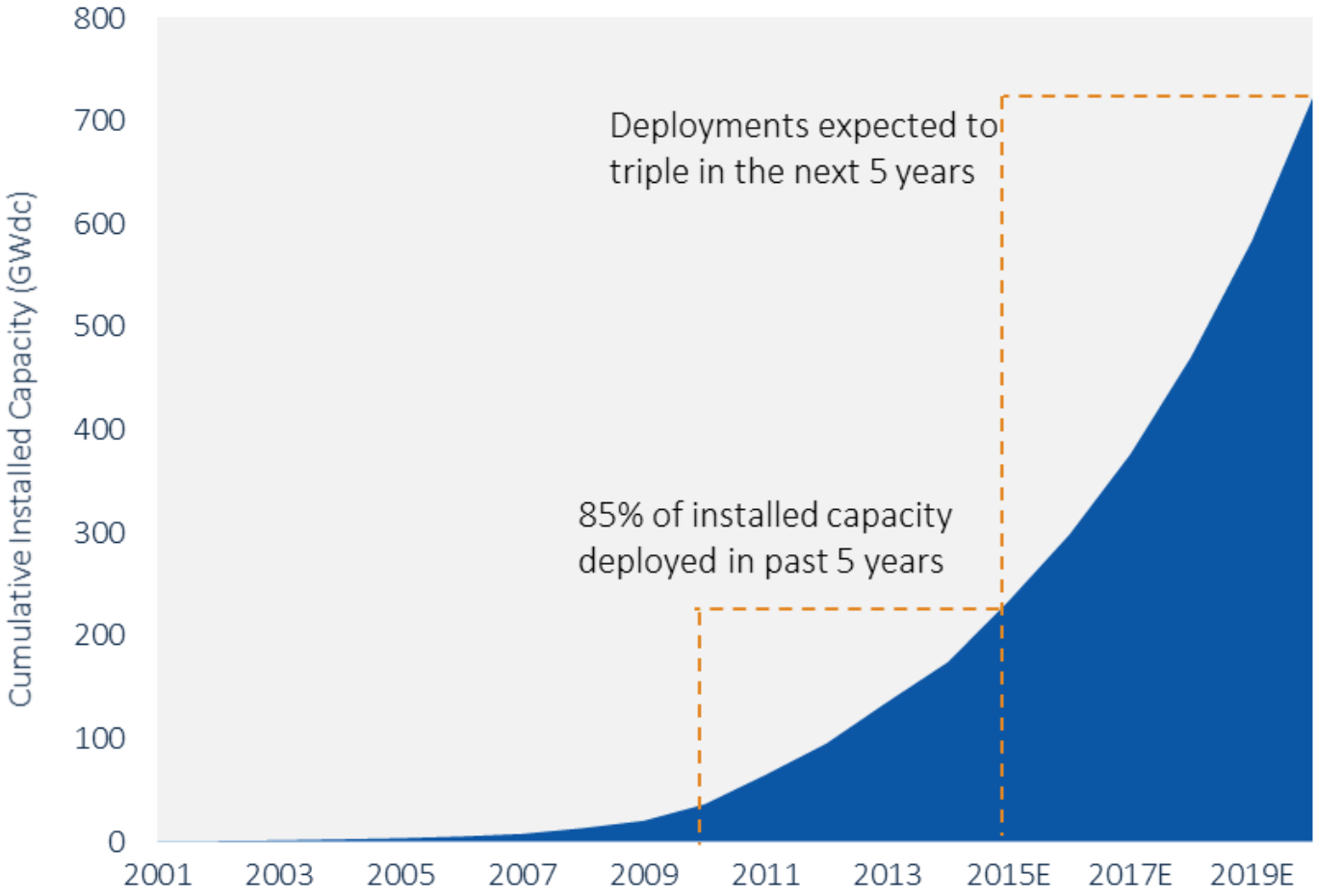
Dr. Jordan, EUPVSEC, 9/2012

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- *Review of Failures of Photovoltaic Modules*, IEA PVPS 2014

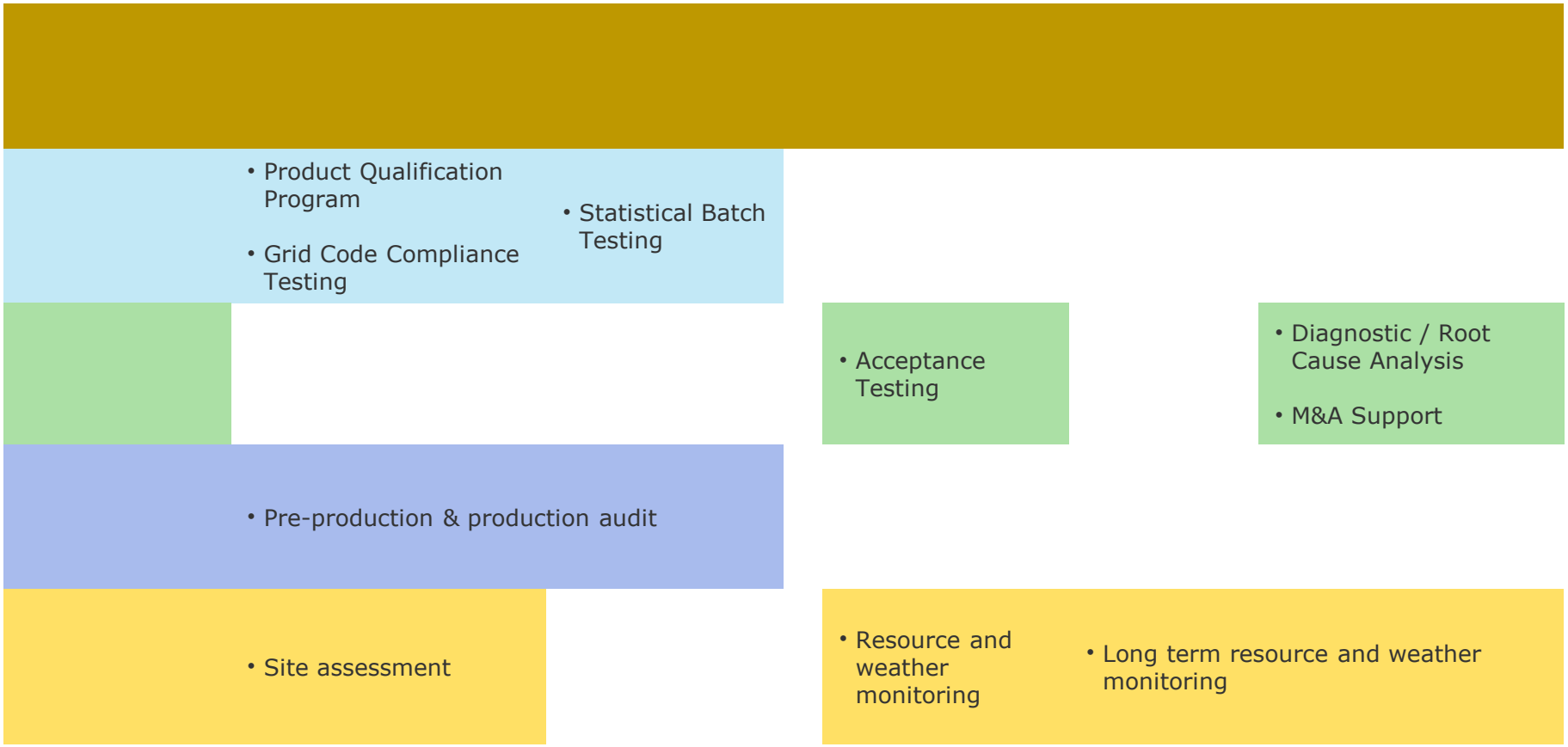


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Source: GTM Research

Where DNV GL can help reduce risk



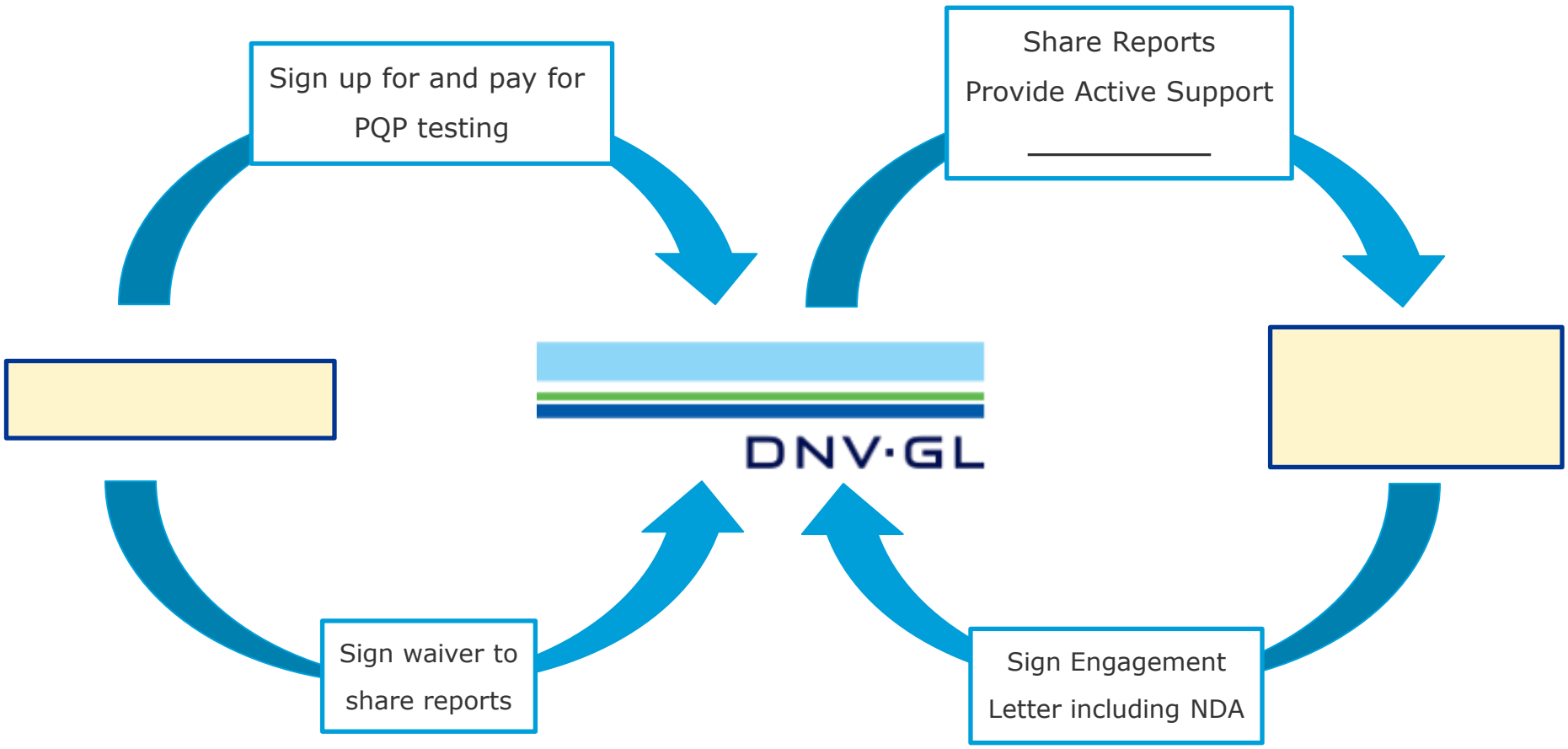
- downstream partners obtain data / reports at zero cost. Support for managing Approved Vendor List or RFP invites

PV Modules	PV Inverters	Energy Storage

• Testing per BOM
• Extended Reliability Testing
• Performance Testing
  ○ PAN Files
  ○ IAM coefficients
  ○ LID
  ○ NOCT
	• Reliability Testing
	• Envelope Characterization
	• Transient Response
	• Low Light Performance
	• Efficiency
	• Arc / ground fault
	• Micro, string, and utility scale
	• AFCI nuisance trip
		• Round Trip Efficiency
		• Self-Discharge
		• Response Time & Ramp Rate
		• Overvoltage / Undervoltage Protection
		• SOC Validation
		• Full System Cycle Testing
		• Environmental Testing
		• Cell Level Testing

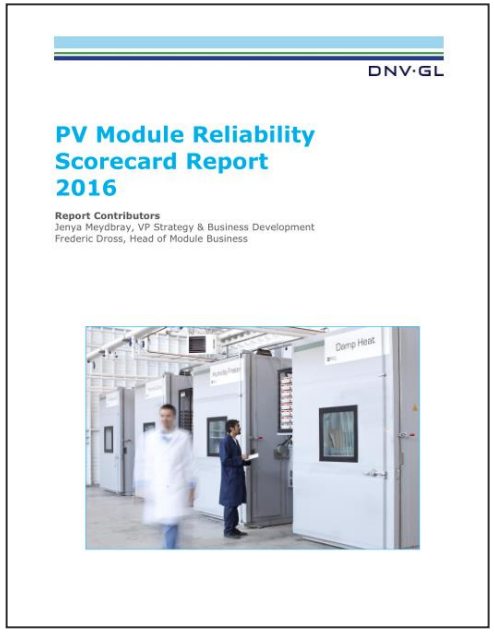
- Statistical testing at the project by project level to screen for defects and to verify that you got what you paid for

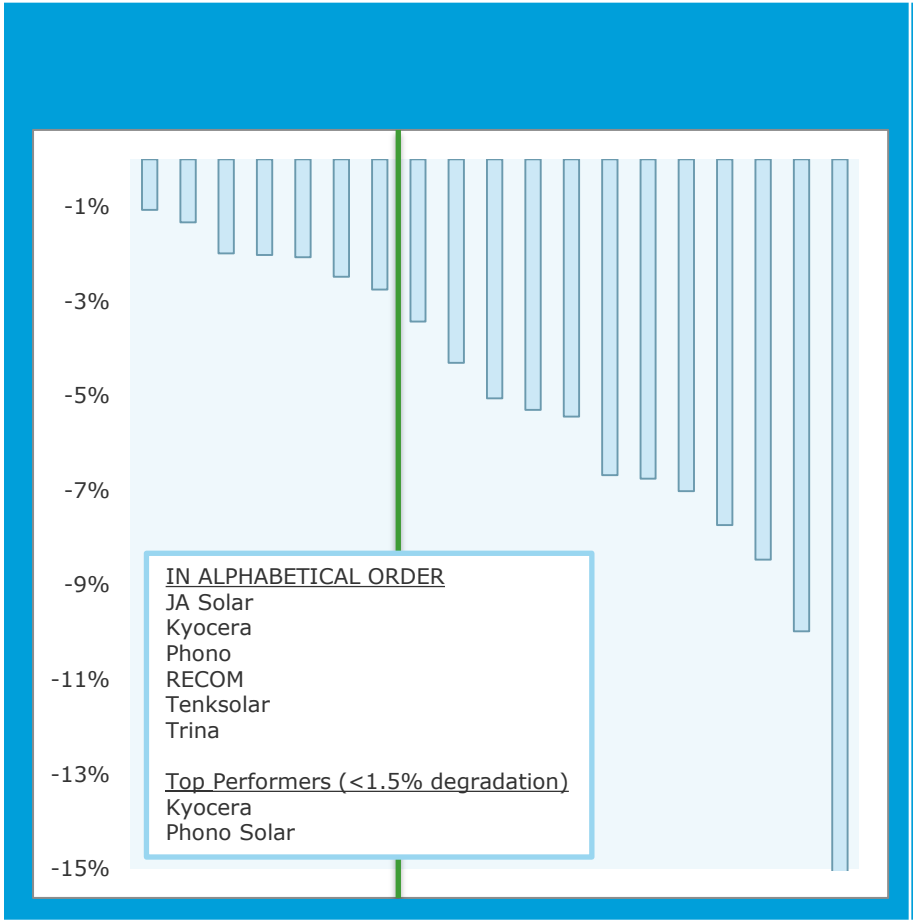
- Verification that power plant operation matches expectations

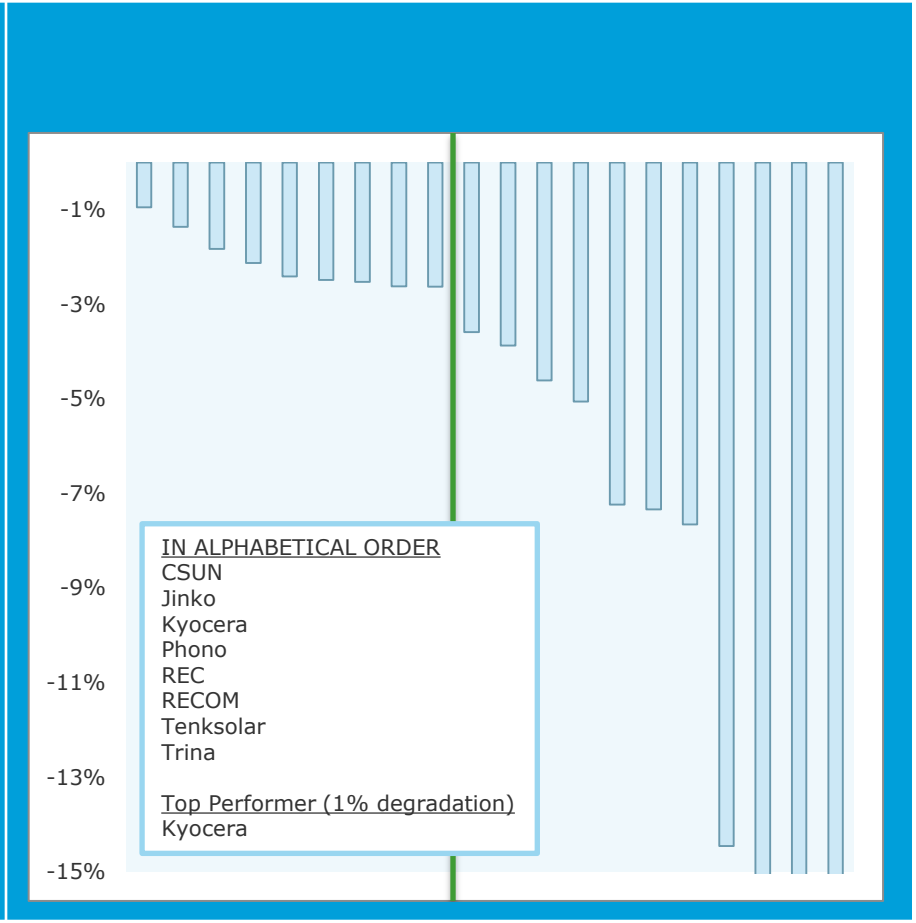

Sign up for and pay for PQP testing
Share Reports
Provide Active Support
DNV·GL
Sign waiver to share reports
Sign Engagement Letter including NDA

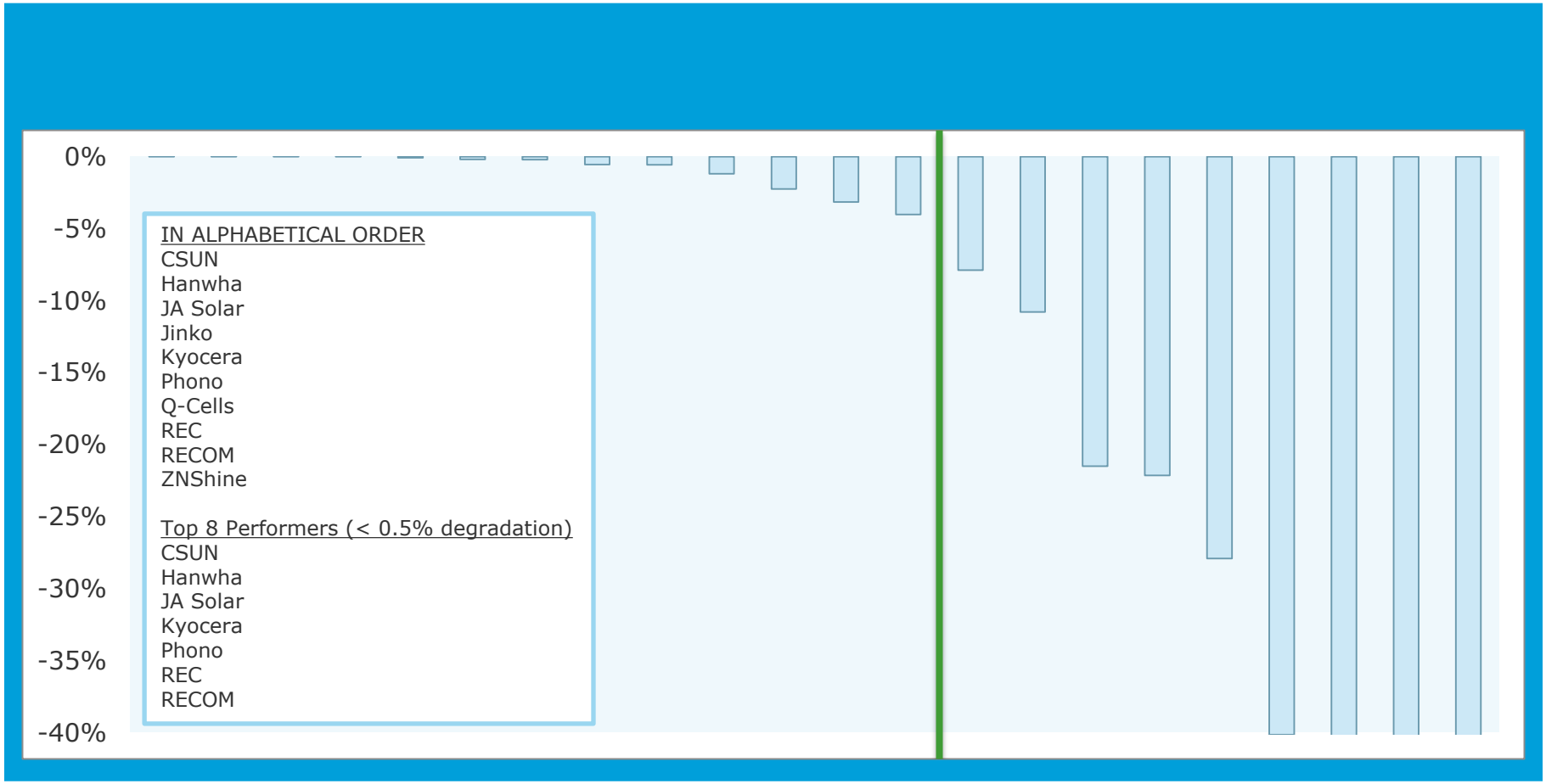
First of its Kind in the Industry

- Using the Qualification Program data we have released the
  – Free Download
- Report contains high level test results – details are available to Downstream Partners at no cost – *BOM and factory location is critical*
- coming in 2017

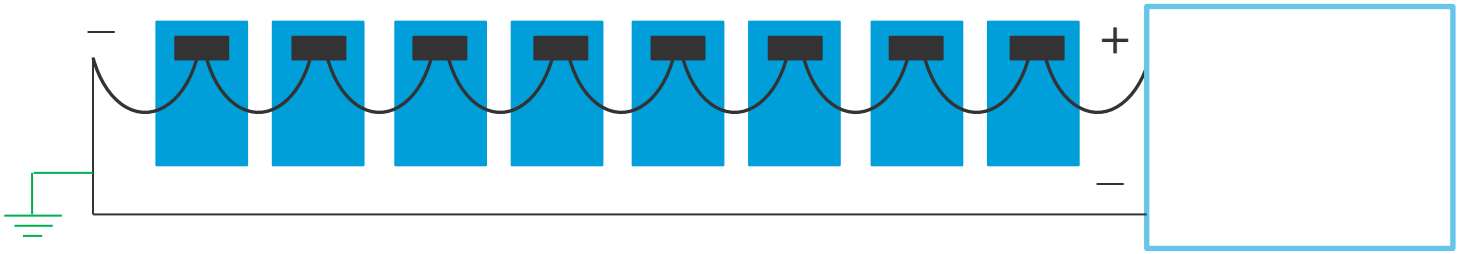



-1%
-3%
-5%
-7%
-9%
-11%
-13%
-15%
IN ALPHABETICAL ORDER
JA Solar
Kyocera
Phono
RECOM
Tenksolar
Trina
Top Performers (<1.5% degradation)
Kyocera
Phono Solar

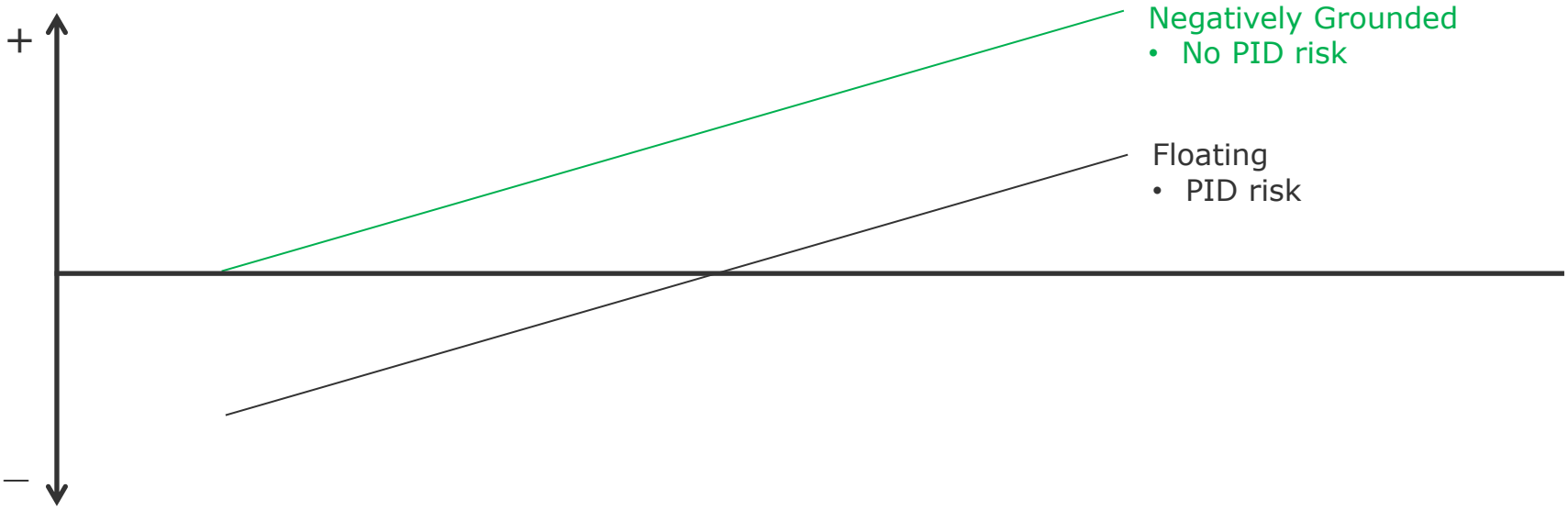

-1%
-3%
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-7%
-9%
-11%
-13%
-15%
IN ALPHABETICAL ORDER
CSUN
Jinko
Kyocera
Phono
REC
RECOM
Tenksolar
Trina
Top Performer (1% degradation)
Kyocera



- About 40% of modules degraded more than 5%
- -1kV for 100 hours under Damp Heat conditions

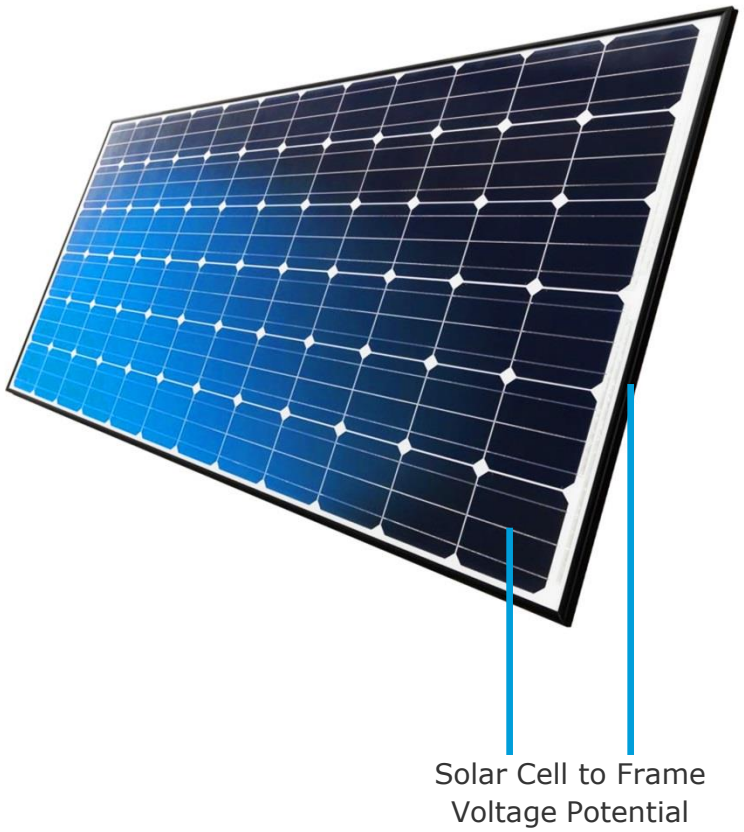


Solar Cell voltage relative to PV module frame



DNV·GL

- PID is one of several primary technical risks causing PV module degradation that DNV GL can help evaluate
- PID is stimulated when the voltage potential of the solar cells relative to the module frame (equipment ground) is negative
- Not all modules are sensitive to PID degradation as demonstrated by the Scorecard test results
- The risk is increased with system voltage
  - 1kV → 1.5kV



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Contact us to learn more:

Jenya.Meydbray@DNVGL.com

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