Historical Scorecard

The Historical Scorecard below shows the 2020 Top Performers and their history of top performance in past Scorecards. Manufacturers are listed by the number of years they have been designated a Top Performer, in alphabetical order.

A select group of manufacturers have earned Top Performer designations in PVEL's PV Module Reliability Scorecard multiple times through the years. PVEL commends these manufacturers for their commitment to product quality and reliability.

	2020	2019	2018	2017	2016	2014
Jinko	●	●	●	●	●	●
Trina Solar	●	●	●	●	●	●
Hanwha Q CELLS	●	●	●	●	●	
JA Solar	●	●	●		●	●
REC Group	●	●	●	●	●	
GCL	●	●	●	●		
LONGi	●	●	●	●		
Suntech	●	●	●			●
Adani/Mundra	●	●	●			
Astronergy	●		●	●		
Seraphim	●	●		●		
Silfab	●	●		●		
SunPower	●		●	●		
Vikram	●	●		●		
ZNShine	●	●			●	
Boviet	●	●				
First Solar	●		●			
HT-SAAE	●		●			
Panasonic	●		●			
Canadian Solar	●					
Heliene	●					
Sunergy California	●					

The Impact of Factory Location

Evidence of the impact of factory location on product quality was recently observed by PVEL when two very similar BOMs were produced at different locations. One was produced at a manufacturer's own factory and the other was produced at their contract manufacturer's factory. The DH2000 power degradation from the manufacturer's own factory was 1.0%. The same test performed on the modules produced at their contract manufacturer's factory yielded results of 3.9% degradation.

Two factories produced near-identical BOMs. One BOM was a Top Performer while the other degraded nearly 2x the Top Performer threshold.

Top Performer Factory Locations	
Adani (Mundra Solar PV Ltd.)	Gujarat, India
Astronergy (Chint Solar [Zhejiang]) Co., Ltd.	Haining, China; Yixing, China
Boviet Solar Technology Co., Ltd.	Song Khe-Noi Hoang Industrial Zone, Vietnam
Canadian Solar Inc.	Sriracha, Thailand
First Solar Inc.	Perrysburg, U.S.A.
GCL System Integration Technology Co., Ltd.	Van Trung Industrial Park, Vietnam
Hanwha Q CELLS Co., Ltd.	Jincheon-gun, South Korea; Cyberjaya, Malaysia; Dalton, U.S.A.
Heliene Inc.	Mountain Iron, U.S.A.
JA Solar Technology Co.	Hefei, China; Fengxian, China
Jinko Solar Co., Ltd.	Shangrao, China; Van Trung Industrial Park, Vietnam
LONGi Solar Technology Co., Ltd.	Kuching, Malaysia; Taizhou, China
Panasonic Corporation	Buffalo, U.S.A.
REC Group	Tuas, Singapore
Seraphim Solar System Co., Ltd.	Changzhou, China
Silfab Solar Inc.	Mississauga, Canada; Bellingham, U.S.A.
Shanghai Aerospace Automobile Electromechanical Co. ("HT-SAAE")	Istanbul, Turkey
Sunergy California, LLC	Dinh Tram Industrial Zone, Vietnam
SunPower Corporation	Ensenada, Mexico
Trina Solar Co., Ltd.	Changzhou, China; Van Trung Industrial Park, Vietnam; Sriracha, Thailand
Vikram Solar Ltd.	Kolkata, India
Wuxi Suntech Power Co., Ltd.	Wuxi, China
ZNShine PV-Tech Co., Ltd.	Changzhou, China

Industry perspective

"After more than 300 audits on over 95 GW of manufacturing capacity, we frequently see inconsistent product quality coming from different factories under one manufacturer. Even among tier one suppliers, factories and individual workshops within a factory may differ in production quality."

IAN GREGORY
Managing Director
PI Berlin North America

Case Studies

PQP Failures

20% of BOMs eligible for inclusion in this year's Scorecard had at least one failure. Without BO stabilization after damp heat testing, the 2020 failure rate is consistent with the overall failure rate observed in 2019.

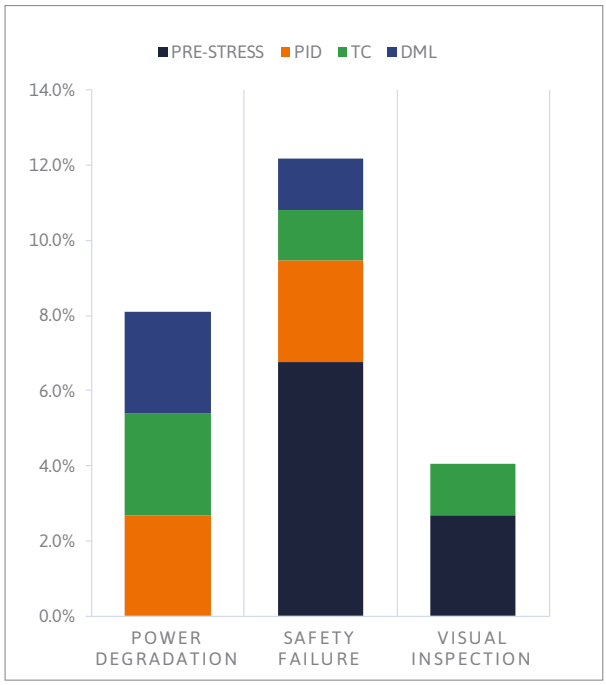
What is a failure?

There are three types of failures in the PQP:

1. **Safety**
   Safe operation is determined via wet leakage testing using the IEC 61215 standard, which evaluates the electrical insulation of the PV module under wet operating conditions (i.e. rain, fog, dew, humidity, snow melt). **Failure means that module operation may be hazardous in the field.**
2. **Visual inspection**
   Modules are examined for delamination, corrosion, broken or cracked surfaces and other changes to the module using the IEC 61215 criteria. **Failure indicates that major manufacturing defects are present, leading to premature failure in the field.**
3. **Power degradation**
   Although the PQP does not assign specific pass/fail thresholds for degradation, module manufacturers are able to remove their products from testing if rates fall below expectations. In these cases, manufacturers usually change their BOM or production process, then submit new samples for retesting. PVEL notes all retests in PQP reports for full transparency with downstream buyers. **Failure means the modules may underperform in the field and ultimately result in financial losses for the asset owner.**

20% of BOMs had at least one failure

The chart below describes failures per test per BOM that occurred in PQP testing for the 2020 Scorecard. Pre-stress failures are those that were detected upon initial inspection prior to testing.



PQP Failures Continued

Junction box defects in the field

The image above shows a PV module at the project site with a junction box that melted due to electrical arcing.

A 50 MW PV plant in Africa built in 2013 began to exhibit serious failures from poor soldering and failed diodes after just five years of operation.

Over 3,000 modules were affected by poor soldering in the junction box, which led to catastrophic junction box failures due to electrical arcing.

In one case, the molten plastic from the melted junction box started a brush fire in the dried grasses below the modules.

The asset owner's warranty claim is being resolved at the manufacturer's discretion, so field repairs of the affected modules have been prioritized over full replacement.

As the volume of module failures grows over time, the site owner is increasingly concerned with the plant's long-term viability and profitability.

Junction box defects in the lab

PVEL observed an increase in junction box related failures in PQP testing for the 2020 Scorecard as compared to the 2019 and 2018 Scorecards. These include bypass diode failures following thermal cycling, and wet leakage failures originating at the junction box before testing, and after thermal cycling, PID and the DML sequence.

Short-circuited bypass diodes are categorized as power degradation failures because they cause power drops of at least 33%. However, diode failures are also a safety concern: an open-circuited bypass diode cannot prevent hot spots when the module is partially shaded.

In extreme cases, hot spots can crack the module glass and/or burn through the backsheet. Improper component selection or poor electrostatic discharge controls on the junction box or module production line can cause failed diodes in the field.

Many of the recorded wet leakage failures were traced to poor sealing around the junction box via the junction box lid, adhesive or pottant. Correct placement of the lid and application of sealants are critical manufacturing processes, but they can be overlooked in the pursuit of production targets.

The junction box above became unsealed after damp heat testing.

One in five manufacturers tested for the 2020 Scorecard period experienced at least one junction box failure.