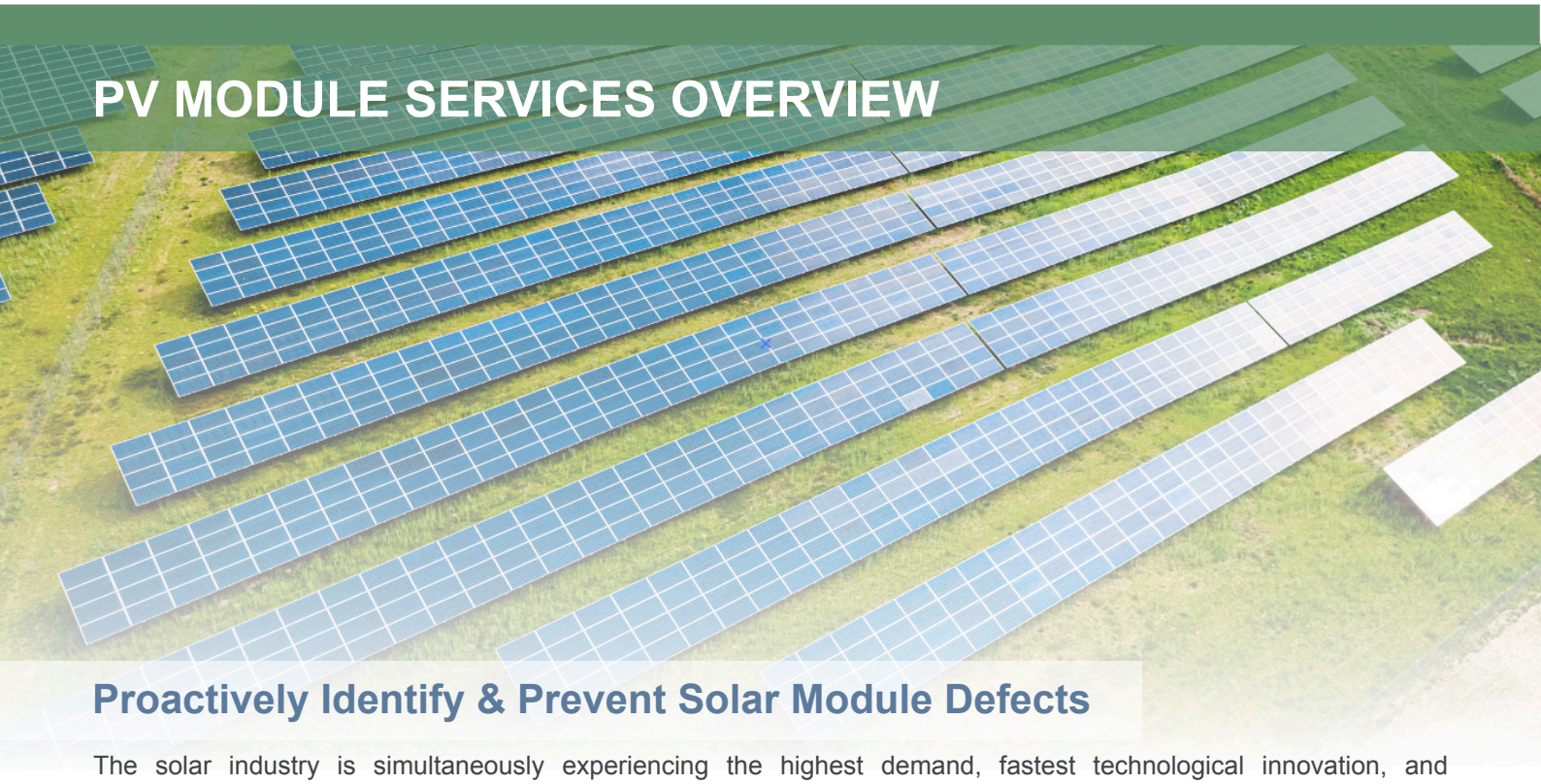
CEA
Clean Energy Associates

Investment Confidence

PV MODULE SERVICES OVERVIEW



Proactively Identify & Prevent Solar Module Defects

The solar industry is simultaneously experiencing the highest demand, fastest technological innovation, and greatest uncertainty in its history. These three facets have all contributed to a rapidly changing environment where technologies, factories, workshops, and workerforce are updated, replaced, and added at an unprecedented pace—the perfect recipe for things to go wrong. Quality issues and defects that may impact the operating lifetime and performance of your project can occur at any time during design, manufacturing, shipping, installation, or operation. However, dramatic ramp-up speed alongside rapid technology advancements have made defects a regular occurrence amongst even the most mature and advanced suppliers.

What Can Go Wrong Upstream?

Several issues upstream...

- Poor operator's training
- Unqualified raw materials (i.e. cells, EVA, backsheet, sealant, etc.)
- Unqualified calibration of factory equipment/machinery
- Soldering defects
- Poor module handling
- Lamination issues

…can cause complications...

- Hotspots
- Water penetration
- Delamination
- Interconnection failure
- Cracked cells
- Junction box failure
- Corrosion
- Glass breakage

… with potentially serious consequences downstream.

- Module failure
- Performance losses
- Fire hazard
- Electrical safety hazard
- Project delays
- Financial loss

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How Can I Be Sure My Equipment is Manufactured According to the Specs & Quality Requirements in My Contract?

Pre-Production

- Factory's certification (ISO, OHSAS, etc.) assessment
- Product's certification (IEC, UL, CE, etc.) assessment
- Bill of Materials (BOM) review
- Warehouse and storage conditions verification

Production Monitoring

- Input material monitoring
- Production environment monitoring
- Production process monitoring
- Equipment maintenance and calibration monitoring

Pre-Shipment

- Random sampling
- Approved test criteria
- Visual inspection
- Electroluminescence (EL) test
- IV test
- Independent reliability testing

Container Loading

- Proper packing
- Proper loading
- Proper sealing
- Container and product documentation check

CEA's 16 Year Track Record Of Understanding Manufacturing Processes & Pitfalls

350+

engagements in solar and storage factories worldwide

250+ GW

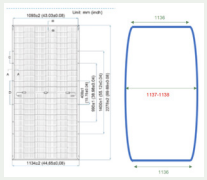
of PV project experience

2000+

project site safety and quality inspections

Case Studies

Product Type:	**Crystalline silicon module**
QA Services:	Inline Production Monitoring (IPM)
Issue Description:	Module dimension out of specification
CEA Value Added:	• Highlighted potential risks to supplier and implemented supplier internal improvements • Inspector conducted 27 points dimension check to ensure each dimension is in accordance with the drawings. • CEA identified modules with bowing frame where the total width exceeded the specifications. This was only detectable through multi location dimensional check. This deviation can lead to insufficient spacing on the racks e.g. for thermal expansion.



Product Type:	**Crystalline silicon glass/backsheet mono PERC module**
QA Services:	Pre-Shipment Inspection (PSI), Inline Production Monitoring (IPM)
Issue Description:	Very high EL defect rate due to microcracks; extensive soldering issues on rear side evading EL detection; bad practices at the tabbing / stringing station
CEA Value Added:	• CEA inspectors managed to bring the defect rate from peaks of 50% down to 5%. • CEA rejected 57,000 modules (22 MW) with high microcrack rates and suggested the supplier to improve rear side inspection for weak soldering instances. • Mitigating actions allowed production to continue, applying good practices and ensuring high product quality.

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