

PV RELIABILITY & PERFORMANCE

A PROJECT DEVELOPERS EXPERIENCE

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ABOUT US

- **BORREGO SOLAR SYSTEMS**

- Established 1980
- Offices in San Diego, Berkeley & Lowell, MA
- Active in CA, NV, AZ, MA, NJ, PA, NY, CT, TX, OH
- 70 Employees
- Installed over 25MW of PV (1000+ Systems)
- Project Developer & Integrator
- Originally Residential, Now Commercial/Industrial/Utility Focused`

OUTLINE

- **SYSTEM RELIABILITY**

- Analysis of 5 Years of Service Data

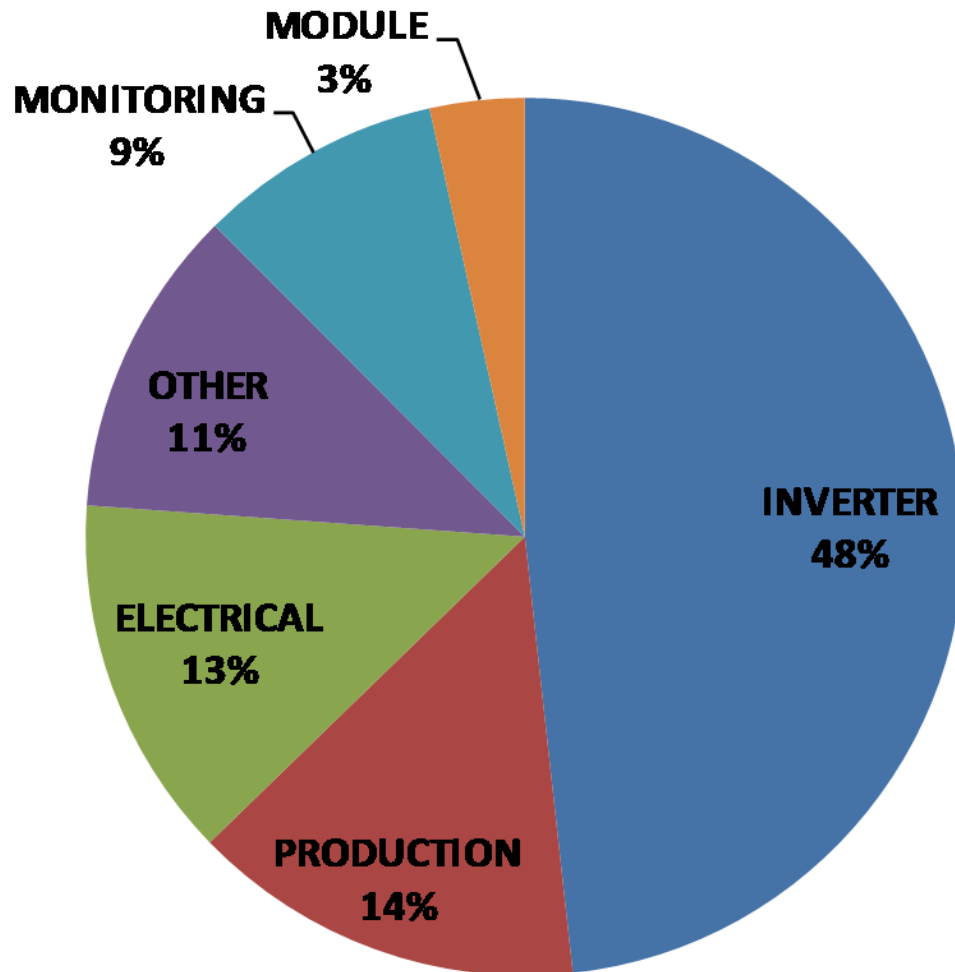
- **MODULE RELIABILITY**

- Summary of Experience
- Photographs of Failed and Damaged Modules

- **OUR RELIABILITY CONCERNS**

- Transportation
- Installation Practices
- Structural, Voltage, Shading, Moisture, Testing & New Products

SYSTEM RELIABILITY



- Analysis of 750 service cases reported through end 2010
- Residential and commercial installations.

SYSTEM RELIABILITY - BREAKDOWN

- **INVERTER (48%)**
 - Failure and Replacement (Complete/Partial) – Approx. 50%
 - Related Issues – Breakers/Fuses, AC Voltage, Turned Off
- **PRODUCTION (14%)**
 - Low Production Reported, Electricity Bill High
- **ELECTRICAL (13%)**
 - Installation Issues, Wiring Issues, Ground Faults, Tripping Breakers
- **OTHER (11%)**
 - Roof Leaks/Water in Conduit/Boxes, Damaged Tiles, Dirty Array, Rattling Modules, Bird/Rodent Issues, Other Damage
- **MONITORING (9%)**
 - Web Based Monitoring Not Working, Inverter/Local Monitoring Display Blank, Network Issues

MODULE RELIABILITY

- **INSTALLATION STATISTICS**

- 25MW / 125,000 Modules Installed
- Modules from Sharp, Yingli, BP, Shell/Siemens/SolarWorld, Evergreen, First Solar, Kyocera, Uni-Solar, Sanyo, Kaneka
- Residential & Commercial Installations

- **DAMAGED DURING TRANSPORT/INSTALLATION**

- Quantity Unknown – Data Showing 60+ Modules ~0.05% of Installed

- **DOA MODULES**

- DOA Modules - Appear OK, Non Functional
- 2 Instances, 1 Module & 6 Modules – ~0.005% of Installed
- Identified During Commissioning (V_{OC} testing)

- **INSTALLED MODULE ISSUES**

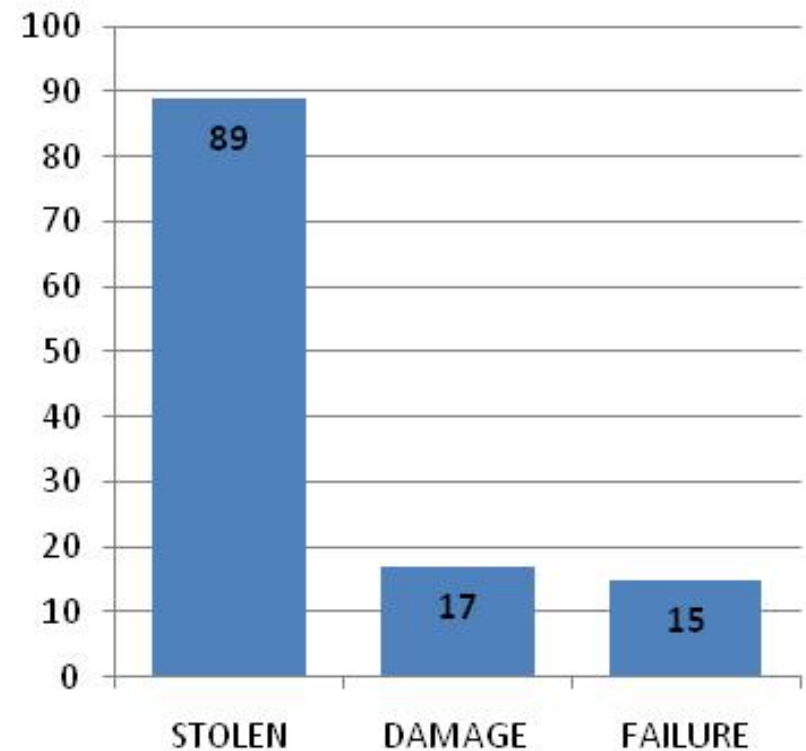
- 3% Of Service Cases

MODULE RELIABILITY

% OF CASES (OF 3% MODULE CASES)



OF MODULES EFFECTED



MODULE RELIABILITY

- **FAILURES**

- 7 Separate Incidents, 6 Different Brands, 15 Modules (0.01%)
- Solder Bond, Seal, Structural, Corrosion & Hot Spot/ Failures
- Replaced Under Warranty (Except One – Mounting Problem)
- CAVEAT – These are Catastrophic Failures, We Expect There Are Unknown Non-Catastrophic Failures Reducing Performance

- **DAMAGED**

- Majority from Customer Who Has Neighbor With 9 Hole Golf Course!

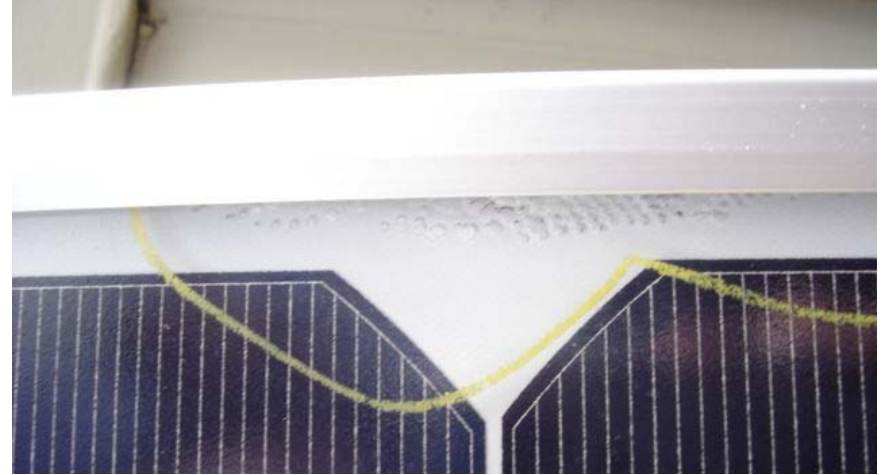
- **STOLEN**

- Was a Growing Problem, Seems to Have Tapered Off, Better Security, Reduced Value, Focus on Commercial Systems

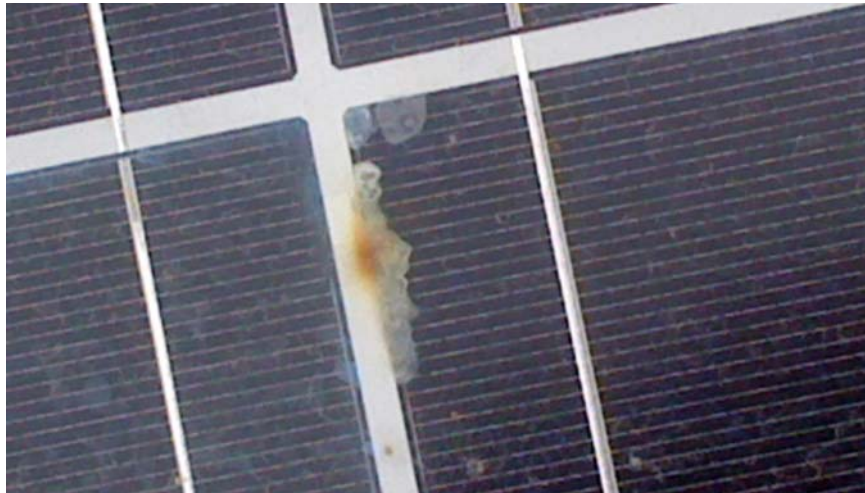
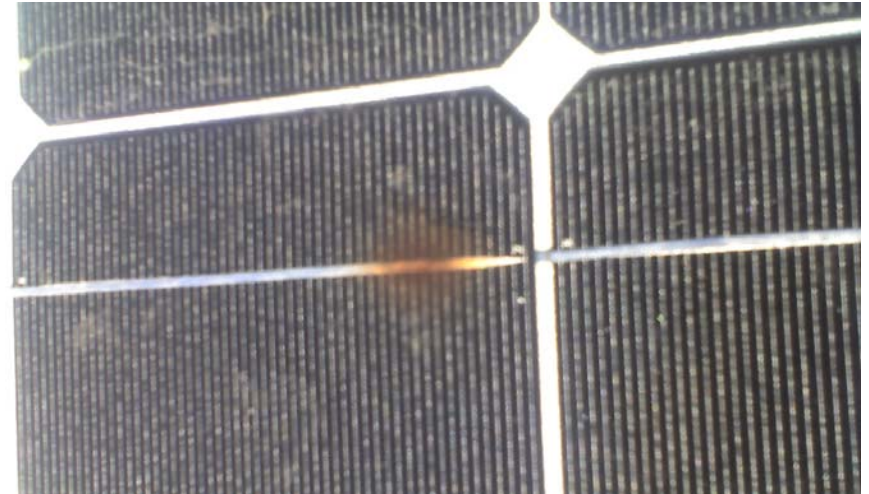
MODULE RELIABILITY - FAILURE



MODULE RELIABILITY - FAILURE



MODULE RELIABILITY - FAILURE



- **CORROSION OR SOLDER BOND ISSUE?**

- LEFT – Same Module Type
- ABOVE – Diff Module Type

MODULE RELIABILITY - FAILURES



- **EDGE SEAL COMPROMISED**
 - Ground Fault in Inverter
 - Inverters Replaced
 - Numerous Visits to Identify



- **FRAME SEPARATION**
 - Improper Module Support
 - Only 1 Module Impacted
 - Issue Corrected

MODULE RELIABILITY - DAMAGE



MODULE RELIABILITY – DAMAGE



OUR RELIABILITY CONCERNS

- **TRANSPORTATION**

- What Issues in 5 or 10 Years From Transporting Modules?
- What if Modules Were Unpackaged & Then Transported?

- **INSTALLATION PRACTICES (PRE-FABRICATION)**

- Assemble Modules to Racking Off-Site (Warehouse)
- Changes Some Construction to Manufacturing
- Reduces Onsite Assembly, Craning Cost/Time,
- Improved Quality
- What Is Impact on Modules?
- Planning on Testing Modules That Have Been Through Process

OUR RELIABILITY CONCERNS



TRANSPORT TO SITE



STORAGE/READY TO SHIP

OUR RELIABILITY CONCERNS



TRANSPORT TO SITE

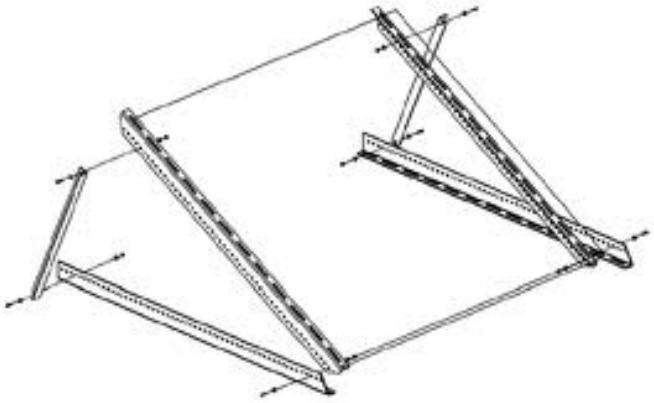


ASSEMBLY ON SITE



CRANING TO ROOF

OUR RELIABILITY CONCERNS - OTHER

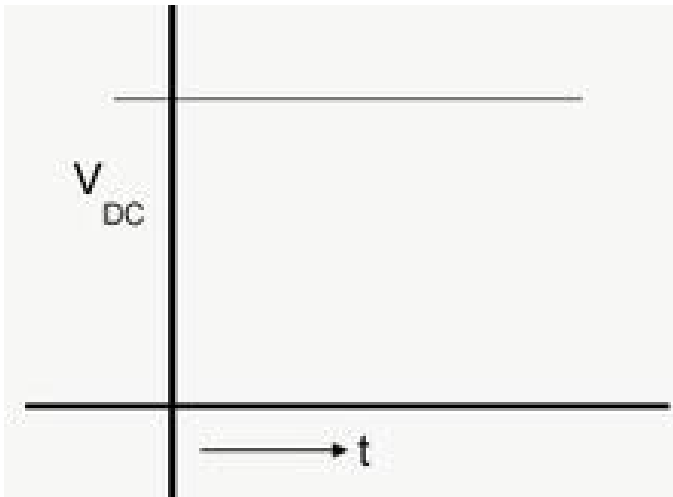


• STRUCTURAL SUPPORT

- Can Racking Structures Reduce Cell Fracture (Or Conversely Promote It)?
- How Significant is this Issue?

• VOLTAGE DEGRADATION

- Does Module Voltage Change Over Time?
- Industry Assumption is 50% V, 50% I
- Limits System Design Flexibility OR Potentially Poorly Performing Systems



OUR RELIABILITY CONCERNS - OTHER



- **SHADING**

- Is Consistent Shading on Portions of Modules a Long Term Issue?



- **MOISTURE**

- Shallow Tilt/Water Pooling?
- Consistent Snow Coverage?

OUR RELIABILITY CONCERNS - OTHER



- **CIRCUIT TESTING – HIGH BIAS (MEGGER)**

- Can We Safely Megger Circuits Including Modules?
- Large # of Circuits Not Currently Tested
- Can Reduce Fire Danger if we Test
- Need Best Practice Guide

- **NEW PRODUCT RELIABILITY EVALUATION**

- Integrated Inverters/DC Converters/Intelligence
- Need Standard Reliability Test



THANK YOU