

Introduction

Module failure in the field is a reliability issue from both a manufacturing and Balance of System (BOS) installation perspective for most PV module types. Utilizing data from thin film glass /glass installations totaling 236 MW DC of installed capacity, the modes of module failure in the field are examined.

Materials and Methods

The 236 MW DC of installed capacity represents 520 installations with a total of 3,324,220 modules ranging in project size from 2kW DC to 38MW DC. The data represents projects beginning operation in 2005 through present day. Module Failure Modes in the field have been divided into five categories for the company's identification, tracking and warranty replacement purposes. Once a failed module is identified and classified a return request is filed with the manufacturer.

Installation Company Module Failure Mode Classification	
Classification	Description
Shipping/Packaging	Out of the box damage including glass breakage from transport
Installation and Handling	Glass breakage and cracks as a result of incorrect handling or installation
Diminished Module Output	Module output power is low.
Intrinsic Module Damage After Deployment	Module has defective wires, glass breakage or cracks or no power output.
Externally Caused Module Damage After Deployment	Module has been damaged by external source.

Shipping/Packaging



Installation and Handling



Externally Caused Module Damage After Deployment



Intrinsic Module Damage After Deployment



Results

Once the return report has been filed, the manufacturer evaluates if the return request meets the warranty specifications and authorizes the return. At this point the failed modules are returned and the manufacturer performs a technical assessment of the failure. The manufacturer determines the module failure and whether the module qualifies for warranty replacement.

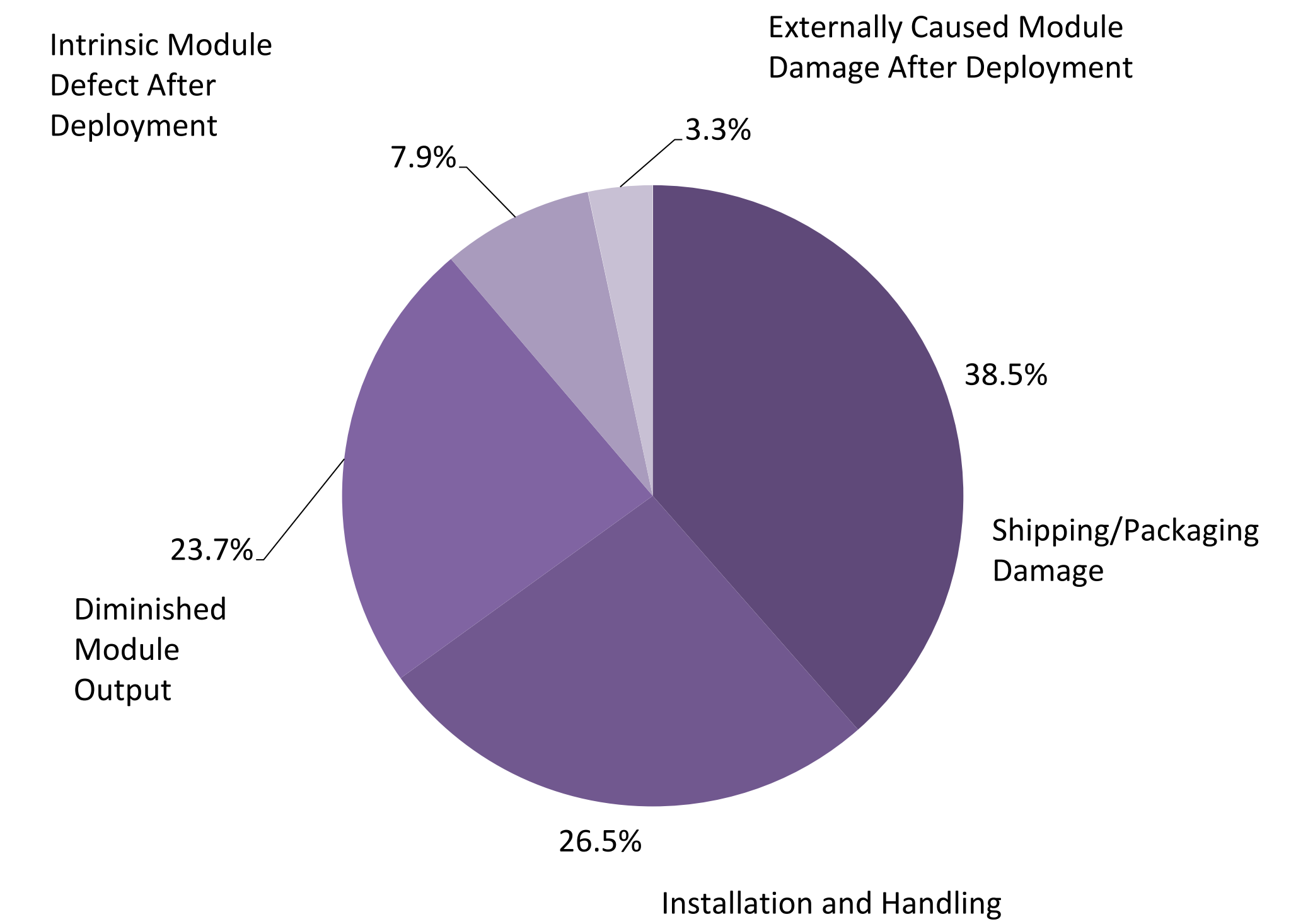
Manufacturer Failure Mode Designations After Technical Assessment

Defect/Damage Covered by Warranty Replacement

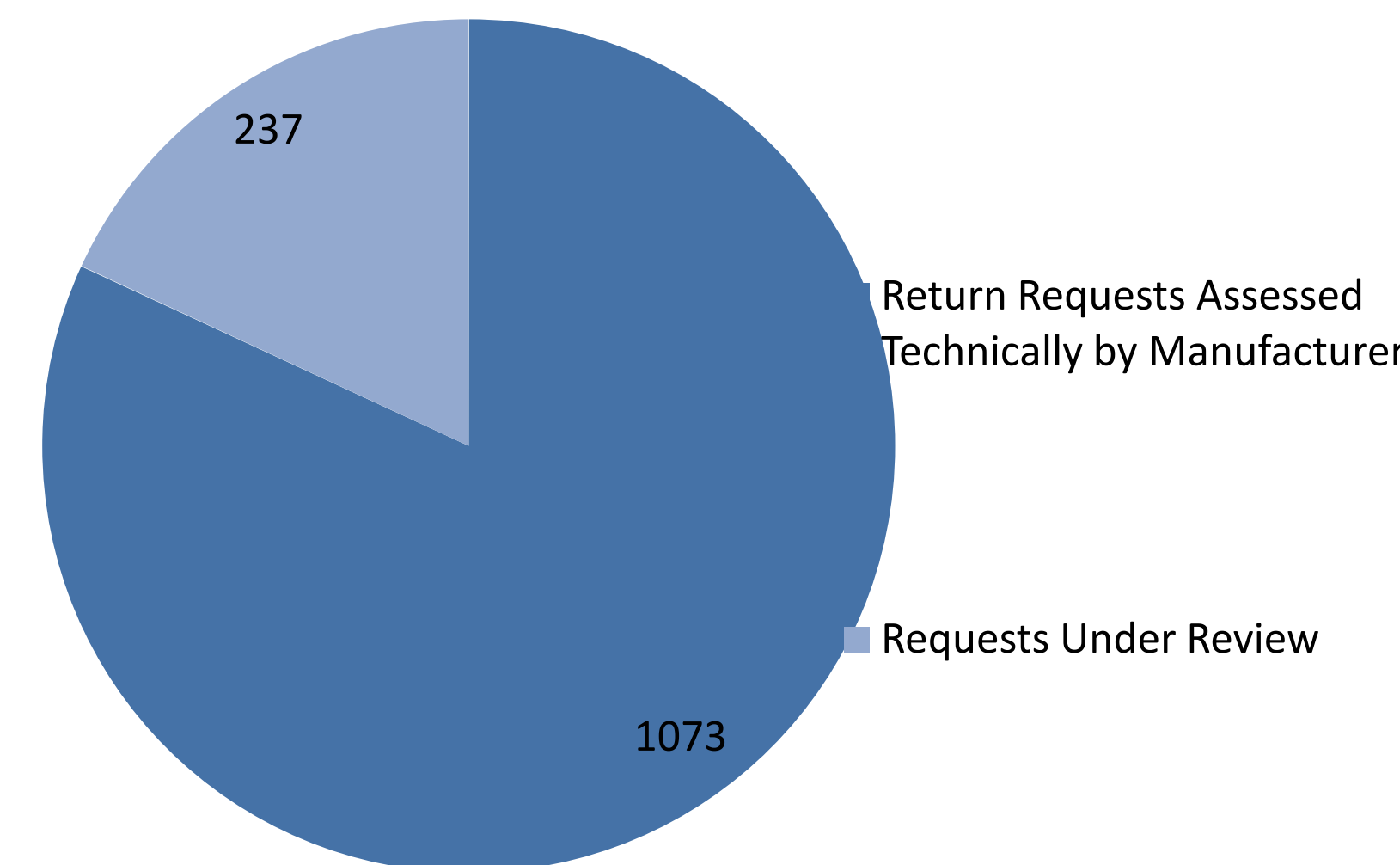
- Damage due to Handling or Installation:
 - Damage through mounting system (glass scratches)
 - Damage due to bad module clip position
- Glass Crack due to Thermal Cycling
- Damage Due to External Source

Of the 1310 Return Requests filed, 1073 have been accepted and reviewed technically by the manufacturer .

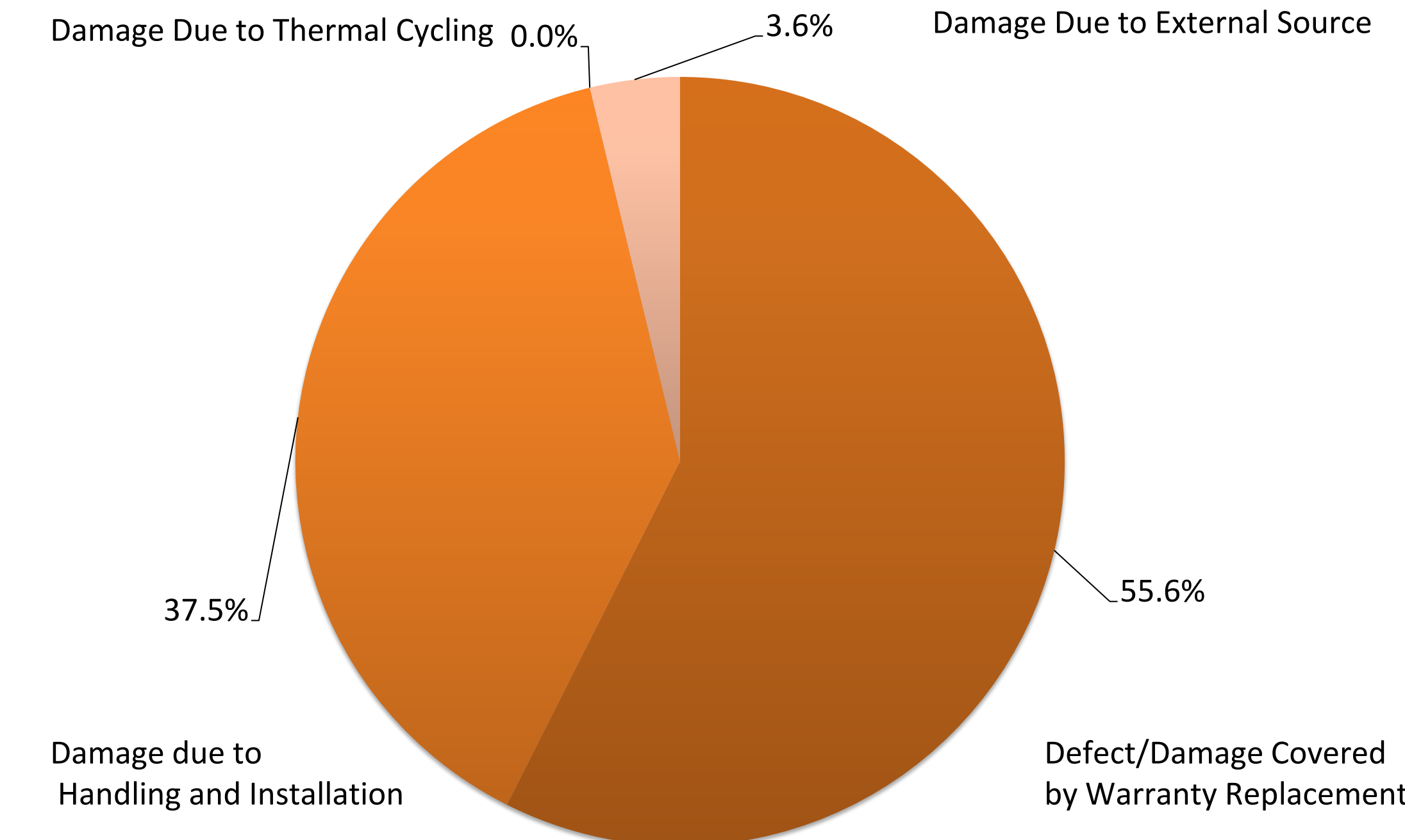
Company Failure Mode Designations for Installed Projects



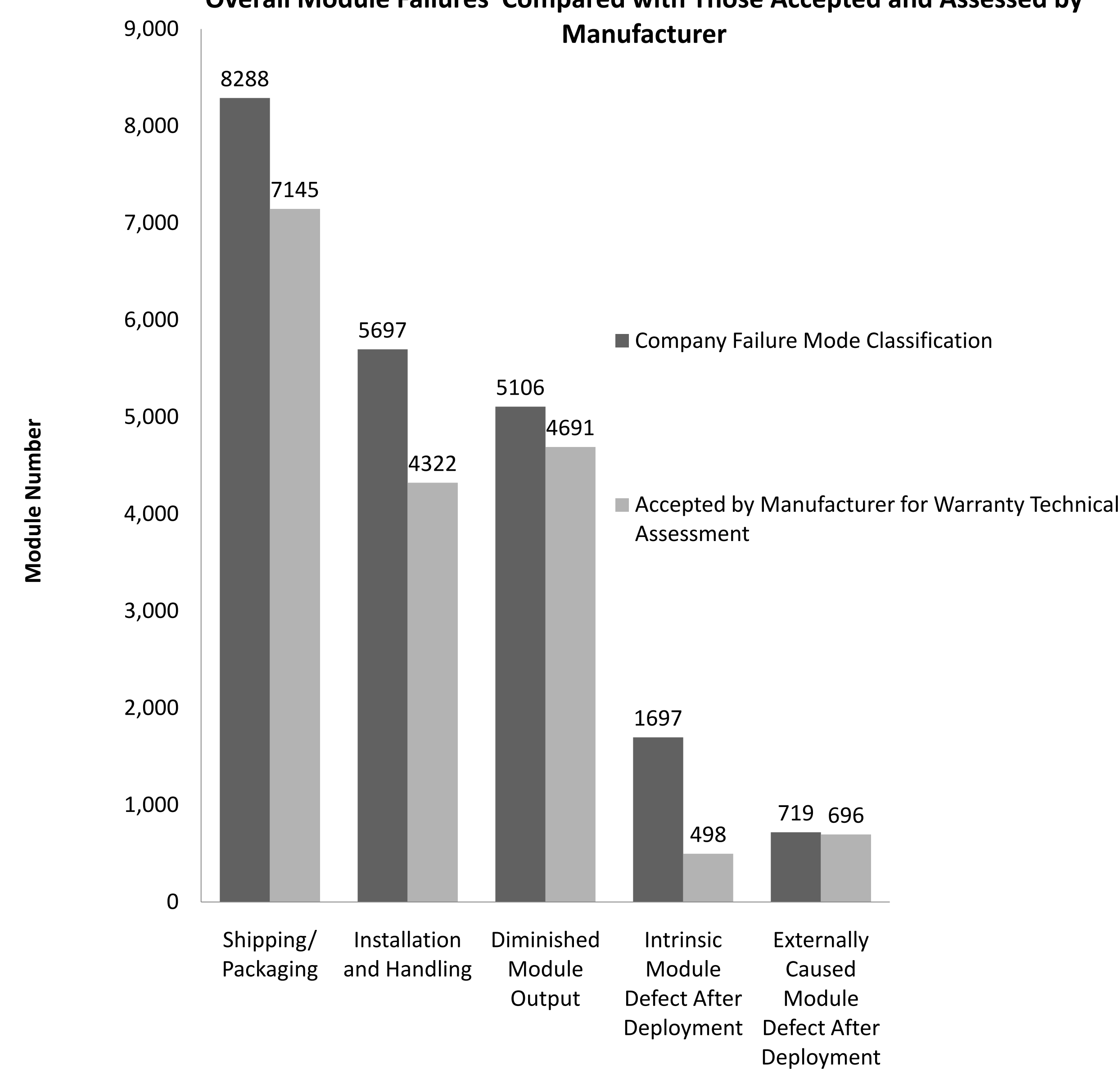
Return Requests Assessed by Manufacturer



Manufacturer Failure Mode Designations Based Upon Technical Assessment of Returns



Overall Module Failures Compared with Those Accepted and Assessed by Manufacturer



Conclusions

Shipping/Packaging and Handling and Installation are the greatest mechanisms of module failure in the field for these installations.

How Lessons Learned from the Field:

How modules are packaged and handled during shipment is important.

The difference between the company and manufacturer designation of module failure due to handling and installation indicates that installations can benefit from increased attention to how modules are installed .

Minimizing the number of times a module is handled during installation may help to reduce this risk.

Operation and Maintenance requires special attention to prevent externally caused damage to modules by maintenance crews and rocks kicked up during mowing, ..