Long Term Damage Testing (NREL)

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Main goal, identify how damaged modules change over time.

- Expose damaged modules, outdoors for long duration
  - 1-10 years (depending on damage and failure)
  - Power loss may be 20 year rating or >10% loss.
- Evaluate data signature for damage
  - Noise, rapid drop in power, string voltage or current droops.
- Track how fast module output degrades due to specific damage

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Evaluation Methods

Characterize damaged modules using standard and non-standard industry practices, to include:

- EL imaging – cracking, electrical hot spots
- IR imaging – hot and cold spots internal to module
- IV curves – electrical characterization
- Real time data - PVLib Python Tools for degradation analysis

Methods Evaluation

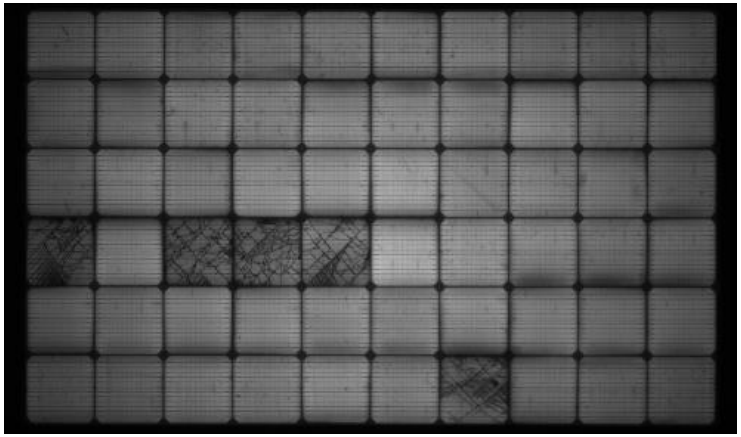
EL Imaging: Find cracks, internal damage to cells and modules

IR Imaging: Find hot and cold spots in modules associated with high resistance connections or damaged internal connections

Visual Imaging: Show visible damage progression

IV Curves: Determine power loss mechanisms through electrical characterization

Real Time Data: Show energy loss over time



EL Image, Installation and Hail damage, LG - M1806-0005

Types of Damage

- Hail exposure
- Wind damage
- Installation cracks
- Wiring and J-box
- Back-sheet delamination

Large Hail (NREL 2017)

Hail Damage to Irradiance Sensor (NREL 2017)

Wind Damage –Long read: What broke at Oakey – pv magazine Australia (pv-magazine-australia.com)

Shipping Damage – back sheet scratched during unpacking (NREL 2016)

[2] Smith

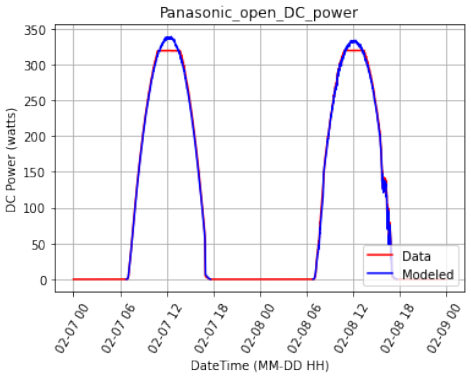
Project Outputs

Evaluate degradation and loss mechanisms as they progress.

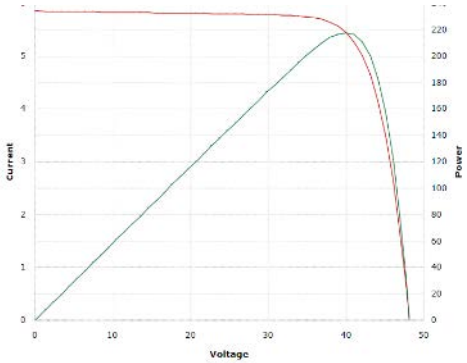
- Update data sets every 12 months or sooner as modules fail.
- Periodically publish on NREL website and industry journals.

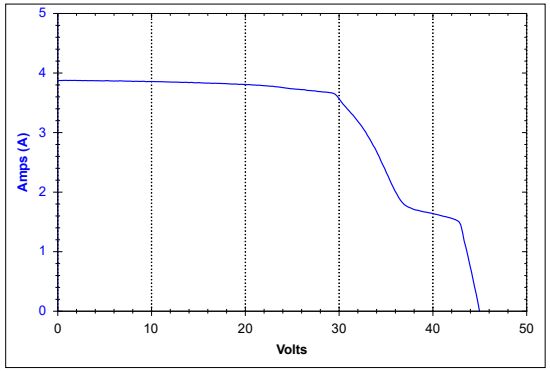
Module Data – IV and Real Time

- Real Time Data
  - DC monitoring
  - Micro-Inverter loading



- IV Data
  - Field and Indoor Measurements (Ivs taken





EL Imaging (Indoors and Outdoors)

Defects Found:

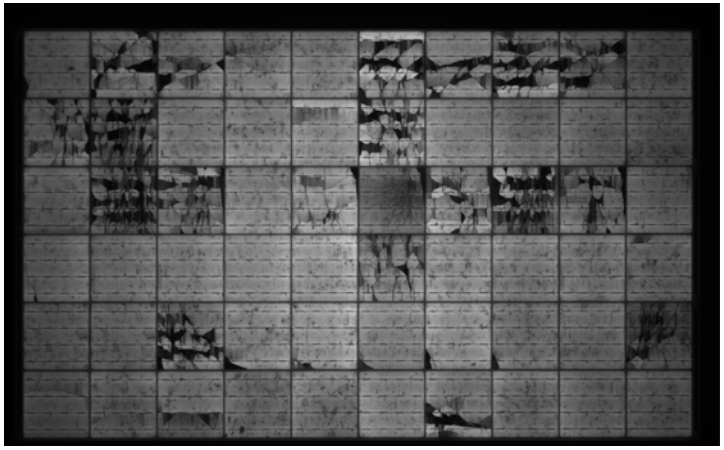
Cracks, high resistance connections,

Impact damage, poor conduction.

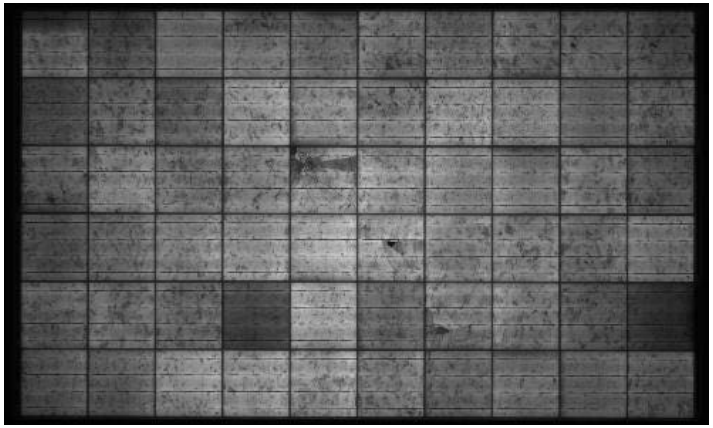
Defect Causes?

Installation, weather, manufacturer defects, vandalism

Frequency: 3-6 months depending on severity of defect



EL Image, Hail damage, Trina - M1610-0043



EL Image, Hail damage, Jinko - M1609-0059

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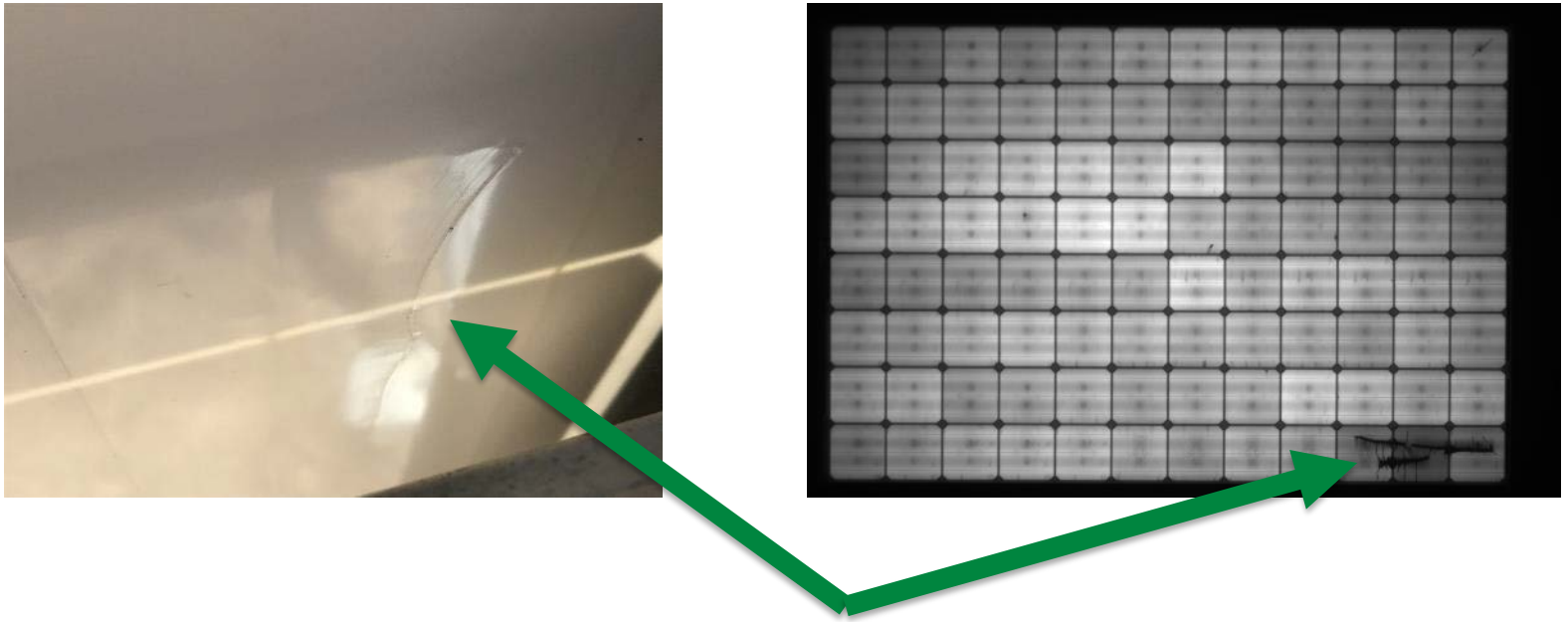
Visual and EL imaging

- Module possibly damaged during shipping



Shipping Damage, lower right 3 cells
(Visual Image and EL image)

PVRW PV Damage Testbed Questions

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