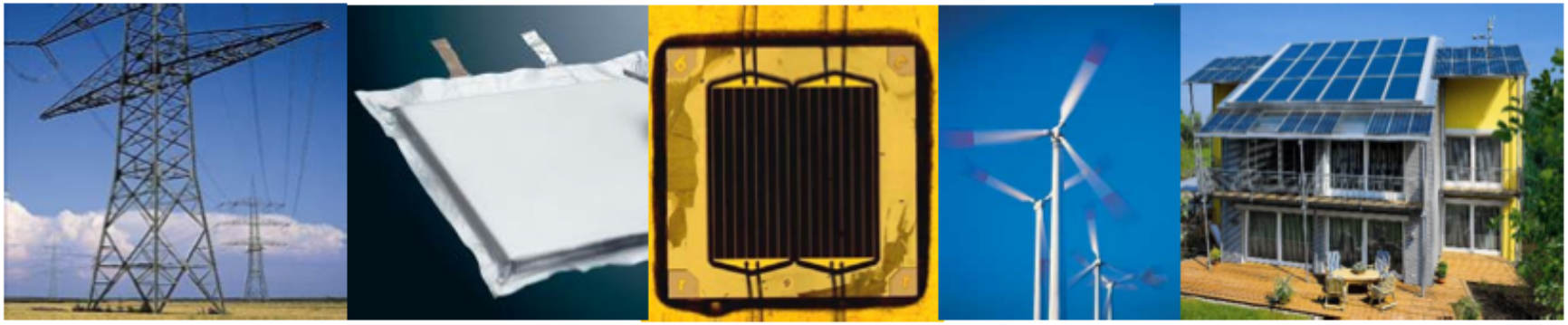
Photovoltaic Durability Initiative (PVDI)
A Durability Program Providing Bankability and Marketing Leverage

NREL PV Module Reliability Workshop
Golden, CO February 29th, 2011



David H. Meakin
Fraunhofer Center for Sustainable Energy Systems
Advanced PV Modules Group

Fraunhofer USA

Agenda

- Motivation and Goals
- Key Test Protocol Features
- Reporting of Results
- Improvement Strategy

A Fraunhofer ISE and Fraunhofer CSE joint program

Motivation

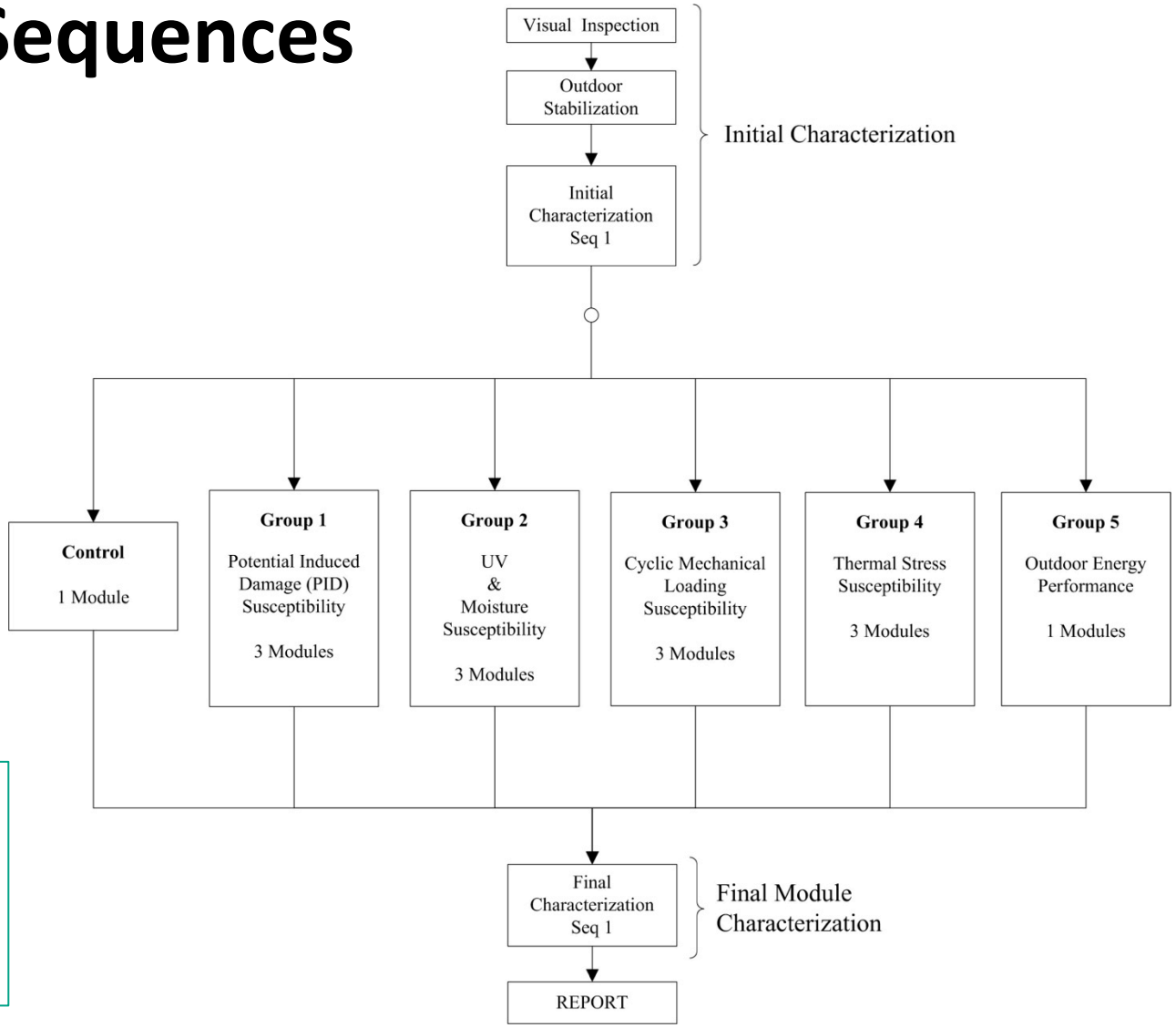
- Demand from financial sector, installers, and module manufacturers for “Module Bankability” testing protocol
- Protocol to provide quantitative comparative data for modules in various operating environments
- Guidance with regards to module service lifetime/durability

Program Goals

- To regularly publish durability reports and rankings
- To enable PV system developers and financiers to make educated deployment decisions
- To reduce cost of PV systems by reducing deployment risks

To provide ranking of PV modules relative to their likelihood to perform reliably over their rated service life

PVDI Test Sequences



Module Component Testing

- Diode
- Junction Box
- Hotspot

Fraunhofer USA

Test Protocol Features

- PID test sequence looking at both positive and negative grounding configuration
- UV combined with damp heat.
  - UV exposure equivalent to at least 1 year with partial saturation
- Cyclic and static loading
  - Cyclic loading at -40 °C
  - Followed by thermal cycling to exacerbate crack separation
- Extended thermal cycling
- Long term outdoor exposure at MPP with intermittent IV measurements
- Use of infrared, EL imaging to better identify failure mechanisms
- In situ dark I-V to track module degradation modes
- Test completed in 6 months with the exception of continuing outdoor testing

Other Key Features

- All module are purchased through distribution channels
- Tests are designed
  - To identify wear-out characteristics and EOL failure modes using moderately censored data
  - To manifest failure modes based on operating environments
  - To be sufficiently long to manifest some degree of degradation
- All results are quantitative, as opposed to Pass/Fail
- Iteration is used to generate multiple intermediate data points and preserve the degradation history.
- Multiple modules in each sequence aid in identifying anomalistic behavior (outliers)

Reporting

- Three levels of test report, participant, all participants, and public
- Information is considered confidential with the exception of the public report
- Public report will be provided to technical journals and trade publications

Reporting by Operational Environments

Test sequences are designed to provide durability assessments of 4 operational environments

- High Voltage Stress
- Radiation Stress (High UV Radiation Environments)
- Thermal Mechanical Stress (High Wind, High Snow Environments)
- Thermal Stress (Environments with High Temperature Variance)

Continuous Improvement through R&D

- Improve the test protocol through continuous R&D.
- Generate data necessary to predict probabilistic module lifetimes
- Continuous outdoor testing for a minimum of 3 years to facilitate correlation to actual lifetime estimation
- Provide data for international standards development efforts