WELLS FARGO

The Value of Durable Materials in Maximizing Your Investment in Solar Energy

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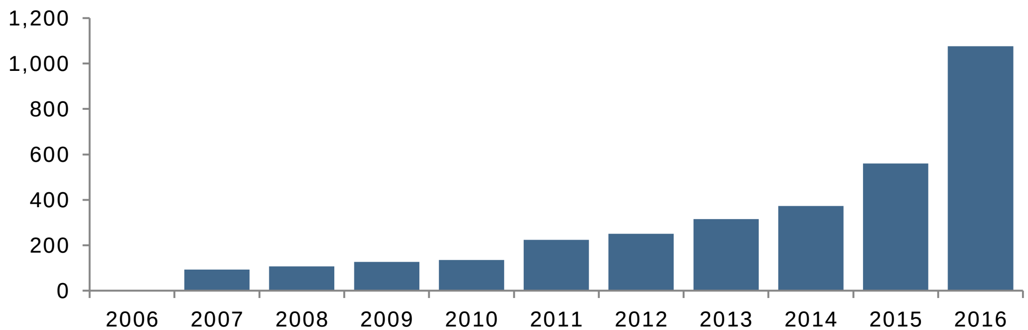
Together we'll go far

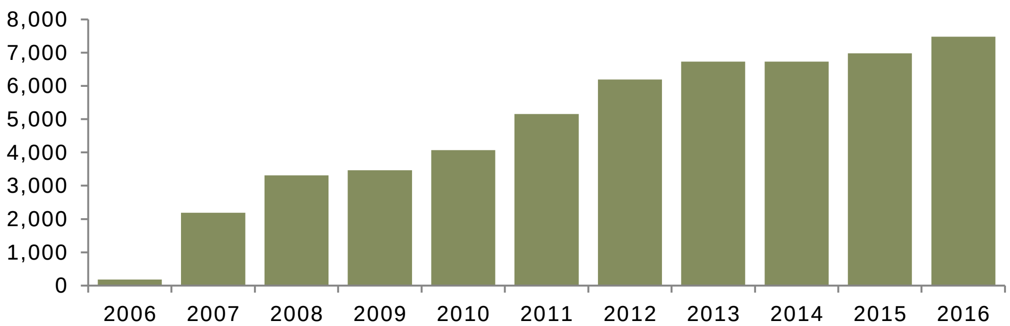
Wells Fargo Renewable Energy & Environmental Finance (REEF)

- Established in 2006 to **provide *tax equity* capital for the renewable energy industry.**
- Today, the group has **28 professionals with decades of combined experience in renewable energy.**
- Collaboration with **Wells Fargo CleanTech Banking** which offers traditional banking services & relationship management.

Cumulative Solar Projects Financed by Wells Fargo (MWDC)

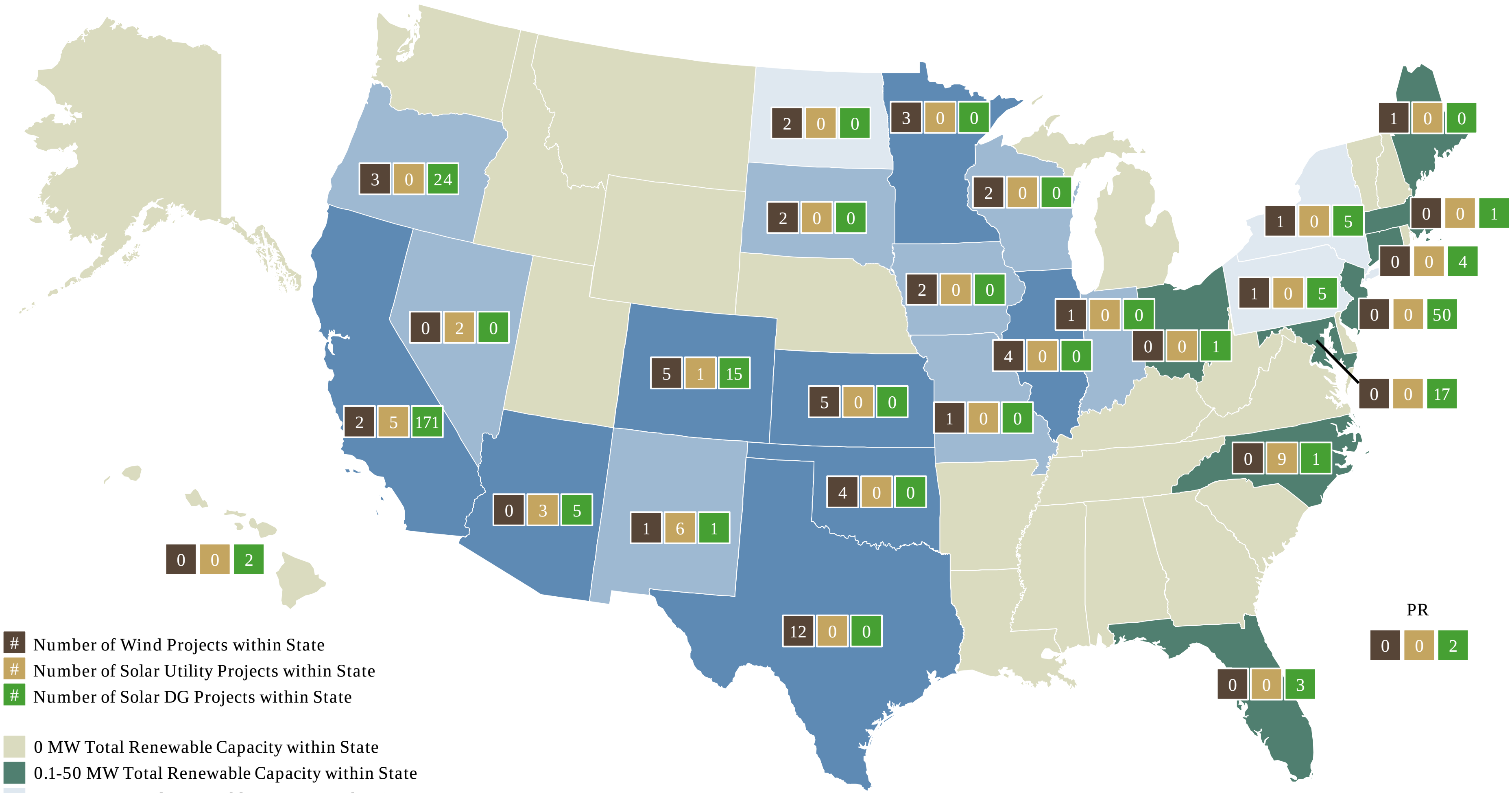


Cumulative Wind Projects Financed by Wells Fargo (MWAC)



Wells Fargo Renewable Energy & Environmental Finance (REEF)

8+GW portfolio comprised of 50+ Wind projects and 300+ Solar projects



- # Number of Wind Projects within State
- # Number of Solar Utility Projects within State
- # Number of Solar DG Projects within State

- 0 MW Total Renewable Capacity within State
- 0.1-50 MW Total Renewable Capacity within State
- 51-150 MW Total Renewable Capacity within State
- 151-300 MW Total Renewable Capacity within State
- > 300 MW Total Renewable Capacity within State

Typical PV Project & Portfolio Technical Due Diligence

Term Sheet

Project Commitment

Mechanical Completion
20% Initial Funding (partnerships only)

Substantial Completion
Final Funding (partnerships)
Funding (leases)

Project Developer, EPC, Operator, Asset Manager
- Planning, Engineering, Procurement
- Construction
- Dry Commis-sioning
- Performance Testing & Final Commis-sioning
- Operation & Asset Management
- Decom or Recom

Solar module manufacturer
- Module production

IECRE Standards & WF Approved Advisors

Module factory auditor[1]
- Pre-production audit & remediation, production oversight (20%), pre-shipment inspection, QMS data review

Module Test Lab[1]
- Qualification Accelerated Lifetime Tests (ALT) for each BOM (CSA EXP 450, DNV GL PQP, proposed UL method) 2
- ALT/Durability tests of module batch (each BOM/assembly line combo3) per IEC61215
- Degradation rate tests (if needed)

Independent Engineer[1]
- Phase 1 IE Report, construction lender IE report ***or equivalent***
- Phase II IE Report (more focus on long-term performance)
- Construction Monitoring/Site Visits

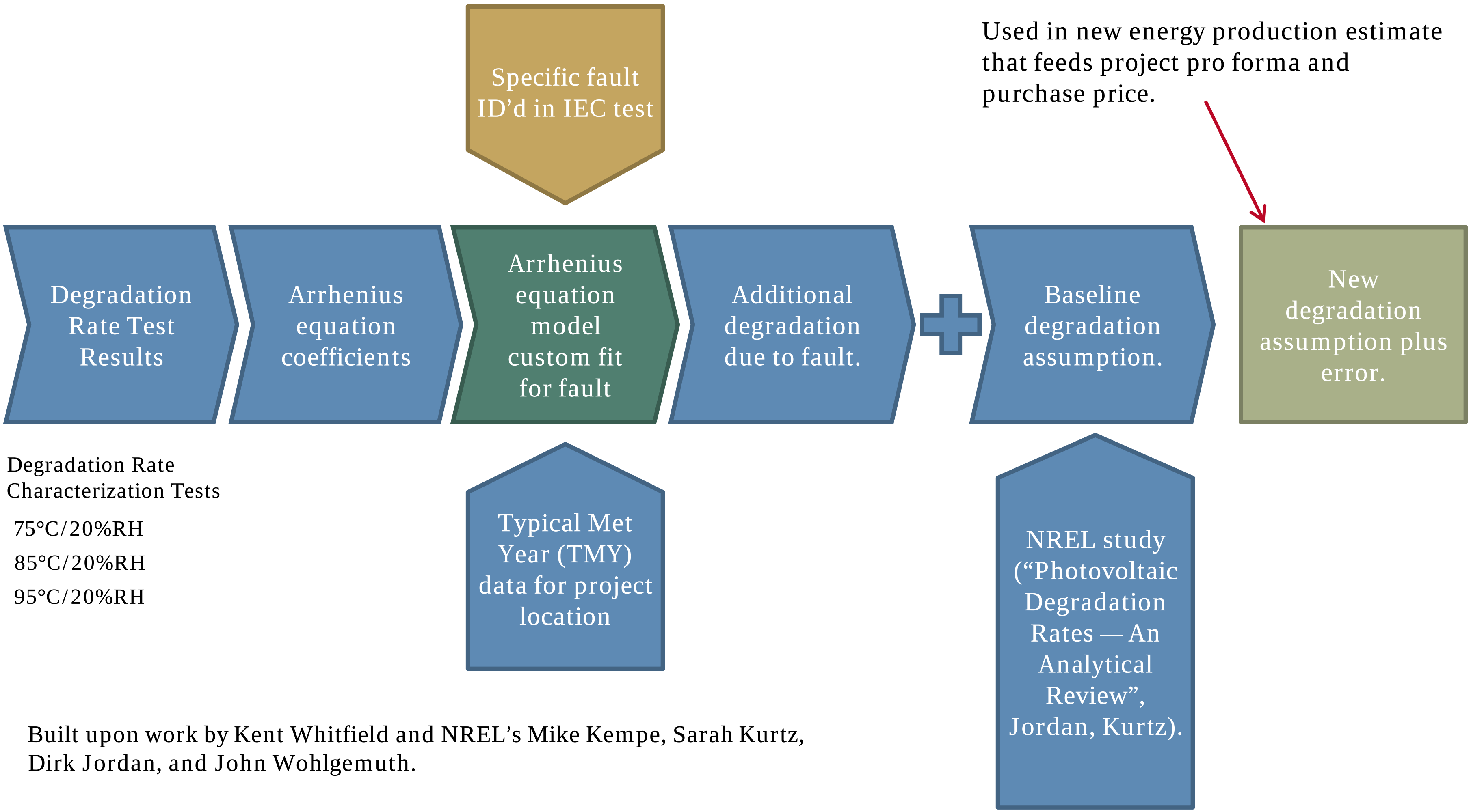
[1] Sampling techniques and expert judgement based on record can be used to reduce cost
[2] Ideally done in advance of module production, but could be done at start of production
[3] Unless factory auditor confirms consistency between assembly lines

Example of PV Module Accelerated Lifetime Testing (ALT) Scope of Work

	Standard or Source	Test Module Count or Component Sample Count															
Weeks:			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Days at Lab:				7	14	21	28	35	42	49	56	63	70	77	84	91	98
Air Shipment			x														
Sample prep, outdoor preconditioning (Clause 5 61215)				x													
Visual, EL, IV, Flash Test, Wet Leakage (when required)				x	x	x		x	x	x	x			x			x
Module Qualification Tests (IEC and Extended Testing)																	
TC (Thermal Cycling)	NREL Qualification Plus	varies				200		500		800							
DH (Damp Heat)	NREL Qualification Plus							500			1000			1500			2000
DML/TC50/HF30	NREL Qualification Plus					x											
PID (Potential Induced Degradation)	NREL Qualification Plus					192											
Statistical Module Batch Tests (each BOM/factory combo)																	
TC (Thermal Cycling)	IEC 61215	30 (6 per test) for 95% confidence level that 90% of modules will be defect free				200											
DH (Damp Heat)	IEC 61215							500			1000						2000
TC50/HF10 (Thermal Cycling/Humidity Freeze)	IEC 61215				x												
PID (Potential Induced Degradation)	IEC 61215				96												
DML (Dynamic Mechanical Load)	IEC 61215								x								
LID (Light Induced Degradation)	IEC 61215	20 of existing sample set						x									
PAN file validation/creation (for PVSyst)	IEC 61853-1	3 of existing sample set						x									
IAM (Incident Angle Modifier) loss validation	IEC 61853-2			x													
Bypass Diode Test	IEC 61215	All of sample set		x													
Degradation Rate Characterization Tests*																	
75°C/20%RH	NREL special for Wells Fargo	6 (1 with defect + 1 control with no defect per test)						500			1000			1500			2000
85°C/20%RH	NREL special for Wells Fargo							500			1000			1500			2000
95°C/20%RH	NREL special for Wells Fargo							500			1000			1500			2000
Other tests**																	
Modules:																	
Hot Spot Test	NREL Qualification Plus/ASTM E2481-06	5			x												
Components:																	
UV Exposure of Junction Box	NREL Qualification Plus	5						500									
Bypass Diode and Junction Box Thermal Test	NREL Qualification Plus	5			96												
UV Exposure for Encapsulants	NREL Qualification Plus	5															~4000 hours>>
UV Exposure for Backsheets	NREL Qualification Plus	12															~4000 hours>>
UV Exposure for Cables and Connectors	NREL Qualification Plus	3															~4000 hours>>
Result checks/Reports				Initial Check	Check 1	Check 2		Check 3	Check 4	Check 5	IEC 61215 Report, Stop deg rate char tests if no fault found						Extended Test Report, Degradation Rate Characterization (if needed)

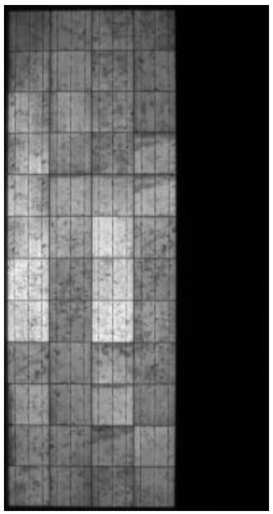
*Initiated for each BOM/factory combo, but stopped if no fault found in IEC baseline
**Performed if there is a reason for concern, e.g. historical defect, known issue, significantly new component, material or design, etc.

PV Module Degradation Rate Characterization Analysis Method

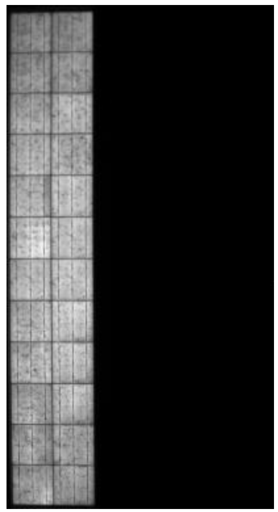


Built upon work by Kent Whitfield and NREL's Mike Kempe, Sarah Kurtz, Dirk Jordan, and John Wohlgemuth.

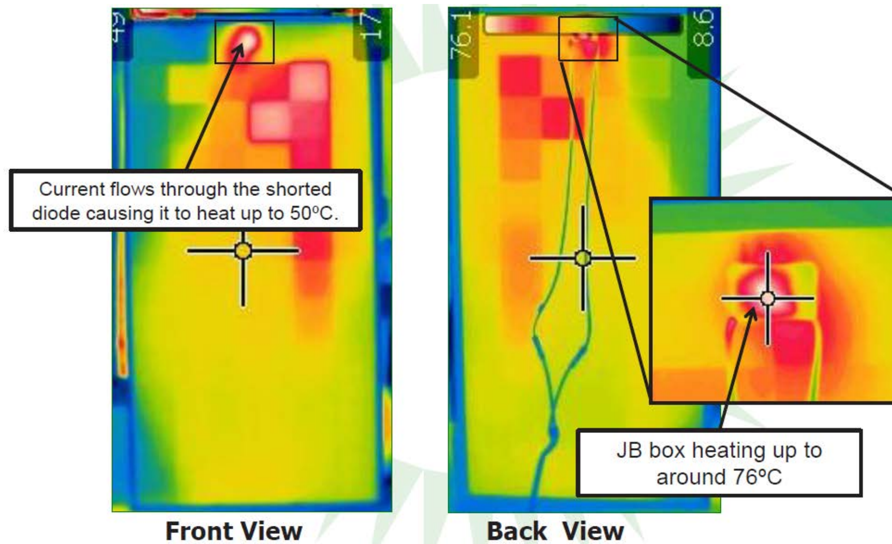
Bypass diode failures



Diode failure at TC400

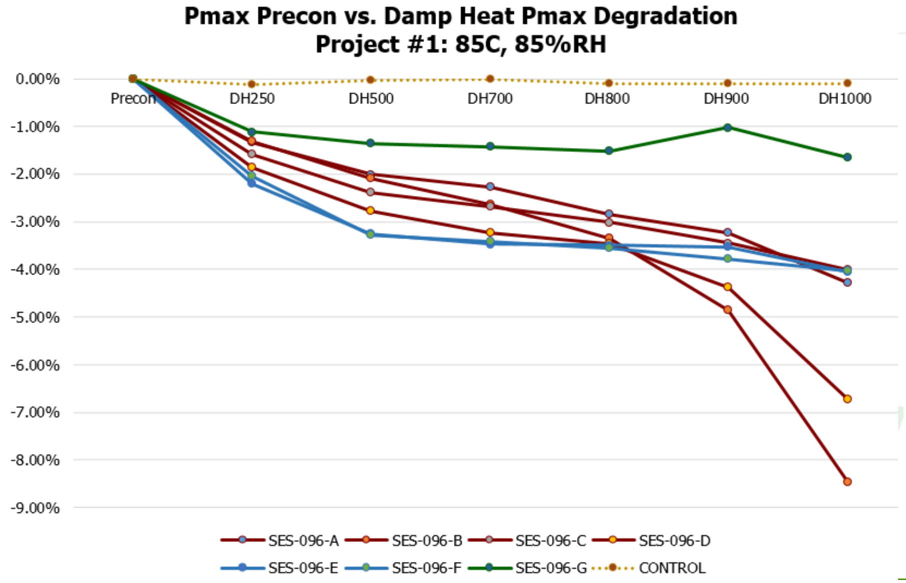


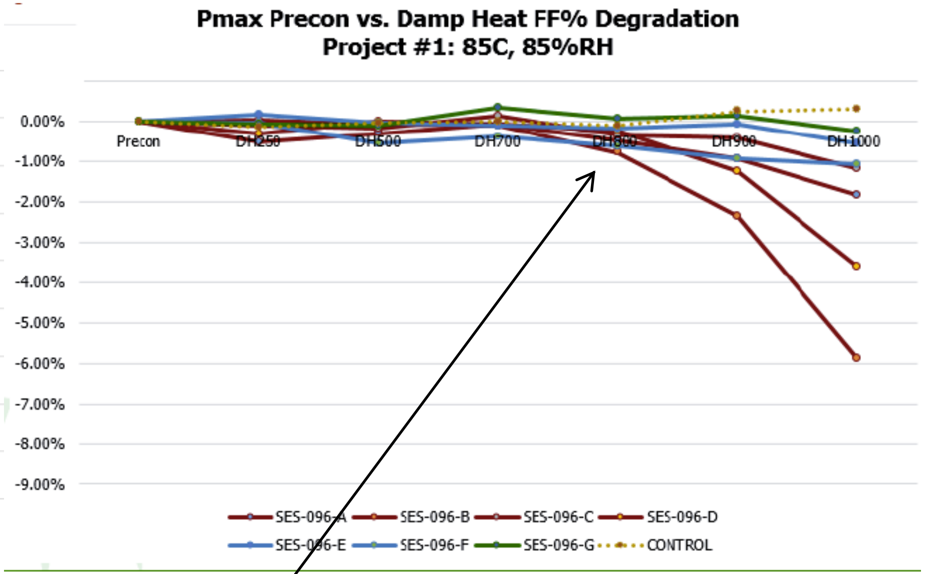
2-diodes fail at TC600

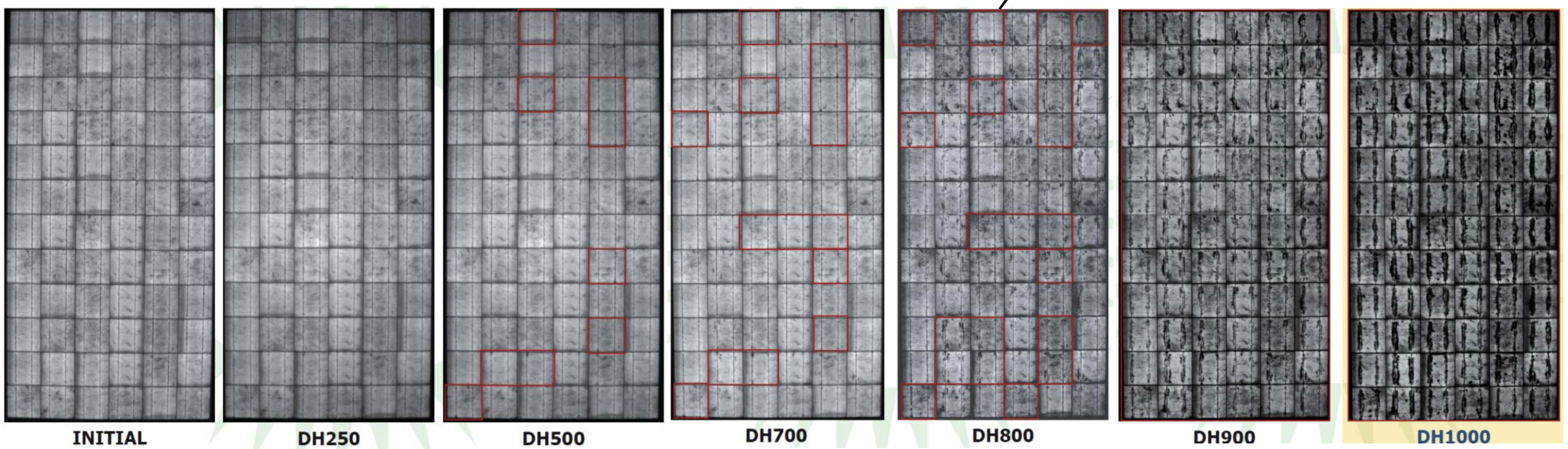


Outdoor failure signature

Accelerated cell corrosion







Junction box lid failures

Resulting corrosion after 3 years near coast

Lid Type	Stress	Amount	N	Failure Rate	
1	DH	1000	23	52%	2014 testing
2	DH	1000	145	2%	2014 testing
2	DH	2000	23	4%	2014 testing
2	HF	20/40	12	0%	RETC
2	HF	60	12	8%	RETC
2	HF	80	12	17%	RETC
2	HF	100	12	25%	RETC
2	TC / HF	50 / 20	20	10%	2014 + RETC
2	TC / HF	100 / 40	10	0%	RETC
4	DH	1000	24	0%	
4	DH	2000	22	0%	
4	HF	20/40/60/80	36	0%	RETC
4	HF	100	10	0%	
4	TC / HF	50 / 20	34	0%	
4	TC / HF	100 / 40	30	0%	

Thank you!

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