Outdoor Accelerated Testing of PV Modules

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What?

This project is developing and testing low cost methods for accelerating the ageing of PV modules during outdoor operation

Why?

Conventional methods for accelerated testing require large, expensive climate chambers.

Where?

This work is being done at Sandia National Laboratories in Albuquerque, New Mexico.

When

- Module characterization: May and June 2019
- Accelerated temperature began in July 2019
- Accelerated humidity planned to begin in September 2019

Accelerated Temperature Hardware Design and Configuration

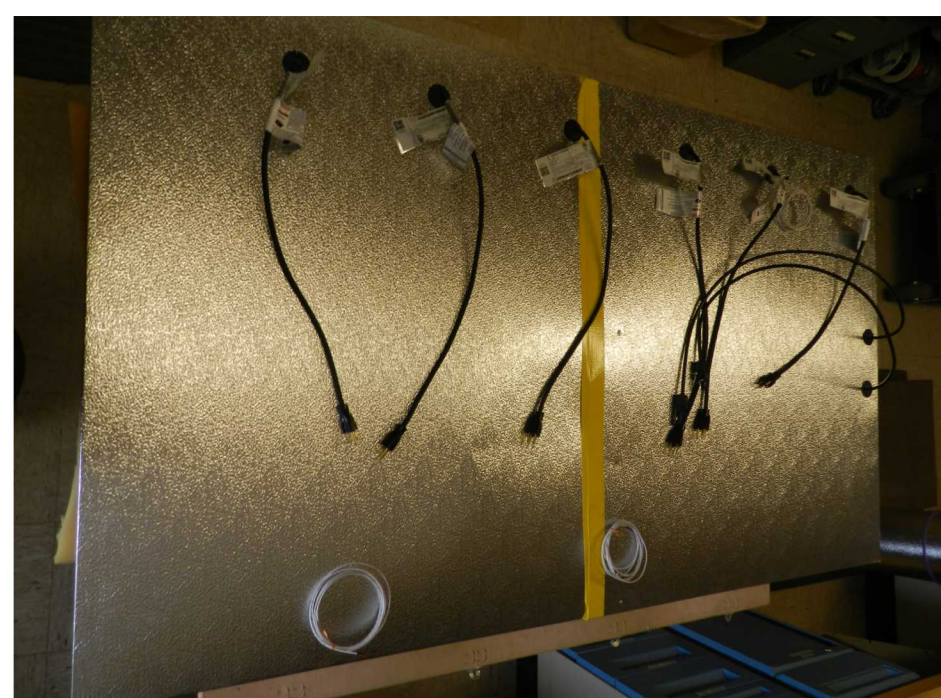Three SolarWorld 260W Poly modules, each with three RTDs attached to backsheet:
1. Reference module
2. Insulated module
3. Insulated and active heating of module
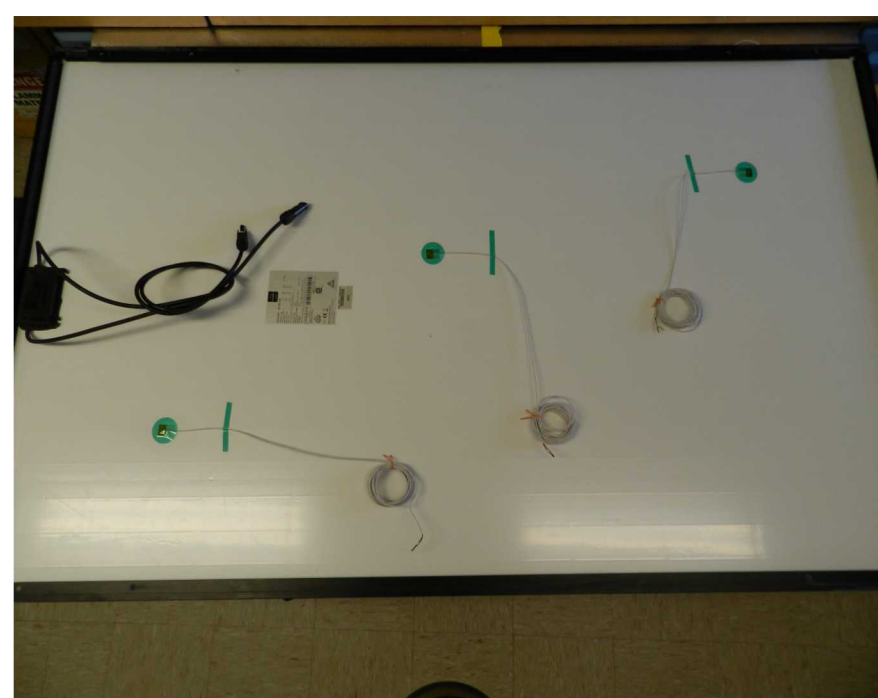
RTDs attached to back of modules

Blanket heaters placed behind module

Insulation fitted to back of module
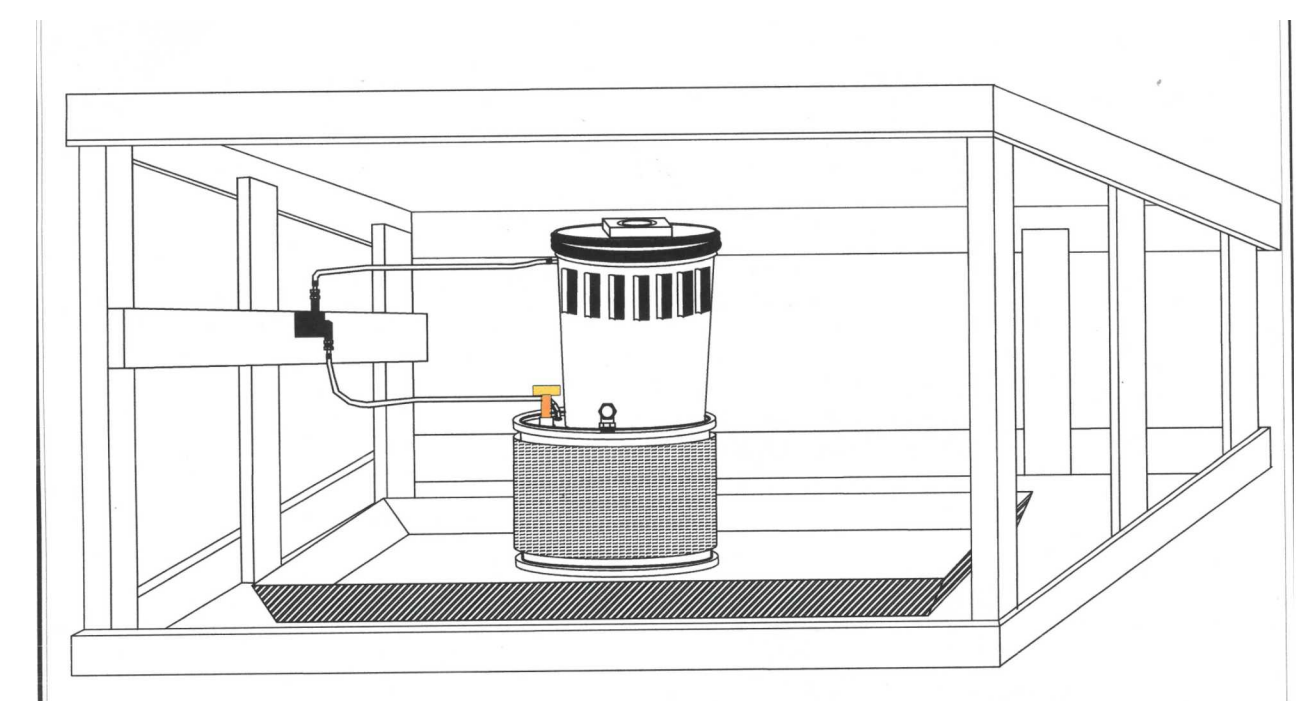
Accelerated Humidity and Temperature Design

Coming Soon!
One Solar World 260W Poly module, with three RTDs attached to backsheet:
- *"Swamp Heater" design*
  - *Heated water pumped over filter with forced heated air circulation*
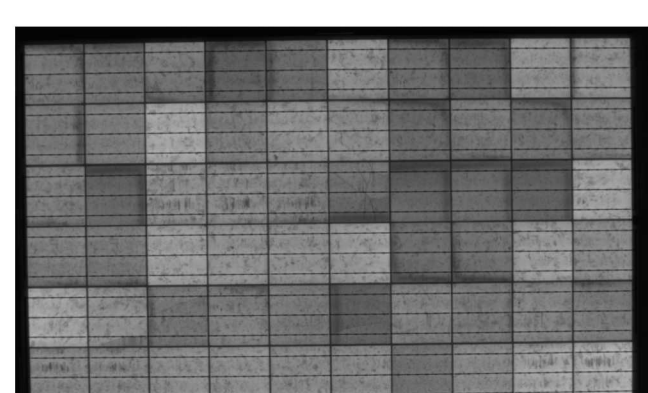

Assembly of wooden box/rack for humidity chamber

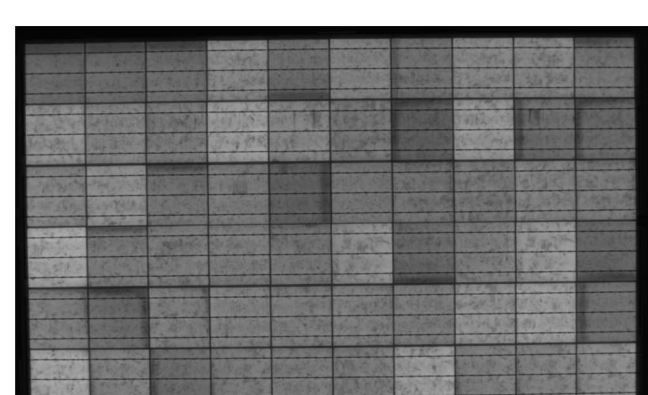Design drawing showing water tank and humidity/heater concept.
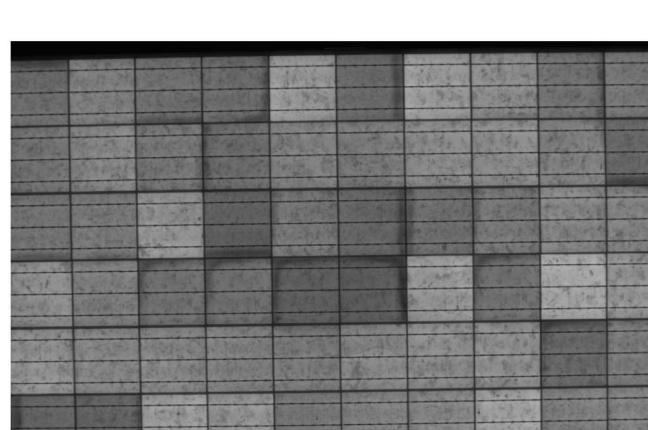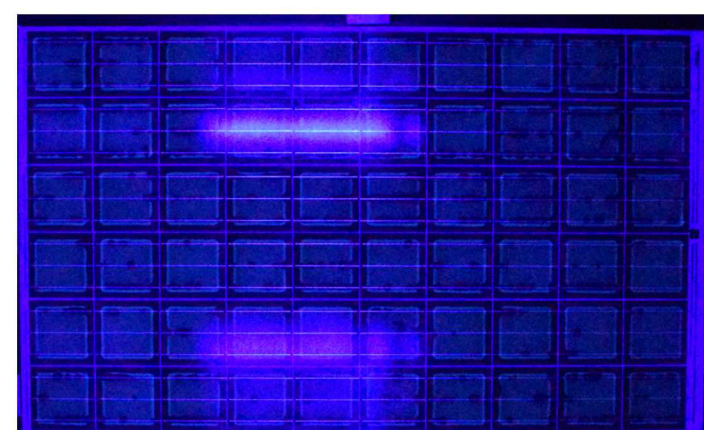
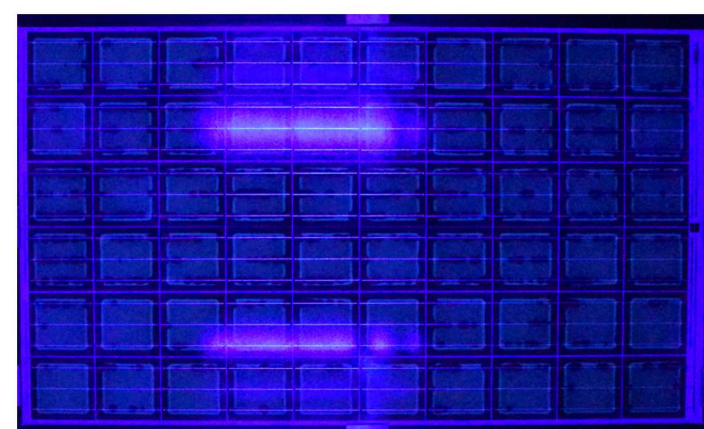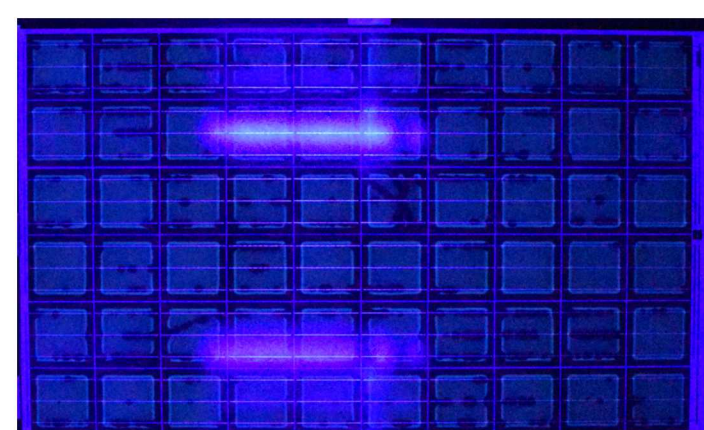## Initial Module Characterization

EL (6/3/2019)

UVF (6/10/2019)

3341

3343

3344

Recent improvements in Sandia's UVF will result in much improved imaging capability

Flash Tests (5/20/2019)

- Pmax = 257.3 W
- Isc = 9.05 A
- Voc = 37.4 V
- Imp = 8.54 A
- Vmp = 30.1 V

- Pmax = 256.5 W
- Isc = 9.01 A
- Voc = 37.3 V
- Imp = 8.52 A
- Vmp = 30.1 V

- Pmax = 256.8 W
- Isc = 9.04 A
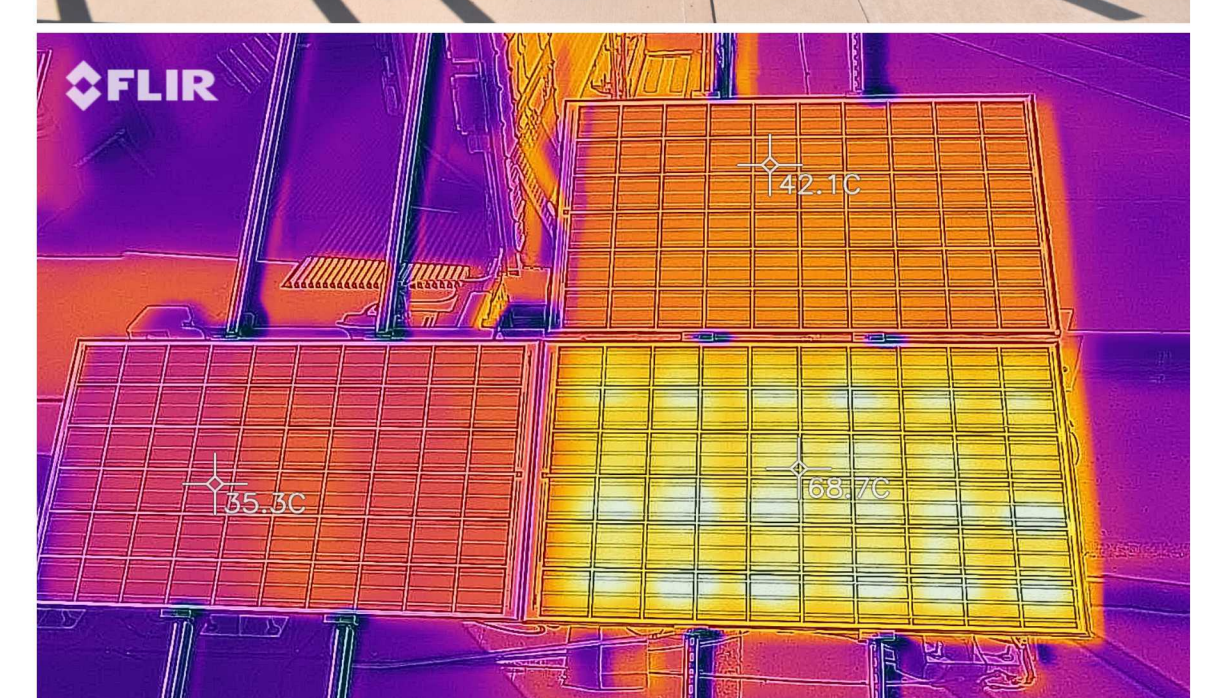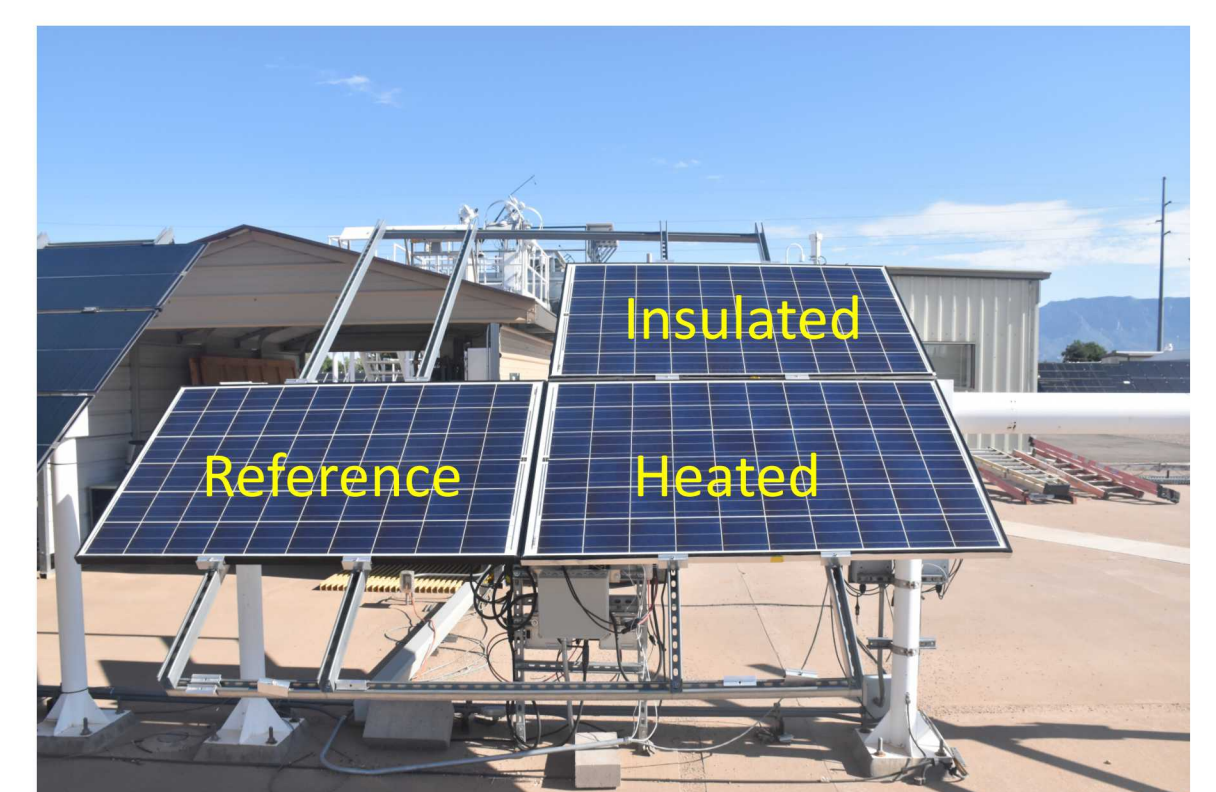- Voc = 37.3 V
- Imp = 8.54 A
- Vmp = 30.1 V

Field Deployment

Three modules have been deployed in the field (S-facing at 35° tilt).

Monitoring System
- Modules on microinverters
- Module level current and voltage measured with shunts and voltage dividers
- RTC temperatures measured with ICP-DAS
- Logging onto Raspberry Pi

Temperature Results

Average back of module temperatures (°C)
(Includes night time)

Sensor	Reference	Insulated	Heated
RTD1	31.9	36.1	73.7
RTD2	32.6	37.0	63.3
RTD3	33.1	37.1	64.9

Is this early evidence of accelerated degradation?

- Temperature uniformity in the heated tests is an issue. We suspect that variations in the thermal contact between the heaters and the module may explain the differences.
- Cumulative temperatures of heated module are about twice that of the reference and insulated modules.
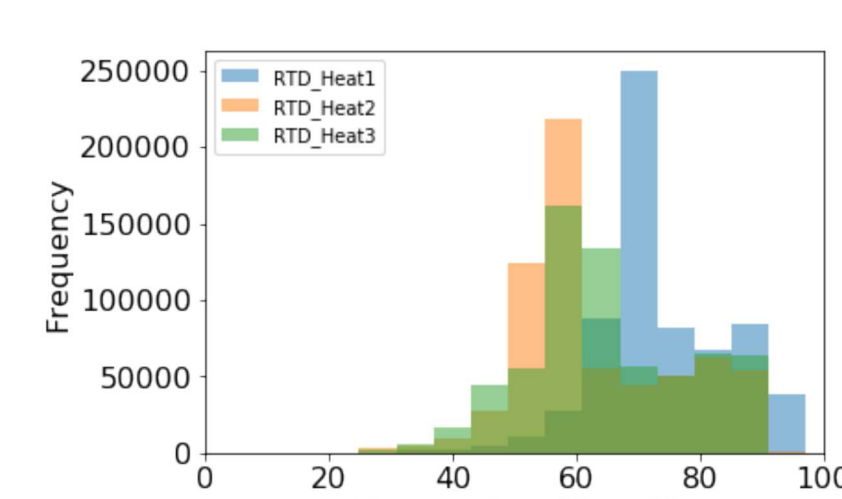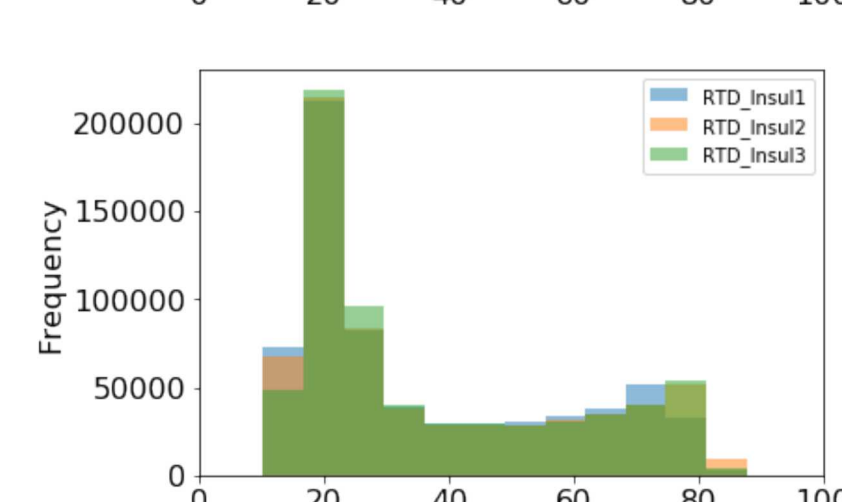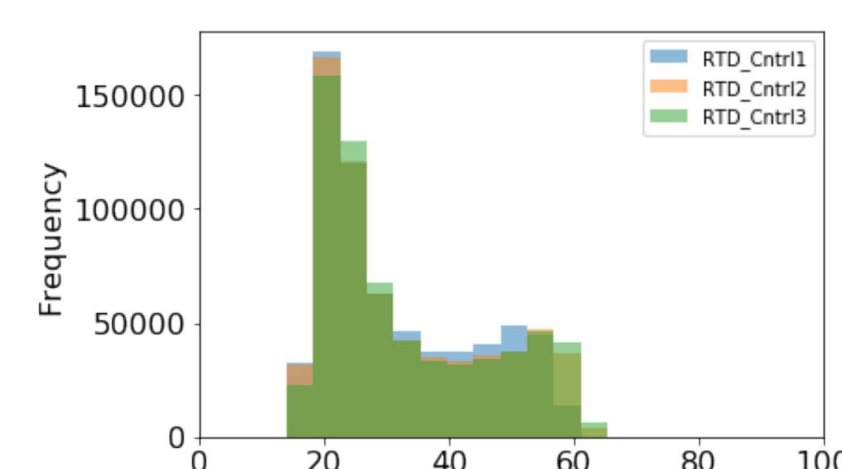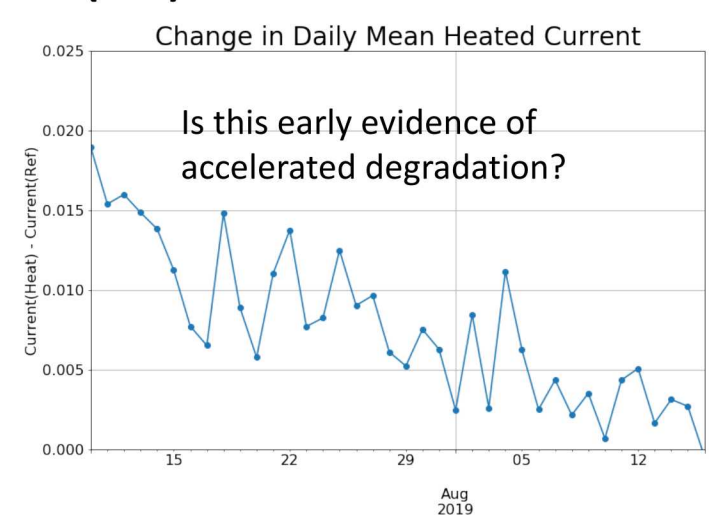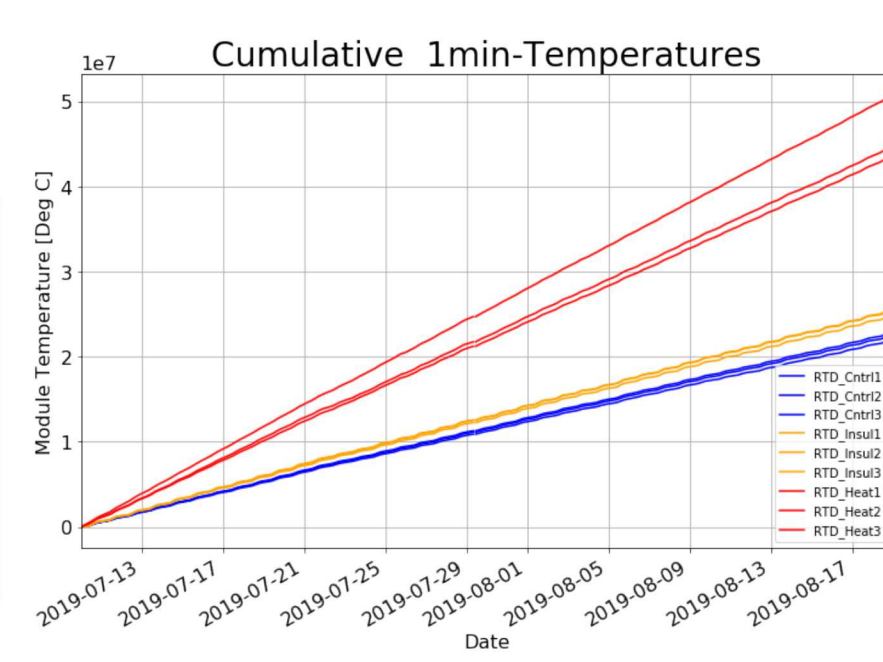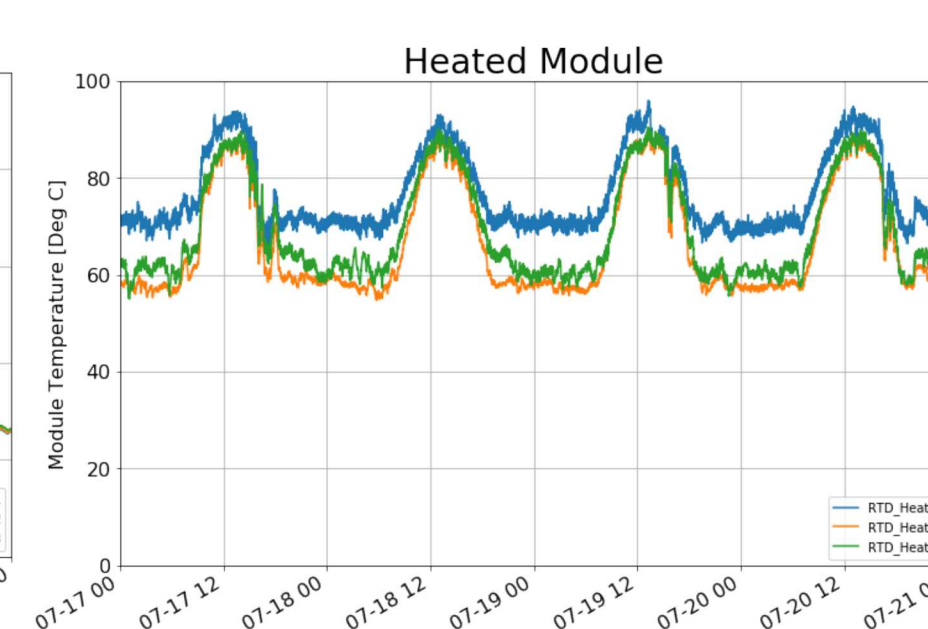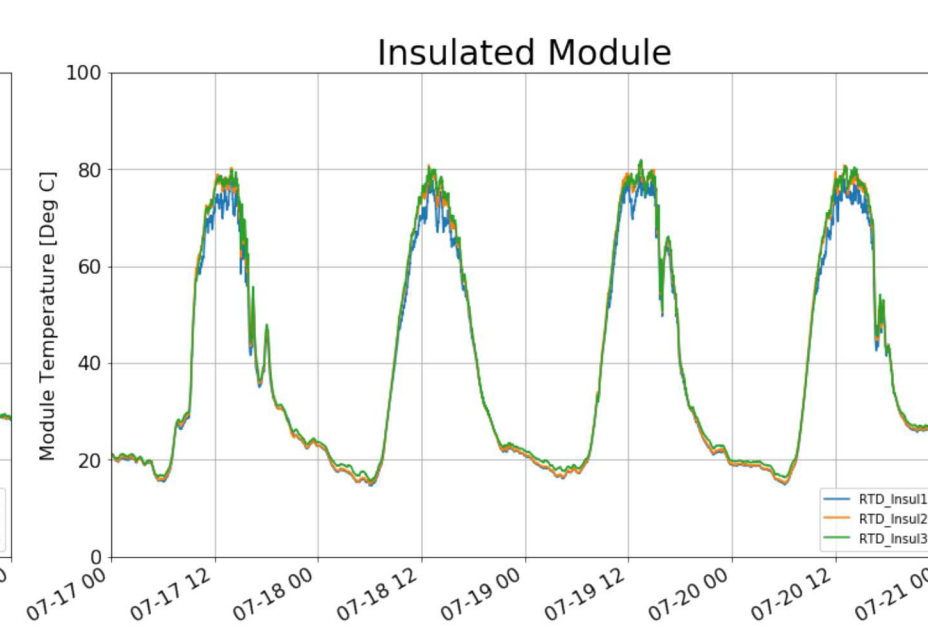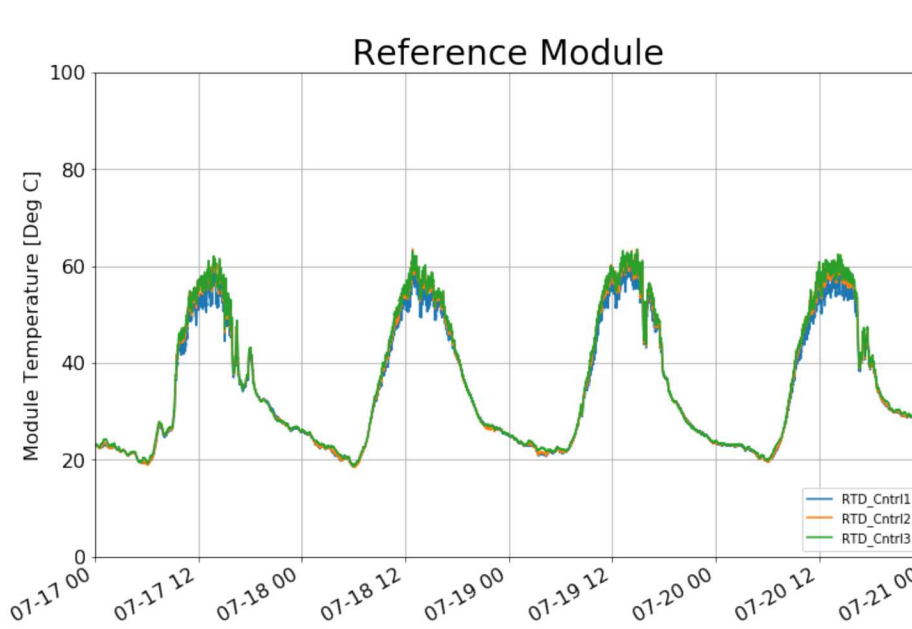
Electrical Results

Example Electrical Performance Results