Impact and Detection of Pyranometer Failure on PV Performance

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Introduction

Long-term PV Performance
1. Financially:
   Cash Flow
   Uncertainty directly related to risk
2. Technically:
   Lifetime prediction
   Product improvement

Pyranometers often used to measure Plane-of-array irradiance (POA)
Pyranometers are recommended to be calibrated 1-2 years
Better understand one failure mechanism we observed in the field
Find analytical signal for early-fault detection

CM10 Pyranometer

Catastrophic Failure

Field failure of pyranometer at NREL

If failure not catastrophic but seal slowly disintegrates
Could be a long time until failure is recognized!

Saturated NaCl maintains relative constant humidity in closed-spaced environment

ASTM E104-85 (1996) Standard:
Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions

Cartridge filled with saturated NaCl

High humidity

Cartridge filled with desiccant SiO2

Low humidity

By swapping salt and desiccant, periods of high & low humidity are alternated so as not to destroy pyranometer
Use both data for PV system degradation rate determination

Detection Method

Detection Results

Using CM10 irradiance, High humidity: circles

Using system POA irradiance

Humidity is indicated for comparison sake

Effect clearly visible on sunny days & high temperature

R^2 adj drops significantly during pyranometer problem

Pyranometer with High Humidity

Performance Impact

CM10 pyranometer (high humidity) drifted about 1%/year

Significant performance impact if problem is not detected

Cloud effect Foggy Pyranometer

Careful tracking of R^2 of DC Power vs. POA

Detection

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Conclusion

Accurate PV performance often depends on accurate irradiance measurements

Pyranometer with high humidity inside was used to simulate slow failure

More than 1 year of data have been collected

Pyranometer has drifted by about 1%/year

At sufficient high temperature condensation forms on inside of dome that skews data

An analytical method based on the fit of DC Power vs. POA irradiance in weekly intervals was used to detect the faulty pyranometer.