Impact and Detection of Pyranometer Failure on PV Performance

D.C. Jordan, B. Sekulic, S.R. Kurtz
National Renewable Energy Laboratory, Golden, CO 80401, USA

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

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

Cloud effect
Foggy Pyranometer

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

Catastrophic Failure

Field failure of pyranometer at NREL

Catastrophic field failure: Seal of SiO2 cartridge failed > moisture penetrated inside
If failure not catastrophic but seal slowly disintegrates
Could be a long time until failure is recognized!

Sunny – High Humidity

On sunny days, high humidity leads to condensation that diminishes signal
Effect clearly visible on sunny days & high temperature

Detection Results

Using CM10 irradiance, High humidity: circles
Using system POA irradiance
Humidity is indicated for comparison sake

$R^2$ adj = $R^2$ adjusted for different number of data points per interval

Pyranometer with High Humidity

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

Cartridge filled with desiccant SiO2
Cartridge filled with saturated NaCl

Saturated NaCl maintains relative constant humidity in closed-spaced environment

Performance Impact

Pyranometer with high humidity inside was used to simulate slow failure

Pyranometer has drifted by about 1%/year
At sufficient high temperature condensation forms on inside of dome that skews data

Significant performance impact if problem is not detected

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.