Irradiance Estimation for a Smart PV Array

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The Problem

Data collected at inverter leaves unanswered questions:
• Are PV modules performing to spec?
• Does the array need cleaning?
• Are there significant mismatch losses?
• Is there a fault in the array?

Our Solution

• Smart monitoring devices deployed at the level of individual modules
• Topology reconfiguration via switching

Inefficiencies:
• Partial shading
• Long mean time to repair

Irradiance Estimation Algorithm

• Estimate Single-diode model irradiance from current, voltage, and temperature:

\[ I_{sc} = \frac{V_{oc} - \frac{V_{oc} - V_{m}}{R_{sh}}}{1 - \frac{V_{oc} - V_{m}}{R_{sh}} - \frac{I_{sc}}{R_{sh}}} \]

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Performance

• < 4% error in Irradiance for air mass < 3
• < 1% error for temperature errors < 10° C

Error due to air mass uncertainty at STC

Error due to temperature measurement uncertainty at STC

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