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The Outdoor Bifacial PV Testing Facility at Technical University of Denmark

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Background: Since summer 2018, European Energy A/S and DTU have measured the performance of bifacial PV strings mounted on trackers and fixed tilt systems located in Northern Europe (55.6° N, 12.1° E). A new publically funded project is underway with the intent to evaluate in-house and commercially available bifacial PV performance models. The facility includes several sub-systems where the conditions known to affect bifacial performance are varied including tracker spacing (GCR), albedo (ρ) and module tilt (β).

Equipment and Layout
• Monofacial and bifacial strings of similar front side power mounted side-by-side.
• Horizontal East-West (HSAT) trackers (x8) and south facing 2V racks with adjustable tilt angle (x8).
• Tilted single axis trackers (x2) and dual axis tracker (x1).
• Multiple ground covers under test:
  - Seasonal grass
  - Coarse sand
  - Medium-size gravel
  - White polymeric tarp
  - µ-structured reflector

Sensors and Detailed Monitoring
Max-power current (I_{max}) and voltage (V_{max}) measurements on 64 individual strings.
Monitoring independent inverter measurements
DC Power meters with isolated surface mount resistors and digital filtering
Four panels with 10 individually measured 5” mono-Si cells for studying distribution of rear side irradiance.

Tracker error monitor for single axis trackers.

Albedo sensors at four locations around the facility.

Performance Modeling
We are using the onsite meteorological data as inputs to bifacial PV models. The model’s output is then compared to our electrical measurements. View factor models under consideration currently include MoBiDiG (ISC Konstanz), PVsyst, and SAM. Ray trace models currently being tested include Zemax and Radiance.

Measured Model Inputs
• DHI, DNI, Albedo, GHI, Tamb and Windspeed
• PV electrical parameters
• Shade Scene, tracker features

Model Assumptions
- DC+AC power
- Transposed irradiance
- Cell temperature (Tcell)

Obtain Model Outputs
Simulation
Compare to Field Measurements
- DC+AC power
- Plane of array irradiance (front and rear)
- Tcell (currently only mono-fi)

HSATs at 15m pitch
(GCR = 0.22)

South facing fixed-tilt rows with adjustable tilt angle (GCR = 0.40)

Spectrally resolved reflectance can be measured in the DTU Fotonik laboratories.

Distribution of back of module irradiance on the center modules within the ‘2V’ module string during a clear sky conditions (top (left) and bottom (right) modules in the 2V configuration are shown.

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Partners