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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
- Monofacile 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_{MP}) measurements on 64 individual strings.
- DC Power meters with isolated surface mount resistors and digital filtering.
- Fixed tilt and HSAT production profile.
- Windspeed measurements on 64 individual strings.
- Spectral pyranometer to measure plane of array irradiance in two directions.
- Micro-radar and wind speed measurements.
- Albedo sensors at four locations around the facility.
- Albedo of grass as measured by Class A pyranometers vs. Class C photodiodes.
- Trackerr error monitor for single axis trackers.
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Performance Modeling
We are using onsite meteorological data as input to bifacial PV models. The model 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.

Measur Model Outputs
- DC+AC power
- Transposed irradiance
- Cell temperature (T_{cell})

Model Assumptions
- Simulated structural geometry (right).
- Measured DC Power (W).
- Modelled DC Power (W).
- Obtained Model Outputs.
- Non-sequential ray tracing in Zemax (left). Simulated structural geometry (right).
- Module efficiency vs. measured power of four rows of 25° fixed tilt bifacial systems mounted on seasonal grass over 6 months (Jan. - Jul. ’19).
- Measured model output compared to field measurements.
- Modelled vs. Measured power of four rows of 25° fixed tilt bifacial systems mounted on seasonal grass over 6 months (Jan. - Jul. ’19).

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Partners