**Instructions for participating in the blind PVPMC PV modeling intercomparison**

**Disclaimer**

By participating in this study and providing your results, we are assuming that we have permission to include them in the comparison and publish the results anonymously; if you include sensitive information in any form or manner, please let us know.

**Objectives**

The objectives of this blind intercomparison are to:

1. quantify differences among modelers
2. investigate whether some models are more accurate than others
3. see if performance modeling can be improved
4. quantify validity of PV performance models
5. find sources of uncertainty
6. develop workplan to improve functionality and reproducibility

**Scenarios**

Six scenarios of practical interest to the community were identified to include a) fixed and tracking systems, b) monofacial and bifacial modules, c) modules beyond the traditional aluminum back surface contact (Al-BSF) technology, d) distinctively different geographical locations/climates. The six scenarios include:

1. 3.9 kW of monofacial, fixed-tilt, Panasonic heterojunction with intrinsic thin layer (HIT) in Albuquerque, New Mexico over a 1-year period
2. 3.3 kW of monofacial, fixed-tilt, Canadian Solar mono-crystalline silicon (mono-c-Si) in Albuquerque, New Mexico over a 1-year period
3. 26.84 kW of monofacial, tracked, Trina mono-crystalline silicon passivated emitter and rear cell (PERC) in Roskilde, Denmark over a 1-year period
4. 25.96 kW of bifacial, tracked, Trina mono-crystalline silicon PERC in Roskilde, Denmark over a 1-year period
5. 26.84 kW of monofacial, fixed-tilt, Trina mono-crystalline silicon PERC in Roskilde, Denmark over a 1-year period
6. 25.96 kW of bifacial, fixed-tilt, Trina mono-crystalline silicon PERC in Roskilde, Denmark over a 1-year period

**Methodology**

The six modeling scenarios are described in the following section. In order to participate one must “copy and paste” their hourly estimates (i.e., POA irradiance, module temperature, DC power) into the corresponding tabs (S1 – S6) of the Results.xlsx file (the link is on the [PVPMC website](https://pvpmc.sandia.gov/pv-research/blind-pv-modeling-comparison/)). Running all scenarios is optional, but strongly encouraged. In addition to the estimated hourly timeseries, the participants are requested to provide answers with respect to the model/software they used and inputs/assumptions according to the questionnaires at each excel tab.

The Due Date for all modeling submissions is **Friday, September 10, 2021**.  Please send the completed Results.xlsx file to Dr. Marios Theristis at mtheris@sandia.gov before the deadline.  If you have any questions after reading all of the documentation please email Marios and he will update the FAQ section of [this](https://pvpmc.sandia.gov/pv-research/blind-pv-modeling-comparison/) webpage, as appropriate so everyone can see the same answers.

The results will be collected and handled by Sandia. Sandia plans to present an anonymized summary of the results at the next PVPMC workshop planned for October 19-20, 2021 in Salt Lake City.  Following this workshop, Sandia would like to prepare a journal article describing the study with all of the participants included as co-authors. The authors list will be listed in the order of 1) leading writer(s) and/or organizer(s), 2) execution of most scenarios, 3) contribution to the paper writing, 4) availability of data, 5) provision of feedback. If any of the participants do not wish to have their name included in any publication, please inform mtheris@sandia.gov.

**Information regarding the six scenarios**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 | Scenario 6 |
| **Site information** |
| Location | Albuquerque, New Mexico | Albuquerque, New Mexico | Roskilde, Denmark | Roskilde, Denmark | Roskilde, Denmark | Roskilde, Denmark |
| Latitude | 35.05° N | 35.05° N | 55.696° N | 55.696° N | 55.696° N | 55.696° N |
| Longitude | 106.54° W  | 106.54° W  | 12.104° E | 12.104° E | 12.104° E | 12.104° E |
| Altitude (m above sea level) | 1600 | 1600 | 15 | 15 | 15 | 15 |
| Time zone | MT (GMT-7) | MT (GMT-7) | CET (GMT+1) | CET (GMT+1) | CET (GMT+1) | CET (GMT+1) |
| **System information** |
| Capacity (kW DC) | 3.9  | 3.3  | 26.84  | 25.96  | 26.84  | 25.96  |
| Inverter | SMA Sunny Tripower 20000TL-US | SMA Sunny Tripower 15000TL-US | Delta RPI M50A (2 MPPT, each system on separate MPPT) | Delta RPI M50A (2 MPPT, each system on separate MPPT) | Delta RPI M50A (2 MPPT, each system on separate MPPT) | Delta RPI M50A (2 MPPT, each system on separate MPPT) |
| Monofacial/Bifacial | Monofacial | Monofacial | Monofacial | Bifacial | Monofacial | Bifacial |
| Technology | HIT | mono-c-Si | Mono-PERC | Mono-PERC | Mono-PERC | Mono-PERC |
| Manufacturer | Panasonic | Canadian Solar | Trina | Trina | Trina | Trina |
| Model | VBHN325SA16 | CS6K-275M 275W | Allmax+ | Duomax Twin | Allmax+ | Duomax Twin |
| Module nominal power | 325 W | 275 W | 305 W | 295 W | 305 W | 295 W |
| Fixed/Tracked | Fixed | Fixed | Tracked – horizontal single axis | Tracked – horizontal single axis | Fixed on a horizontal single axis tracker | Fixed on a horizontal single axis tracker |
| Tracking limit angle | N/A | N/A | ±60° | ±60° | N/A | N/A |
| Tilt Angle | 35° | 35° | Varies | Varies | 25° | 25° |
| Azimuth | 180° (facing South) | 180° (facing South) | 90° or 270° | 90° or 270° | 180° ° (facing South) | 180°° (facing South) |
| Back tracking | N/A | N/A | Yes | Yes | N/A | N/A |
| Tracker pitch | NA | NA | 12 m ±0.1 m | 12 m ±0.1 m | 7.6 m ± 0.1 m | 7.6 m ± 0.1 m |
| Hub height | NA | NA | 1.95 m ±0.2 m | 1.95 m ±0.2 m | 2.3 m ± 0.1 m | 2.3 m ± 0.1 m |
| Physical String Length |  |  | 45.1 m | 45.1 m | 45.1 m | 45.1 m |
| PV panel configuration | 2-Up landscape | 2-Up landscape | 2-Up portrait | 2-Up portrait | 2-Up portrait | 2-Up portrait |
| Total number of PV panels in system | 12 | 12 | 88 | 88 | 88 | 88 |
| PV panels in series | 12 | 12 | 22 | 22 | 22 | 22 |
| PV strings in parallel | 1 | 1 | 4 | 4 | 4 | 4 |
| **Provided inputs [**[**Albuquerque**](https://pvpmc.sandia.gov/download/8188/)**,** [**Roskilde**](https://pvpmc.sandia.gov/download/8193/)**]** |
| Period | 2020 | 2020 | 2019 - 2020 | 2019-2020 | 2019 - 2020 | 2019-2020 |
| Resolution | Hourly averages reported at the end of the hour shown in the time column\* | Hourly averages reported at the end of the hour shown in the time column\* | Hourly averages reported at the end of the hour shown in the time column\* | Hourly averages reported at the end of the hour shown in the time column\* | Hourly averages reported at the end of the hour shown in the time column\* | Hourly averages reported at the end of the hour shown in the time column\* |
| Front Gpoa (W/m2) | No | No | No | No | No | No |
| Rear Gpoa (W/m2) | No | No | No | No | No | No |
| GHI (W/m2) | Yes | Yes | Yes | Yes | Yes | Yes |
| DNI (W/m2) | Yes | Yes | Yes | Yes | Yes | Yes |
| DHI (W/m2) | Yes | Yes | Yes | Yes | Yes | Yes |
| Tamb (°C) | Yes | Yes | Yes | Yes | Yes | Yes |
| Tmod (°C) | No | No | No | No | No | No |
| RH (%) | Yes | Yes | Yes | Yes | Yes | Yes |
| WS (m/s) | Yes | Yes | Yes | Yes | Yes | Yes |
| Albedo | Yes(monthly averages in second tab of meteo data) | Yes(monthly averages in second tab of meteo data) | Yes(monthly averages in second tab of meteo data) | Yes(monthly averages in second tab of meteo data) | Yes(monthly averages in second tab of meteo data) | Yes(monthly averages in second tab of meteo data) |
| **Availability of additional information** |
| Module spec sheet available | [Yes](https://pvpmc.sandia.gov/download/8173/) | [Yes](https://pvpmc.sandia.gov/download/8169/) | [Yes](https://pvpmc.sandia.gov/download/8177/) | [Yes](https://pvpmc.sandia.gov/download/8181/) | [Yes](https://pvpmc.sandia.gov/download/8177/) | [Yes](https://pvpmc.sandia.gov/download/8181/) |
| IEC 61853 matrix data available | [Yes](https://pvpmc.sandia.gov/download/7701/) | [Yes](https://pvpmc.sandia.gov/download/7701/) | No | No | No | No |
| SAPM coefficients available | No | No | No | No | No | No |
| PAN file available | [Yes](https://pvpmc.sandia.gov/download/7674/) | [Yes](https://pvpmc.sandia.gov/download/7665/) | No | No | No | No |
| IAM+NMOT report available | [Yes](https://pvpmc.sandia.gov/download/8009/) | [Yes](https://pvpmc.sandia.gov/download/8021/) | No | No | No | No |

\* e.g., 2 pm corresponds to the mean values from 1.01 pm to 2 pm. It is important when calculating solar positions; common practice is to shift the index 30-min back.

**Nomenclature**

Gpoa – global irradiance on the plane-of-array

GHI – global horizontal irradiance

DNI – direct normal irradiance

DHI – diffuse horizontal irradiance

Tamb – ambient temperature

Tmod – module temperature

RH – relative humidity

WS – Wind speed

SAPM – Sandia Array Performance model

IAM – incidence angle modifier

NMOT – nominal module operating temperature

**Filters applied to the data**

**Albuquerque input data is present when:**

* GHI is higher than 0 and less than 1300 W/m2
* DNI is higher than 0 and less than 1200 W/m2
* DHI is higher than 0 and less than 800 W/m2
* Wind Speed is higher than 0 and less than 32 m/s
* Ambient Temperature is higher than -40 and less than 50oC
* Relative Humidity is higher than 0 and less than 100%
* Albedo is higher than 0.15 and less than 0.25

**Roskilde input data is present when:**

* Solar elevation >5o above the horizon
* Tracker tilt angles for S3 & S4 matching within 5o
* All data acquisition systems available
* No morning shade present on tracker for S4