2018 bifiPV Workshop Summary

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PRESENTED BY

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1. Bankability of Bifacial Technology

- NPV over project lifetime is metric of choice for evaluating PV projects. (Meydbrey)

- In the US, the current 30% ITC improves the value of yield by almost 50%. (Stephens)
  - 9% increase in yield = $0.13/W for equivalent NPV.
  - Promising for innovations leading to higher yields (e.g., MLPE)

- Bifacial module cost adder is about half of the total system cost adder.
  - Eff. Penalty, Lower DC/AC ratio, and other financial addons.

- Economic driver for bifacial at least as strong as tracking. Will adoption rates reflect this?

- Financial model determines which parameters matter most to a deal (Previtali)
  - Partnership Flip vs. Sale-Leaseback (see NREL SAM site for Excel examples)
  - Bankability assessment is on FULL system rather than single components.

- Bifacial estimated to be the fastest and most impactful technology to lowering LCOE (e.g., -$0.40/kWh, 1-2 yrs for broadscale adoption) (Woodhouse)

- Biggest gap: Validated Bifacial Performance Models!

2. Bifacial Systems and LCOE

- Current field studies lack a unified model for presenting bifacial advantages (still Wild West)
  - Tracking systems show varied BG from 7% - 13%
  - Fixed tilt BG varied from 8.3% - 39% (difference from model 0.1 - 6.4%)
  - We need to get to the point that when we show such variations they make sense in terms of a unified model or conceptual framework. (e.g., PVWatts for monofacial).

- Bifacial gain used as metric. Why?
  - $E_{bifi} = (1+BG_E)*E_{mono}$, we know how to calculate E_{mono} (e.g., PVsyst)

Bifacial Gain depends on:
  - Albedo, obstructions, tilt & azimuth, height, module spacing, row length, row spacing, system size, sun path, rearside spectrum, backside IAM, snow shedding, tracking algorithms, etc…

- View factor models are relatively simple but neglect many of the site details (e.g., PVsyst, bifacialvf, etc.).

- Ray-tracing models are complex to set up and expensive to run for many timesteps (e.g., Radiance). But they can include many details.
  - Optical properties need to be defined.

- Empirical models (e.g. Prism) work well for narrowly defined applications.

Lots of work to do in this area and many people are working on it!

3. Bifacial Cells and Modules

- Wide range of bifacial cells are available (mono-PERC, n-PERT, HJT, etc..)
  - Differences in cost and performance (bifaciality, temp coef., low light behavior…)
- Module performance (and reliability) depends not only on cell type, but also the full BOM and climate.
  - Validating modules and specific BOMs for specific applications and climates is still an unresolved issue.
  - Lots of questions about specific degradation modes for different technologies.
- White cell template for backglass growing in popularity.
  - Reduces/eliminates bifacial penalty (lowers cost/W), reduces bifaciality
- Reported module gains are based on a wide variety of system sizes (from a single module to kWs, to hundreds of kWs).
- Mismatch increases with albedo but has a generally small effect on performance.

- We did not hear any details about transparent backsheets, shingled bifacial cells, integrated module level power electronics, or new module formats.

4. Bifacial Modeling and LCOE

- "PV is local" – Site and climate conditions are very important.

- Vertical bifacial performance especially good in high latitude sites.

- Ground sculpting may offer another means for increasing

- BIFOROT results match well with miniaturized test rig.
  - Opportunity: Miniaturized test rig is a promising approach to test different bifacial plant designs on-site.

- Models are beginning to agree with each other.
  - Major source of uncertainty include measuring inputs (albedo, spectral mismatch of backside irradiance, and edge effects).

- SAM is getting ready to release easy-to-use bifacial view factor model
  - Needs validation to field data.

- Albedo values need more rigor
  - Published "typical" values vary widely.
  - Measured values have errors related to instrumentation and deployment that need to be analyzed and documented.
  - Satellite values may not represent local conditions.

5. Bifacial Characterization and Qualification

- Bifacial PV Rating Standard (IEC TS60904-1-2) is finished and will be available in January 2019.
    - Bifaciality = min of bifaciality for Isc and Pmax.
    - Single illumination and double illumination methods match well
    - International round robin of 20+ institutions is underway (9 different module types, bifi and mono, 2 samples each). Planned completion by end of October.

- UL 1703 is changing to UL 61730
    - Submittals after Dec 4, 2019 will be tested to UL 61730.
    - Bifacial changes include (hot-spot test at 1.3 suns, fuse sizing for reverse current overload test, etc. …)

- Conflicting results shown on whether bifaciality varies with irradiance.
    - Anhalt Univ. found no variation
    - Fraunhofer ISE measured changes

2018 11th PV Performance Modeling Workshop (Dec 4-7, 2018) Weihai & Suzhou, China

- Dec 4-5: Technical workshop (Modeling and Monitoring) in Weihai (~$365)

- Optional PV manufacturing tours (fixed price (~$665) includes:
  - Dec 4-5 PVPMC Workshop in Weihai
  - Dec 5 (p.m.) Flight from Weihai to Shanghai – transport to Suzhou.
  - Dec 6-7: Guided tours to 3-4 PV manufacturing centers (TBD)
  - Hotel in Suzhou (2 nights)
  - Meals
  - Local transportation
  - PV Manufacturing Tutorial
- Optional Local tour add-on (~$725):
  - Dec 8: Local tour of cultural sites in Suzhou
- https://pvpmc.sandia.gov/resources-and-events/events/