AMSTERDAM WORKSHOP

Bankability improvement for bifacial technology

The other side of the coin

17 Sept 2019

BIFACIAL TECHNOLOGY

1. Introduction
2. Design variables
3. Bifacial main challenges
4. Testing and certification
5. Bankability and modeling
6. Main mitigations
7. Conclusions / Questions

BIFACIAL TECHNOLOGY

Introduction

- **For Lenders, bifacial technology** is considered as **a "new technology"**

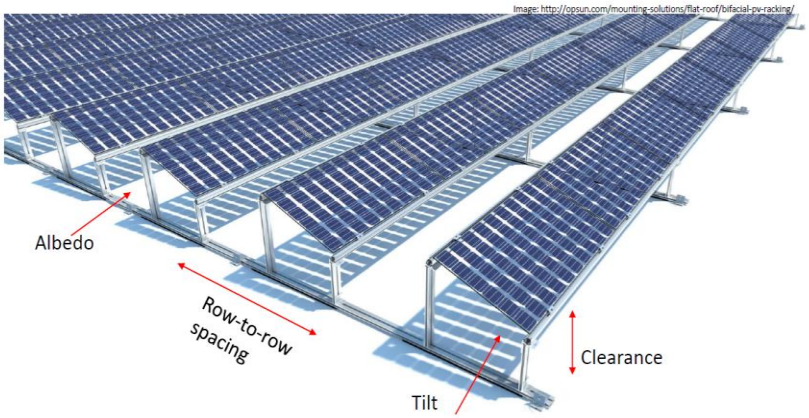
- **Lender's points of attention** regarding bankability study to grant the "non recourse loans" are:
  - The resource
  - The specific technological risks
  - The supplier's track record
  - Specific O&M risks
  - Additional risks

BIFACIAL TECHNOLOGY

Design variables (1/3)

Front- and rear-side performance to be optimized to maximize bifacial gain without an offsetting reduction in front-side performance

- **Albedo:** bright is better (but rare)
- **Ground clearance:** 0.5 m (NREL recommendation)
- **Front aperture ratio:**
  - Ratio of front height over collector width
  - Ratios of 0.5 or more are recommended
- **Tilt angle:**
  - Higher than what might be optimal for monofacial
  - Unless tropical latitude

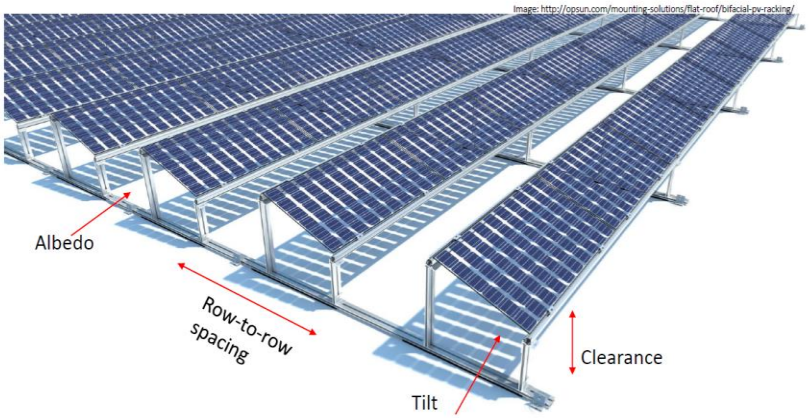


BIFACIAL TECHNOLOGY

Design variables (2/3)

Front- and rear-side performance to be optimized to maximize bifacial gain without an offsetting reduction in front-side performance

- **Structure:**
  - Minimize shading interference (but expensive)
  - Special racking and cable guidance
- **Row E-W configuration:**
  - Short rows increase bifacial value
  - But are impractical for utility-scale systems
- **Ground cover ratio, GCR :**
  - Low GCR is key to high bifacial boosts
  - Must be balanced by practical limits on area and wire/trenching cost

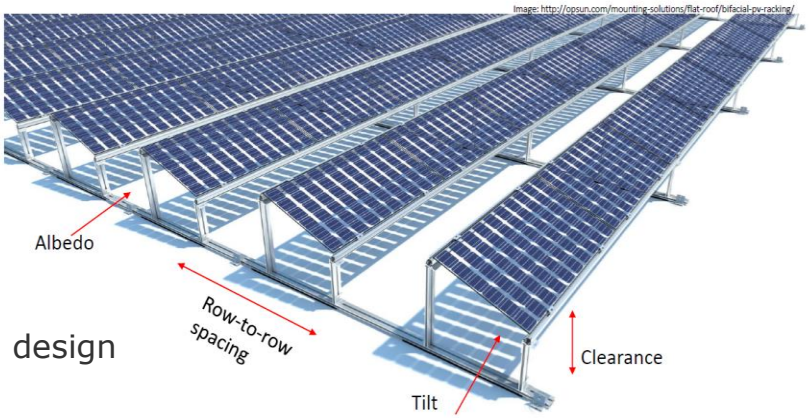


BIFACIAL TECHNOLOGY

Design variables (3/3)

Front- and rear-side performance to be optimized to maximize bifacial gain without an offsetting reduction in front-side performance

- **Height:** higher is better (but expensive)
- **Spacing:** wider is better (but unpopular)
- **Wiring and connection/routing geometry:**
  - E-W wiring rather than N-S serpentine wiring
- **DC/AC ratio:**
  - Less than 1.15 may be optimal depending on the site and design
  - Clipping
- **Combiner, fusing, and conductor upsizing thresholds:**
  - Step-change increases in the ratings and costs of these BOS items



PV MODULE TECHNOLOGY BANKABILITY

Main Challenges / Risks – PERC / Bifacial

Manufacturing

- Additional steps
- New Materials
- Quality Assurance System

Technical

- New product reliability and durability
- LID / LeTID
- Long term degradation
- Weight
- Mismatching

Design

- Site Selection
- Measurements
- Supporting Structure
- Lower GCR
- Backside shading
- Overtightening bolts. Frameless

Testing

- Not fully developed
- IEC 60904-1-2
- Warranties

Modelling

- Lack of validation
- Stability and actual value of Bifaciality factor
- Albedos Variability
- Tracking System

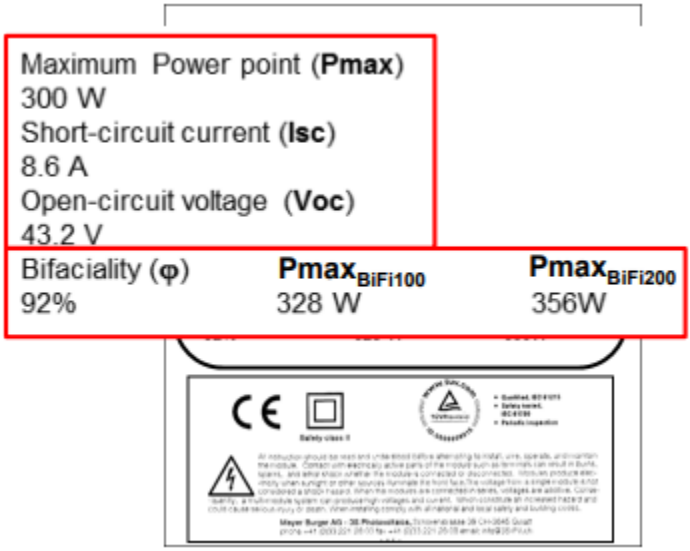
O&M

- Limited field experience
- Higher OPEX
- Clipping, actual vs predicted

BIFACIAL TECHNOLOGY

Testing & Certification

- **Specific adaptation of existing standards needed** : higher currents
  - because of the power contribution from the rear side requires
- **Standard for bifaciality factor:** IEC TS 60904-1-2.
  - Important also for labelling. To be issued by the beginning of 2019
- **Re-testing guidelines** for differences in BOM for bifacial modules
  - not available yet for bifacial modules
- **Quality and reliability testing**



PV MODULE TECHNOLOGY BANKABILITY

Bankability and modeling

- The **bankability** of a project **depends on the confidence** of the energy output predictions which are generally modeled
- **Validation of bifacial energy modeling** has not been generally accepted in the industry yet
- IE community is actively **seeking sufficient field validation data** to support bankable energy forecasts

PV MODULE TECHNOLOGY BANKABILITY

Main Migation Measures / Intiatives

- **Outdoor bifacial comparative** Energy yield. Davis, California

- **Lower the uncertainties** based on modiifed softwares (DNV GL SolarFarmer) will be developed with a bifacial option calculation

- Test different BOMs to **improve the module reliability** in different site conditions
  - Increase the accelerated life time test sequence for some specific ítems (See DNV GL PQP program)
  - Update the IEC/UL reliability test conditions for bifacial modules accordingly

PV MODULE TECHNOLOGY BANKABILITY

Main Mitigation Measures / Initiatives

- Mixing technologies Mono/bi
- Reducing leverage of debt
- Increased warranty levels
- Manufacturer Bankability reports
- Collaboration with manufacturers
- The importance of BOM
- Maintenance Reserve Account
- Presentations to Banks

U.S. Department of Energy awards study of bifacial PV technology, which could prove a 10% increase in energy output

Research study by DNV GL will be the most comprehensive energy yield analysis for bifacial PV modules to date

PV MODULE TECHNOLOGY BANKABILITY

Conclusions

- Bifacial Technology is **a really promising technology**
- DNV GL notes that gains of **even 5% may require significant attention** to design and siting detail
- However, **standards and technology are subject to future improvements** for a better bankability

Questions

Thank you.

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