Cofund

Transnational Project

Progress Report Template

Table of Contents

Introduction and Overview

initial situation

Although bifacial cells need some additional manufacturing steps, from an economical point of view the production costs are comparable and the yield increase can be between 5 and 30% yield [1,2]. This depends on the solar cell technology used, the location and system design. Today one of the most effective ways to include PV is the usage of solar panels on manufacturing sites and public buildings, where the generated power is used immediately. In many of these buildings, flat roofs are state of the art. Therefore, the BI-FACE project focused on optimized light weight bifacial PV systems for flat roofs.

The first main challenges at the beginning of the project were optimization of the module itself, e.g. the used components and design rules. Novel materials for i.e. encapsulation and glass / foil had to be evaluated with regards to costs as well as reliability. Furthermore, the manufacturing process was not well analyzed and needed optimization. Besides that, also the characterization of the built modules was still challenging. At that time the characterization of bifacial modules was not well defined, labelling was therefore unprecise and unsatisfactory for customers as well as for manufacturers.

Especially there was a big gap between laboratory and manufacturer characterization and measurements. Parallel to these module aspects the second main challenge was the optimization of the overall system design, where layout and mounting design of the system had to be optimized for energy performance. Energy performance of a system is critically influenced by structure and albedo of the roof surrounding modules and shape of the modules and should be thus evaluated and optimized to achieve maximum performance. The system design needs to take into account different (ballast) load profiles, due to added wind load, which can influence ground reflection and irradiation. Heavy ballast contradicts the requirements of many flat roofs, as many cannot handle heavy weights. This combined optimization of module, system and construction needed to be combined with the economic needs to have high energy yield at low costs.

The main expected results of the project were:

Bi-face project aimed the following objectives:

(1) New validated simulation tools for bifacial modules and systems, including simulation of the wind load

(2) Modeled and validated standardization advice for characterization of bifacial modules
(3) New high efficiency bifacial modules and systems
(4) Outdoor performance qualification of the bifacial system in different European climate zones and wind and snow load conditions
(5) Guidelines for flash tester upgrade at the module manufacturer's site

General Project Information

Project acronym: BI-FACE
Project title: High-efficiency bifacial PV Modules and Systems for flat roof applications
Project number: SOLAR-ERA.NET Cofund 1 N° 028
Project website: https://www.ait.ac.at/themen/photovoltaics/projects/bi-face/

Start date of the project: *01.03.2018*
End date of the project: *29.02.2020 new 30.09.2020*

Final report (Public Summary)
Report date: 21.12.2020

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Please indicate the number of the young researchers (< 35 years) and of female researchers related to all researchers involved in the project and the number of jobs created.

Number of researchers involved and jobs created

Total number of researchers involved (Full-time equivalents)	Number of young researchers involved (Pax)	Number of female researcher involved (Pax)	Number of permanent jobs created (Pax)	Number of temporary jobs created (Pax)
6.16	7.00	6.00	2.50	10.05

Publishable Project Summary

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The scope of the project **BI-FACE** was to develop innovative bifacial modules and systems for flat roofs to exploit the enormous potential of this technology. The results included three novel variations for bifacial modules and systems which were tested in three different climate zones: subtropical (Cyprus), temperate (Austria, 2 sites) and maritime temperate (The Netherlands, 2 sites). The ultimate design of these systems was challenging due to the large number of parameters that influence the energy yield (tilt and distance between modules, reflecting surfaces, shading, cell spacing, materials used and weather conditions).

Within the project 5 bifacial PV systems were realized, 1 at each site, and monitored. The set-ups each featured 3 different types of modules (mono-facial, bifacial n-type (bifaciality ~90%), bifacial p-type (Bifaciality ~70%), so bifacial energy gain on yield could be assessed, as function of module bifaciality, openness of the support structure, as well as the dependence on ground albedo. The monitoring campaign took place over the summer of 2020, putting the extension of the project end-date to good use. The data were evaluated and analyzed with the tools and knowledge developed for bifacial PV within the project.

A holistic approach to energy performance took the aspect of standardization into account. This standardization was at the beginning of the project for bifacial modules not available, hindering rapid market introduction. Therefore, critical efforts were put in to harmonize performance characterization of bifacial PV modules in a factory and laboratory setting and correlate this with the outdoor performance. The results were communicated with the standardization committees.

The layout and mounting design of a bifacial system was critical to obtain the maximum possible performance on flat roofs. The construction demands with respect to wind load, stability, total weight (incl. ballast) and maximum allowed weight on a roof were directly influenced ballast design and needed to be critically examined in parallel. The intended approach compared theoretical investigations with tests in the laboratory and in the field.

Performance simulations of bifacial modules and systems were developed and compared to laboratory and in field test results. Finally, all innovations were collected, synthesized and validated on a flat roof where the need for lightweight was an additional challenge.

The project BI-FACE aimed to develop technically as well as economically novel bifacial PV systems to exploit the enormous potential of this technology.

<u>The expected main results were:</u>

- Novel lightweight bifacial modules and systems for flat roofs for representative climates in Europe
- Innovative, comprehensive models for design and installation of bifacial modules and systems including construction requirements
- Novel manufacturing strategies
- New performance and characterization measurements
- Innovative mounting structures

Summary on Project Progress

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