

HORIZON EUROPE PROGRAMME

TOPIC HORIZON-CL5-2021-D3-03

Demonstration pilot lines for alternative and innovative PV technologies

(Novel c-Si tandem, thin film tandem, bifacial, CPV, etc.)

GA No. 101084046

**Digitalised pilot lines for silicon heterojunction tunnel
interdigitated back contact solar cells and modules**



PILATUS

PILATUS - Deliverable report

Deliverable D3.1

MES implementation including Industry 4.0 concepts



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Deliverable Background:

The present deliverable is part of PILATUS WP3.2 entitled *MES implementation including Industry 4.0 concepts*. It describes the demonstrator of a newly designed and programmed manufacturing execution system (MES) which is managing the PV module production orders on the IBC module pilot line established in WP3.1. Besides the management of the used bill of material (BOM), all relevant production data including machine settings and recipes will be stored in a database for backtracking and future performance data analysis. This also links to deliverable D5.3 related to I4.0 predictive maintenance concept for failure analysis of the cell connecting station (CCS) via a software from CSEM developed in WP5.

Publishable summary

Deliverable Context

One of the main objectives of the PILATUS project is the creation of pilot lines for tunnel interdigitated back contact cells and modules based on heterojunction technology in Europe by integrating cutting-edge analysis and Industry 4.0 features. The module pilot line, established in work package (WP) 3, will demonstrate an annual manufacturing capacity of 170 MW with a production yield of at least 90%. Deliverable 3.1 covers the manufacturing execution system for this module pilot line. This deliverable outlines the challenges faced by setting up a pilot production in an operational environment with extended R&D compatibility. Results from work package 5, the development of I4.0 concepts in form of predictive maintenance algorithms, are running with data extracted from the MES and are described in detail in deliverable 5.3.

Deliverable Achievements

The new developed MES offers an adaptable and cost-effective solution for managing module development data in a semi-automated pilot and R&D environment, aligning with modern Industry 4.0 principles. It provides a high degree of flexibility, allowing for the customization of workflows, product definitions, and manual input where necessary. This flexibility ensures the system can meet the diverse and evolving needs of the pilot line, while also being scalable for future improvements or automation. The in-house development built on open-source technologies makes the system highly adaptable for seamless integration of new tools, processes, and technologies, ensuring long-term relevance. It is fully compatible with Industry 4.0 initiatives, making it ready for future automation and machine learning. One of the system's core strengths is its ability to provide end-to-end material traceability. From material entry to production orders, every piece of material is tracked throughout the entire module build process. This traceability is critical for quality control, ensuring that every module's history is accessible for analysis and audit. Key features of the new MES are the reduction of system interfaces, centralized data collection, material tracking, and process management into a single platform. This simplifies data flow, reduces potential points of failure, and makes the system easier to manage and increases efficiency. The centralized database, combined with business intelligence and advanced analytics tools, empowers users to obtain utilizable insights. With support for machine learning and AI-driven tools, the MES enables fast data-based decision-making, helps production optimization, monitors material usage, and ensures continuous improvement.

Deliverable Structure

Chapter 2 describes the structure of the new developed MES solution with simplified material traceability including I 4.0 applications and specifies the machine and human interfaces. Process flows of a module build process as well as a subsequent data analysis are described in chapter 3. Chapter 4 and 5 conclude the outcomes, describe the interaction of this deliverable within the project, and discuss risks and mitigation strategies.

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Project partners:

#	Partner	Partner Full Name
1	UNR	Uniresearch BV
2	MBG	Meyer Burger (Germany) GmbH
3	MBI	Meyer Burger (Industries) GmbH
4	FhG	Fraunhofer Gesellschaft zur Forderung der Angewandten Forschung EV
5	FZU	Fyzikalni Ustav AV CR V.V.I
6	EURAC	Accademia Europea di Bolzano
7	EXATEQ	Exateq GmbH
8	TNO	Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek TNO
9	NCR	Norwegian Crystals AS (Terminated)
10	ULIEGE	Universite de Liege
11	PADA	Padanaplast SRL
12	ISRA	ISRA Vision GmbH
13	CSEM	CSEM Centre Suisse d'Eletronique et de Microtechnique SA – Recherche et Developpement
14	MBCH	Meyer Burger (Switzerland) AG
15	MBR	Meyer Burger Research AG
16	PASAN	PASAN SA
17	WCH	Wacker Chemie AG
18	EPFL	École Polytechnique Fédérale de Lausanne
19	CPT	Cambridge Photon Technology Limited
20	NOR	NORSUN AS

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