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Silicon solar cells with Low Environmental footprint and Advanced interfaces

SiLEAN - Deliverable report

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Project Scientific Abstract

The SiLEAN project deals with the development of advanced innovations to tackle the major drawbacks of silicon heterojunction solar cell technology, namely the high energy and material demand for Si wafer manufacturing, limited current generation, and the consumption of scarce materials like silver, bismuth and indium. Within the scope of the project, we will directly grow the wafers from the gas phase, apply alternative passivation concepts that show higher optical transparency, develop indium-free contact layers and apply silver and bismuth-free metallization with all-in-one cell interconnection and encapsulation. The project aims to achieve >25.5% solar cell efficiency and >23.5% module efficiency with 50% lower costs for Si wafers and contacting, as well as up to 75% lower carbon footprint. All processes applied allow upscaling to larger sizes as well as high manufacturing throughput. Eventually, the developments of SiLEAN will pave the way for a new, lean, generation of heterojunction solar cell technology that will both increment the energy conversion efficiency and unlock production at terawatt-scale.

Public summary

This report presents an overview of the key innovations developed within the SiLEAN project, which aims to advance silicon heterojunction (SHJ) solar cell technology by addressing its current limitations. These include high energy consumption in wafer production, reliance on scarce materials such as silver, indium, and bismuth, and challenges in scaling to terawatt-level manufacturing.

SiLEAN introduces a lean and sustainable process chain for SHJ solar cells, incorporating epitaxially grown ultra-thin wafers, indium-free transparent conductive oxides, silver-free metallization, bismuth-free interconnection, and advanced passivation and texturing techniques. These innovations are designed to reduce costs, improve efficiency, and lower the environmental footprint of solar cell production.

The report identifies and describes a set of Exploitable Results (ERs) generated during the project. Each ER is analysed in terms of its technical content, potential value, target sectors, and strategic path to market. The ERs span a wide range of domains including materials, processes, equipment, software, and knowledge assets. They are relevant to multiple sectors such as photovoltaic manufacturing, energy deployment, and scientific research.

The document outlines exploitation strategies for each ER, including potential applications in residential, commercial, and utility-scale solar energy systems, as well as opportunities for industrial partnerships, licensing, and further research. It also highlights relevant European funding instruments that can support the scale-up and commercialization of these innovations.

Overall, the report provides a roadmap for transforming SiLEAN's technological advancements into tangible outcomes that contribute to a more sustainable and efficient solar energy industry.

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Project partners:

#	Partner short name	Partner Full Name
1	FZJ	FORSCHUNGSZENTRUM JULICH GMBH
2	IMEC	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM
3	TUD	TECHNISCHE UNIVERSITEIT DELFT
4	UNR	UNIRESEARCH BV
5	NXW	NEXWAFE GMBH
6	PVW	PV Works B.V.
7	GET	GraphEnergyTech
8	3SUN	3SUN S.R.L.
9	GUNAM	ODTÜ-GÜNAM

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