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Sustainable Photovoltaics Integration in buildings and Infrastructure for multiple applications

D6.1 – COST ASSESSMENT OF SPHINX IPV MODULES

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Public Summary

An upstream analysis was adjusted based on a small-scale –20 MW– manufacturing line with low levels of automation. This analysis finds that high labour intensity is the main cost hurdle in shingle module manufacturing within this environment. Production costs also vary significantly between products. On one hand, BOM pricing differs across models, even when similar materials are used, reflecting variations in design and sourcing strategies. On the other hand, better equipment utilization in smaller modules can lead to lower CAPEX per watt. However, the limited throughput of a 20 MW line makes production costs highly susceptible to fixed overheads, particularly labour and equipment amortization. Labour is the most sensitive cost driver, with small-scale and manual processes being particularly inefficient. CAPEX is also significant due to expensive shingling equipment, but its impact is only secondary. Across the models studied, labour costs range between 195,73 € and 8,32 € per module, accounting for approximately 32,6% to 52,1% of total shingling step costs. Some BOM savings are observed across certain designs, which could support further development of the technology under the right conditions. At higher production capacities, cost savings of 20% to 40% in labour and CAPEX can be achieved. For example, the cost of the shingling step is estimated to decrease from 5.6 €ct/Wp at 20 MW to 1.9 €ct/Wp at 300 MW, primarily due to improved workforce productivity and more efficient distribution of fixed costs. This highlights the significant economic potential of scaling up production while optimizing operational efficiency.

For the upstream cost analysis, we adjusted a techno-economic model to compare the estimated factory gate costs of IPV modules with shingling technology compared to conventional ones. A per-step analysis was done to analyse the shingling step in isolation, confirming its more efficient use of materials. Different module and scale scenarios were adjusted, complemented by a sensitivity analysis on different cost insights to provide a more nuanced analysis on shingling expense (CAPEX/OPEX) requirements.

The downstream cost competitiveness analysis consisted of, first, establishing cost benchmarks by analysing similar IPV products, regular BAPV solutions, and conventional construction. This data was obtained through several sources, such as R&D projects (BIPVBOOST, SEAMLESS-PV, SUPER PV), stakeholder's surveys and desk research. The comparative cost benchmark covered BIPV roofs and façades, carports and PVNB, offering a clear view of the premiums and cost-allocation for each integration type, allowing us to see extra investment each type of system would require, and which components drive the largest share of that premium.

The benchmarking shows BIPV roofs range in cost from near-BAPV levels for in-roof systems (200–350 €/m²) up to three times higher for skylights (1050 €/m²) due to the higher level of complexity and customization of the system. Although notably, the cost span widens significantly as the complexity of the system increases, indicating that these prices are highly dependent on each project. Similarly, in façades, rainscreen façades can go from as low 350 €/m² all the way to 1150 €/m². However, when you factor in the avoided expense of a separate roof or façade, BIPV can achieve cost-parity in new builds or major renovations. Module prices remain the largest single expense across most systems, but as integration complexity increases, installation and BOS rise significantly. In the case of PVNB modules

represent a larger share of the total cost of the system, roughly 66%, because of the added noise reduction requirements. Conversely, in carports, structural and safety requirements drive BOS spend, making modules a smaller share of the budget.

This benchmark is limited to upfront costs; it does not yet capture the advantages of shingling technology, such as better yields under partial shading. Therefore, the second step of the cost competitiveness analysis will consist of looking at end-user economic indicators, like LCOE, NPV and IRR, for each SPHINX demonstrator use-case. By leveraging the detailed cost and performance data generated in WP5, in this phase we will quantify the impact on performance and yield of matrix shingling and thus revealing its true added value.

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Project partners:

#	Partner short name	Partner Full Name
1	VOL	VOLTEC SOLAR
2	ETW	ETWAY S.R.L.
3	HLP	HELIUP
4	M10	M10 INDUSTRIES AG
5	UNR	UNIRESEARCH BV
6	Fraunhofer	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV
7	ICARES	iCARes Consulting SRL
7.1	BI	Becquerel Institute France SAS
7.2	BIE	Becquerel Institute España S.L.
8	CEA	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES
9	FSUNS	Freesuns SA
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11	EPFL	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE
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