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Eco-design and LCA of emerging European photovoltaic (PV) technologies

Sabela Teixeira Taboada, Angélique Léonard | *Université de Liège, Belgium*

Using LCA to power PV's sustainable growth

In recent years, solar energy has become essential not only to reach the decarbonization targets set in Europe by the Green Deal but also for the REPowerEU plan. Two main factors are driving the PV market:

1) Switch from European manufactured PV technology to Asia: low global PV supply diversification.
2) Fast-evolving technologies, continuous innovations arriving.

This study aims to use LCA as an eco-design tool to highlight the hotspots of an emerging PV technology (SHJ-IBC) during the manufacture and use-phase as well as to comparatively assess its production in Europe vs. Asia.

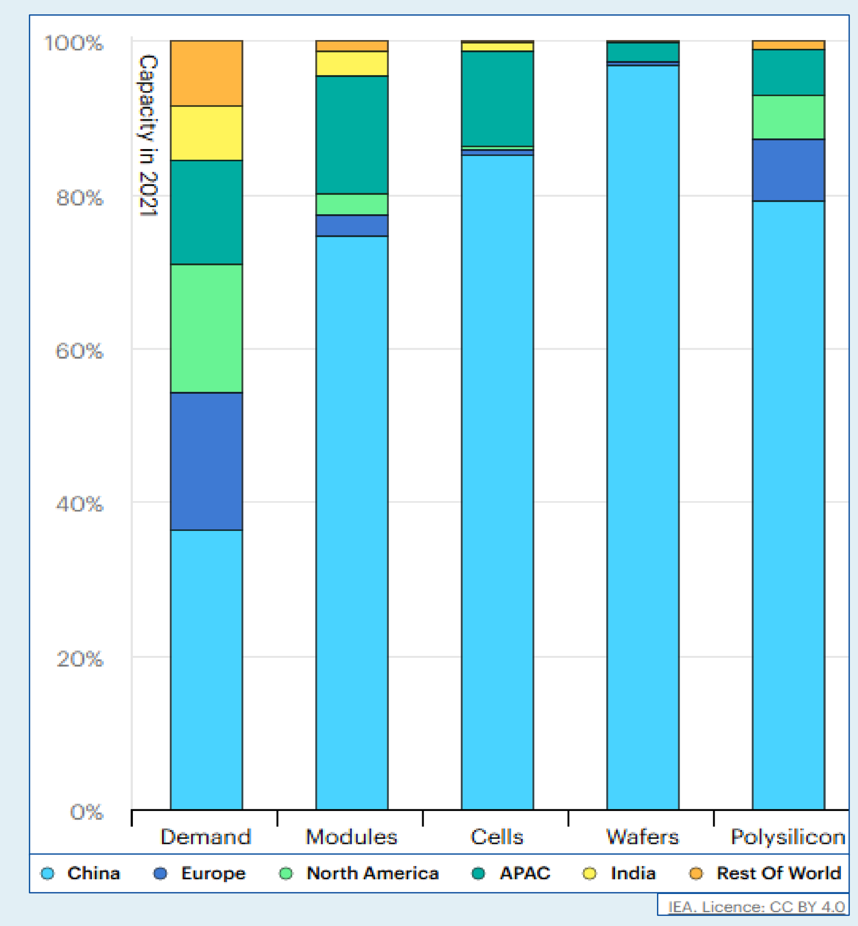
Cradle-to-gate LCA

FU: kWh of DC produced

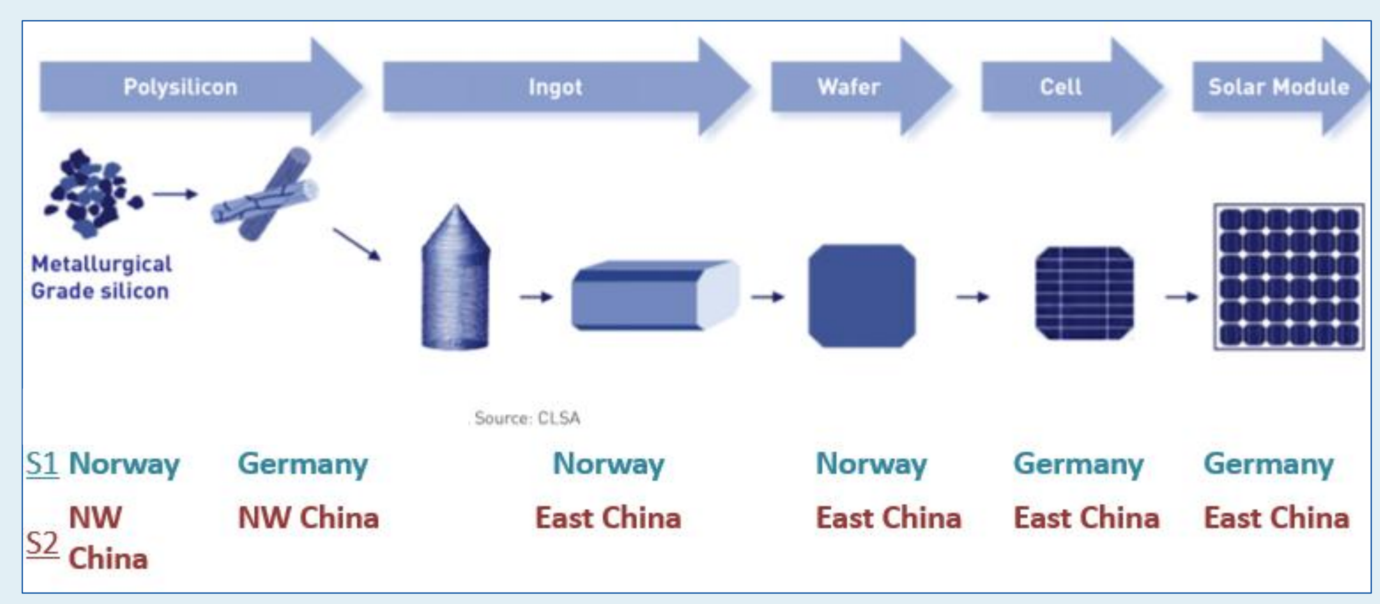
EF 3.1 Impact Assessment Method

Background data from Ecoinvent 3.10

Modelled with Simapro 9.6



Parameter	Pessimistic	Baseline	Optimistic
Module efficiency	21.6% (- 10%)	24%	26.4% (+10%)
Lifetime (y)	25	30	40
Solar irradiation (kWh/m^2/y)	1218 (Sweden)	1330 (EU average)	1886 (Spain)
Performance ratio	0.7	0.85	0.9
Degradation rate, DR	0.63%/yr	0.7%/yr	0.77%/yr
Electricity consumption (kWh/m^2)	84 (- 10%)	93	102 (+10%)
Wafer thickness: silicon content (um)	170	110	100



Finding hotspots and improving production pathways

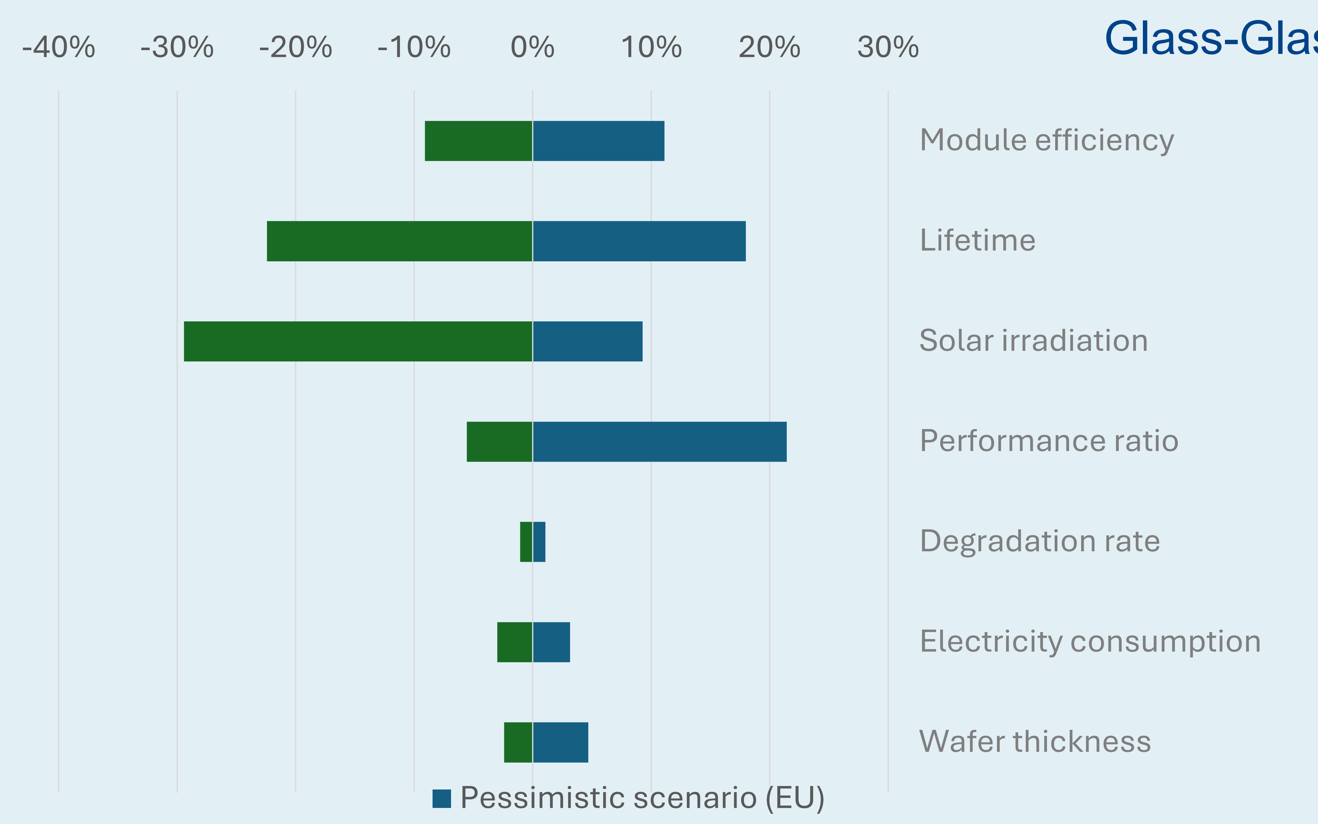
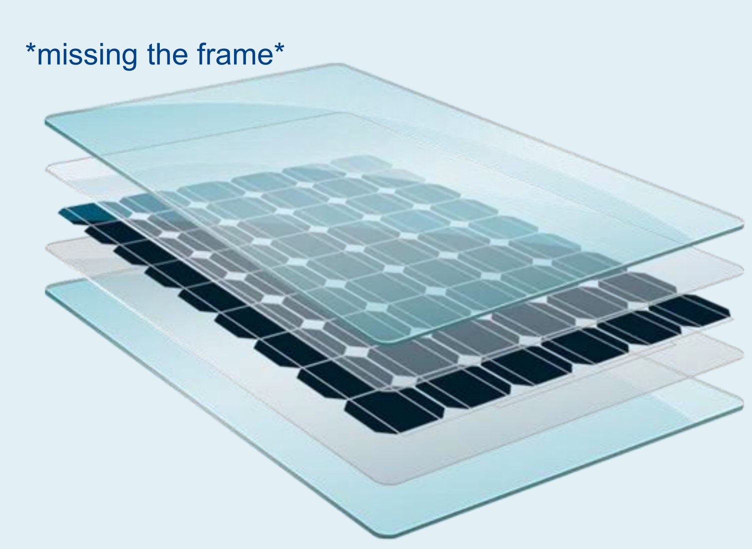


Fig. 1. Carbon footprint reduction potential

Glass-Glass with Al frame SHJ-IBC module (TRL: 7)



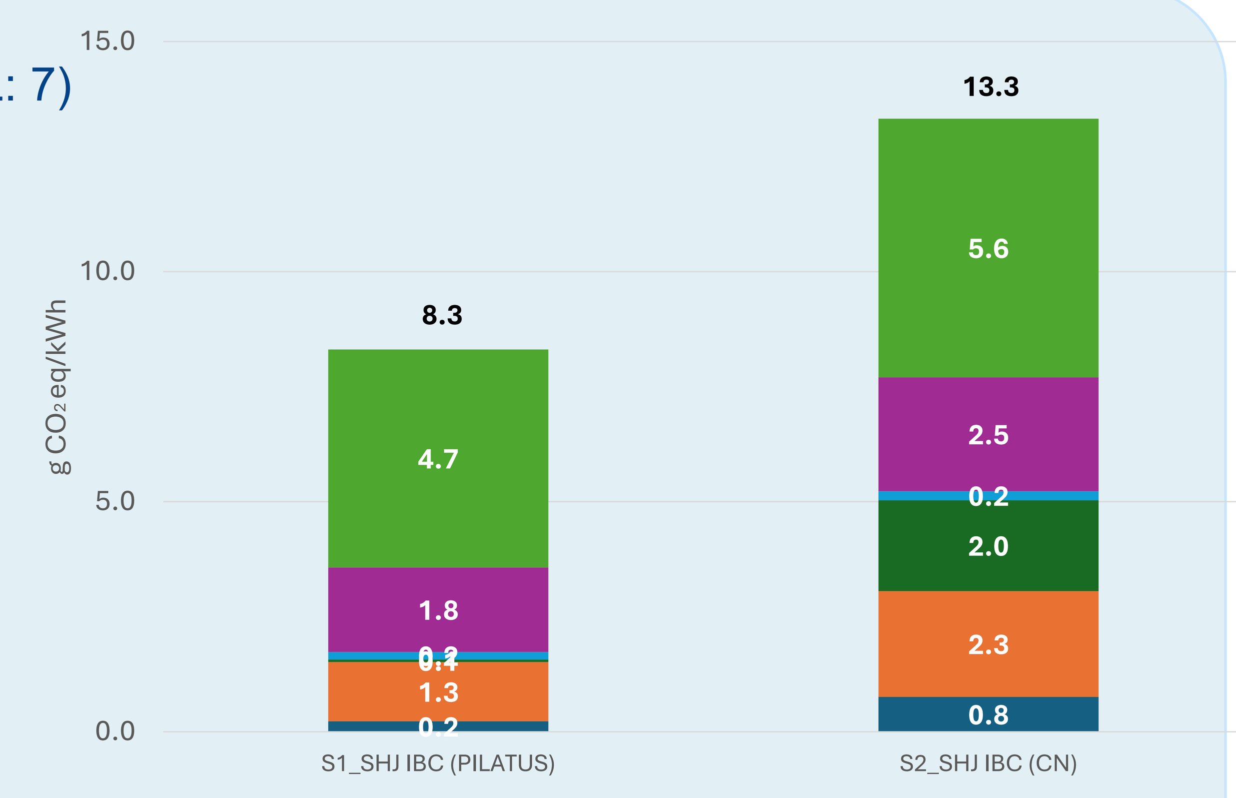


Fig. 2. Cumulative carbon footprint of PV manufacture for S1 and S2

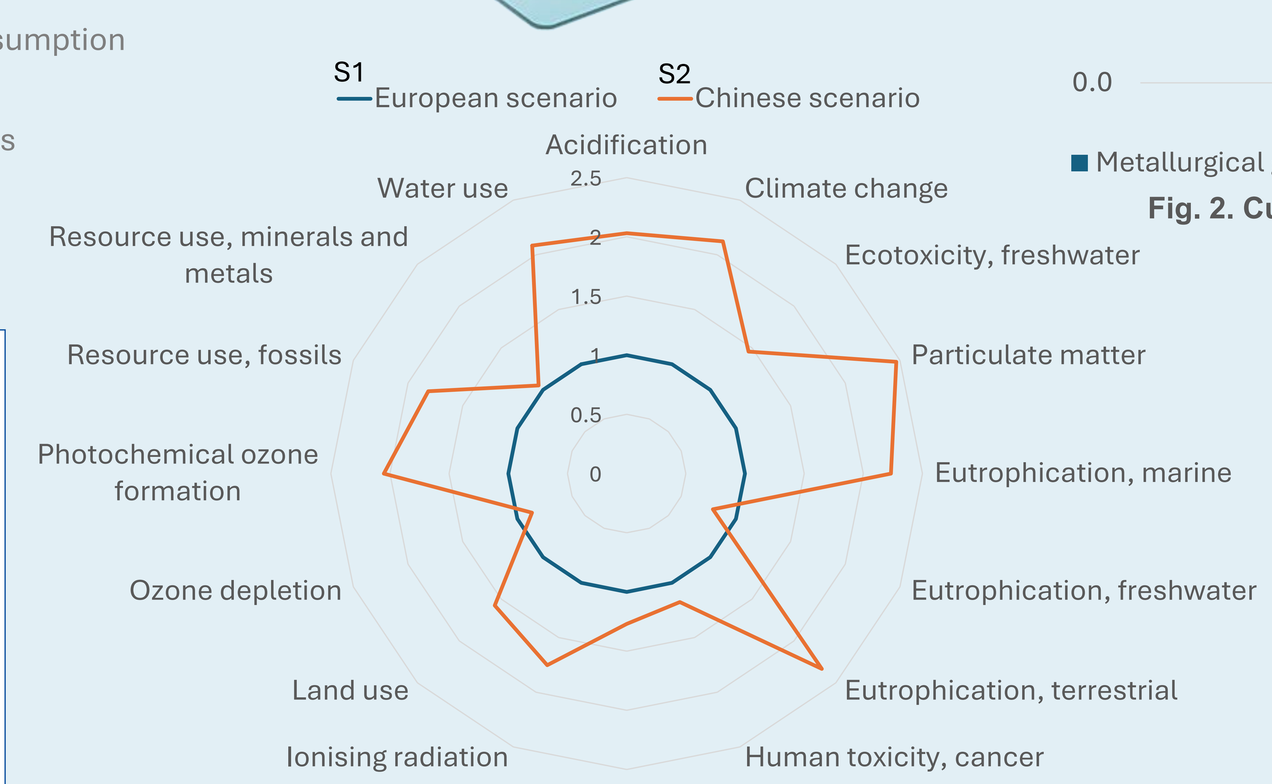


Fig. 3. Comparative analysis of the impacts of PV manufacture for S1 and S2

Conclusions:

- Clear advantage of producing in Europe for all manufacture stages and most of the impact categories
- Parameters linked to the electricity output (efficiency, lifetime, solar irradiation) are key to reduce the carbon footprint of this technology
- For Chinese production, purification of silicon is the main hotspot whereas for Europe it is the module line (panel): this is linked with the electricity mix used

Further research:

- To analyze EoL scenarios
- To add balance of system components (BoS)
- To include primary data from outdoor monitoring
- Contribution to 17 SDGs

Project and Partnership

✓ Duration: **36 months** project (November 2022 – October 2025)

✓ Total Budget: 21.3 M€ (EU, Swiss and UK funded)- EU funding under the **Horizon Europe programme**

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