Sustainability assessment of polyvinyl butyral management alternatives in end-of-life of laminated glass

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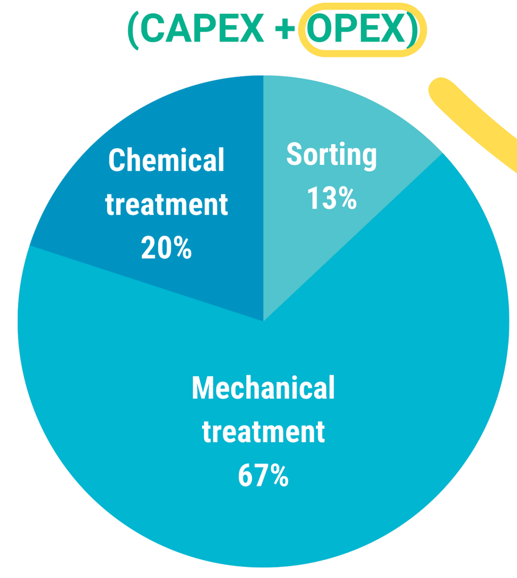
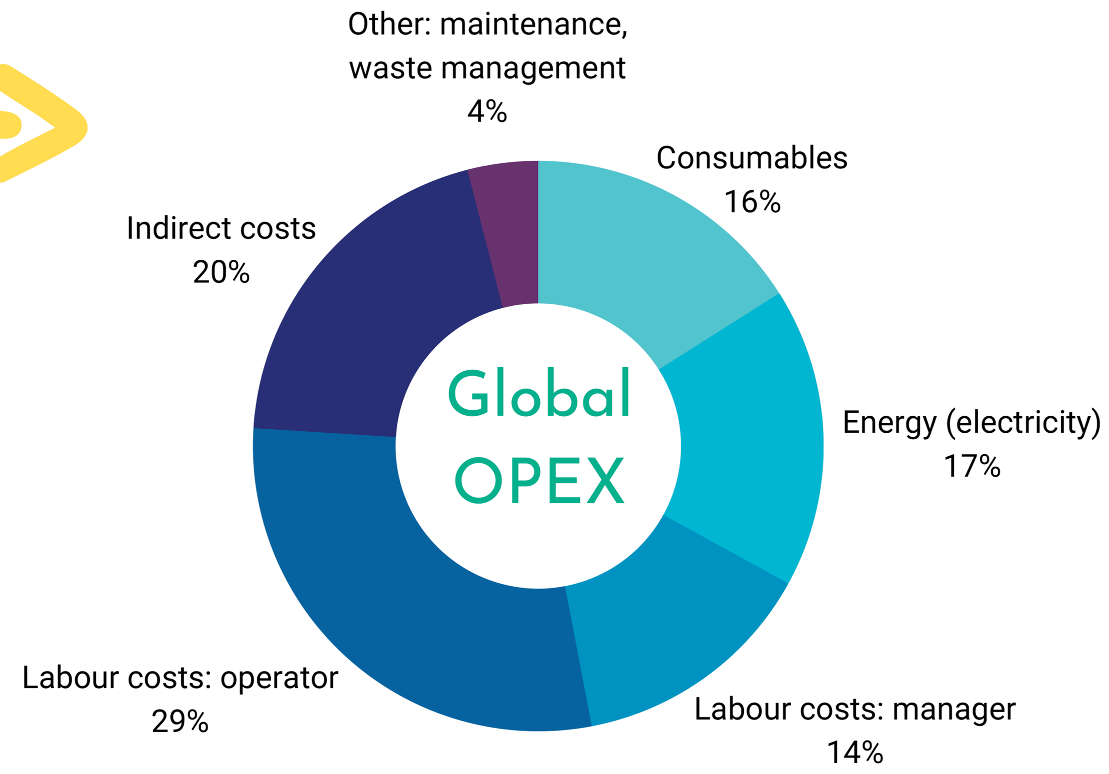
INTRODUCTION: the PVB challenge

- Polyvinyl butyral is a highly valuable polymer used as interlayer in laminated safety glass.
- Only **9%** of PVB interlayer foil is currently recycled in Europe.
- Quality loss and composition mixing hinder PVB recycling from end-of-life windshields and glazing.
- The SUNRISE project proposes an innovative sorting system to address the challenge, based on:

LCC assessment

Costs distribution (CAPEX + OPEX)





HIGHLIGHTS

- Mechanical treatment has the highest costs, but is likely to be optimised with upscaling.
- Optical multisensor is the most expensive device, but also the most innovative.
- Waste PVB management costs ranged between **35–175 €/tonne** for landfilling / incineration.

SUSTAINABILITY ASSESSMENT: LCA + LCC

3 scenarios were assessed for benchmarking comparison:

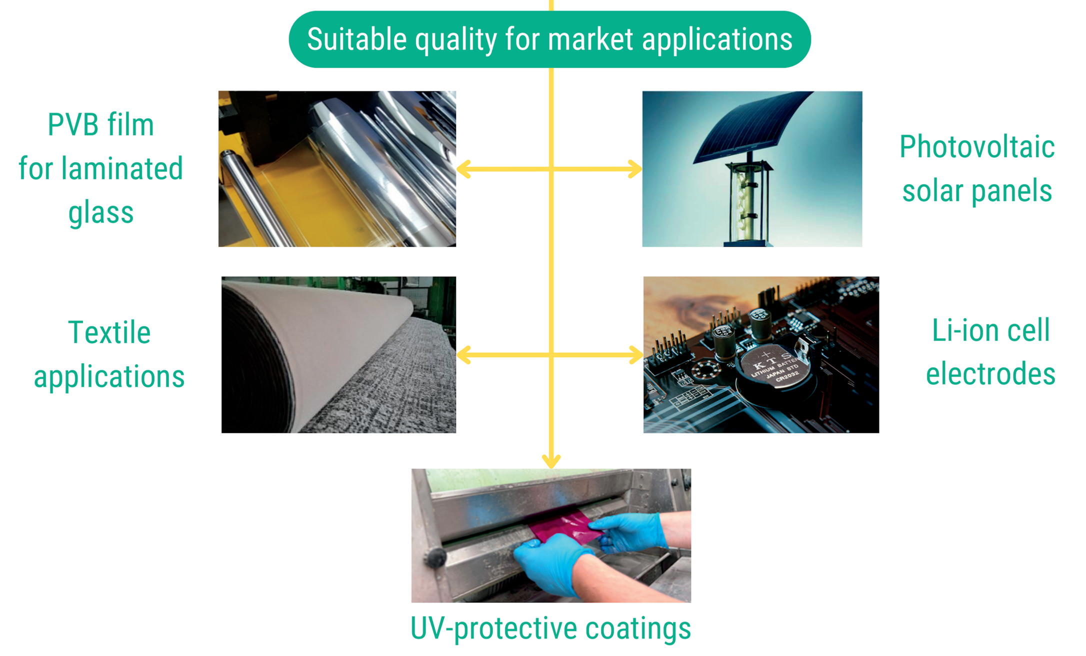
- **SUNRISE**: 1 t PVB recycled as in SUNRISE; 4.4 GJ conventional energy generation (natural gas)
- **WtE**: 1 t PVB disposed in WtE facility; 1 t PVB from primary production
- **Landfill**: 1 t PVB disposed in sanitary landfill; 1 t PVB from primary production; 4.4 GJ conventional energy generation (natural gas)

The **LCI inventories** considered:

- Materials and energy for each process, with prices.
- Emissions derived from landfilling and WtE.
- Landfill/WtE fees.

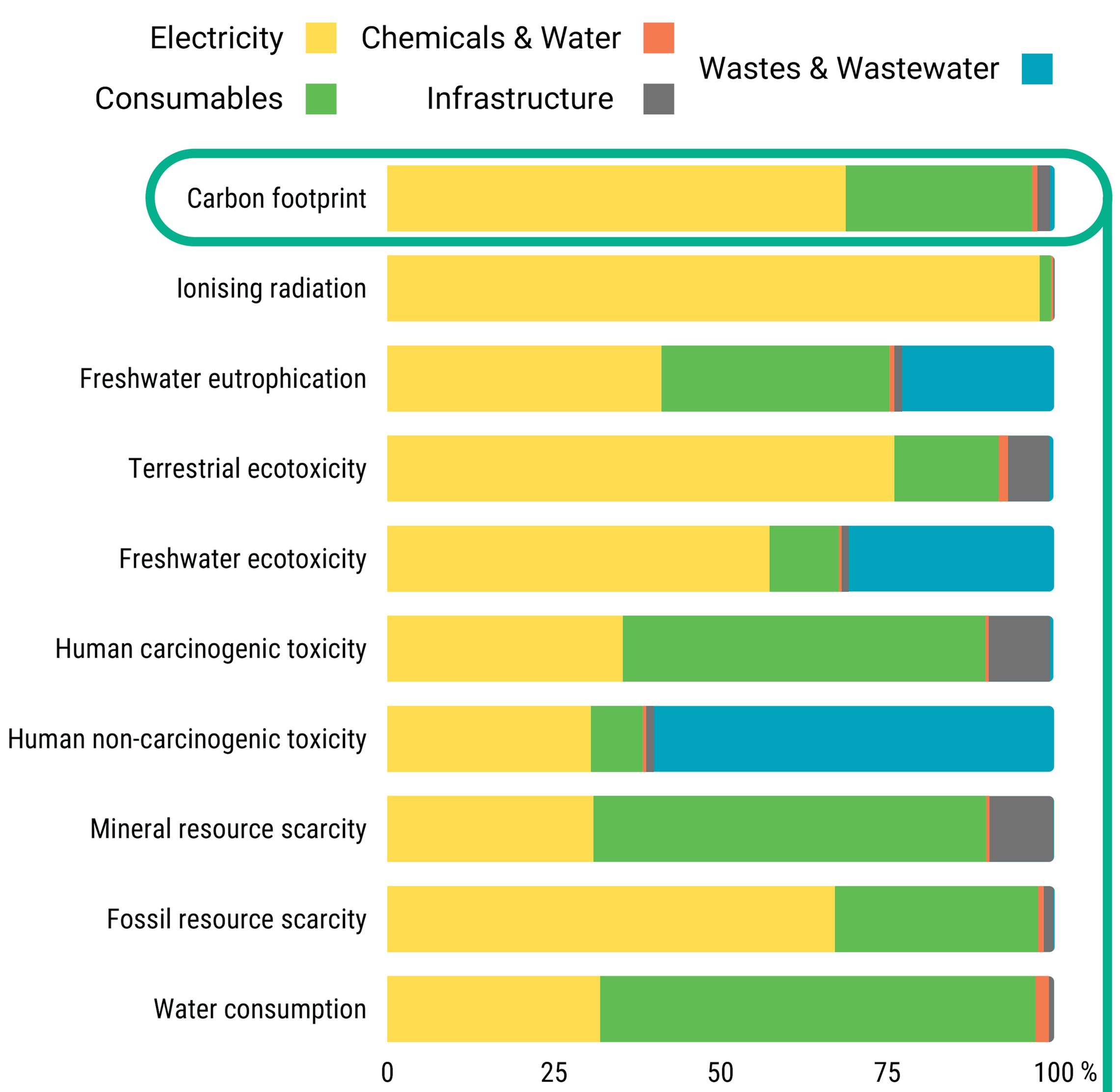
Comparison of PVB prices (€ per 1 tonne PVB)

Recycled flakes (unsorted)	Granulated recycled (unsorted)	**SUNRISE Recycled flakes (sorted)**	Primary PVB resin	Primary PVB film
1000	1200–1600	886	5000–6000	24500



Environmental key-points

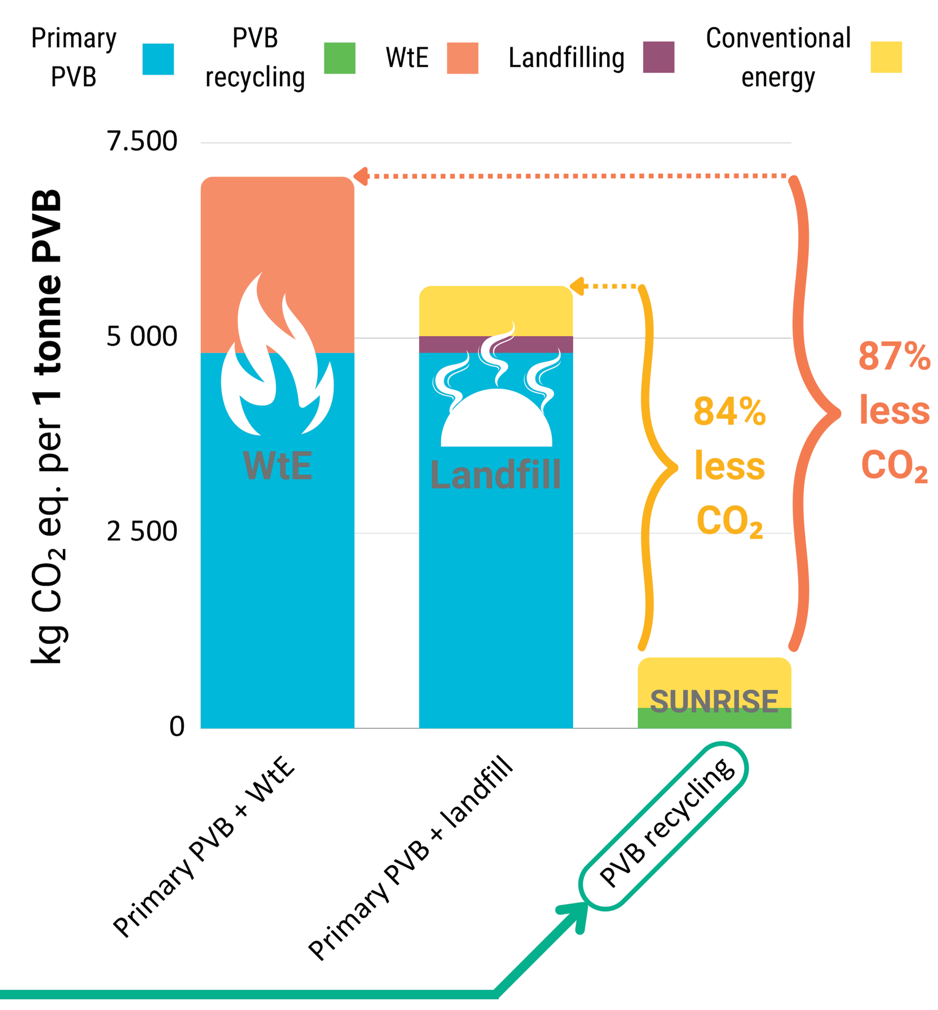
Impacts assessment (ReCiPe midpoint)



HIGHLIGHTS

- Electricity consumption accounted for most impact within recycling, but to a lesser extent than PVB primary production.
- Carbon footprint of PVB incineration was higher than for PVB landfilling; however the opposite happened regarding water quality impacts.
- PVB heating value did not compensate the impacts of WtE emissions in air quality; natural gas incineration generated less impacts.

Carbon footprint reduction



CONCLUSIONS

- The first **LCI inventory for PVB recycling** has been generated and made available.
- The solution proposed for **PVB recycling** is potentially more environmentally beneficial than the current practice of discarding PVB as waste.
- Waste management fees and taxes show large differences between countries, but **the increasing trend favours recycling**.
- Environmental bottlenecks are focused on two main aspects: **electricity consumed** and residual waste material from glazing, currently not recovered.
- The costs determined for PVB recycling at pilot scale reported are similar to current recycled materials found in the market; but the solution of SUNRISE has the **added value of categorisation**.
- Further optimisation of costs is feasible through **upscaling** from pilot to industrial plants, enabling it to be **competitive with alternatives**.
- Further research is expected in order to include **PVB reprocessing** in the assessment.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 958243