

Closing the loop: Recycling of MAPbI₃ Perovskite Solar Cells

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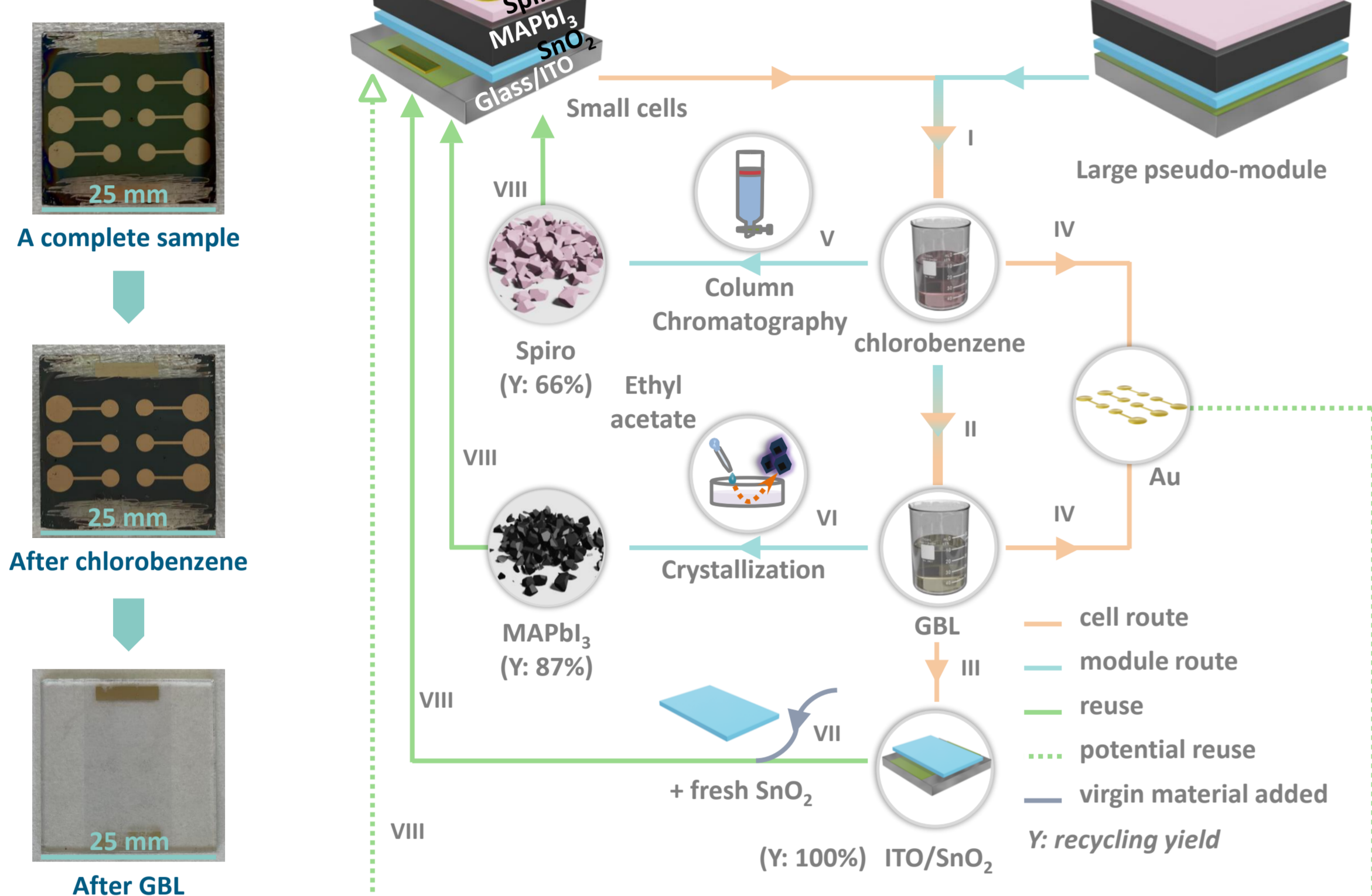
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Motivation

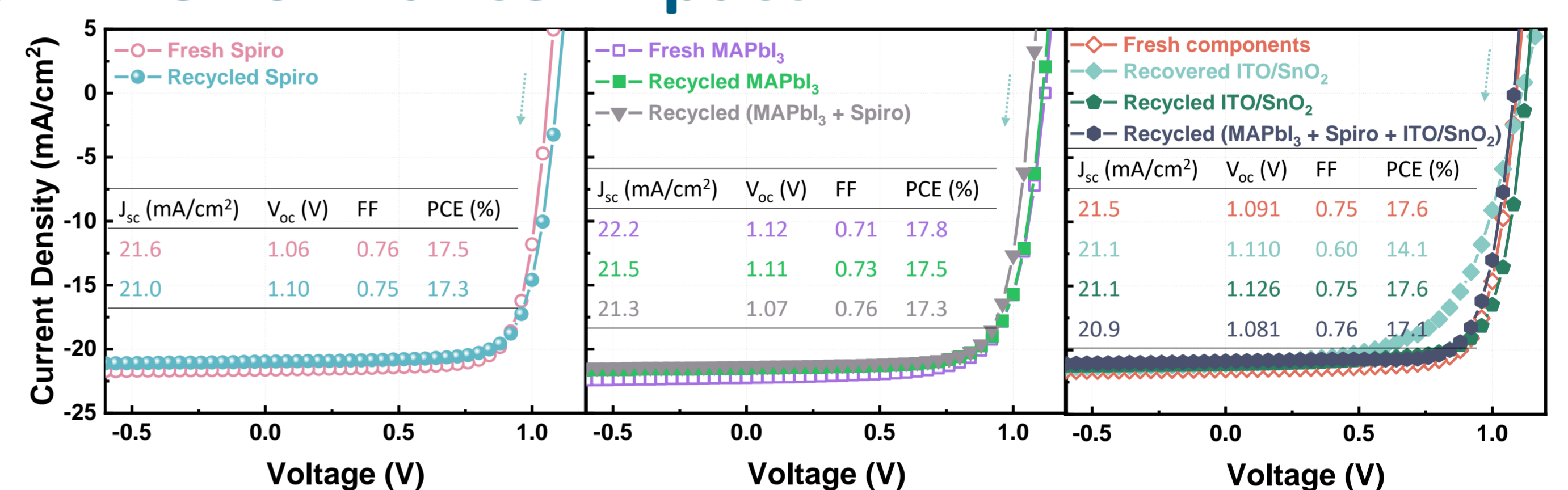
- ▶ Closed-loop recycling is vital in the rapidly expanding photovoltaic sector. Recycling commercial silicon photovoltaic modules is challenging due to inadequate component separation. In contrast, layers in solution-processed perovskite solar cells can be separated with relative ease through selective dissolution.
- ▶ We investigated the recycling of perovskite solar cells and analyzed their economic and environmental impacts.

Approach



Process of closed-loop recycling of perovskite solar devices.

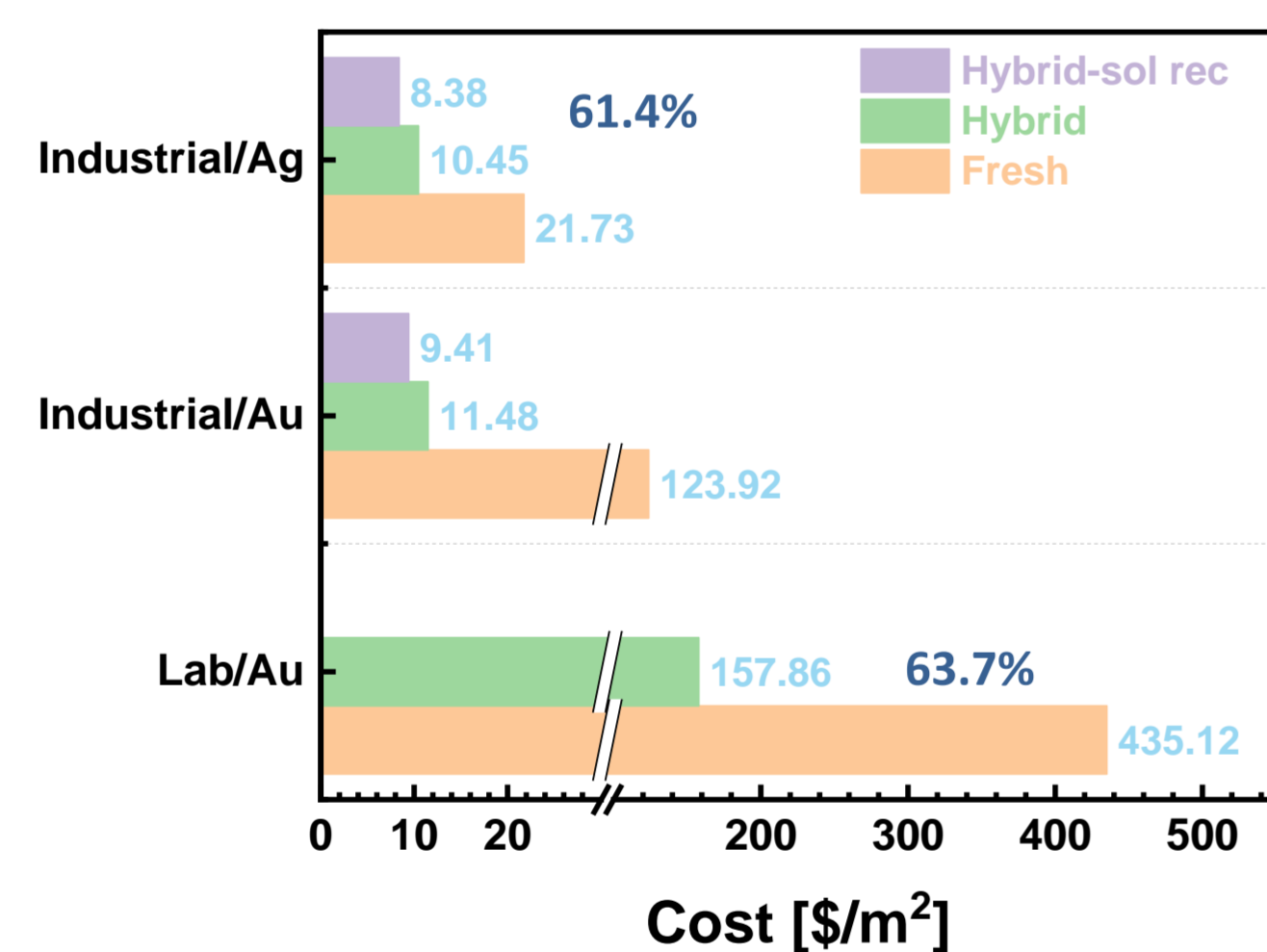
Performance Impact



Current density voltage curves comparing perovskite solar cells with: fresh Spiro-OMeTAD vs recycled Spiro-OMeTAD (left); fresh MAPbI₃ vs recycled MAPbI₃ vs both recycled MAPbI₃ and recycled Spiro-OMeTAD (middle); fresh materials vs recovered ITO/SnO₂ vs recycled ITO/SnO₂, i.e. recovered ITO/SnO₂ + fresh SnO₂ vs all recycled components (right).

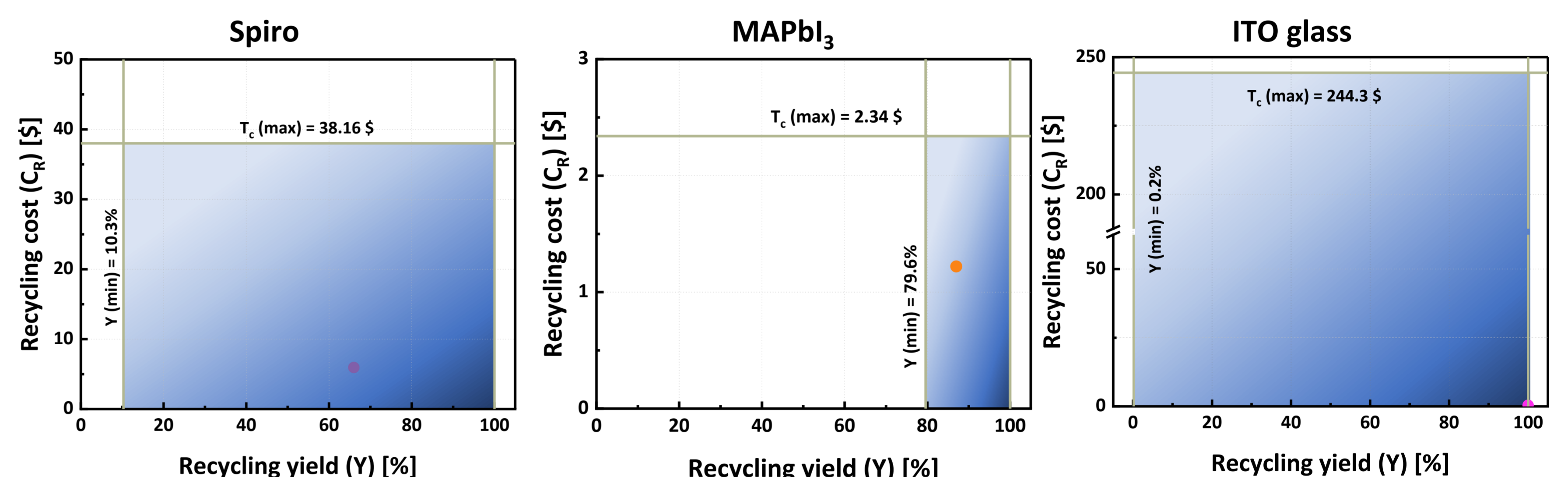
Cells using recycled materials perform comparably to those made entirely from virgin materials

Economic Impact



Economic viability of the recycling approach at lab and industrial scales. 'Hybrid' module are made with recycled materials and top-up fresh materials; 'sol-rec': solvents utilized during recycling are recycled.

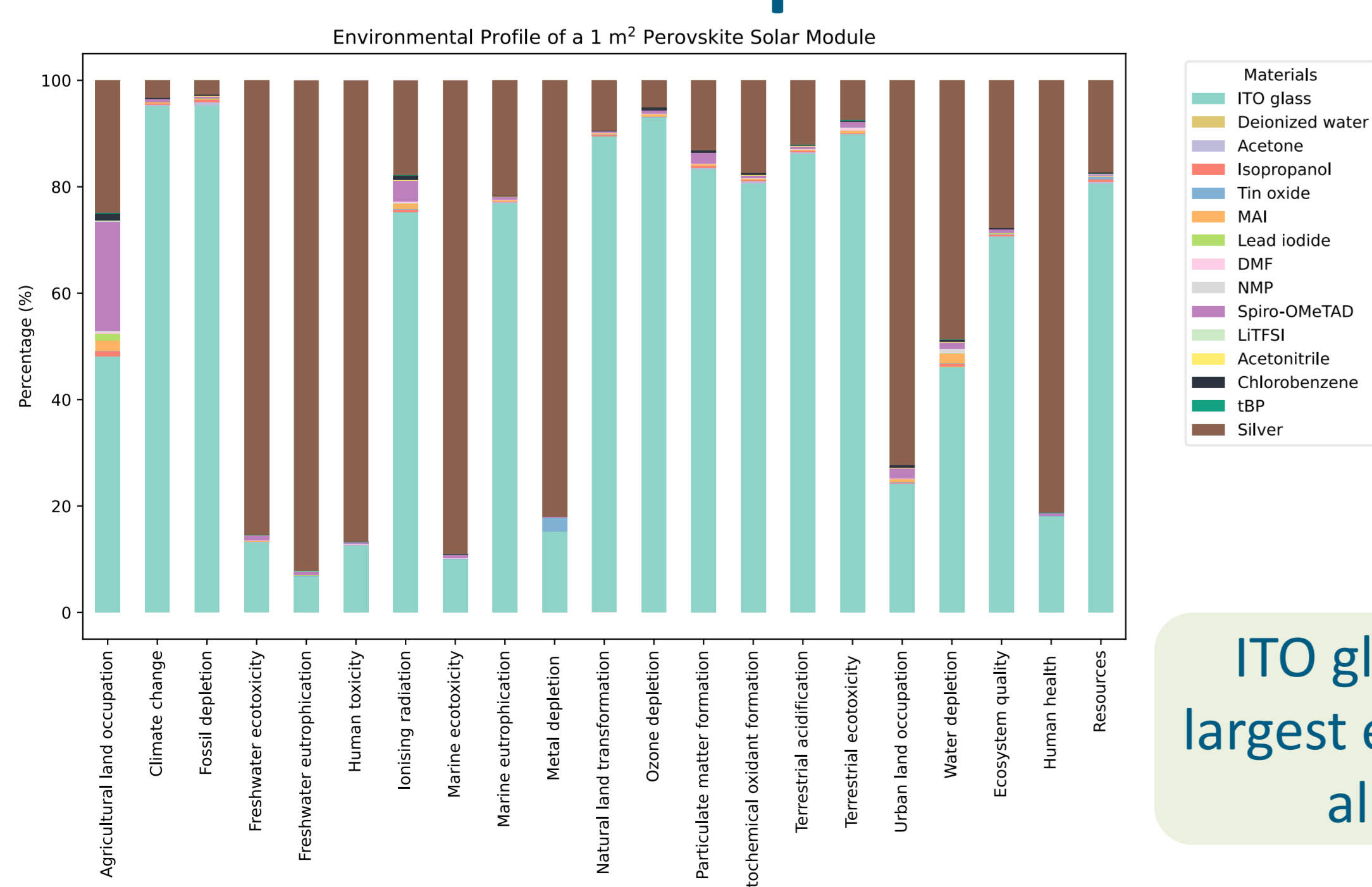
Cost reduction of > 60% achieved through recycling



Profitability analysis: theoretical thresholds and profitable regions for recycling process viability. Profit margins increase as the shade of blue deepens. The data points represent the estimated values in our case.

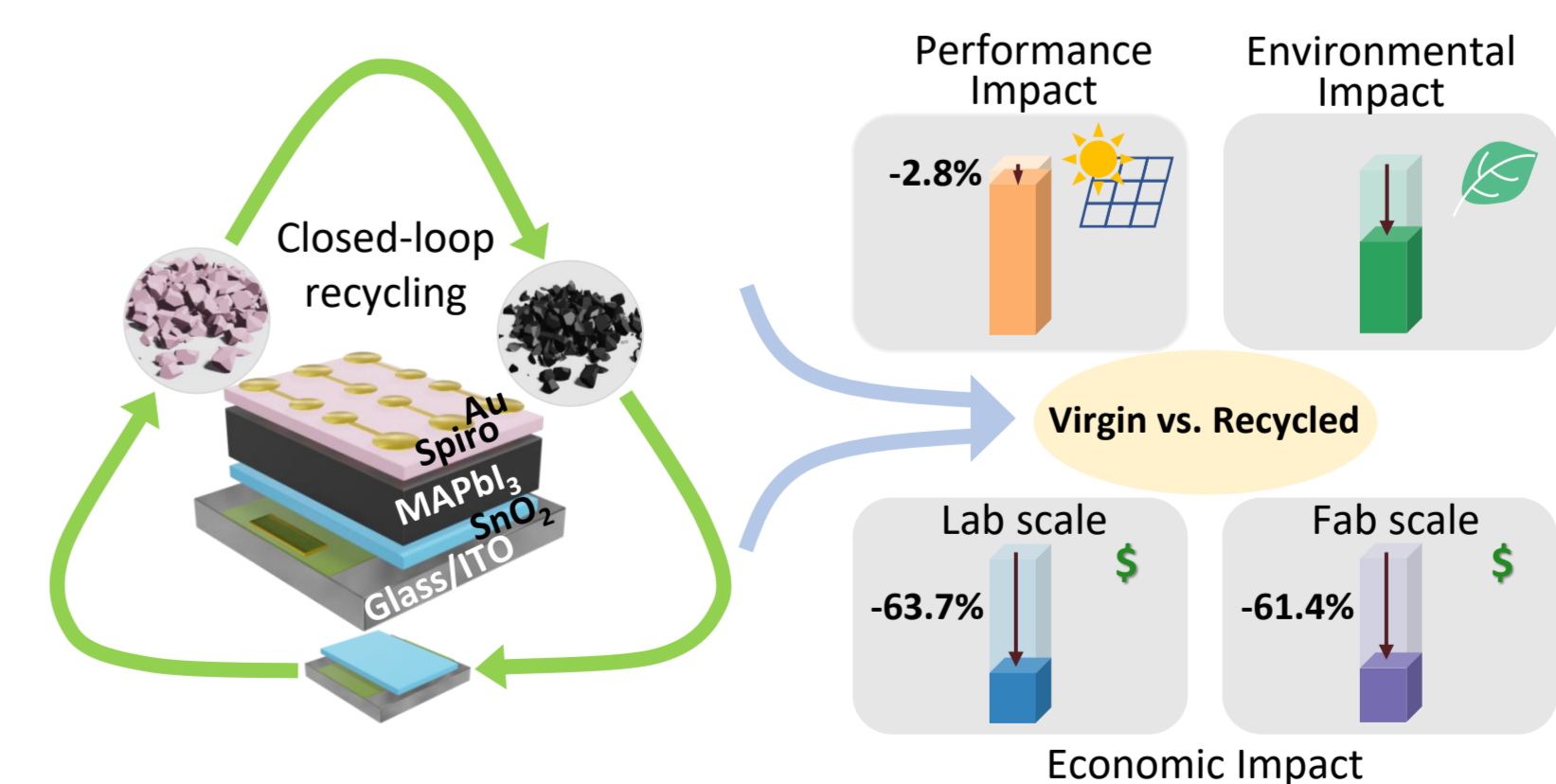
The recycling processes of Spiro-OMeTAD and ITO glass are greatly economically attractive

Environmental Impact



ITO glass has the largest environmental impact

Conclusion



This study developed a closed-loop recycling approach for MAPbI₃ Perovskite solar cells, maintaining performance while enhancing economic and environmental benefits