Techno-economic modelling for Perovskite solar cells recycling strategies

Semester/Master Project

Context

Perovksite solar cells (PSCs) are going to be the future of PV technology. During the last decade, the enormous jump in their efficiencies to >26% make them one of the strongest competitiors to the established Si solar cells industry. The technology has following advantages as compared to the conventional solar cells:

- low material consumption
- low-temperature solution based processing
- roll-to-roll printing/ deposition compatibility i.e, high scalability
- efficiencies comparable to silicon solar cells > 26%
- compatible with tandem PV technologies having efficiencies > 34% with easily tunable bandgaps

With the above mentioned pros and progress, it is likely that in this decade, the technology can take huge share of the PV market and may surpass the market share of established Si industry. With the aim of making this a reality, IPESE, EPFL is working on projects related to demonstrationof industrially feasible high performance perovskite PV modules. With the ultimate aim of optimising the perovskite recipes, this project will focus on developing model and creating the inventory for carrying out the techno-economic assessment (TEA) for PSC production recycling based on the experimental routes followed in the literature. This will involve studying TEA models developed in the literature and coming up with more exhaustive and robust model for such analysis. Further, correlations for scaling-up the equipments and materials depending on the supply chains and auxiliary services required will be developed.

Project 1

The project will be structured in the following parts:

- creating process designs for perovskite recycling based on existing literature using a methodological framework
- overview of different technologies used at various steps of the recycling process
- first principle models for each of the process steps based on mass and energy balance
- defining characteristics of techniques like cost, energy consumption, size limit, material and energy efficiencies
- developing database for material inventory and equipment inventory for PSC production
- developing the model for techno-economic analysis of recycling of PSCs and calculating various associated KPIs

Skills

- Interest and understanding of PV technologies and other energy technologies
- independent and motivated
- Coding skills in Python or other language are necessary
- Results interpretation and report writing
- Language skills: English (C1/C2 level)
- Systematic thinker and problem-solver oriented
- Background: Material science, Mechanical (or manufacturing), Micro engineering, Energy science, others

Lectures: - Fundamentals & processes for photovoltaic devices - Energy conversion and renewable energy

Supervision

If interested, please contact Naveen Bhati (naveen.bhati@epfl.ch) attaching your CV, short motivation letter, and transcript of records (Bachelor's and Master's). Short-listed candidates will be interviewed. Early applications are encouraged.

Practical information

The IPESE laboratory is located in the Sion EPFL campus. Travels between Lausanne and Sion are compensated by EPFL.

References:

1. Song, Z., Phillips, A. B., Celik, I., Liyanage, G. K., Zhao, D., Apul, D., … & Heben, M. J. (2018, June). Manufacturing cost analysis of perovskite solar modules in single-junction and all-perovskite tandem configurations. In 2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC) (pp. 1134-1138). IEEE: .https://ieeexplore.ieee.org/abstract/document/8547676
2. Zafoschnig, L. A., Nold, S., & Goldschmidt, J. C. (2020). The race for lowest costs of electricity production: techno-economic analysis of silicon, perovskite and tandem solar cells. IEEE Journal of Photovoltaics, 10(6), 1632-1641:. https://ieeexplore.ieee.org/abstract/document/9210081
3. Martin, B., Amos, D., Brehob, E., van Hest, M. F., & Druffel, T. (2022). Techno-economic analysis of roll-to-roll production of perovskite modules using radiation thermal processes. Applied Energy, 307, 118200. https://www.sciencedirect.com/science/article/pii/S03062619210