ASIA-PACIFIC SOLAR RESEARCH CONFERENCE – 2018

COMPARATIVE LIFE CYCLE ASSESSMENT OF END-OF-LIFE SILICON SOLAR MODULES

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AGENDA

- INTRODUCTION
- APPROACH AND METHODOLOGY
- RESULTS AND DISCUSSION
    - End-of-Life silicon solar modules
- CONCLUSION

INTRODUCTION

The cumulative global PV waste is increasing rapidly (most of the EoL modules go to landfill):

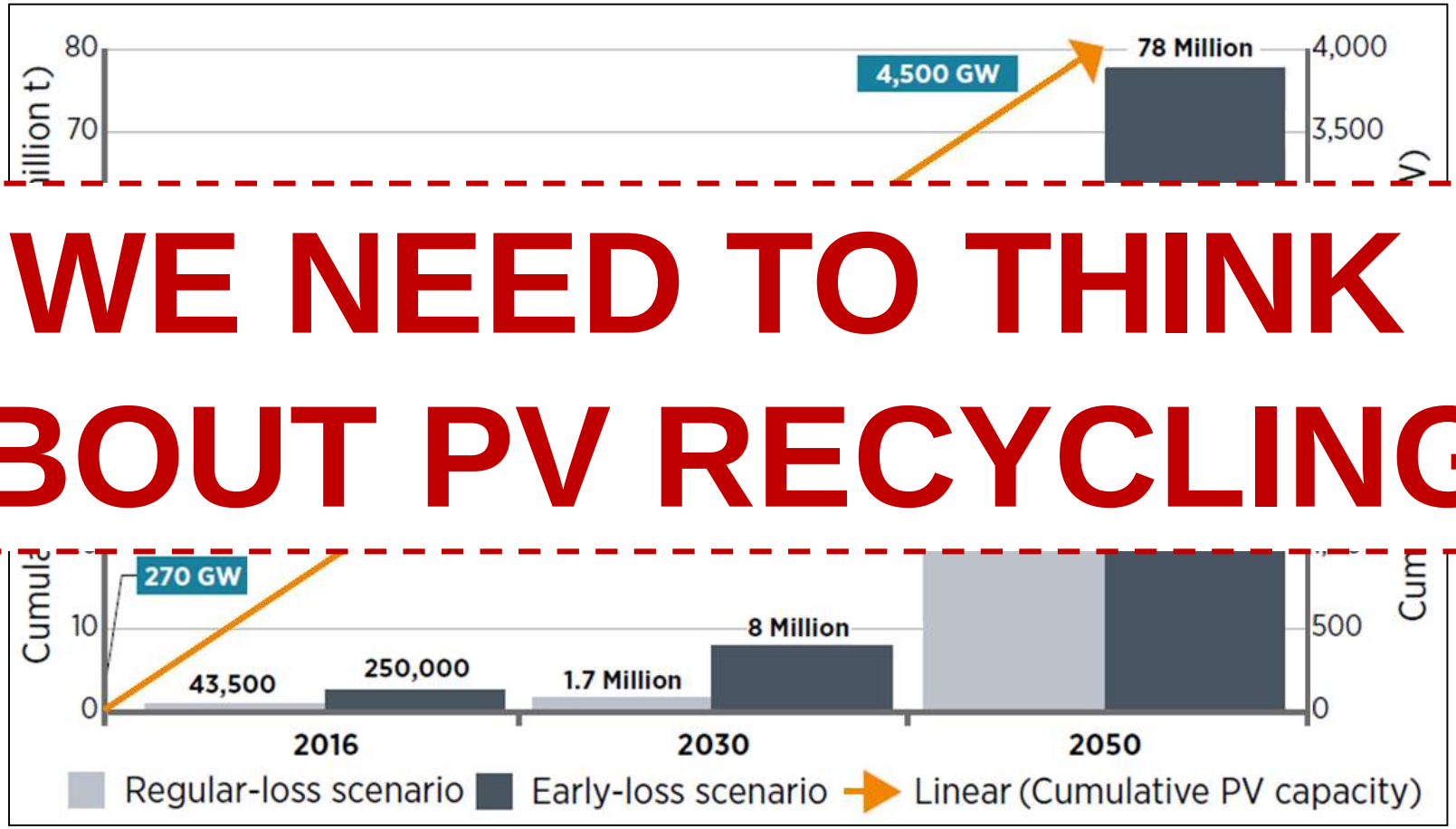
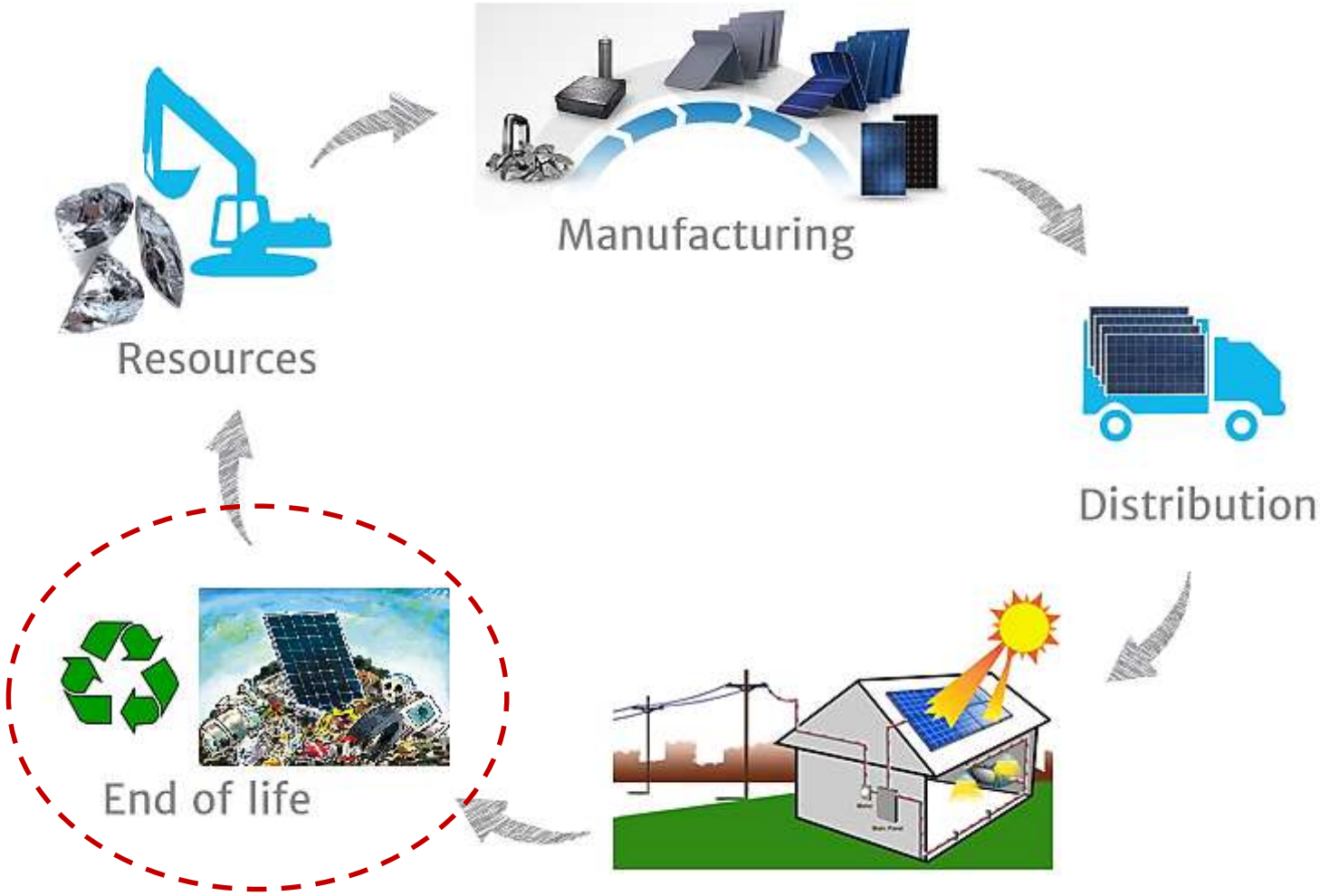


Figure 1: Overview of global PV panel waste projections, 2016-2050 [Weckend, S.; Wade, A. and Heath, G. *(2016). End-of-life management Solar Photovoltaic Panels, IRENA and IEA-PVPS*].

INTRODUCTION

The recycling processes are not yet economically feasible, but there have been developments worldwide.



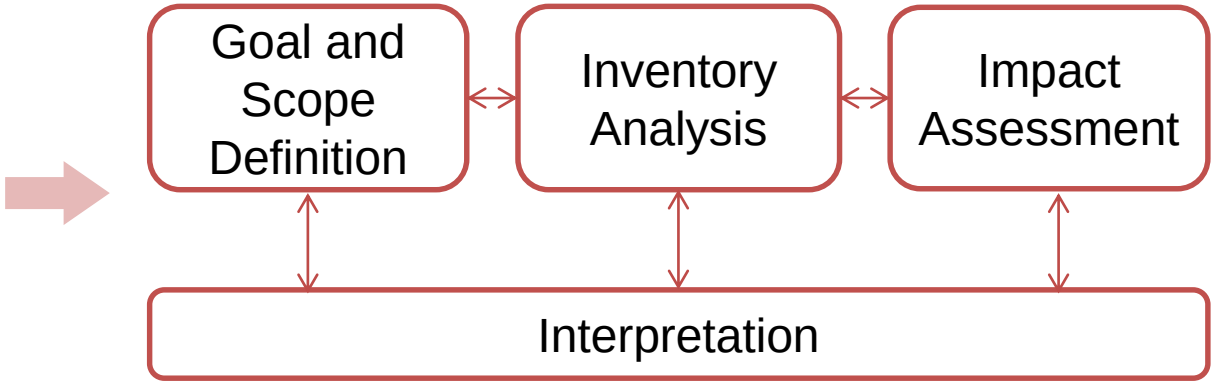
INTRODUCTION

- Recycling processes also have environmental impacts.
- LCA quantifies the environmental impacts of processes.
- This study: LCA of EoL scenarios for c-Si solar modules.

APPROACH AND METHODOLOGY

Life Cycle Assessment

(Standardized by ISO 14040 and 14044)



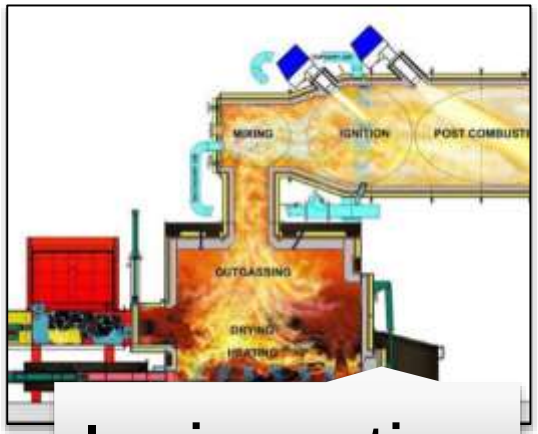
Impact Category (ReCiPe method)	Characterization factor
Human Health	DALY (Disability-Adjusted Life Years)
Ecosystems	Species*year
Resources	Cost (USD$)

APPROACH AND METHODOLOGY

Functional Unit:
1 kg of Si-based solar module

Landfill

Source (image): https://electricalconnection.com.au



Incineration

Source (image): http://theconversation.com/garbage-in-garbage-out-incineration

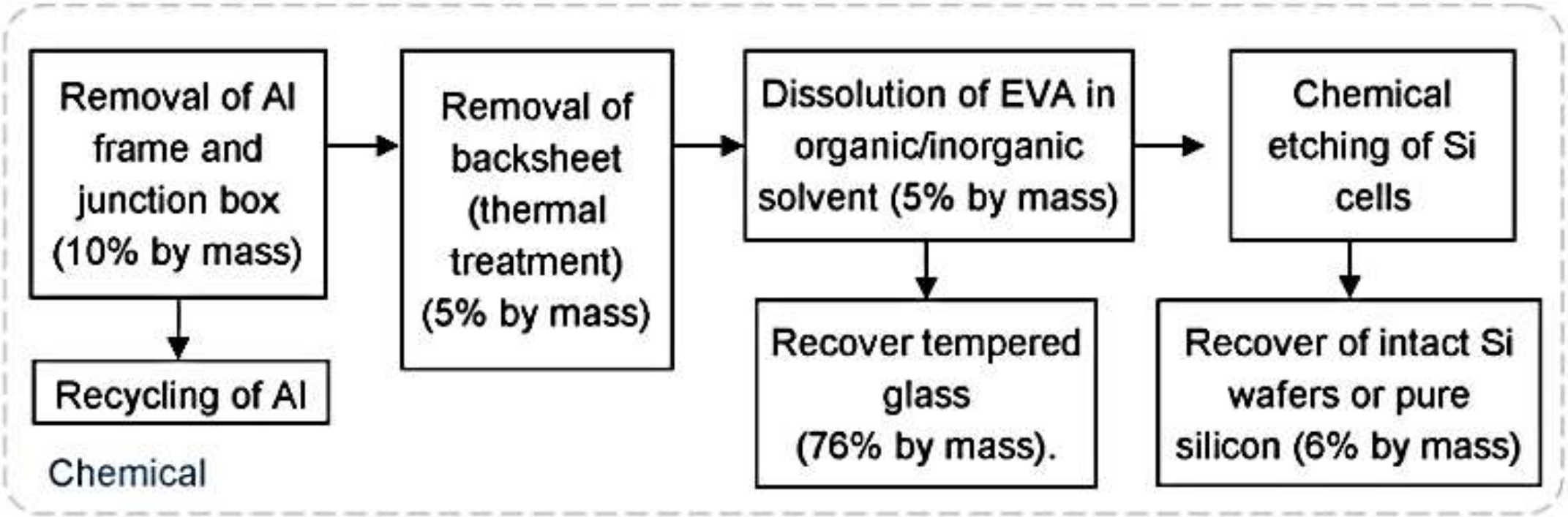
Reuse

Source (image): https://www.solarpowerauthority.com

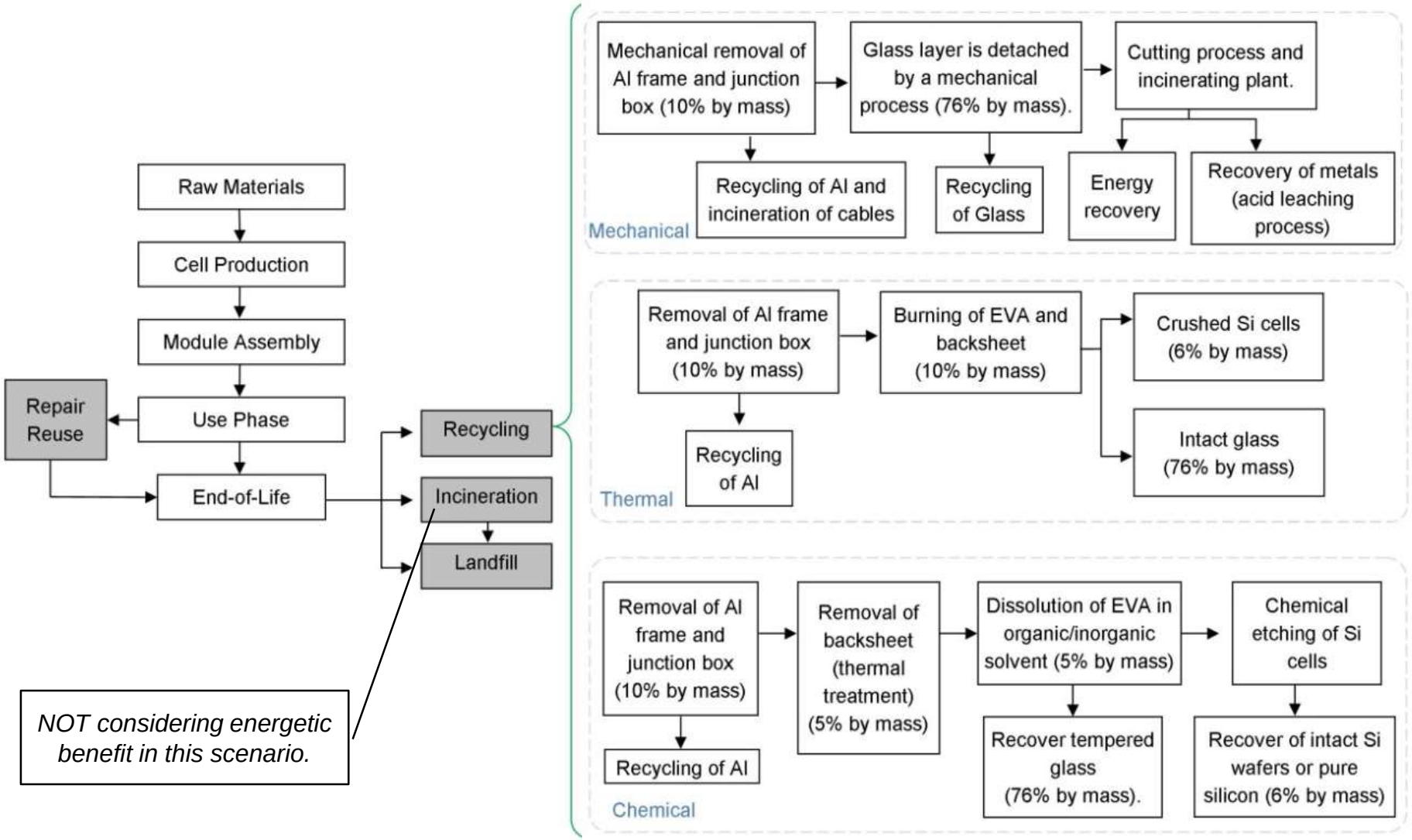
Recycling

Source (image): http://www.linkewire.com

APPROACH AND METHODOLOGY

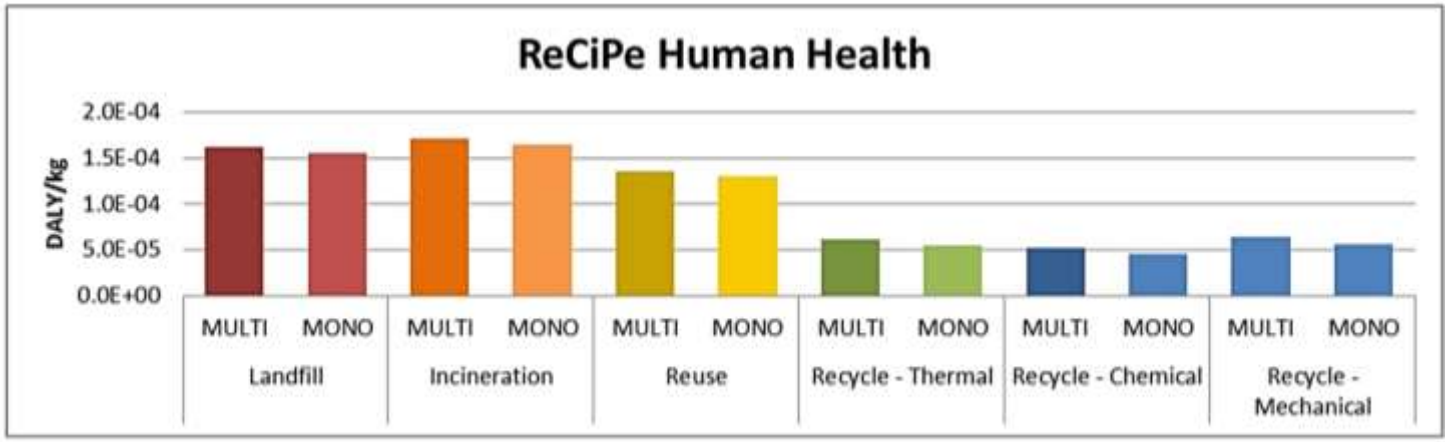


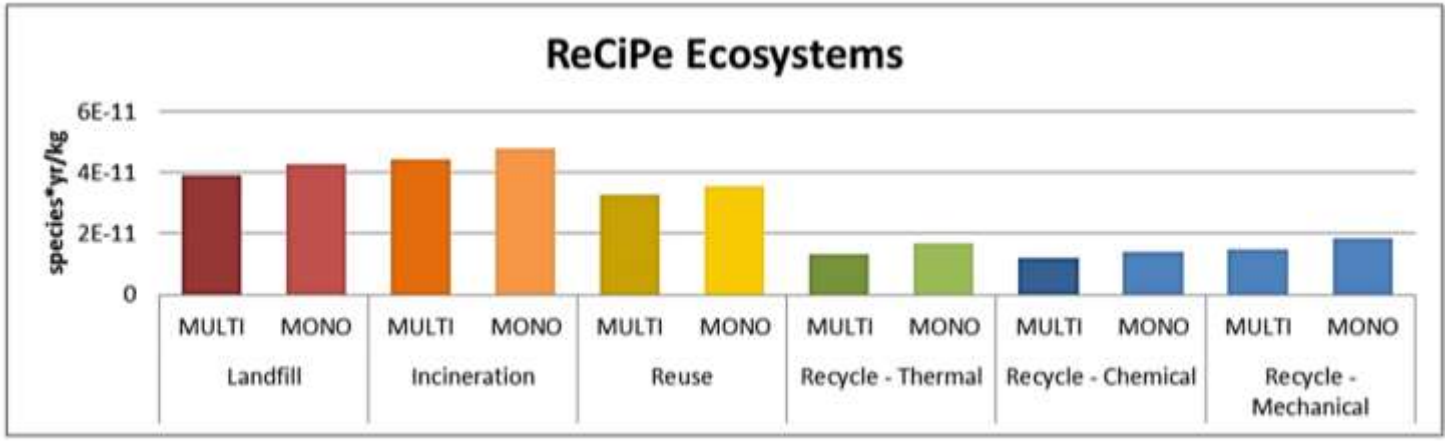
APPROACH AND METHODOLOGY

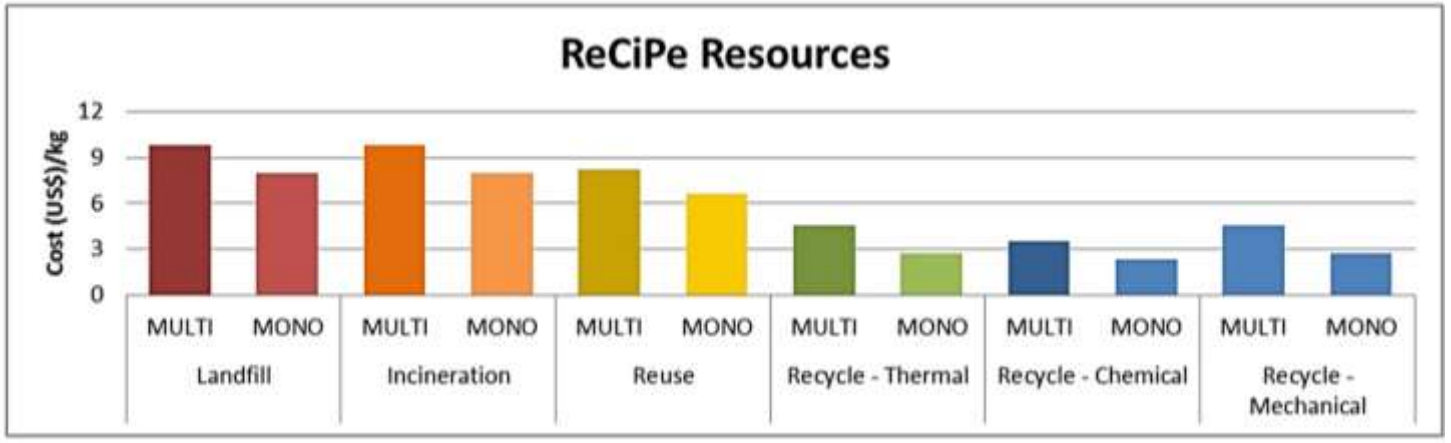


END-OF-LIFE RESULTS

- Recycling and reuse of part of the raw materials: Si, Ag, glass, Al.
- Incineration: the worst impacts.
- Chemical approach: low impacts. But, the use of toxic chemicals should be restricted.
- Reusing: a better option compared to landfill and incineration.
- Some additional aspects should be taken into consideration.





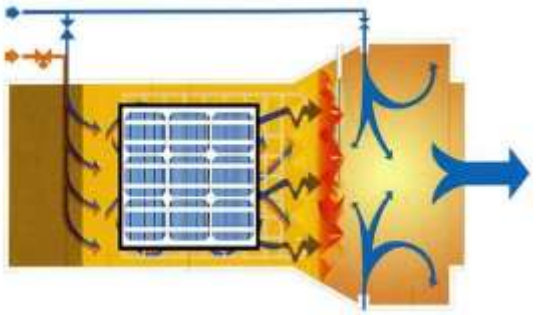


END-OF-LIFE RESULTS

- Transportation can add important impacts to these possible EoL scenarios.
- It depends entirely on the location of the EoL modules and their final destination.
- The data for transport mode and distance is difficult to assess for the general case.

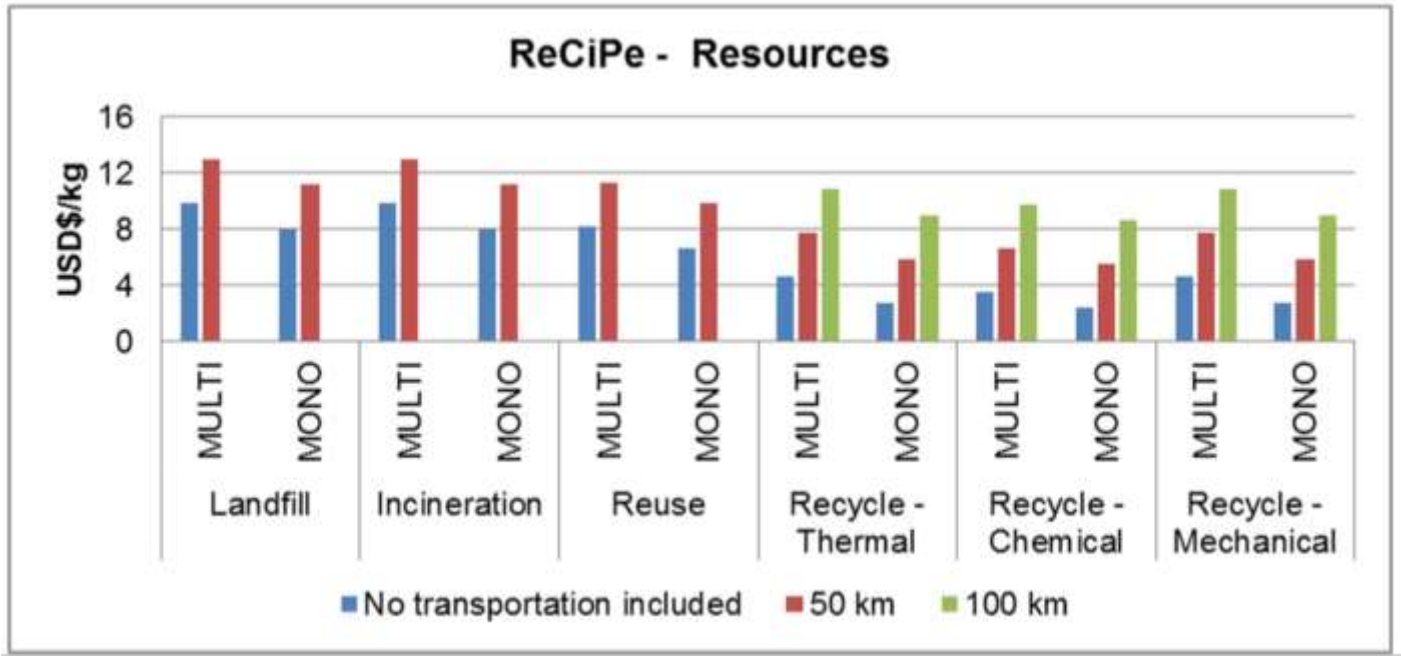
CONSIDERING TRUCK

50 km



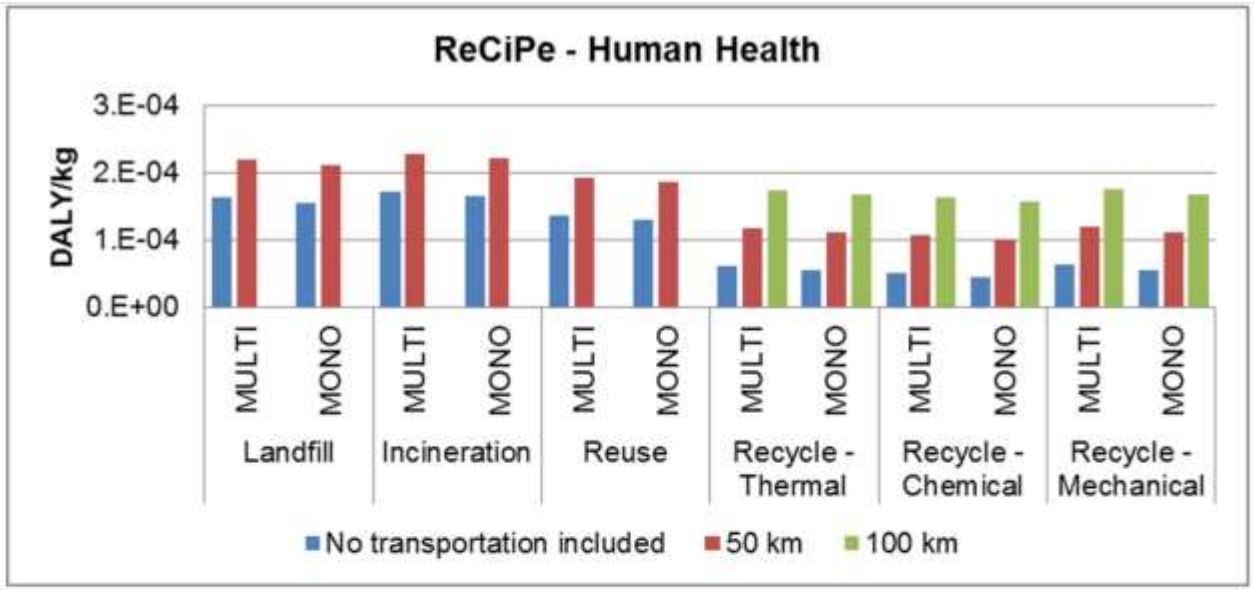
? km

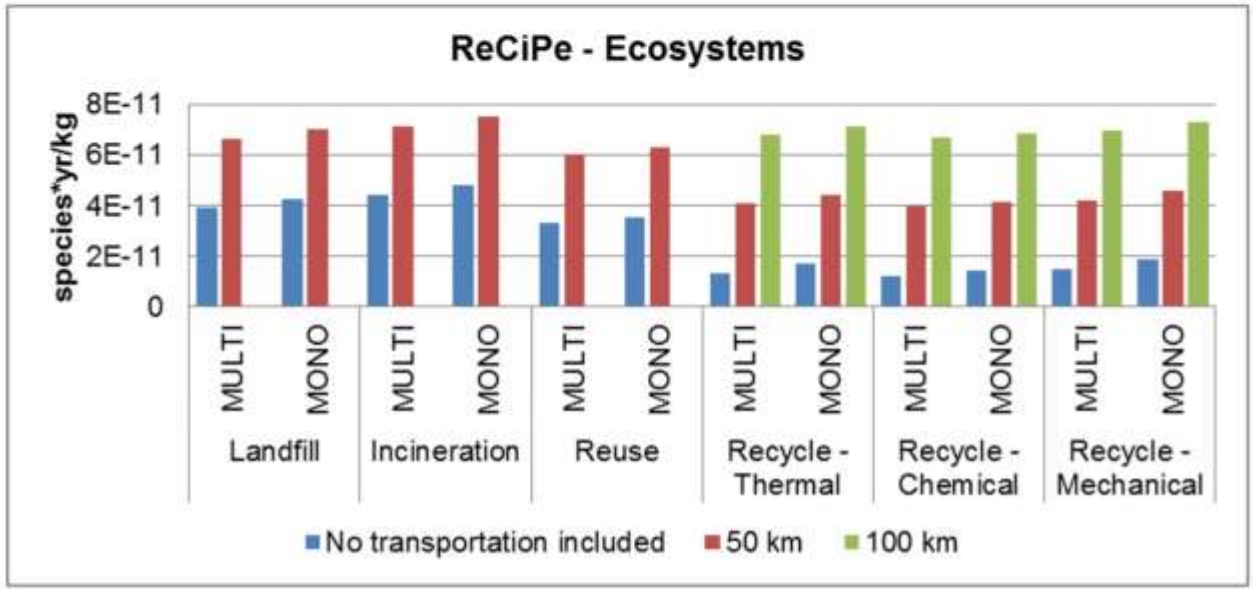
END-OF-LIFE RESULTS



- The environmental impacts are strongly influenced by the transportation process.
- Resources: for the distance of 100 km, the recycling processes are still better environmental options compared with some other choices.

END-OF-LIFE RESULTS





- Human Health and Ecosystems: The PV recycling plant needs to be at most 80 km further away than the landfill and/or incineration, for recycling to have lower impacts.

CONCLUSION

- The results show that recovery of materials from solar modules results in lower environmental impacts when compared with other EoL scenarios.

- These impacts can be even lower with the adoption of more complex recycling processes that can recycle more materials (mostly metals).

CONCLUSION

- Transportation add significant environmental impacts to all scenarios.

- For recycling to be the best option (if landfill/incineration plant is 50 km away) :

  ✓ 80 km (human health and ecosystems ReCiPe)

  ✓ 100 km (resources ReCiPe)

CHALLENGES AND FUTURE WORK

- The PV recycling inventory is still lacking a lot of data.
- More studies are needed in terms of PV recycling development.
- Experiments are being made in order to recover the full Si wafer.

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