ENERGY DEMAND AND GHG EMISSIONS ASSESSMENT OF PV PANELS RECYCLING PROCESS IN SPAIN

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INTRODUCTION

PV power capacity installed will increase considerably in the next decades and sustainability of this source of energy will depend of the end-of-life management of PV panels [1]. It is expected that the high potential environmental benefits (i.e. credits) encourage the consolidation of the circular economy principles in the PV industry. Within this context, the goal of this study was to analysis GHG emissions and primary energy demand of a recycling process of mc-Si PV modules in Spain and to compare it with the manufacturing step.

The process is based on mechanical (disassembly and shredding) and thermal (separation of EVA; with energy recovery) treatments. Aluminium, glass and copper are treated in specific recycling plants, while polymers (back-sheet and junction box) are incinerated for energy recovery. Finally, mc-Si cells recycling have been excluded of this study. Solar cells are disposed in sanitary landfill

MATERIALS & METHODS

Two different assessments have been completed following two approaches on modelling LCI of recycling [2]:

- **Cut-off approach** has been applied to account for the environmental impacts of the process. System boundaries include only the PV recycling process.
- **End-of-life approach** has been applied to account for the environmental benefits. Avoided environmental impacts of primary production are credited.

RESULTS & DISCUSSION

Table 1 shows that GHG emissions and primary energy demand of recycling process are irrelevant in comparison with manufacturing process.

Most of total GHG emissions are due to thermal treatment of EVA. Relevant contribution of transport can be observed in both categories in spite of short distances considered. Energy recovery due to EVA incineration contributes to reduction the primary energy demand of the process (Table 2).

Through the system expansion boundaries and including the recycling processes of materials (i.e. avoided impacts of primary production) potential environmental benefits are observed. Figure 2 displays reduction of GHG emissions and primary energy demand of the mc-Si PV modules life cycle due to recycling integration.

CONCLUSIONS & FUTURE DEVELOPMENTS

Recycling of PV modules is technical and environmentally workable and this process can decrease GHG emissions and primary energy demand of PV modules life cycle.

Exhaustive analysis of transport contribution would be carrying out because a lot of uncertainties related to distances. Finally, integration of semiconductor recycling phase can improve net environmental benefits thank to recovery of valuable materials.

REFERENCES

[1] IRENA and IEA-PVPS (2016). End-of-life management: Solar Photovoltaic Panels. International Renewable Energy Agency and Energy Agency Photovoltaic Power Systems

[2] Frischknecht R. (2010). LCI modelling approaches applied on recycling of materials in view of environmental sustainability, risk perception and eco-efficiency. Int J Life Cycle Assess, 15(7), pp. 666-671

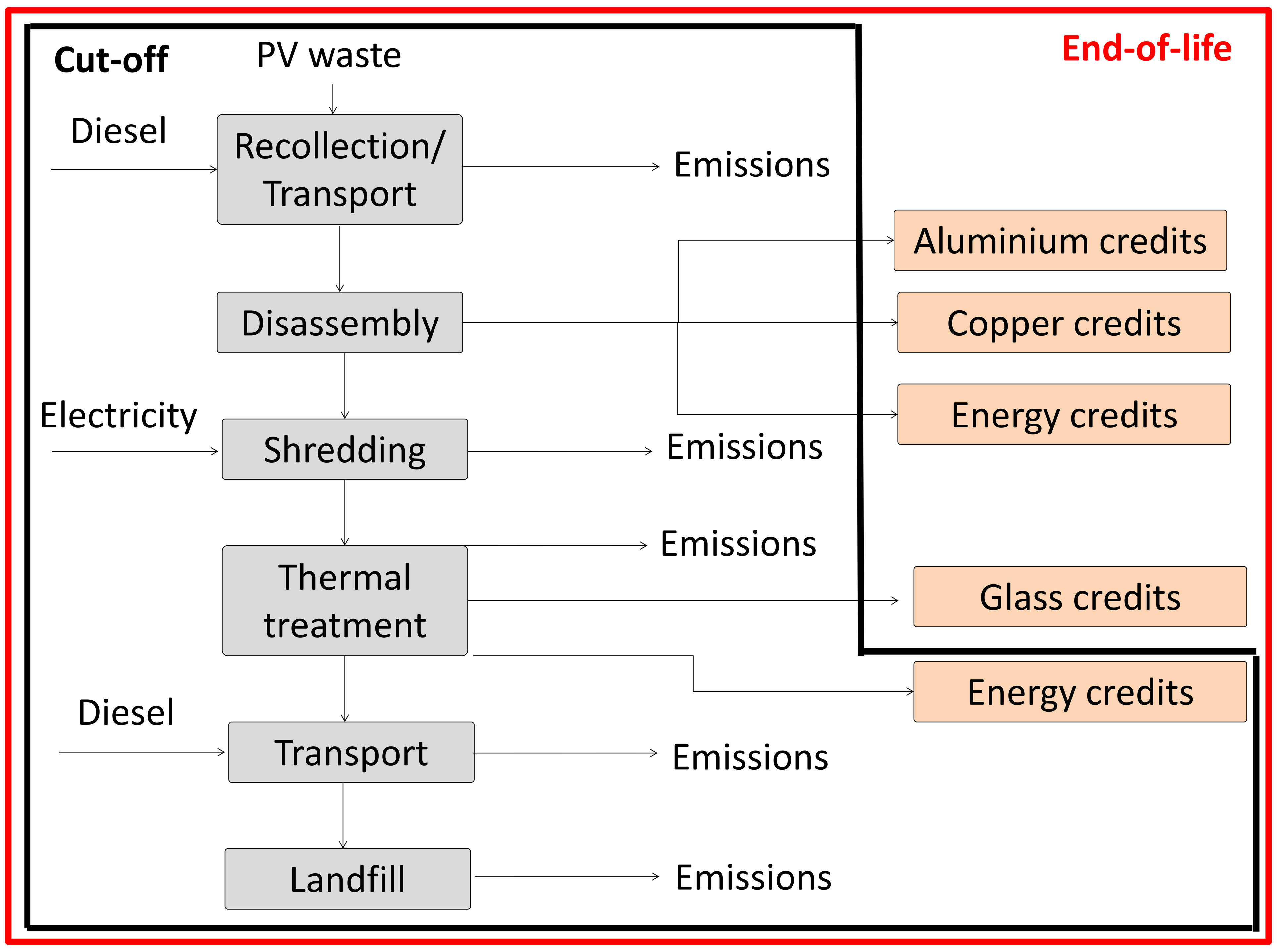

Figure 1. *System boundaries of the LCA of recycling process of mc-Si PV panels according to both approaches (recycling processes of aluminium, copper, glass and polymers are included in credits)*

Table 1. Comparison of GHG emissions and primary energy demand between manufacturing and recycling process of 1000 kg mc-Si PV panels *(cut-off approach)*

		Manufacturing	Recycling	% total
GHG emissions	kg CO_{2eq}	2,48E4	1,67E2	0,68%
Primary Energy Demand	MJ	3,83E5	3,69E2	0,1%

Table 2. *Relative contribution of each step to the total GHG emissions and primary energy demand of the recycling process of 1000 kg mc-Si PV panels (cut-off approach)*

	Transport	Shredding	Thermal treatment	Landfill
GHG emissions	13%	26%	52%	10%
Primary Energy Demand	20%	35%	-39%*	6%

** negative contribution indicates energy recovery during thermal treatment*

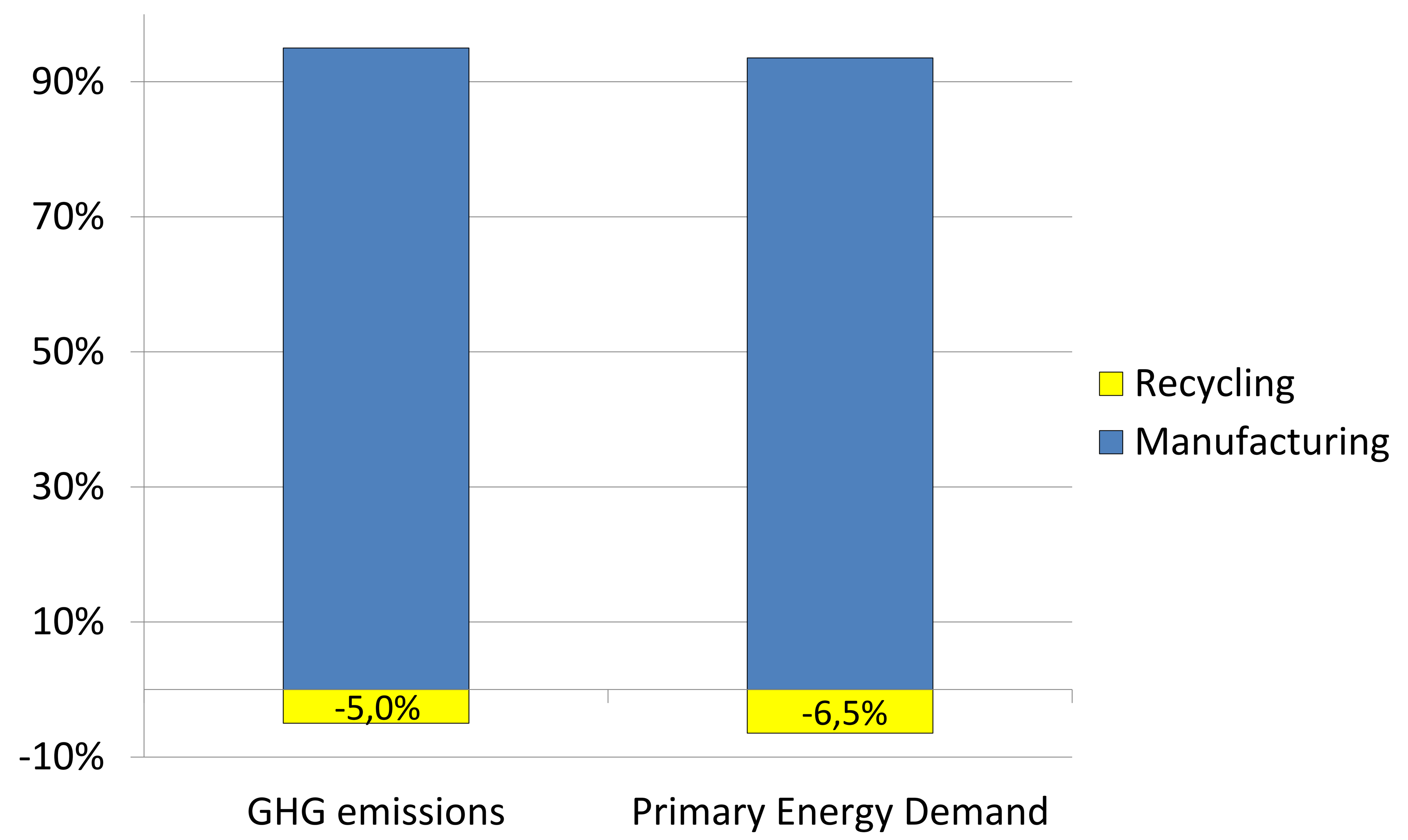

Figure 2. *Relative contribution of the recycling process of 1000 kg mc-Si PV panels to the panels life cycle (end-of-life approach)*

**negative contribution indicates net environmental benefits due to difference between environmental impact of secondary and primary production*

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27–28 November 2017 I Barcelona, Spain

Organised in cooperation with the International Life Cycle Academy