Technical Appendix: Life Cycle Assessment of Solar Lamps

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Authors: Ashima Rajput, Dr Cara Tobin Greene, Sonja Schmid

I. Description

This study uses an earlier study on the environmental impact of solar lanterns conducted by the EPFL EssentialTech Centre as part of a larger project to calculate GHG emissions of activities in displacement settings for the UNHCR.

The objective of this study is to identify key levers to reduce the impact of solar lamps and establish GHG emission factors for the solar lamps currently in the humanitarian supply chain.

The ICRC updated their solar lamp to fulfil the same functions for their beneficiaries with higher longevity and reduced volume – so that more kits can be shipped with the existing infrastructure. This study assesses the change in environmental impact from the older version of the kit to the newer version for the function of a longer lifespan.

The functional unit of this study is 6 years of use of a solar lamp.

II. Methodology

Life Cycle Assessment is a standard methodology used to estimate the potential environmental impacts linked to the entire life cycle of a product or system (ISO 14040, 14044, 14067). The scope in this study is a cradle-to-grave system boundary for the assessment of impact across the complete life cycle named as follows:

- Raw Material
- Production
- Supply & Distribution
- Use
- Waste Management

To perform these studies, data from the Ecoinvent 3.11 cut-off system model is used, which allocates the entire impact of the material to its primary user without any 'rewards' for its potential for being recycled. The results are calculated following the Environmental Footprint 3.1 indicator system in the below categories:

- Climate Change: Global Warming Potential (GWP100)
- Impact on Human Health:
  - Human Toxicity: Carcinogenic and Non-carcinogenic
  - Ionising Radiation
  - Particulate Matter Formation
  - Photochemical Oxidant Formation

The impact on human health results are weighted using the approach detailed in the EF methodology – with a percentage assigned to each sub indicator, as well as normalized for one citizen so as to aggregate and represent as a single score.

III. Key Parameters & Assumptions

Below are the parameters of the old and new solar lamps

LIFE-CYCLE STAGE	PARAMETER	DESCRIPTION OF MODEL
Raw Material	Bill of Materials	Old lamp: 670g net weight; New lamp 564g net weight Polypropylene, PV Panel, LED, PCB, Metal Frame, Wiring, etc.
	Packaging	Cardboard box, paper wrapping
Production	Manufacturing Location	China
Supply & Distribution	Transport Chain	Trucked to port (500 km) Shipped to African DCs (10,000 km)

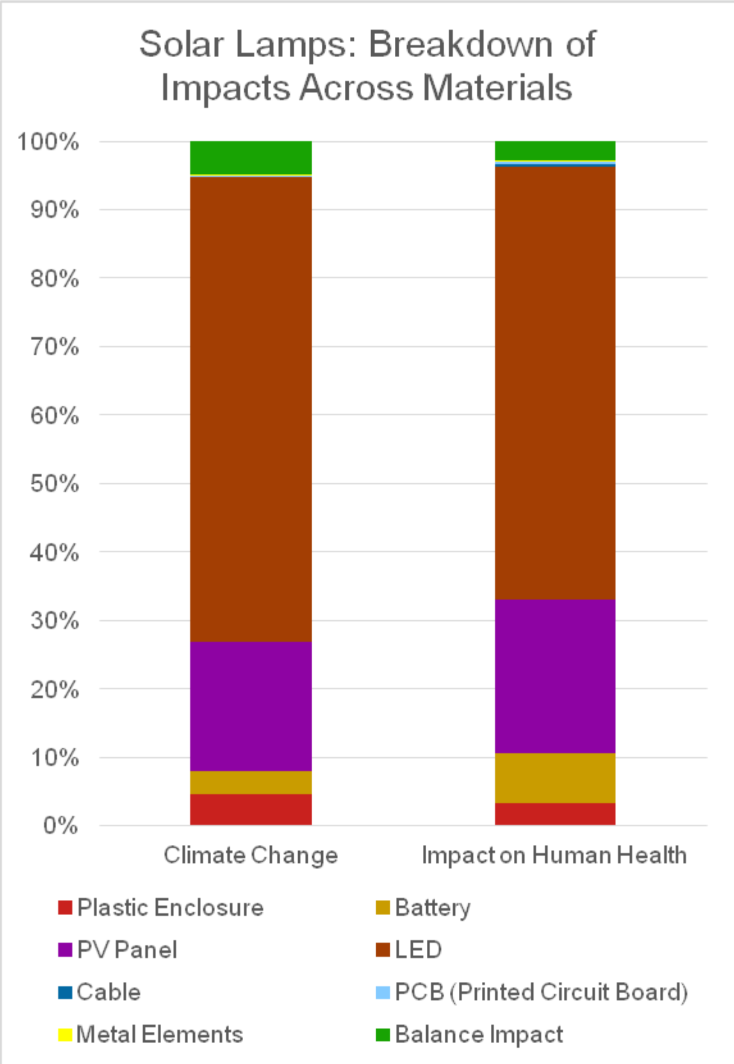
		Trucked for warehousing (500 km) & distribution (1500 km)
Use	Utilization	N/A
	Usage Processes	N/A
Waste Management	Product Disposal Method	Unsanitary Landfill
	Packaging Disposal Method	Open Dumping

The components are as below:

- Plastic Enclosure
- Battery (Li-ion)
- PV Panel
- LED
- Cable (modelled as copper)
- PCB (Printed Circuit Board)
- Metal Elements (modelled as steel and aluminium)

IV. Results & Discussion

As there was a very slight shift in net weight between the old and new lamp, the impacts remain very similar when compared without a function. Raw materials account for 95% of the total GHG emissions and 97% of the total human health impact associated with the solar lamp. Among these materials, the LED component contributes disproportionately to the impact—68% of total climate change impact and 63% of human health impact—despite weighing only 47g out of the total 564g. This is due to the impact-intensive production process of the LED. The second-largest contributor is the photovoltaic cell of the solar panel, responsible for 19% of GHG emissions and 23% of the human health impact.

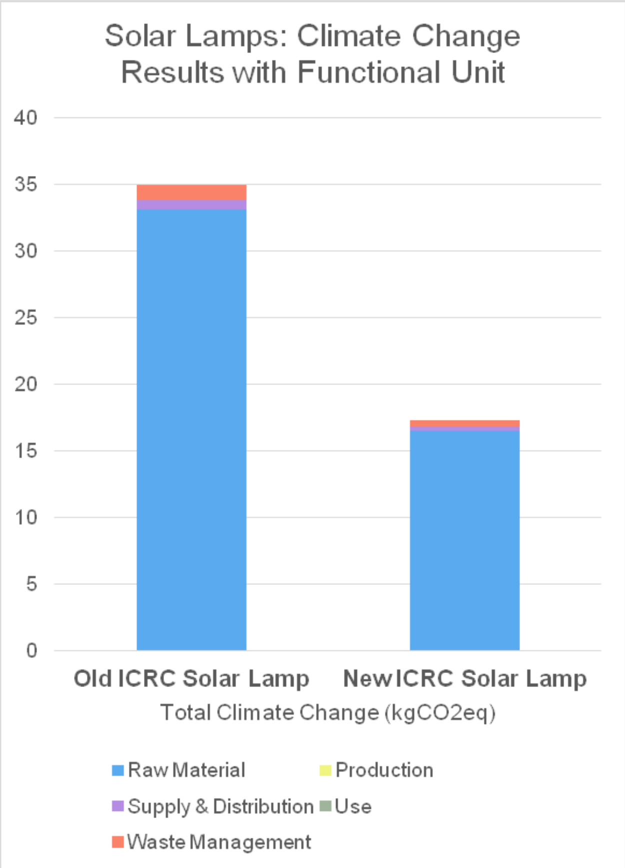


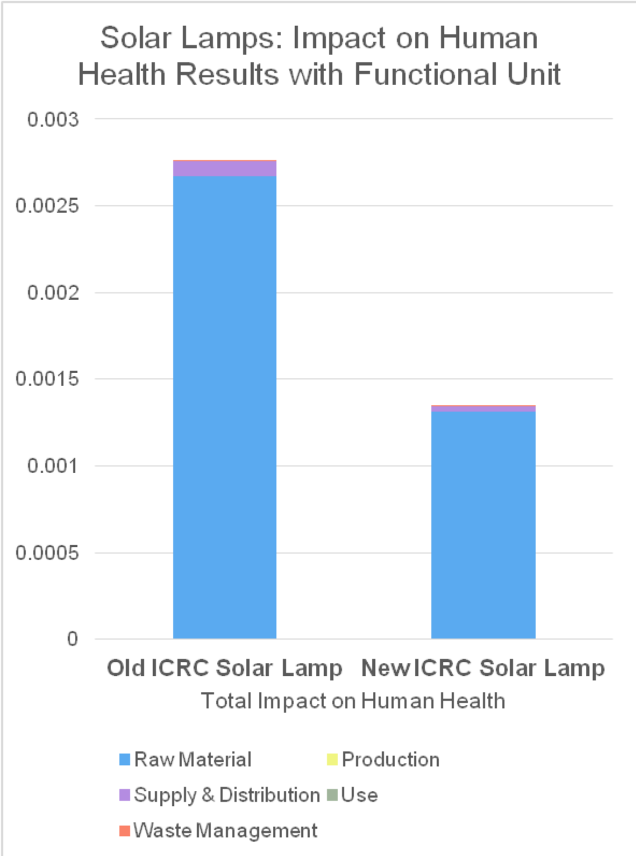
Greenhouse Gas (GHG) Emission Factors: New Solar Lamp

Name	GHG Protocol Category	kgCO2eq/unit
Cradle-to-grave	N/A	17.27
Cradle-to-gate	3.1 Purchased Goods	16.50

Greenhouse Gas (GHG) Emission Factors: Old Solar Lamp

Cradle-to-grave	N/A	17.48
Cradle-to-gate	3.1 Purchased Goods	16.55





By improving the durability of key components, such as the battery, and doubling the lifespan of the solar lamp, the environmental impact is linearly reduced when evaluated against the function of providing household lighting for the same duration.

Using a functional unit of 6 years, the previous solar lamp model—which lasts only 3 years—has twice the impact of the new, longer-lasting version.

More precisely a 50.61% reduction in climate change and 50.80% reduction in human health.

V. Conclusion

By increasing the durability of the components and extending the lifespan of the solar lamp, the impact of the solar lamp reduces linearly as the durability is increased. In this case, doubling the lifespan results in reduction of

- 50% climate change

- 50% impact on human health

The impacts to local environment due to the disposal of the components must be further studied to expand on this result.

VI. Bibliography

Rajput, A., Tobin Greene, C. and Schmid, S. (no date) 'Life Cycle Assessment (LCA) Methodology'. Available at: https://climateactionaccelerator.org/wp-content/uploads/2025/06/EPFL_LCA_methodology_v1.0.pdf.