Technical Appendix: Life Cycle Assessment of Plastic Mattresses

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I. Description

The objective of this study is to establish GHG Emission Factors for polyurethane foam mattresses adapted to the humanitarian context, and analyse the environmental impact of the product's life cycle to identify key levers for impact reduction by studying potential variations.

PU mattresses are heavy and therefore procured and distributed locally. The specifications of the mattress used in the humanitarian contexts vary vastly from a typical western mattress (e.g. ~3 kg instead of the otherwise ~30kg) and therefore the study uses Ecoinvent processes for this product with updated proportions of sub-processes and materials to accommodate this specification.

The functional unit of this study is 10 years of use.

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

The parameters of the baseline mattress are as follows

LIFE-CYCLE STAGE	PARAMETER	DESCRIPTION OF MODEL

Raw Material	Bill of Materials	High density virgin polyurethane foam (2.80kg net weight)
	Packaging	Plastic, wood, steel and cardboard (total 400g net weight)
Production	Manufacturing Location	Local to warehouse & distribution location (i.e. within 500 km)
	Manufacturing Processes	Standard production
Supply & Distribution	Transport Chain	TRUCK local material procurement (500 km) TRUCK from warehousing to distribution (500 km) TRUCK disposal transport for mattress (100 km)
Use	Lifespan	10 years
	Usage Processes	Assumed to not be washed (field context of resource scarcity)
Waste Management	Product Disposal Method	Open burning
	Packaging Disposal Method	Open dumping

IV. Scenario Rationale

a. Raw Material

The various materials involved in the mattress production process in Ecoinvent are used as inputs in this study – after adjustment for the changed weight.

As an alternative to virgin polyurethane foam, a scenario is considered where waste polyurethane foam is washed and used in the mattress production process.

Two sub-scenarios are considered for this case – waste PU mattress that retains the lifespan of 10 years; and a third scenario where the products lifespan is reduced to 8 years as a result of this process.

b. Production

The process mattress production contain certain market energy consumptions, which were replaced with solar energy to map the potential reductions.

Note: modelling for solar energy was done by replacing the average (market) energy supply with a multi-Si flat-roof photovoltaic source from Ecoinvent to see an “maximum reduction” scenario, the results of this scenario are likely to be different from a real-life installation due to the variations in solar technology, losses, etc.

c. Use

No scenarios were treated for this stage beyond the change of lifespan due to material as stated above.

d. Supply & Distribution

No scenarios were treated for this stage.

e. Waste Management

Two alternative end-of-life methods were considered in this study: municipal incineration and sanitary landfill (moist infiltration class).

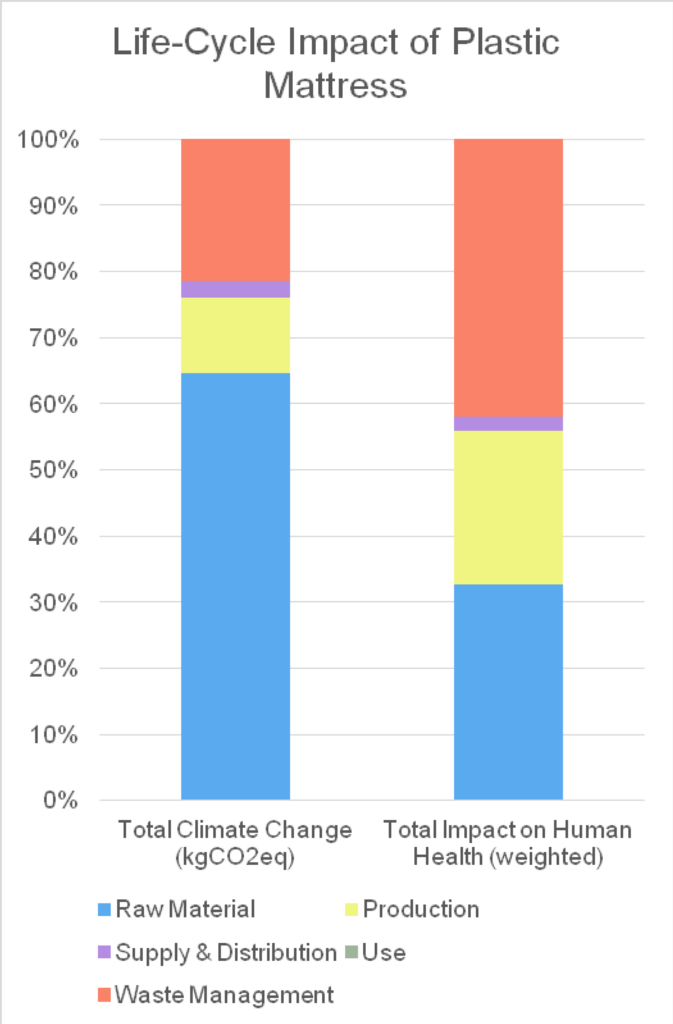
V. Results & Discussion

Considering a lifetime of 10 years, the raw material of the mattress accounts for 65% of the total GHG Emissions and 33% of the total impact on human health

Waste management has a considerable impact on human health, accounting for 42% of the total impact, which it is the second largest share of GHG emissions at 21%

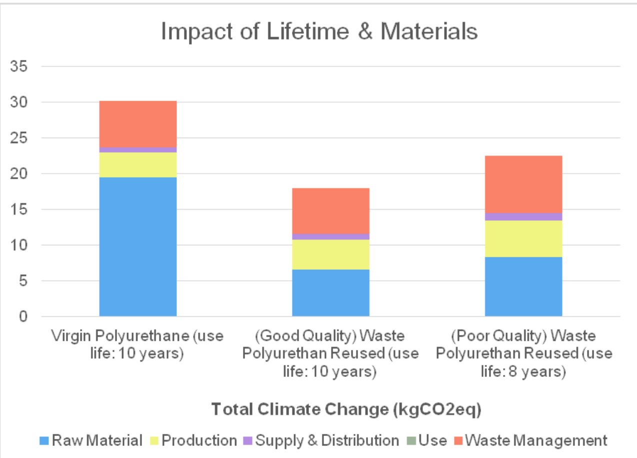
Greenhouse Gas (GHG) Emission Factors

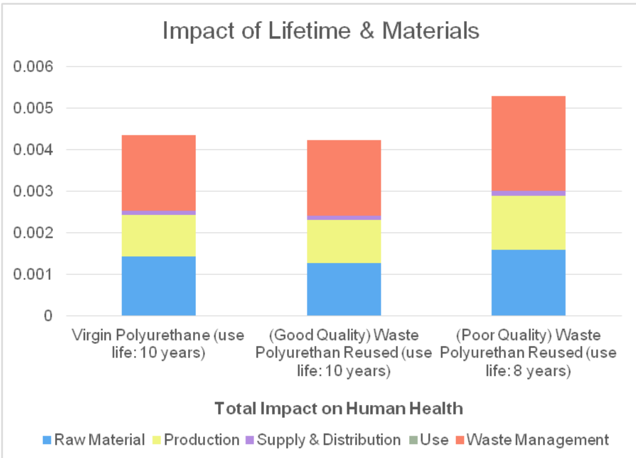
Name	GHG Protocol Category	kgCO2eq/unit
Cradle-to-grave	N/A	30.11
Cradle-to-gate	3.1 Purchased Goods	22.89



V..Results By Category

Raw Material



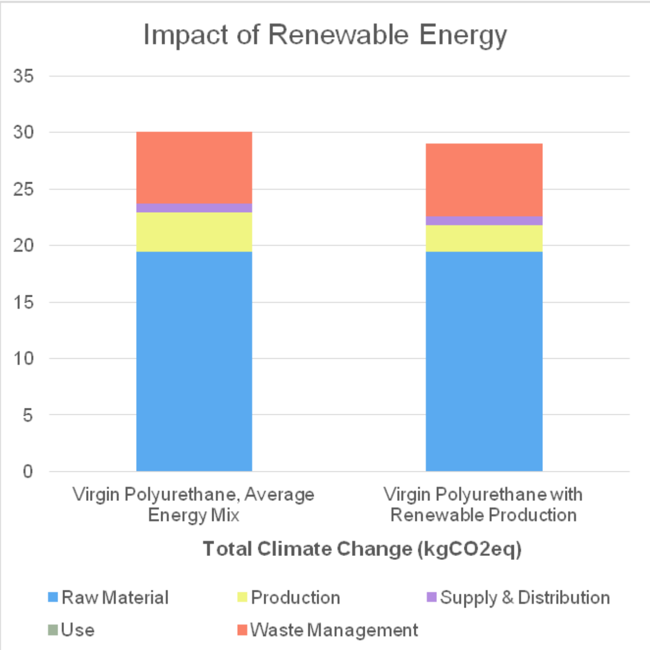


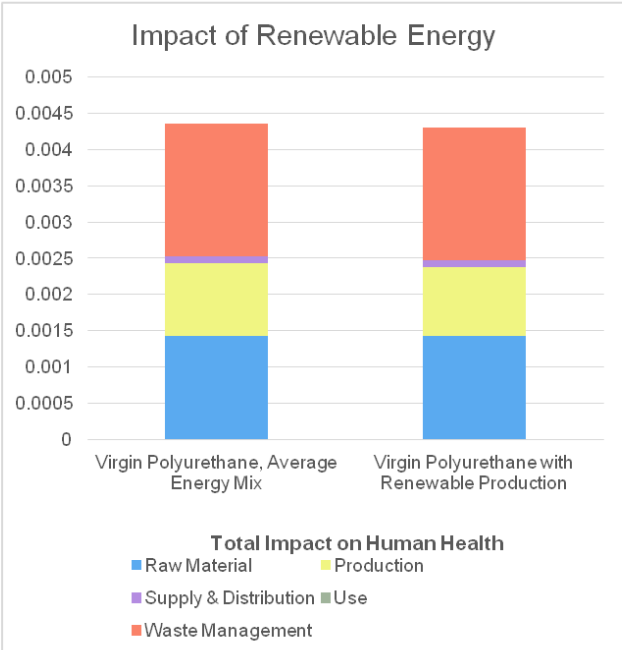
This study models scenarios where waste polyurethane foam is used to replace virgin polyurethane foam for the manufacturing of the mattress. Changing this material reduces the GHG emissions at raw material stage by around 65%, but only reduces the impact of human health by around 11%

The waste foam first needs to be washed/sanitised before it can be used, the modelling of which increases the impact at production, and therefore results in an overall impact reduction of 40% in GHG emissions and 3% in impact on human health – if the quality of the mattress is maintained.

If the mattress has a reduced lifespan due to the use of waste foam – here assumed as a lifespan of 8 years instead of 10 – the overall impact is 25% lower in GHG emissions, however the impact on human health in this case increases by 21%

Energy Supply

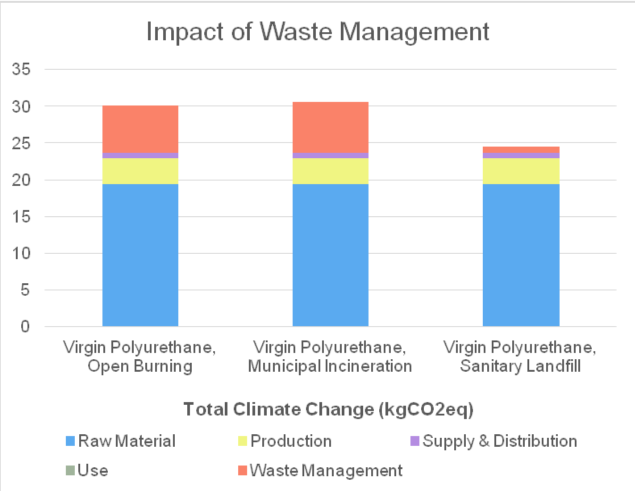


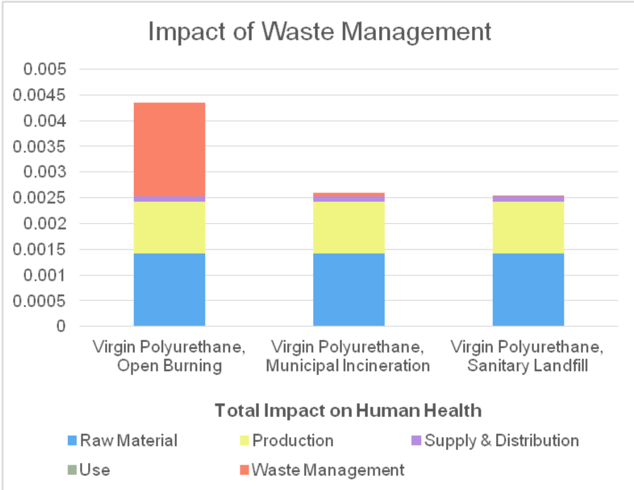


Apart from recycled materials and waste management, this study also assessed the replacement of the average electricity mix during production with solar panels. The resulting change in emissions is very small, a 4%/1% reduction in GHG emissions/impact on human health respectively.

This is mainly due to the fact that other stages like raw material, are responsible for a very large portion of the overall environmental impact, especially GHG emissions

Waste Management

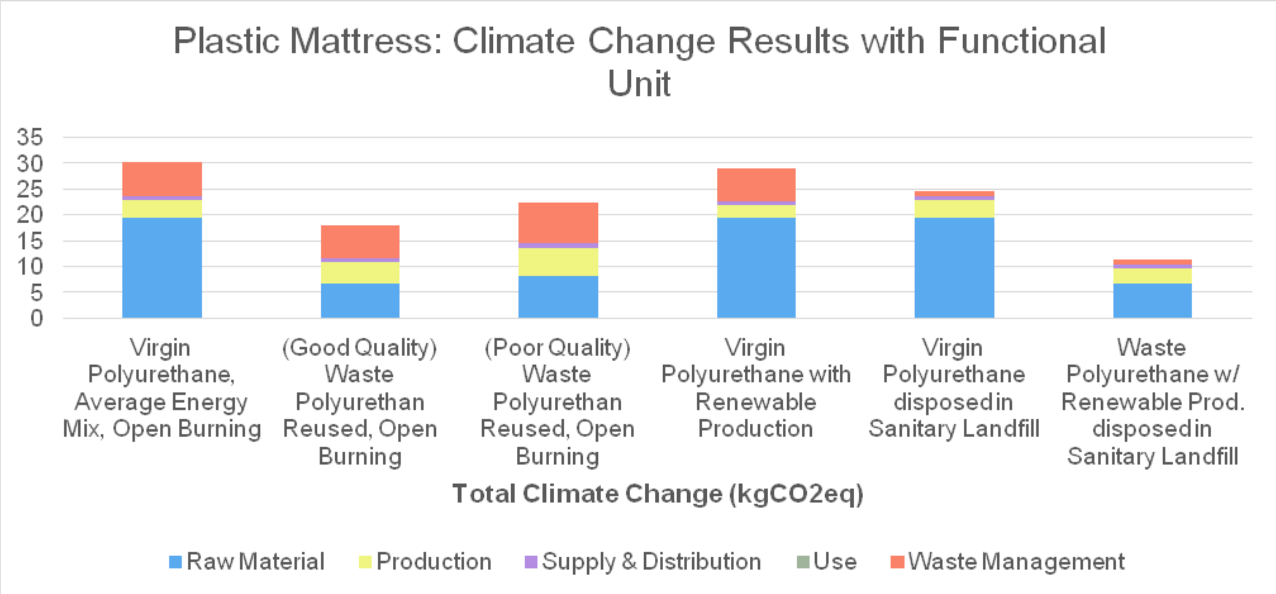


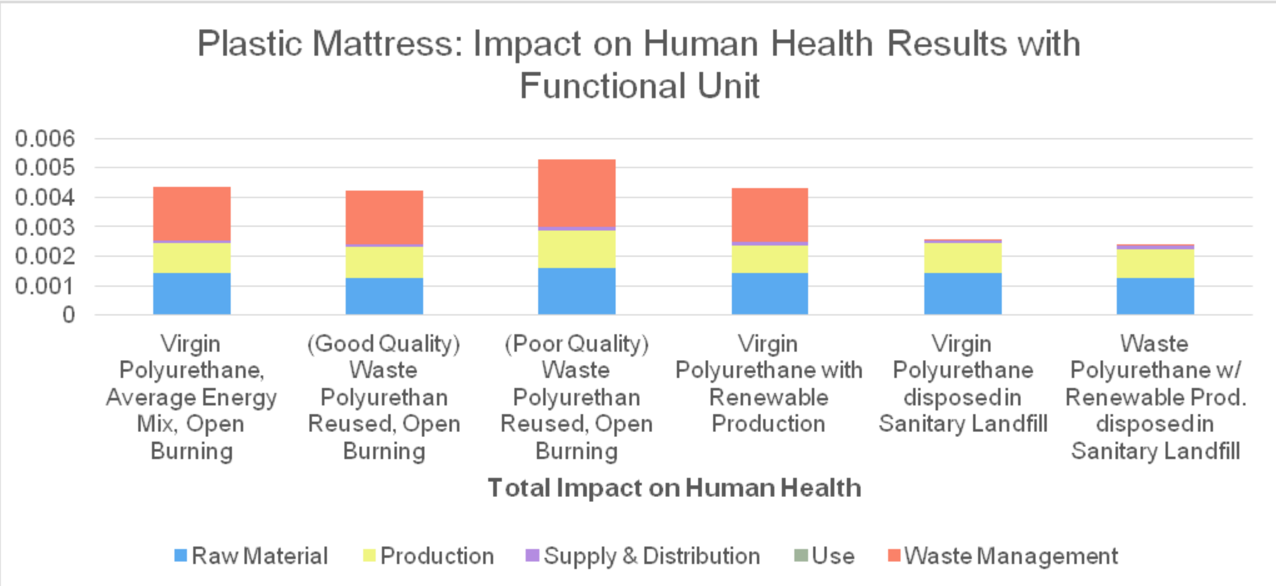


Burning plastic waste in a municipal incineration plant rather than openly will not reduce GHG emissions but will reduce impacts on human health if the plant has the adequate filters. In this case, GHG emissions actually increase by 2% when switching to municipal incineration, but the impact on human health reduces by 40% overall.

There is a significant reduction in GHG emissions when moving from municipal incineration to sanitary landfill, however the impact on human health is similar. An overall reduction of 18%/41% in GHG emissions/impact on human health can be seen when comparing open burning to sanitary landfill, making sanitary landfills the preferred waste management method within the scope of the LCA

VI. Conclusion





Recycled materials and better waste management contribute the most to the impact reduction of the plastic mattress, with a strong dependence on quality and durability of the mattress

For GHG emissions it is more pertinent to focus on reducing the impact on the primary raw material: virgin polyurethane foam

For impact on human health, the waste management methods make a more significant impact on the overall impact of the mattress

Combining recycled materials, renewable energy, and better waste management account presents the below impact reduction:

- 62% climate change
- 46% impact on human health

VII. 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.

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