Life Cycle Assessment of High-thermal Synthetic Blankets

Project: Accelerating the Reduction of the Environmental Impact of Humanitarian Action

Version 1.0, 20.06.2025
Authors: Ashima Rajput, Dr Cara Tobin Greene, Sonja Schmid

Science and Technology for Humanitarian Action Challenges (HAC)

Project website: https://climateactionaccelerator.org/accelerating-the-reduction-of-the-environmental-impact-of-humanitarian-action/

EPFL | EssentialTech Centre   LEURE   ICRC   Climate Action Accelerator

Contents

1 Objective and scope

2 Methodology

3 Key Parameters & Assumptions

4 Impact Assessment

5 Conclusion

Introduction

Objectives and scope

This analysis aims to enhance understanding of the item's impacts on climate, human health, and plastic leakage. It also identifies potential levers to reduce these impacts. However, assessing the feasibility of implementing these levers falls outside the scope of this project.

By no means is it suggested that life-saving assistance to the most vulnerable populations across the world should be reduced for decarbonisation purposes. Effective emissions and other impact reductions should not result in any reduction in the quality, quantity or timeliness of assistance, but rather should explore ways to reinforce or maintain aid, while identifying low-carbon, sustainable, and resilient alternative options.

Objectives and scope

Objectives:

- Establishing GHG Emission Factors for **high-thermal synthetic blankets** adapted to the humanitarian context
- Analysing the environmental impact of the product's life cycle and identify key levers for impact reduction by studying potential variations.

Scope & System Boundaries:

- **Cradle-to-grave*** system for the assessment of impact across the complete life cycle.
  - The materials, production, distribution, use and disposal of the product are in scope of the study
  - Any additional processes after production are not in scope e.g. unplanned storage, etc.
  - The procurement of the packaging is modelled, upstream activities related to the packaging are out-of-scope
  - The study focuses on one unit of the product and does not include larger-scale supply activities i.e. shipping per container, etc.

*In life cycle assessment, **cradle-to-grave** refers to evaluating a product's environmental impacts from raw material extraction through manufacturing, use, and final disposal. In contrast, **cradle-to-gate** focuses only on the stages up to the product's departure from the manufacturing site, excluding use and end-of-life phases.

Methodology

The results are calculated following the Environmental Footprint 3.1 indicator system in two 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
  - Weighted using the approach detailed in the EF methodology – with a percentage assigned to each sub indicator (see reference)
  - Normalized for one citizen so as to aggregate and represent as a single score for human health

Plastic leakage: Experimental projection of the amount of plastic leaked into nature via mismanagement of waste

References:
"European Platform on LCA | EPLCA.". https://eplca.jrc.ec.europa.eu/EnvironmentalFootprint.html
Joint Research Centre (European Commission), Alessandro Kim Cerutti, Rana Pant, and Serenella Sala. 2018. Development of a Weighting Approach for the Environmental Footprint. Publications Office of the European Union. https://data.europa.eu/doi/10.2760/945290

End-of-life

This study aims to model the impact differences between various waste management methods tailored closer to humanitarian contexts. The following end-of-life options were modelled in the analysis, as appropriate:

- **Open dump** (unmanaged)
- **Open burning** (unmanaged)
- **Unsanitary landfill** (minimal management)
- **Sanitary landfill** (managed site)
- **Municipal incineration** (managed plant)
- **Recycling** (as modelled)

For plastics, the differences in measured impact between each end-of-life scenario are similar. (For more info on the impacts and sources of end-of-life impact measurement please see annex.)

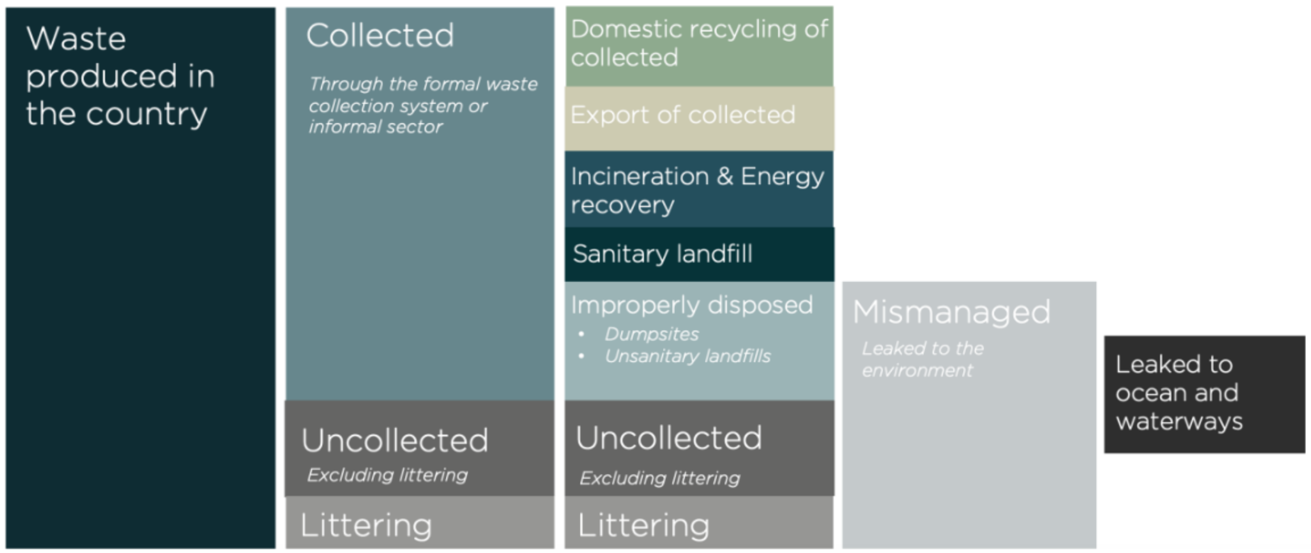
According to the LCA methodology, the analysis of greenhouse gas (GHG) emissions (Global Warming Potential)—is limited to a 100-year timeframe. As a result, any additional impact from plastic degradation in landfills occurring beyond this period is neither measured nor compared to other waste disposal methods.

Plastic leakage

This project aims to estimate the mismanaged waste that may occur at the end of life of products distributed by humanitarian organisations.

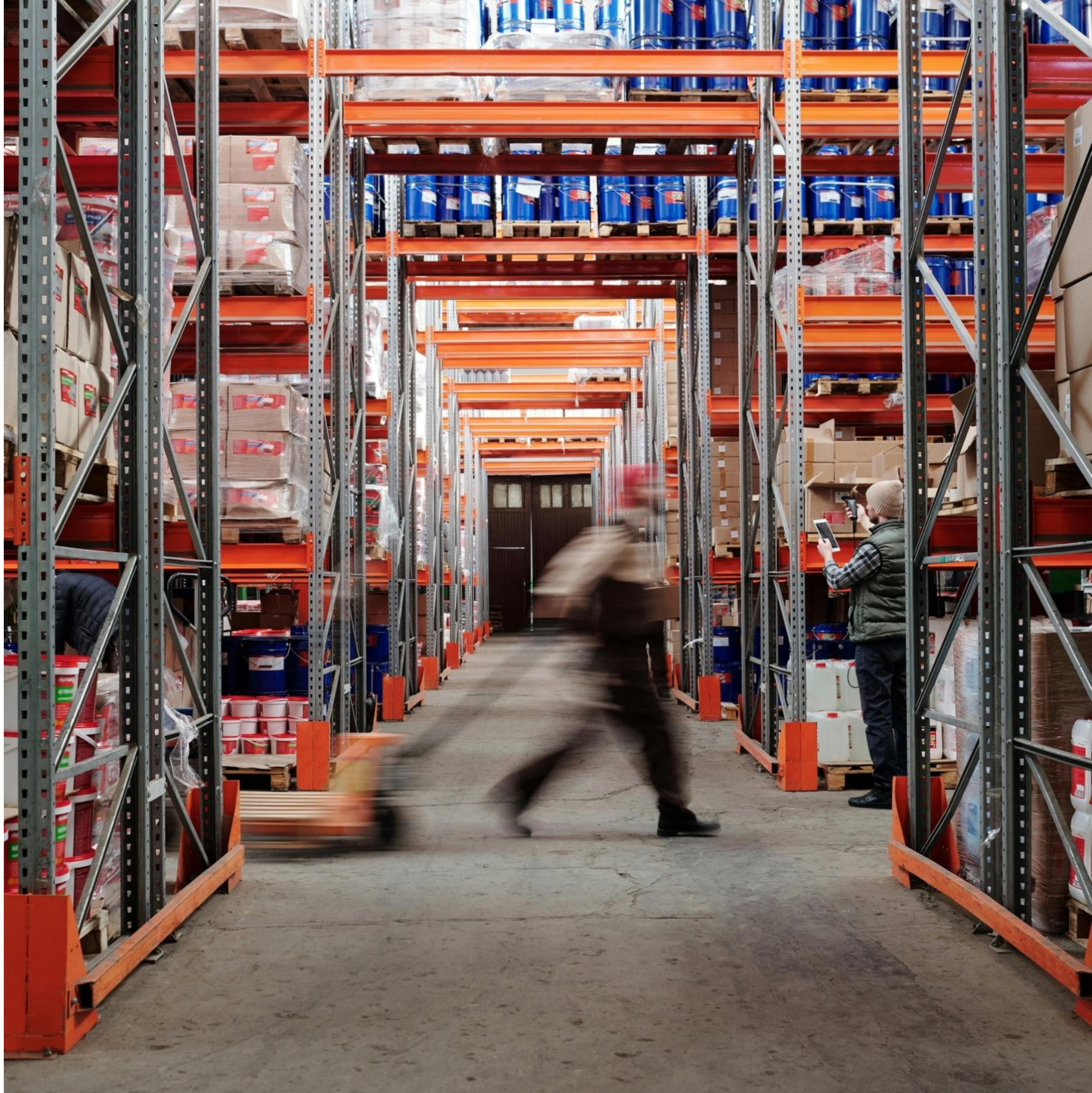
The modelled scenarios are analysed for plastic leakage by selecting the waste management method that is modelled and calculating the projected leakage (or lack thereof) due to the same.

For more information, please refer to: "Global Plastic Environmental Analytics Platform." Plasteax. https://plasteax.earth/.



Source: EA – Earth Action

LCA Results



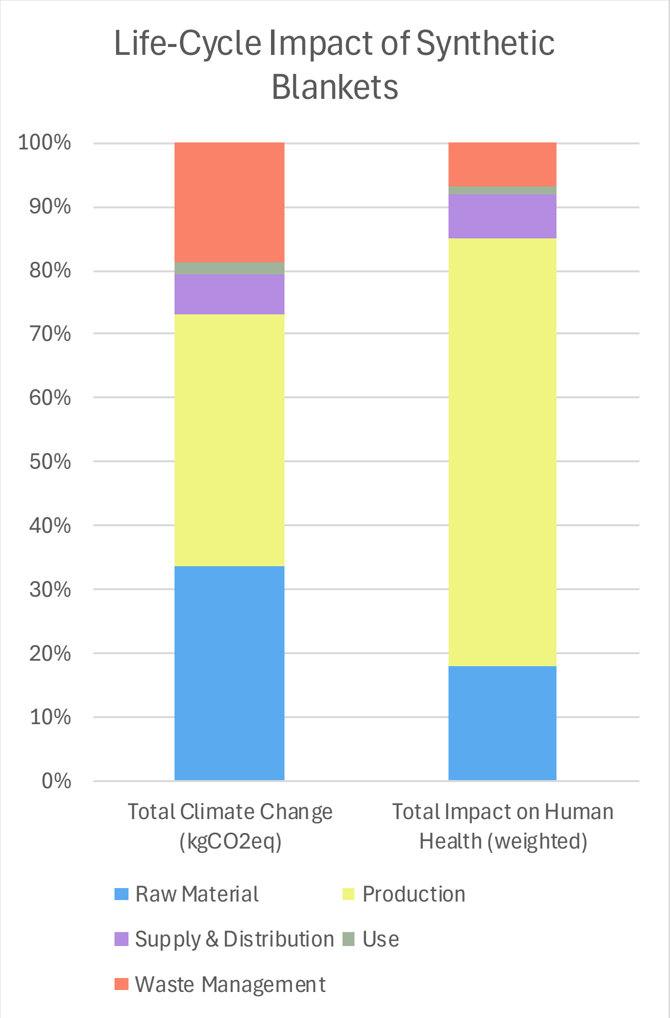
Key Product Parameters & Assumptions

LIFE-CYCLE STAGE	PARAMETER	DESCRIPTION OF MODEL
GENERAL	Field Context	The primary function is providing warmth but in humanitarian contexts it is known that people don't just use the blanket to sleep, they use it as shelter, clothing, etc and use it roughly and longer.
Raw Material	Bill of Materials	Virgin Polyester from PET granulate (2kg net weight)
	Packaging	LDPE Packaging Film (70g per blanket)
Production	Manufacturing Location	Panipat, India
	Manufacturing Processes	Polyester fibre production; fabric production; colouration & treatment, finishing laundry
Supply & Distribution	Transport Chain	TRUCK – SEA – TRUCK (to DC) TRUCK from DC to distribution
Use	Lifespan	5 years
	Usage Processes	Hand washed once a year
Waste Management	Product Disposal Method	Open burning in pits (100 km transport)
	Packaging Disposal Method	Open dumping (10 km transport transport)

Baseline Results

- The production of the blanket accounts for **40%** of the GHG emissions and is the main source of impacts on human health **(67%)**
- Raw material is the second largest source of impact with **34%/18%** GHG emissions/impact on human health respectively
- Open burning at end-of-life accounts for **19%/7%** GHG emissions/impact on human health respectively
- Plastic leakage
  - It is assumed that the product is incinerated, thereby avoiding leakage.
  - The packaging is assumed to be dumped/littered causing leakage for all scenarios.

Emission factors		Unit
Cradle-to-grave	23.38	kgCO2eq/unit
Cradle-to-gate	17.08	kgCO2eq/unit

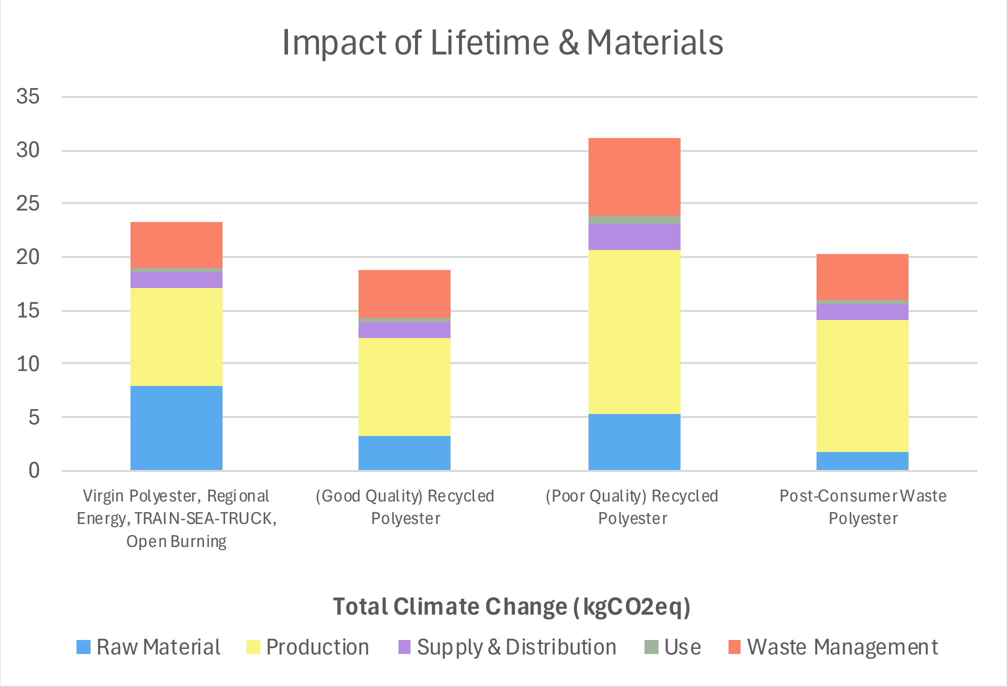


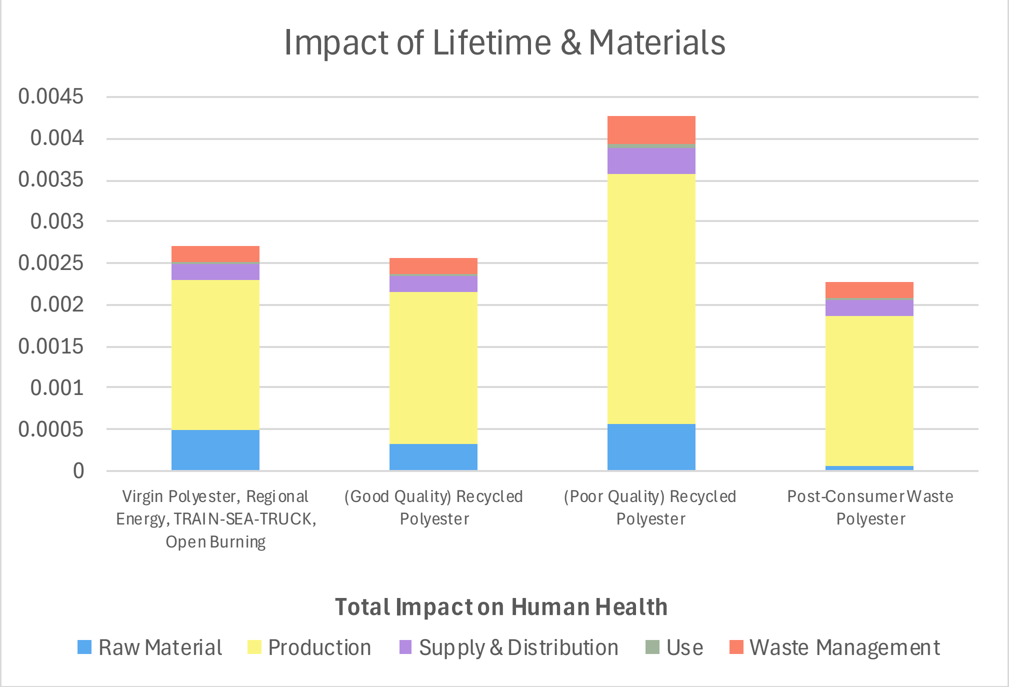
Variations per lifecycle stage

Functional Unit: 5 years of use of a blanket

	Raw Material	Production	Use Life	Supply & Distribution	Waste Management
Baseline	Virgin Polyester	Regional energy mix	5 years, one hand wash per year	TRAIN-SEA-TRUCK	Open burning
	Good quality recycled Polyester	Solar Energy for Electricity + Heat	3 years, one hand wash per year	TRUCK-SEA-TRUCK	Sanitary Landfill
	Poor quality recycled Polyester	Solar Energy for Electricity, Natural Gas for Heat		TRUCK-AIR-TRUCK	Municipal Incineration
	Post-consumer Waste Polyester	Regional heat mix, Solar Energy for Electricity			
		Regional electricity mix, solar energy for heat			

Lifetime & Materials

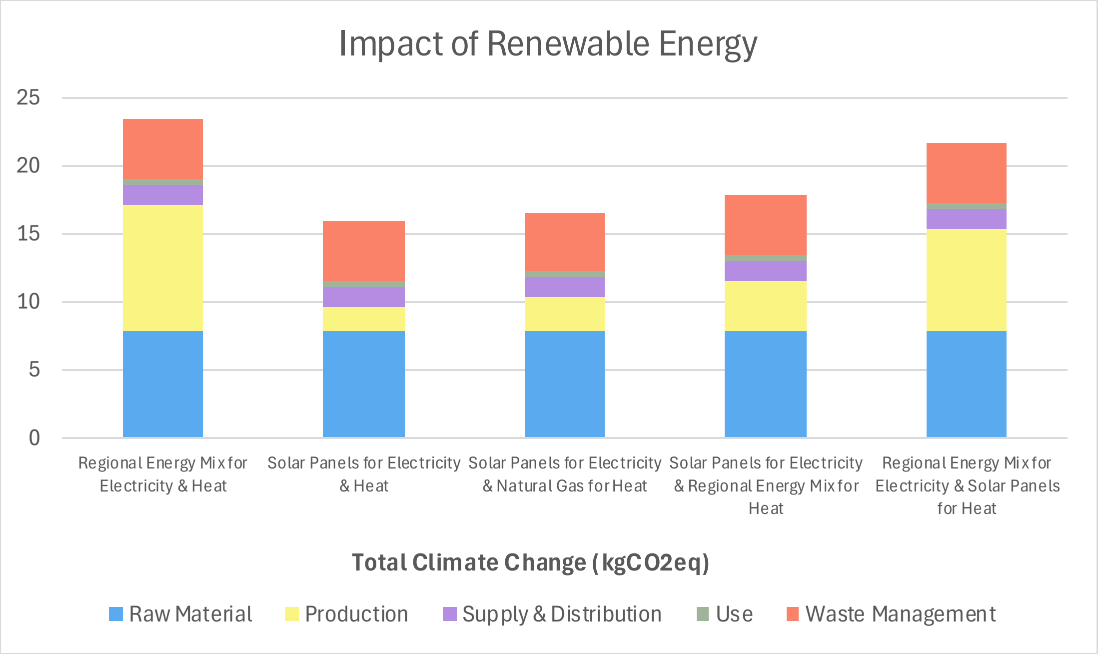


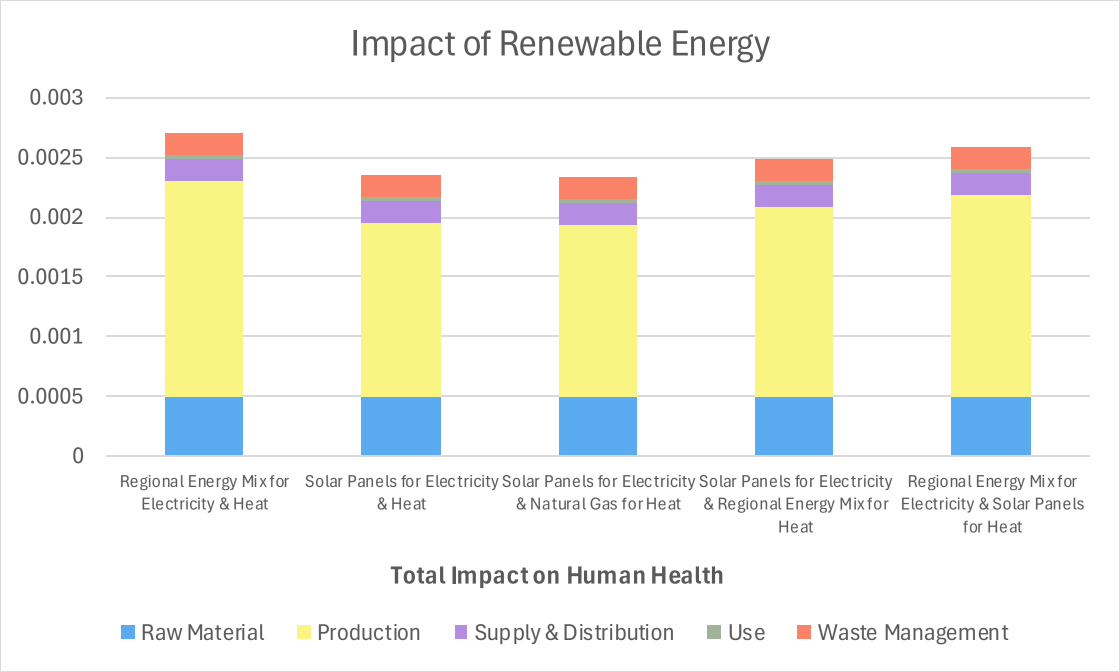


Lifetime and Materials

- Extending the lifetime of the product can lead to a significant reduction in environmental impact, which can be accomplished by improving product quality (by eco-design, etc.) and maintaining the product during the use phase.
- Using recycled PET instead of virgin PET to produce the polyester can reduce the impact of the raw material stage by 50% – however since the production phase is massively impactful, the overall reduction is approximately **20%** in climate change and **5%** impact on human health. However if the recycled PET compromises the lifespan of the blanket (e.g. 3 yrs lifetime instead of 5) the total impact can increase by **33%/57%** in climate change & human health respectively
- Using post-consumer waste textile reduces the impact of raw material stage by 75%-- however since it requires additional processes/yarn production, the overall reduction is lower than that of the good quality recycled PET polyester scenario: **13%/16%** reduction in climate change & human health respectively

Energy for Production

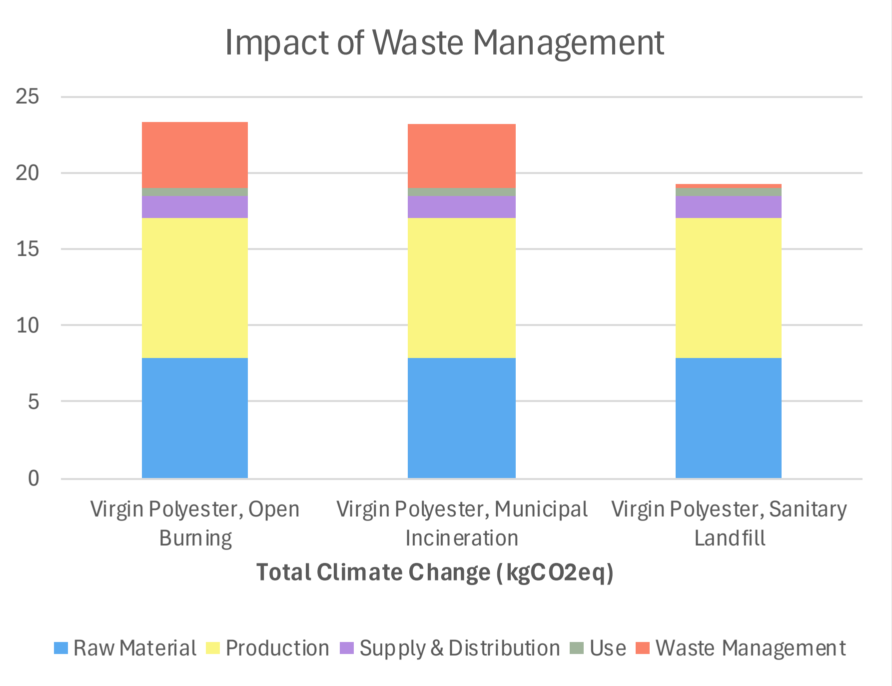


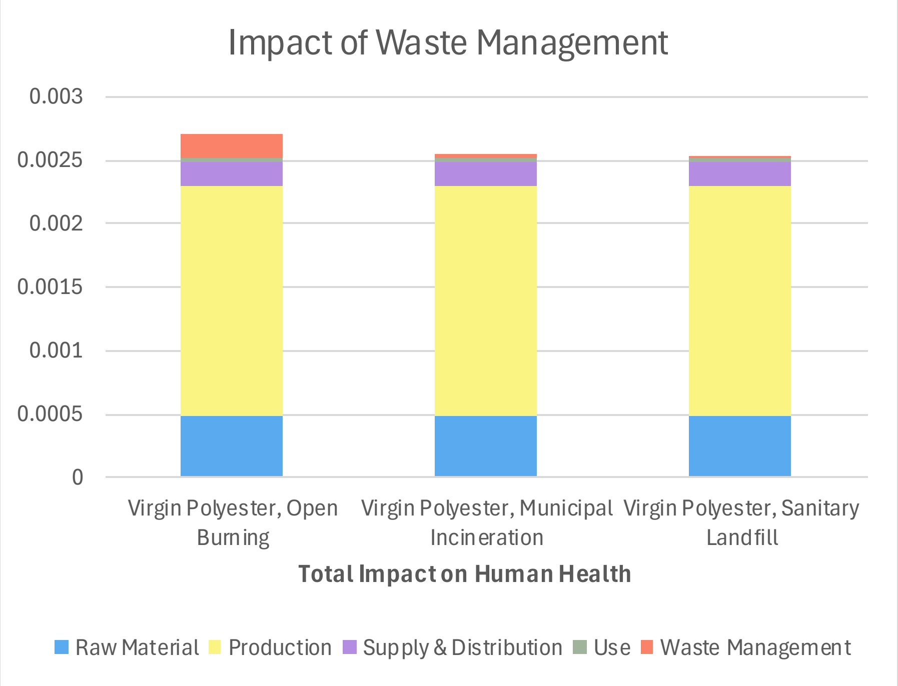


Energy for Production

- Switching the energy source used for electricity or heat during the production phase can significantly reduce environmental impacts—especially when fossil fuel–intensive sources are replaced with low-carbon alternatives.
- Producing blankets using solar power for **both electricity and heat** from an on-site photovoltaic (PV) installation, instead of the average Indian electricity mix (which consists of approximately 75% coal), reduces GHG emissions by **32%** and human health impacts by **13%.**
- Using a mix of solar panels for electricity and natural gas for heat reduces **29%** in GHG emissions and **14%** in human health impacts.
- Individually, replacing only electricity with solar power (and average heat production) shows **24%/8%** reduction in climate change & human health respectively, while replacing only heat production with solar power (with average grid electricity) shows **7%/4%** reduction in climate change & human health respectively.

Waste Management

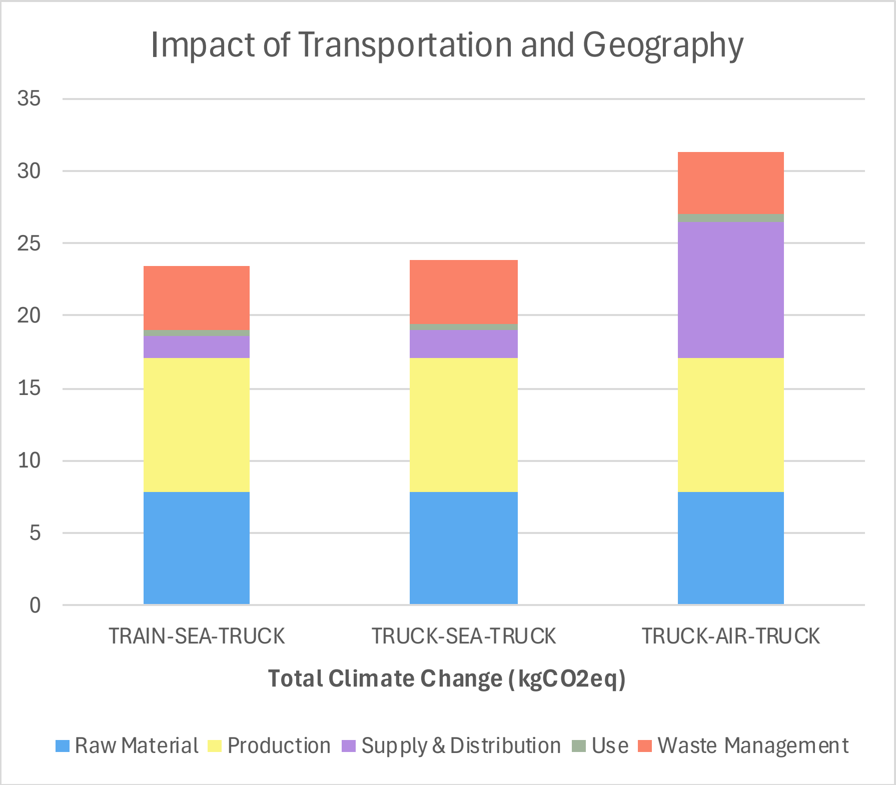


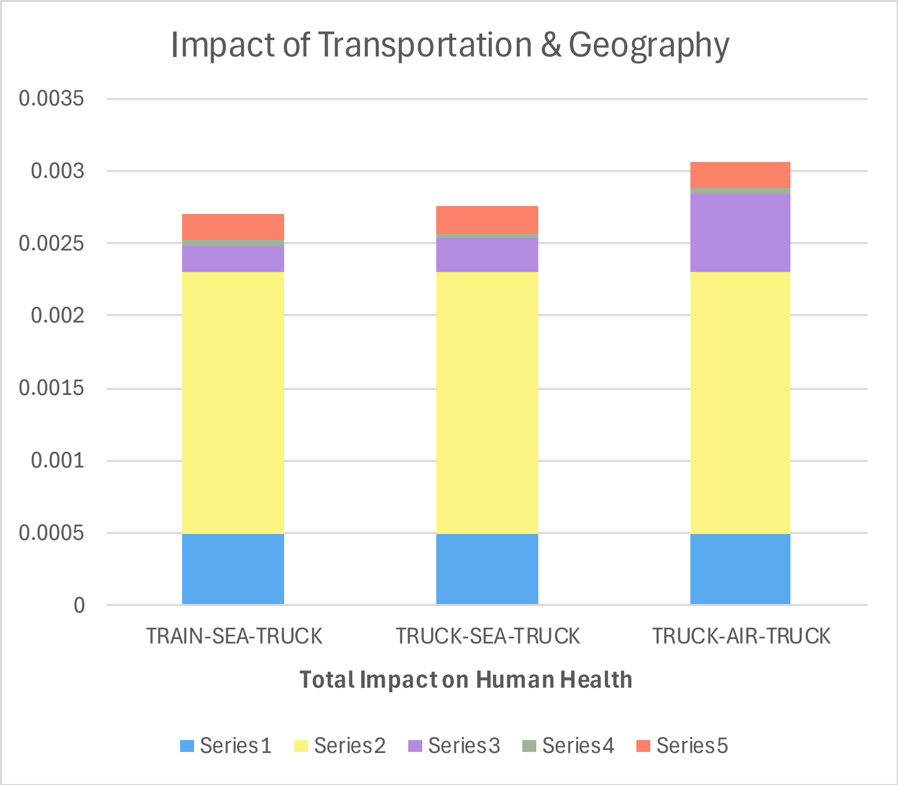


Waste Management

- 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.
- There is a small improvement when considering municipal incineration for climate change **(1%)** but larger for human health **(6%)**.
- A sanitary landfill achieves a greater reduction in climate change **(18%)** and has comparable reduction in human health to municipal incineration **(7%)**, making sanitary landfills the preferred waste management method within the scope of the LCA (see slide 6 for more information).

Transport



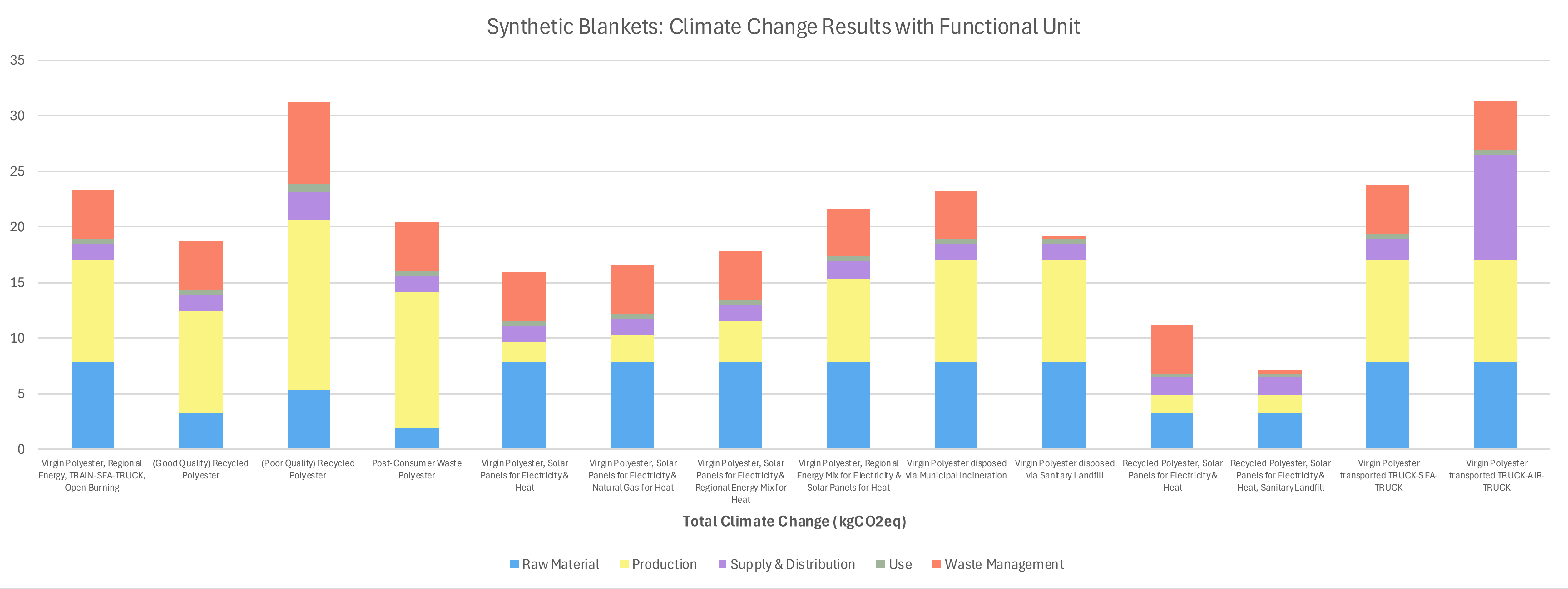


Transportation & Geography

Transportation is not a significant enough share of impact to affect any change in the overall life-cycle of the blanket – replacing the freight train with a truck only increases the impact by **2%** in both GHG emissions & human health, **unless air freight is used**, which increases the impact by **34%/13%** in GHG emissions/human health respectively.

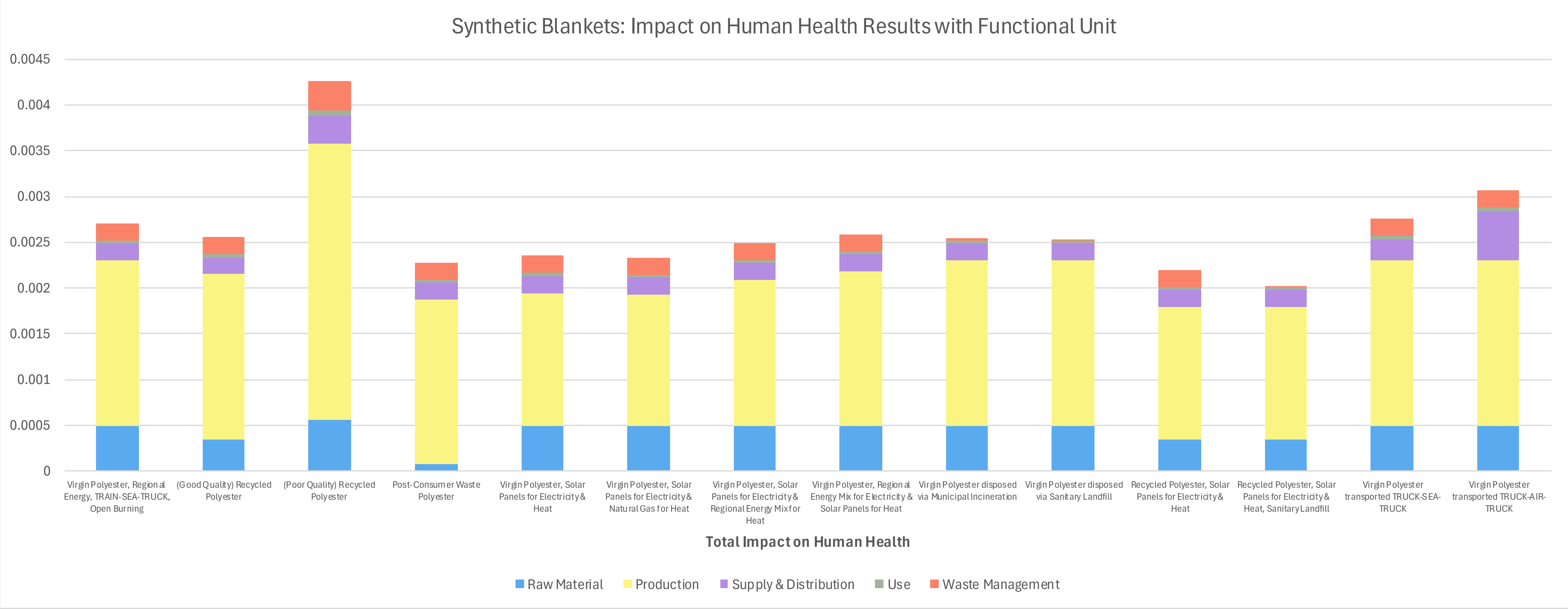
All Results: Climate Change

Functional Unit: 5 years of use of a blanket



All Results: Impact on Human Health

Functional Unit: 5 years of use of a blanket



Key conclusions of comparative analysis

- The modelled scenarios show the following impact reductions (GHG emissions & impact on human health):
  - Virgin to good quality recycled PP: 20%/6%
  - Regional energy mix to solar energy for production: 32%/13%
  - Open burning to sanitary landfill: 18%/7%

Therefore, combining recycled polyester, renewable energy for electricity and heat at production phase, and landfill instead of open burning account for the impact reduction of the synthetic blanket as follows:

- ▼ 70% climate change
- ▼ 25% impact on human health

Email address contact@climateactionaccelerator.org

LinkedIn linkedin.com/company/theclimateactionaccelerator

Website climateactionaccelerator.org

Thank you!

EPFL | EssentialTech Centre

LEURE

ICRC

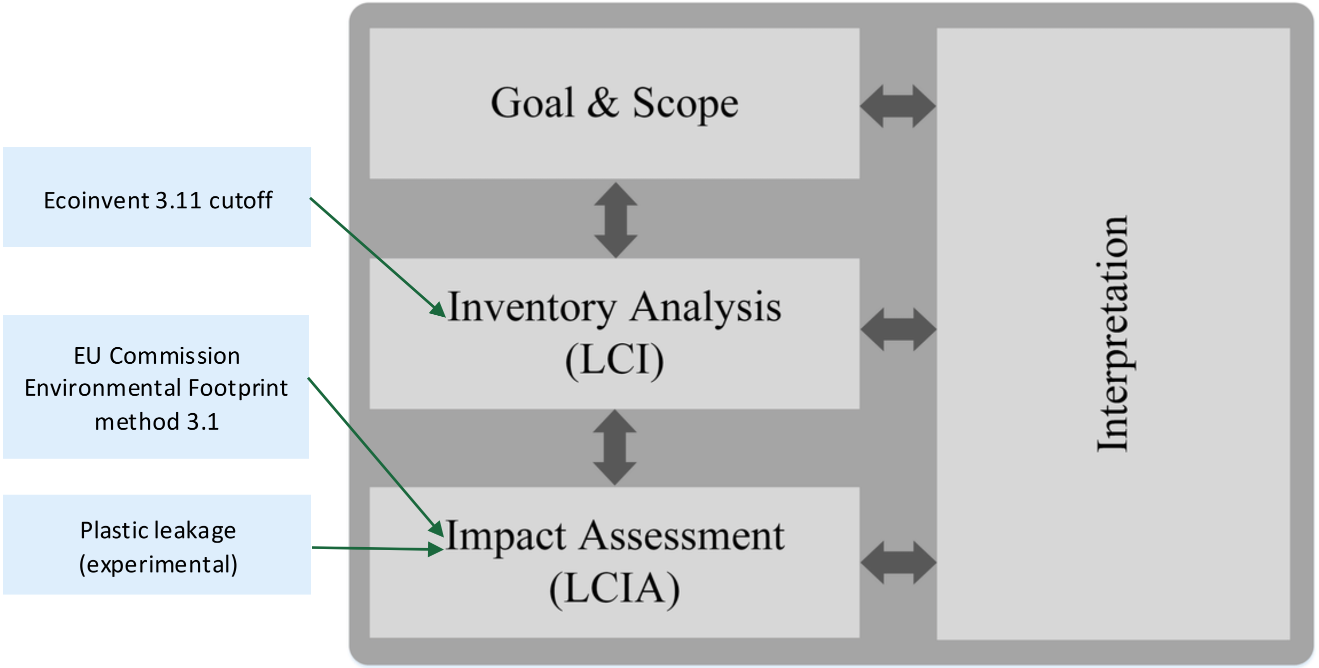
Climate Action Accelerator

Methodology

The primary database used is Ecoinvent 3.11

The studies utilize the data from the **cut-off system model which allocates the entire impact of the material to its primary user** without any ‘rewards’ for its potential for being recycled.

Consequently, any recycled materials do not carry the burden of the impact of the primary use of the material and rather track the impacts from the recycling process onward.



Life cycle assessment (LCA) steps according to ISO 14040, 14044, and 14067.

References:
“Ecoinvent v3.11.” n.d. Ecoinvent. https://ecoinvent.org/ecoinvent-v3-11/

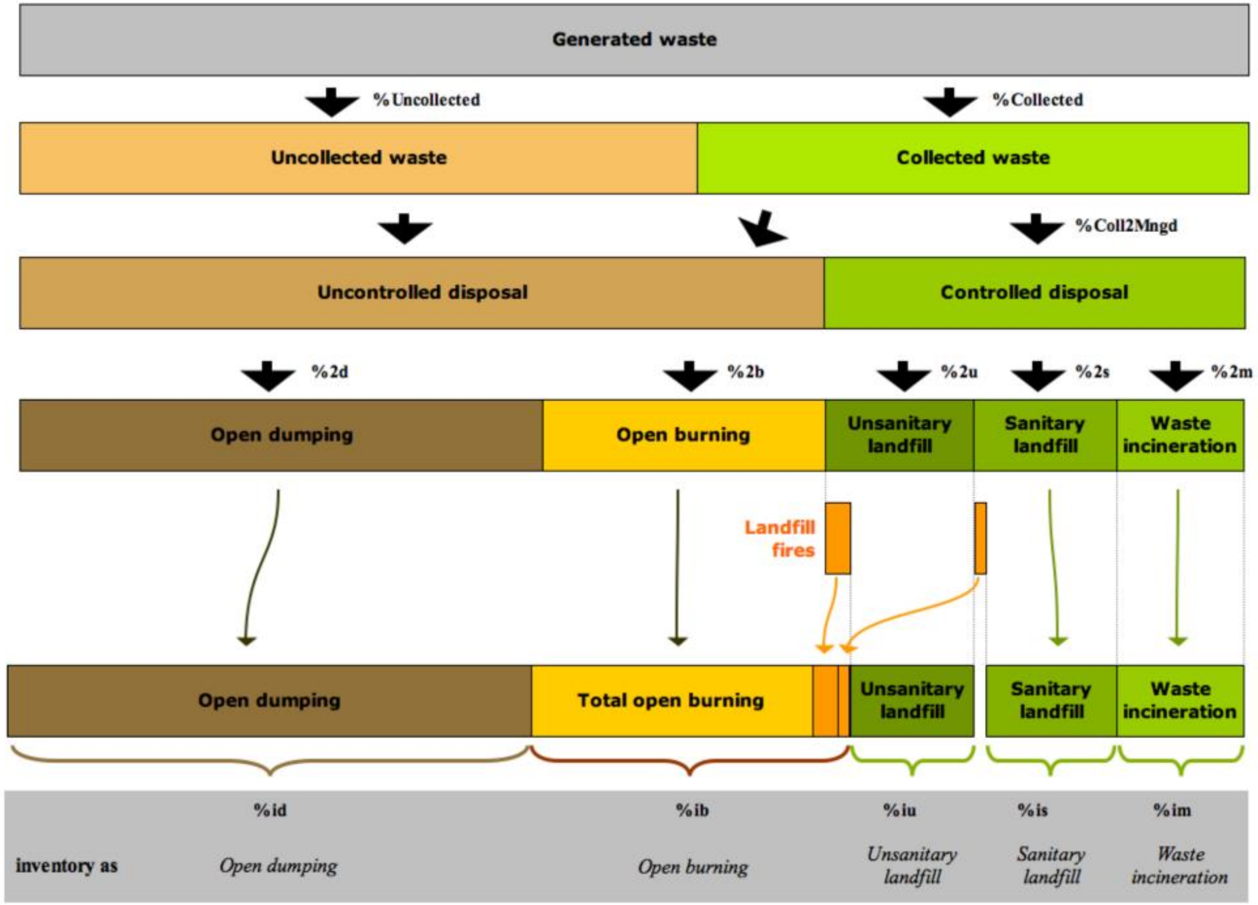
End-of-life waste management

This study aims to model the impact differences between **managed and mismanaged** waste tailored closer to humanitarian contexts.

The end-of-life impact for *a mix of plastic waste* reduces as below:

Method	GHG Emissions	Impact on Human Health
Open Burning	~HIGHEST~	~HIGHEST~
Municipal Incineration	-2.60%	-96.03%
Unsanitary Landfill	-93.80%	-99.40%
Open Dumping	-95.50%	-99.87%
Sanitary Landfill	-96.22%	-99.06%

Open burning creates maximum impact for both categories, but beyond that there are differences between climate change and human health on the specific magnitude of reduction.



Doka, G., 2018, Inventory parameters for regionalised waste disposal mixes

This study uses values for specific types of plastic wherever necessary, however the proportions of impact follow similar trends across the types of plastic product. This is therefore the standard impact implication for plastic products at end-of-life. Whenever possible, recycling is also modelled as a waste treatment option within the scope of the study. NOTE: The methods listed above have differences in how long it takes for the plastic to be removed. It is part the LCA methodology that measurements are limited to a 100 years, therefore any further impact due to the degradation of plastic in landfills is not measured or compared with other methods of disposal.