Technical Appendix: Comparative Life Cycle Assessment of Single-Use vs. Reusable Coveralls

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I. Description

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.

This study aims to establish GHG Emission Factors for single-use coverall suits for medical interventions – as used in EBOLA context – adapted to the humanitarian context, and analyse the environmental impact of the product’s life cycle and identify key levers for impact reduction through a comparison with reusable coveralls.

The functional unit of this study is 100 uses of a coverall suit.

[Figure]

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:

a) Climate Change: Global Warming Potential (GWP100)

b) 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 coveralls considered in this study are as follows

LIFE CYCLE STAGE	PARAMETER	Single Use Coverall	Multi-Use Coverall
Raw Material	Bill of Materials	Virgin Polyester, Polypropylene, Rubber, PET	Virgin Polyurethane, Polyester, Rubber, PET
Production	Manufacturing Location	Manufactured from locally sourced materials in China and transported to the field by ship.	
Supply & Distribution	Transport Chain	TRUCK SEA TRUCK	
Use	Lifespan	1 use	100 uses
	Usage Processes	None	Washing with tap water, soap and chlorine after each use.
Waste Management	Product Disposal Method	Open burning	Open burning

IV. Scenario Rationale: SmartPPE

The comparaison made in this study is a direct reference to the SmartPPE product designed by the *EPFL EssentialTech Centre* and *Médecins Sans Frontières (MSF)* to replace single-use coveralls in the Ebola response context.

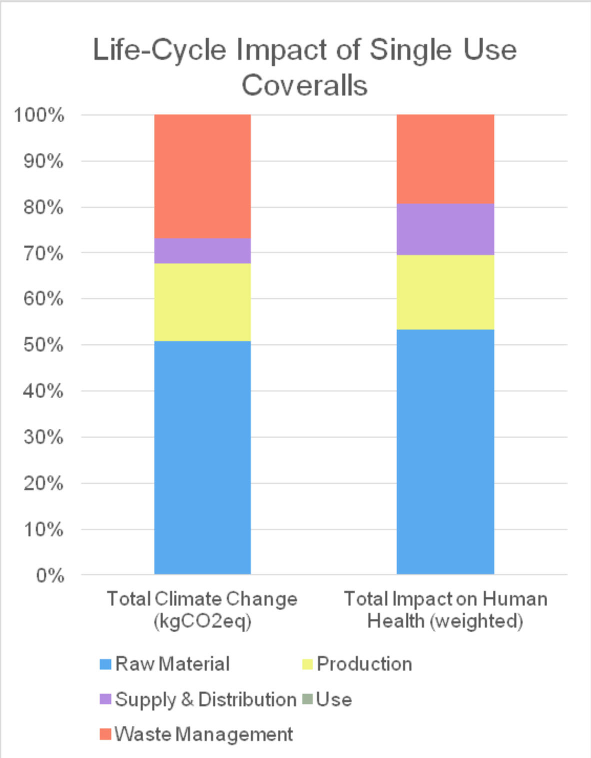
This assessment focuses solely on the suit component of the PPE, not the full smart PPE system with the integrated air vent. The filtration device is considered equivalent across both single-use and smart PPE systems, and is therefore excluded from the comparative analysis. The smart PPE is not yet available on the market, but it is ready for production. Prior analysis has shown that using smart PPE instead of single-use PPE can reduce the hourly cost of intervention by a factor of six. Further information can be found on the link in the reference

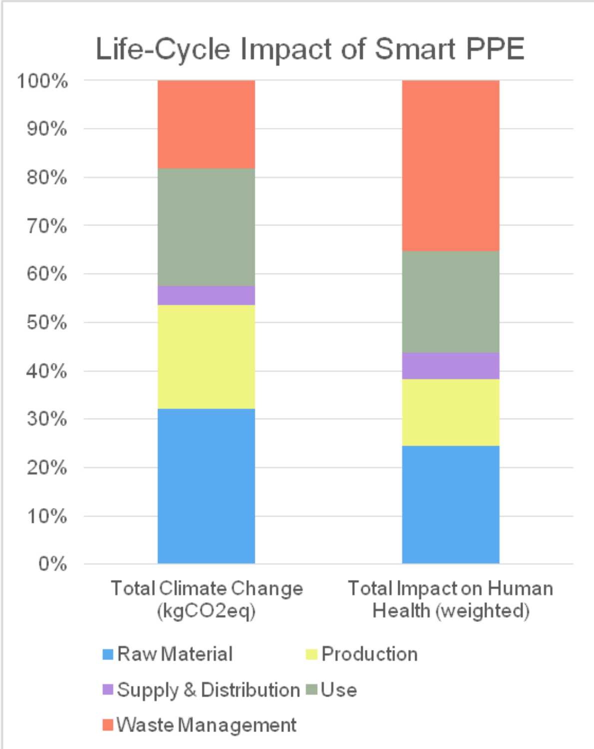
Further scenarios were considered to model the potential impact reductions as compared to the two baselines using the below hypothesis:

- Using recycled polyethylene (PE) for the single-use coverall
- Using only solar energy for production – this 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.

V. Results & Discussion

As both are plastic-based products, raw materials contributes significantly to their impacts, accounting for 50% of GHG emissions and 53% of human health impacts in the single-use coverall and 32% and 24%, respectively, in the reusable coverall. The reusable coverall includes a use phase, which contributes 24% of total GHG emissions and 21% of the impact on human health—a phase that does not exist for the single-use coverall. At end of life, both products are modelled to be disposed of by open-pit burning, due to their classification as medical waste. This accounts for 27% of GHG emissions and 19% of human health impacts for the single-use coverall, and 18% and 35% , respectively, for the reusable coverall.





Greenhouse Gas (GHG) Emission Factors: Single-Use Coveralls

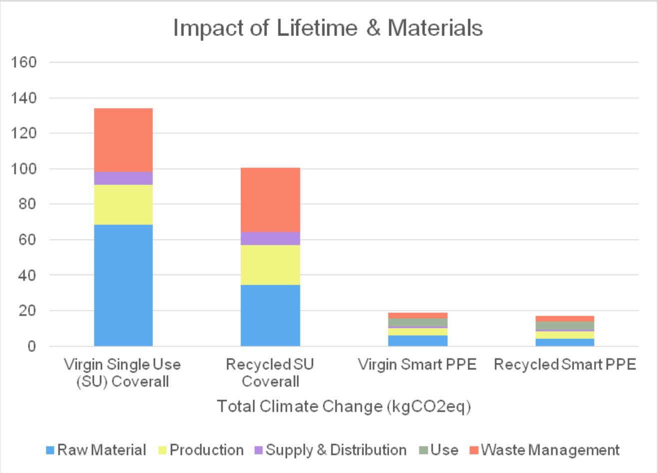
Name	GHG Protocol Category	kgCO2eq/unit
Cradle-to-grave	N/A	1.34
Cradle-to-gate	3.1 Purchased Goods	0.918

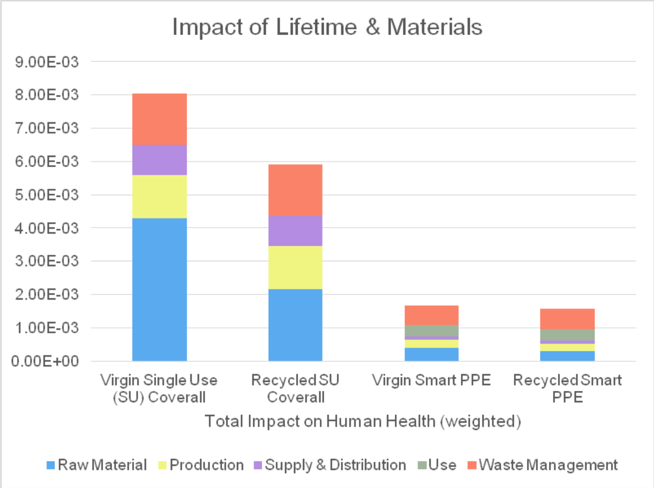
Greenhouse Gas (GHG) Emission Factors: SmartPPE

Cradle-to-grave	N/A	19.0
Cradle-to-gate	3.1 Purchased Goods	10.3

V..Results By Category

Raw Material

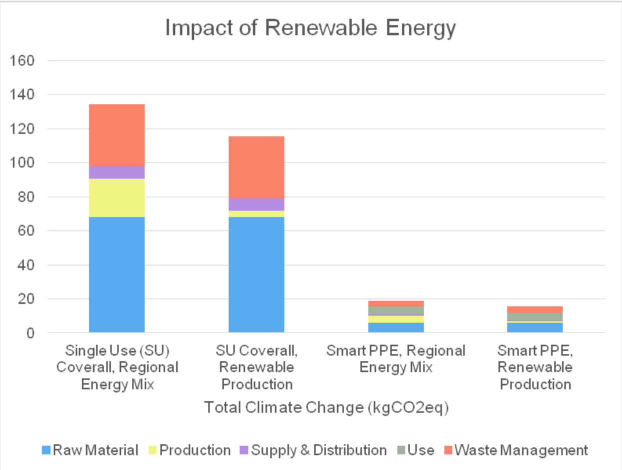


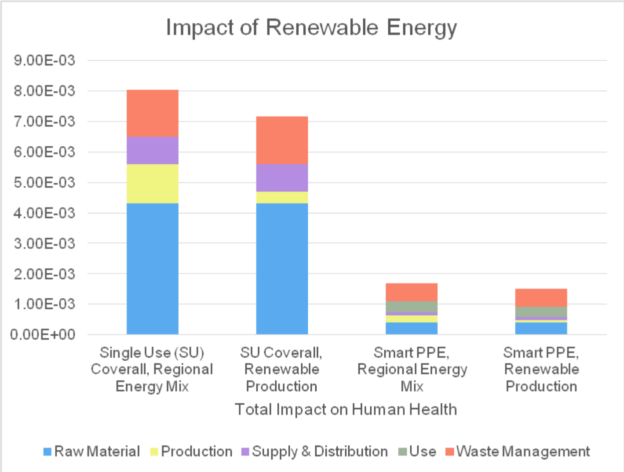


When assuming 100 uses, moving to reusable coverall reduces GHG emissions by 86% and human health impacts by 79% compared to the single-use coverall.

Substituting virgin material with recycled material for the single-use coverall can reduce impacts by up to 25–26% in both GHG emissions and human health categories, assuming no loss in material quality and that the same number of coveralls is required to complete the intervention. For a reusable coverall, this would lead to a 9% of reduction in GHG emissions and a 7% in human health impacts, as raw materials represent a smaller share.

Energy Supply



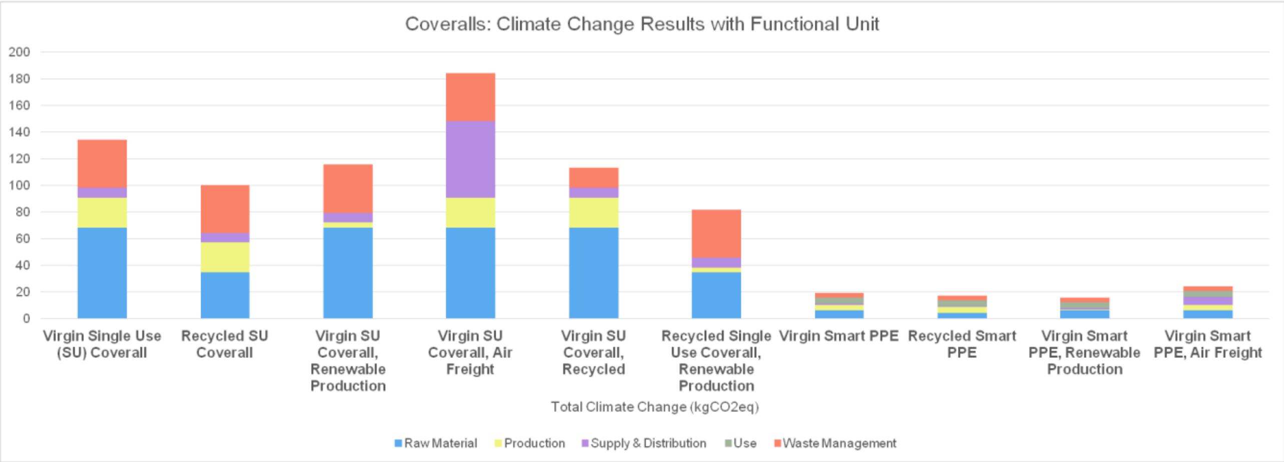


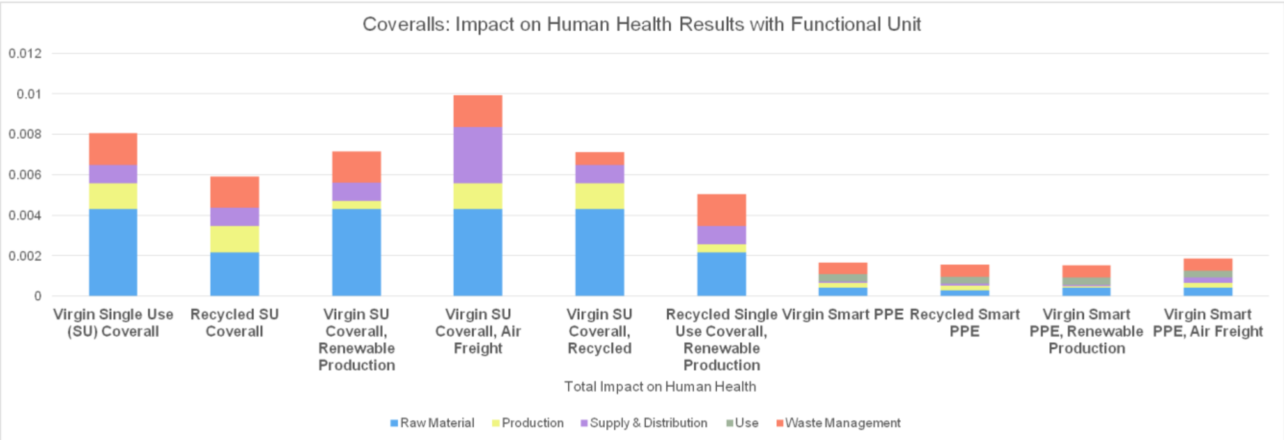
Switching the energy source for electricity or heat used during production can significantly reduce environmental impacts, especially when fossil fuel–intensive sources are replaced with renewable energy

For the single-use coverall, shifting from the average energy mix to solar energy reduces GHG emissions by 14% and human health impacts by 11%.

When combined with other measures—such as using recycled materials—these reductions can be amplified, further lowering the overall environmental footprint.

VI. Conclusion





To reduce the environmental impact of single-use coveralls, significant improvements can be made by focusing on raw materials and the energy used during manufacturing. However, the greatest reductions are possible by switching from single-use to reusable coveralls.

- 86% climate change
- 79% impact on human health

It is important to highlight that this study focuses on two main indicators: climate change and human health. Other impact categories, such as ecosystem quality and water usage, are not covered. For example, the reusable coverall requires approximately 1,000 litres of water for cleaning over its lifespan.

VII. Bibliography

SmartPPE: Essential Tech Centre (no date). Available at: https://www.essentialtech.ch/projects/smart-ppe (Accessed: 14 July 2025).