Technical Appendix: Comparative Life Cycle Assessment of Foldable Jerrycans and Plastic Buckets

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I. Description

The objective of this study is to establish GHG Emission Factors for 20L foldable jerrycans & 14L plastic buckets adapted to the humanitarian context, and analyse the environmental impact of the jerrycan's life cycle to identify key levers for impact reduction through a comparison with plastic buckets as a water container.

Foldable plastic jerrycans are extremely flimsy water containers that are procured in large amounts and distributed in emergencies due to their efficient transportation – their light weight & capability to fold down to a small volume enables organisations to ship many more of this product to a location compared to other water containers.

However field information shows that foldable jerrycans deteriorate at a rapid pace and do not retain their function well over any time period. This study aims to present the plastic bucket as a better option for the long-term fulfilment of this function, with lower environmental impacts due to the longevity of the item.

The functional unit of this study is storage of 20 litres of water for 1 year.

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 baseline parameters of the two items are as follows

LIFE-CYCLE STAGE	PARAMETER	FOLDABLE JERRYCANS	PLASTIC BUCKETS
Raw Material	Bill of Materials	Virgin LDPE	Virgin HDPE
Production	Packaging	Carton & Duct Tape	Carton & Duct Tape
	Manufacturing Location	Manufactured from locally sourced materials in China and transported to the field by ship	
Supply & Distribution	Manufacturing Processes	Blow Moulding	Blow Moulding
Use	Transport Chain	TRUCK SEA TRUCK	
	Lifespan	3 months	5 years
	Usage Processes	None (lifespan too short)	Washing with tap water and soap twice a year
Waste Management	Product Disposal Method	Open burning	Open burning
	Packaging Disposal Method	Open dumping	Open dumping

IV. Scenario Rationale

a. Raw Material

Recycled polyethylene was considered for both products as an alternative to the virgin LDPE/HDPE being used.

b. Production

The average (market) energy used for the production process was replaced with solar energy to model potential impact reductions – 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.

c. Use

No scenarios were considered for this stage beyond the existing difference between the two products.

d. Supply & Distribution

No scenarios were considered 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).

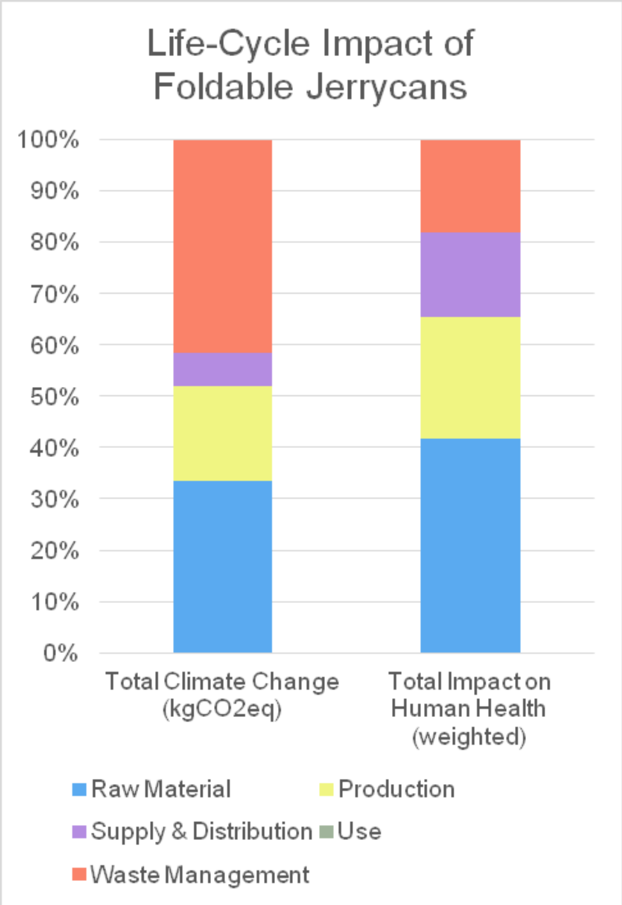
A third option of collection of the production and shipping to recycling facilities in Europe was studied as a “best case” scenario for complete elimination of the waste.

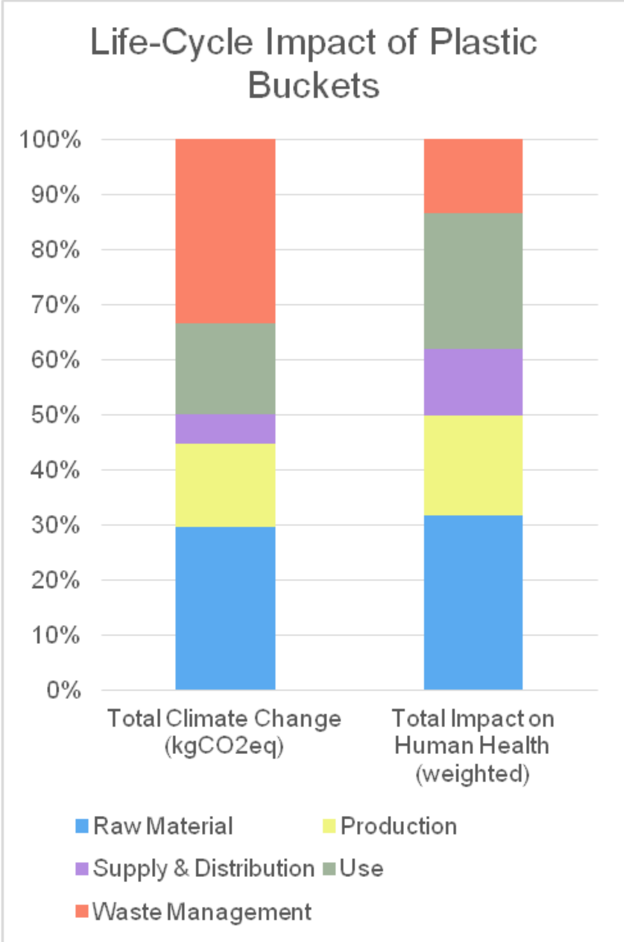
V. Results & Discussion

Both products are made of polyethylene, and raw material production represents a significant share of their environmental impact—33% of GHG emissions and 42% of human health impacts for jerrycans, and 30% and 32%, respectively, for buckets

Unlike jerrycans, buckets include a use phase (washing to keep it clean), contributing 17% of GHG emissions and 24% of human health impacts, which reduces the relative impact of other life cycle stages for buckets

At end of life, both products are modelled to be burned in open pits. This disposal method accounts for 42% of GHG emissions and 18% of human health impacts for jerrycans, and 34% and 14%, respectively, for buckets





Greenhouse Gas (GHG) Emission Factors: 20L Foldable Jerrycan

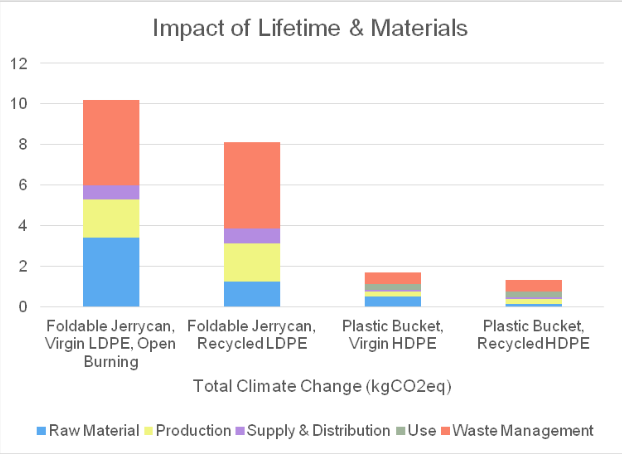
Name	GHG Protocol Category	kgCO2eq/unit
Cradle-to-grave	N/A	2.56
Cradle-to-gate	3.1 Purchased Goods	1.33

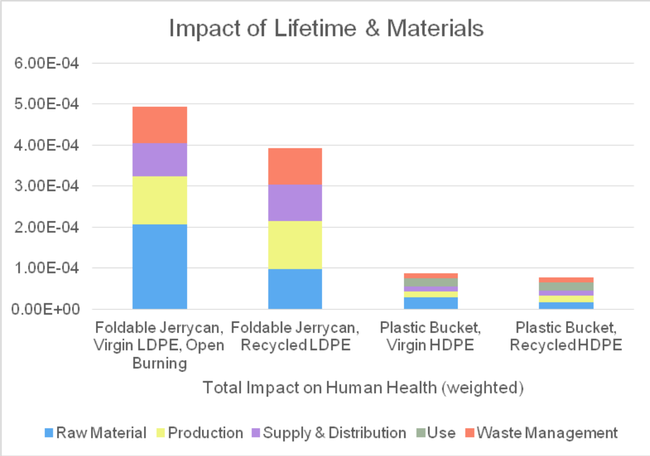
Greenhouse Gas (GHG) Emission Factors: 14L Plastic Bucket

Cradle-to-grave	N/A	8.40
Cradle-to-gate	3.1 Purchased Goods	3.77

V..Results By Category

Raw Material

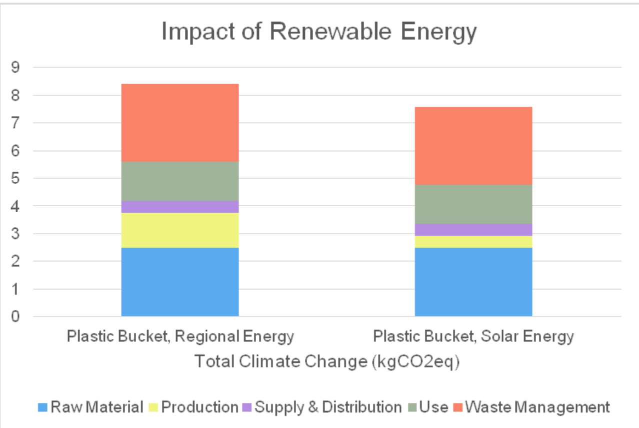


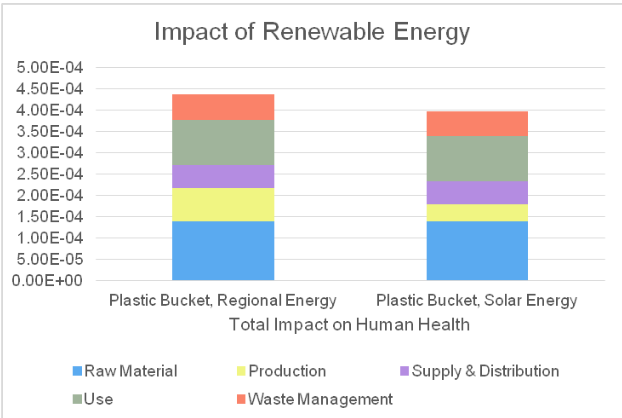


The lifespan of the two products plays a big role in the analysis due to the fact that jerrycans last a very short time (3 months in our model) and buckets, made from sturdier material, last several years. The reduction in impact between the jerrycans and buckets when measuring for one year of use for carrying 20 litres of water (which requires 4 20L jerrycans or 1.43 14L buckets) is 84%/82% in GHG emissions and impact on human health respectively.

Substituting virgin material for recycled materials, further shows a reduction of 2-5% for the buckets in both categories, while for jerrycans the substitution brings about a reduction of ~20% in both categories. In general, a long-lasting product is more impact efficient, no matter the material.

Energy Supply



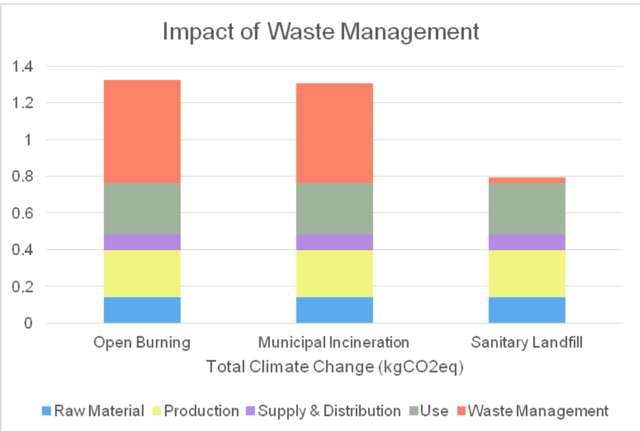


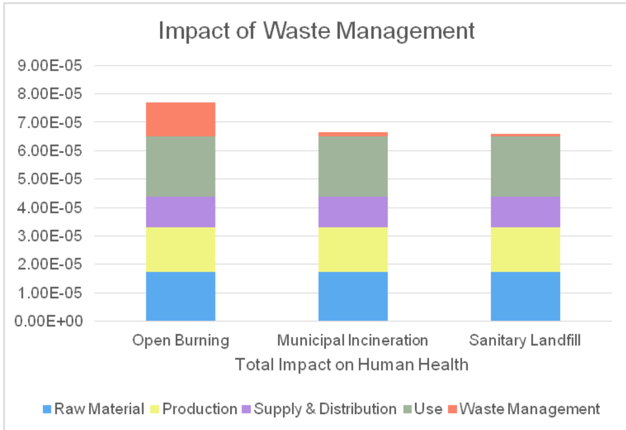
Switching the energy source for the production of the electricity or the heat used during the production phase can lead to a reduction of environmental impacts. This is particularly the case when energy sources intensive in fossil fuel are replaced with renewable energy sources

For HDPE buckets, switching from the average energy mix to solar energy results in a 10% reduction in GHG emissions and a 9% reduction in human health impacts. This relatively modest improvement, compared to other products analysed, is largely because the raw materials, use phase, and end-of-life stages account for a greater share of the total impacts. .

Combining this benefit with other actions e.g. moving to recycled material can, however, amplify the reduction.

Waste Management

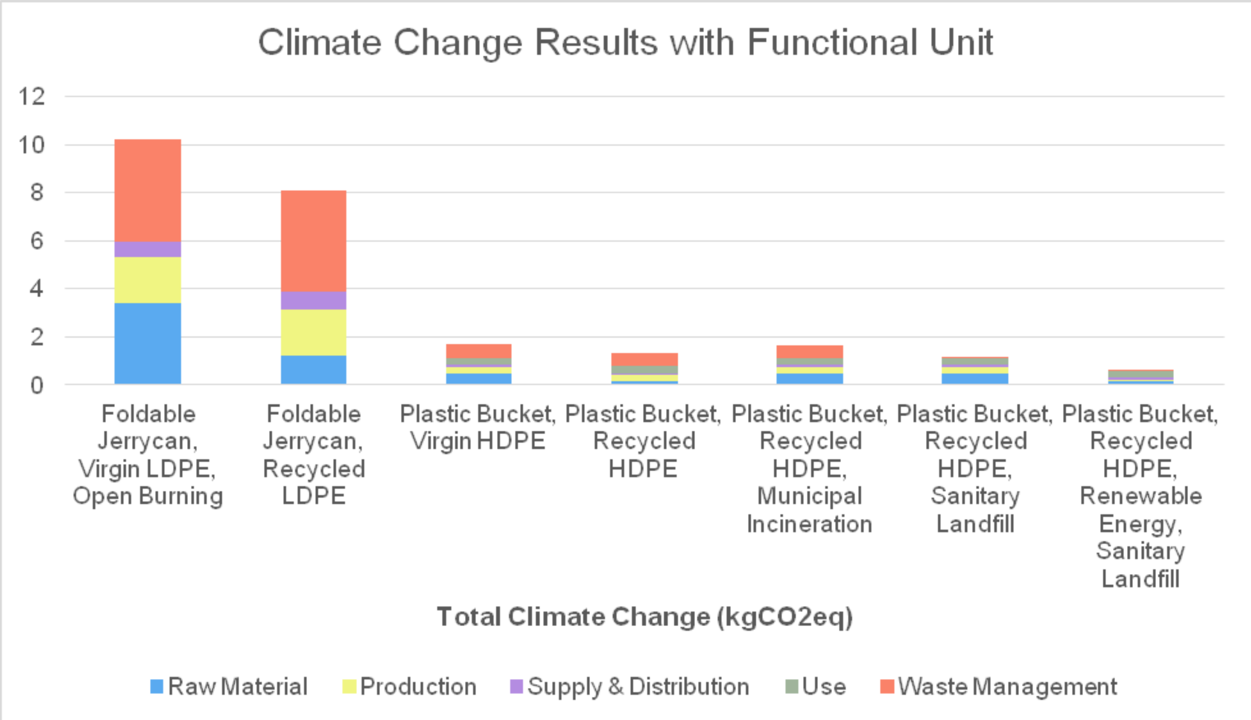


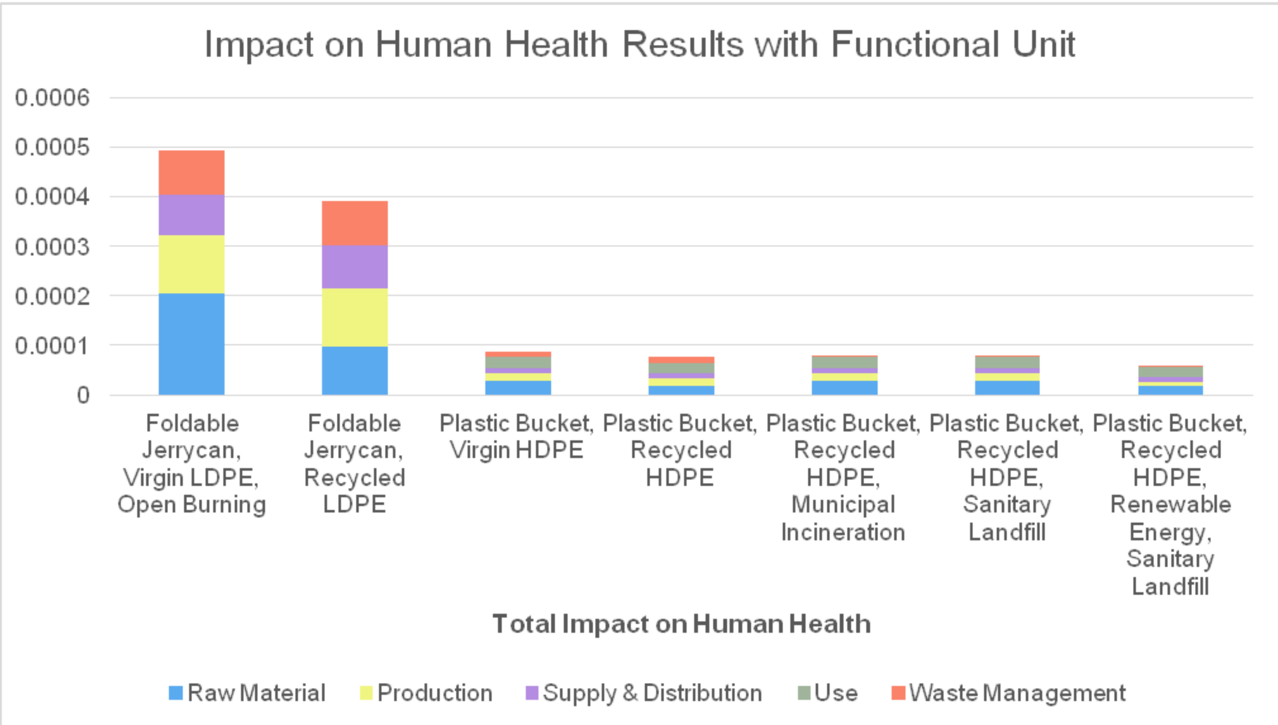


Burning plastic waste in a municipal incineration plant rather than openly will not reduce GHG emissions but will reduce impacts on human health if the plant has the adequate filters - taking the improved product variation, i.e. Recycled HDPE Bucket, we can see a reduction of ~1% in GHG emissions, but a reduction of ~13% in impact on human health

Sanitary landfills however reduce ~40% GHG emissions from the baseline model of open burning as well as ~14% impact on human health, making sanitary landfills the preferred waste management method within the scope of the LCA (see slide 6 for more information).

VI. Conclusion





In satisfying the function of longer-term water storage, replacing the container with an option with a longer lifespan (i.e. replacing jerrycans with buckets) can reduce large amounts of the environmental impact caused by the product itself. Further improving the sustainability product – in this case buckets – can cause even greater impact reductions.

For plastic buckets, combining the reduction from using good quality recycled HDPE, renewable energy for production, and sanitary landfill as a waste disposal method – provides the below impact reduction as compared to using virgin LDPE jerrycans.

- ▼ 94% climate change
- ▼ 88% 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.