

Life Cycle Assessment of the IOM Geodesic Tent



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Why this study?

Humanitarian supply chains are carbon-intensive.

Purchased goods and freight dominate most organisations' footprints, so product choices matter.

Shelters are high-volume, time-critical items. Tents move fast through global logistics; materials and routing drive impacts.

Transitional role of geodesic tents. They bridge emergency and longer-term shelter, often staying in service for months to years.

Evidence gap. NO cradle-to-grave LCAs exist for **geodesic tents**, EOL and realistic reuse rates are rarely modelled.

Decision need. IOM are strengthening **Scope 3** reporting and procurement standards; they need **product-level factors** and **scenario results** to act.

Aims & Objectives

- Assess the **environmental impacts and circularity potential** of the IOM Geodesic Tent by using LCA methodology, to inform IOM's **procurement strategies** and support IOM **Scope 3 reporting** obligations' preparation

Conduct a cradle-to-grave attributional LCA for the IOM Geodesic Tent

Identify environmental hotspots of the IOM Geodesic Tent

Compare alternative material options where relevant

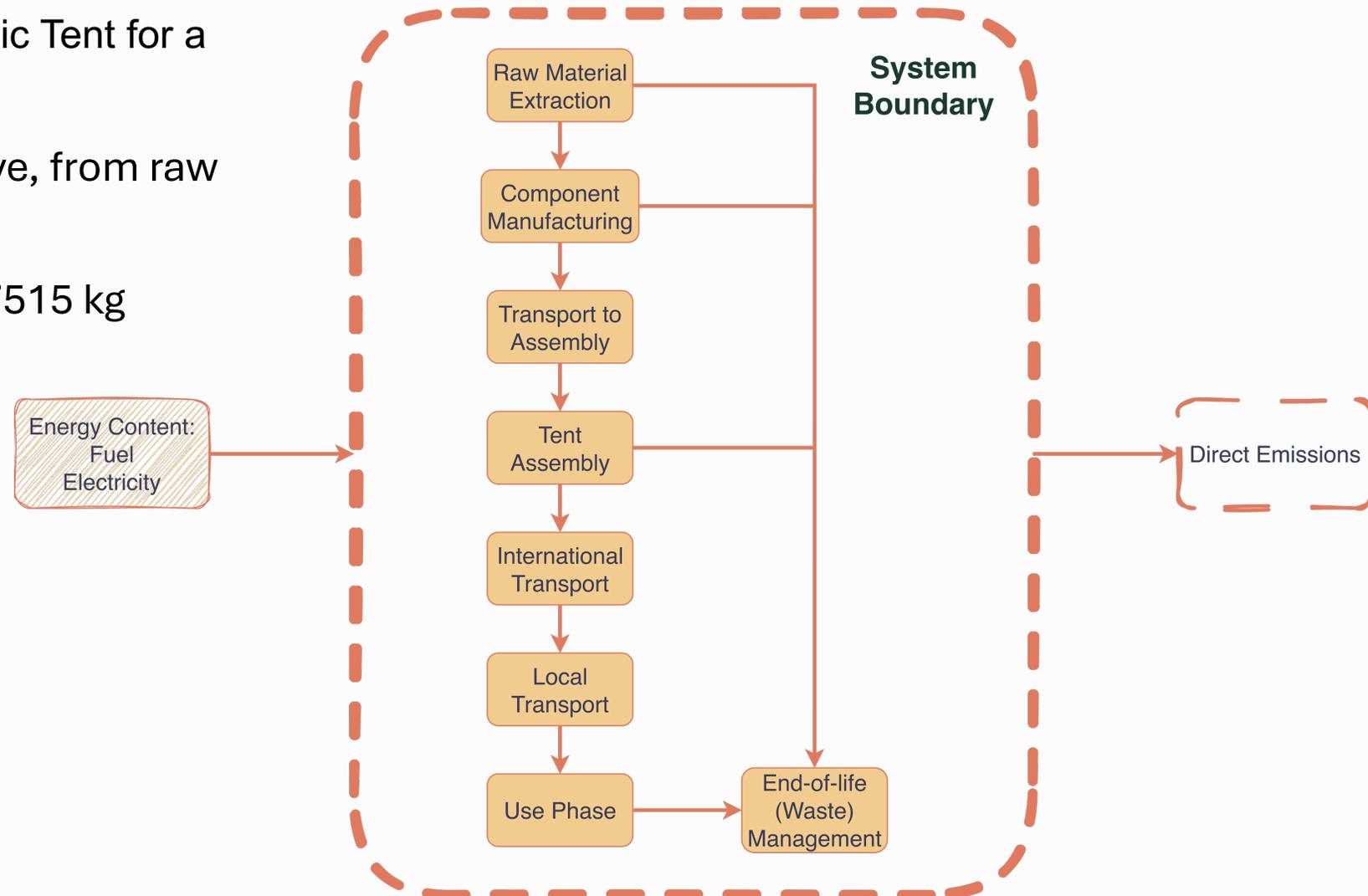
Evaluate opportunities for circularity, waste reduction or logistics optimisation

Provide recommendations for IOM's procurement practices

Help to prepare IOM future Scope 3 emissions reporting requirements

Functional Unit & System Boundary

- **Functional unit:** Use of 1 Geodesic Tent for a family of 5 persons for **4 years**
- **System Boundary:** cradle to grave, from raw material extraction to end-of-life
- **Average Weight** of one tent: 46.7515 kg (with no accessories)



Data & Methodology



- **LCI/LCIA:** Following ISO 14040/14044 standard; Ecoinvent v3.11; ReCiPe 2016 Midpoint (H).
- **Data mix:** IOM bill of materials **primary data** + EcoInvent secondary datasets.

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
 - Photochemical Oxidant Formation

Weighted using the approach detailed in the EF methodology – with a percentage assigned to each sub-indicator

| Activity | Type |
|-------------------------|---|
| Component Manufacturing | Walls, floor, fly, primary packaging |
| | Mesh (mosquito net) |
| | Pole sleeve fabric |
| | Accessories (velcro, zipper, thread, webbing, tape) |
| | Chimney patch |
| | Ropes |
| | Small clear windows |
| | Frame, plate, ropes runner |
| | Stakes, pallet, rings, hooks, lock, hammer |
| | Liner (Partitions, chimney, accessories) |
| | Fly / wall |
| | window / door / accessories |
| | Frame / pegs |
| | Transport to Assembly |
| Tent Assembly | Assembly process |
| | Cage (secondary packaging) |
| | Secondary packaging |
| Local Transport | Cage (secondary packaging) |
| | Transport |
| | Transport |
| End-of-life treatment | Reuse |
| | Landfill |

Key Assumptions



Following are the assumptions made during the assessment:

- The **use phase** of the tent was **neglected**: No emissions from the use of the tent.
- The **density of the ropes** was assumed, as weight per meter of ropes was not provided by vendor: 15 g/m for 6 mm rope and 7.5 g/m for 4 mm rope.
- All distances travelled in the **transport stage** was calculated by **average** route distance on Amap and Google Maps.
- **Emission factors for woven tarpaulin sheets** (ICRC, IFRC and UNHCR, 'Eco-design Tarpaulin Project 2021-2023') were calculated by **average**.
- **Lorry size for tent component freight** was assumed as 7.5-16 metric ton, and lorry size for **tent freight** was assumed as 16-32 metric ton.
- **No warehousing emissions** for geodesic tents in the country of delivery (Jordan or Gaza), since the tents do not need energy-consuming warehousing and no new warehouse needed to be constructed.

Scenario Analysis

Tent Variation

Version 1: Baseline Tent (Geodesic Tent without accessories – default configuration)

Version 2: Tent + Inner Liner

Version 3: Tent + Winter Cover

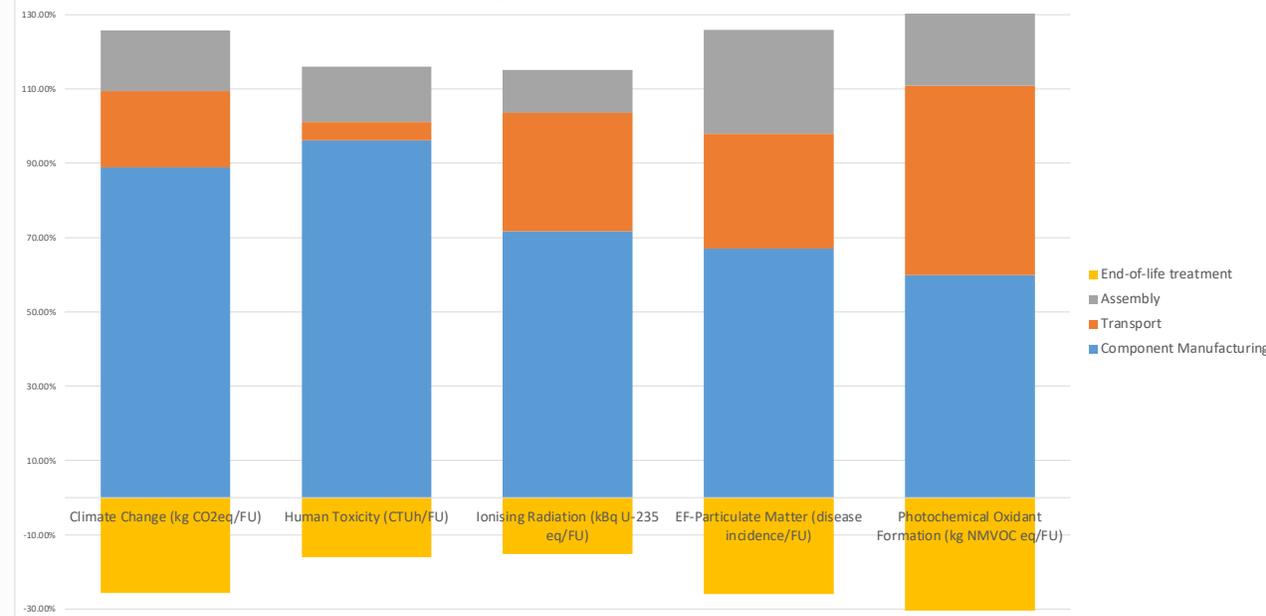
Version 4: Tent + Inner Liner + Winter Cover

Environmental Scenarios (applied to Baseline Tent v1.)

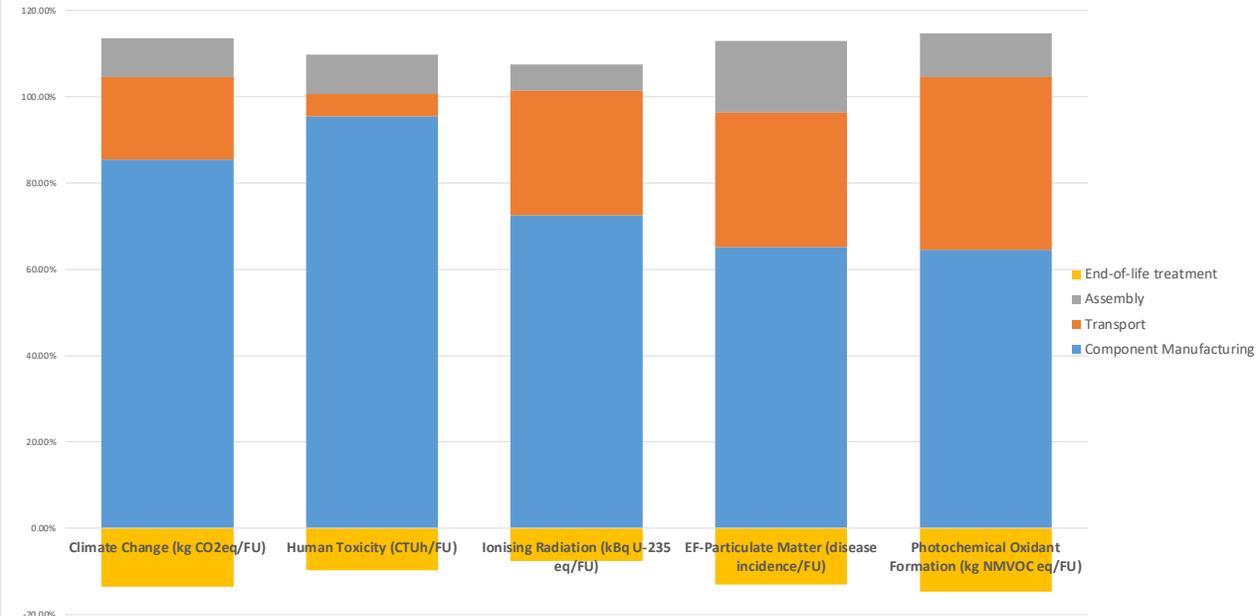
- 1. End-of-life treatment** scenarios (EOL baseline: **tarpaulin reuse 50%, aluminium reuse 80%, rest via landfill**)
 - a. All components disposed of via **landfill**
 - b. **No credits** for aluminium/tarpaulin reuse
- 2. Lifespan** extension: 4 yrs → 8 yrs
- 3. Increased reuse rate** for Tarpaulin (50% → 80%) and Aluminium (80% → 95%)
4. Switch polyester to **recycled polyester**
5. Replace *aluminium* with **steel/recycled aluminium**
- 6. Road + Sea -> Road + Air freight**

Overall Results

All Impact Categories Contribution% (without accessories)



All Impact Categories Contribution% (with accessories)



- **Baseline (no accessories): 195.55 kg CO₂e / FU.**
- **+ Winter cover + inner liner: 354.53 kg CO₂e / FU. (+81% vs baseline)**
- **Annualised factors: ~48.9 (baseline) → 88.6 kg CO₂e per shelter-year with accessories**
- **≈ 9.8 → 17.7 kg CO₂e per person-year (5 persons)**

- Manufacturing stage dominates: manufacturing >> transport/assembly
- EOL reuse claims small credits.

Overall Results – Specific Figures



| Contribution | Climate Change (kgCO ₂ eq/FU) | Human Toxicity (CTUh/FU) | Ionising Radiation (kBq U-235 eq/FU) | EF-Particulate Matter (disease incidence/FU) | Photochemical Oxidant Formation (kg NMVOC eq/FU) |
|--------------------------------|--|--------------------------|--------------------------------------|--|--|
| Component Manufacturing | 302.92 | 135.33 | 14.05 | 0.37 | 0.84 |
| Transport | 67.63 | 7.45 | 5.60 | 0.18 | 0.52 |
| Assembly | 31.91 | 12.98 | 1.20 | 0.09 | 0.13 |
| End-of-life treatment | -47.93 | -13.95 | -1.46 | -0.07 | -0.19 |
| Total | 354.53 | 141.81 | 19.39 | 0.57 | 1.30 |

Specific figures for Tent with both accessories

| Contribution% | Climate Change (kgCO ₂ eq/FU) | Human Toxicity (CTUh/FU) | Ionising Radiation (kBq U-235 eq/FU) | EF-Particulate Matter (disease incidence/FU) | Photochemical Oxidant Formation (kg NMVOC eq/FU) |
|--------------------------------|--|--------------------------|--------------------------------------|--|--|
| Component Manufacturing | 85.44% | 95.43% | 72.46% | 65.19% | 64.50% |
| Transport | 19.07% | 5.25% | 28.88% | 31.10% | 40.08% |
| Assembly | 9.00% | 9.15% | 6.17% | 16.69% | 10.14% |
| End-of-life treatment | -13.52% | -9.84% | -7.52% | -12.99% | -14.72% |
| Total | 85.44% | 95.43% | 72.46% | 65.19% | 64.50% |

Overall Results – Specific Figures



| Contribution | Climate Change (kgCO ₂ eq/FU) | Human Toxicity (CTUh/FU) | Ionising Radiation (kBq U-235 eq/FU) | EF-Particulate Matter (disease incidence/FU) | Photochemical Oxidant Formation (kg NMVOC eq/FU) |
|--------------------------------|--|--------------------------|--------------------------------------|--|--|
| Component Manufacturing | 173.78 | 82.90 | 7.46 | 0.23 | 0.36 |
| Transport | 40.05 | 4.41 | 3.32 | 0.10 | 0.31 |
| Assembly | 31.91 | 12.98 | 1.20 | 0.09 | 0.13 |
| End-of-life treatment | -50.19 | -13.98 | -1.57 | -0.09 | -0.20 |
| Total | 195.55 | 86.31 | 10.40 | 0.34 | 0.60 |

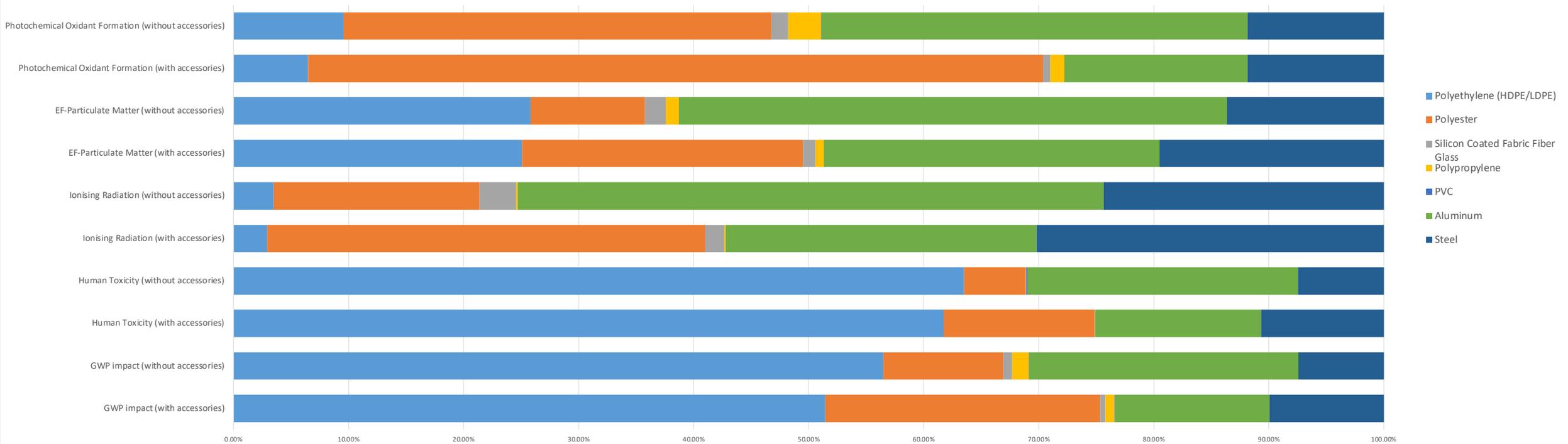
Specific figures for Tent without accessories

| Contribution% | Climate Change (kgCO ₂ eq/FU) | Human Toxicity (CTUh/FU) | Ionising Radiation (kBq U-235 eq/FU) | EF-Particulate Matter (disease incidence/FU) | Photochemical Oxidant Formation (kg NMVOC eq/FU) |
|--------------------------------|--|--------------------------|--------------------------------------|--|--|
| Component Manufacturing | 88.87% | 96.04% | 71.74% | 67.00% | 59.70% |
| Transport | 20.48% | 5.11% | 31.88% | 30.90% | 51.21% |
| Assembly | 16.32% | 15.04% | 11.51% | 28.01% | 21.87% |
| End-of-life treatment | -25.67% | -16.19% | -15.13% | -25.90% | -32.78% |
| Total | 88.87% | 96.04% | 71.74% | 67.00% | 59.70% |

Results — Material Hotspots



All Impact Categories of Components Manufacturing Input Breakdown (with&without accessories)



- **Polyethylene tarpaulins** dominate the emission share (accounts for approximately **45–50%** of total GWP) **because of its extensive use in manufacturing stage**
- **Aluminium** dominates **by intensity even though its input is less compared to the plastics used during the manufacturing phase**, this mainly due to upstream combustion and processing such as smelting.
- When we add accessories to the tent, the share moves toward **polyester** — which implies the inner liner and winter cover showing up, as PE is their primary material

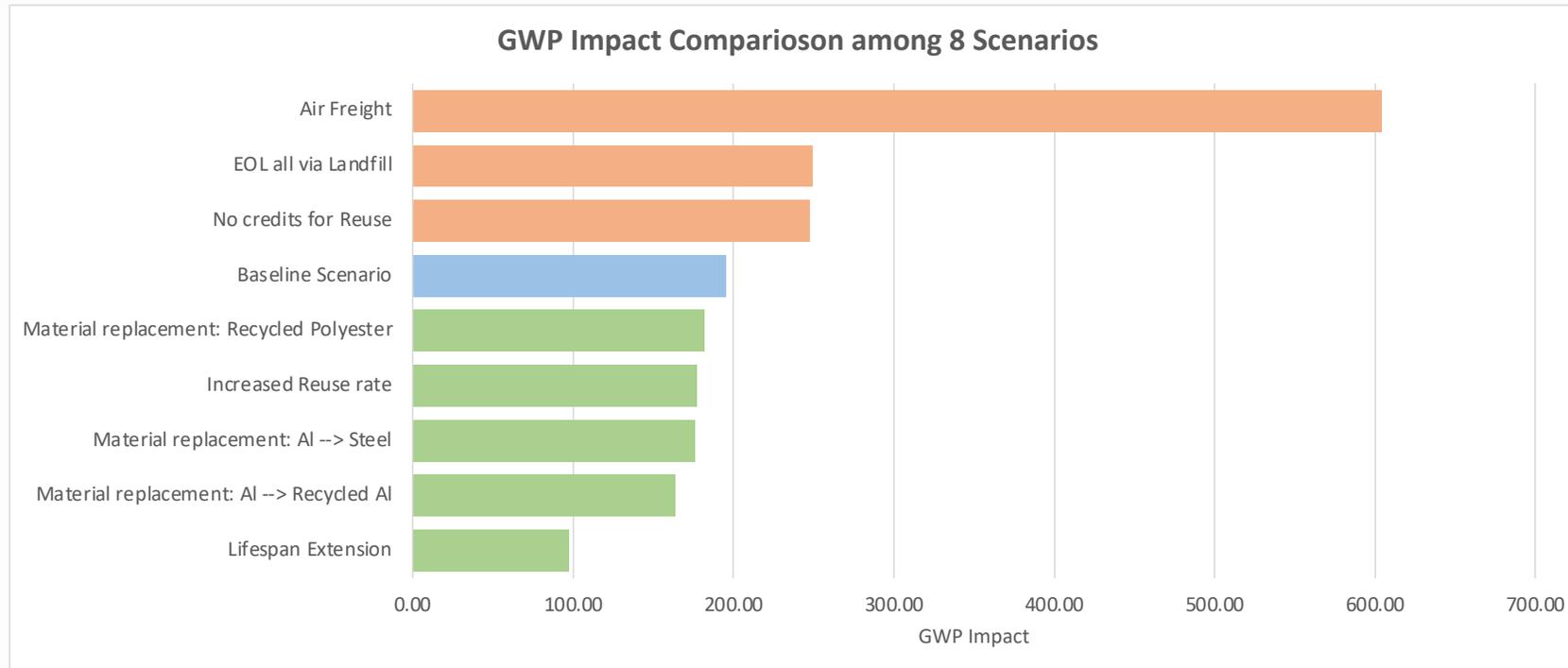
Results — Material Hotspots



| Materials | GWP impact (with accessories) | GWP impact (without accessories) | Human Toxicity (with accessories) | Human Toxicity (without accessories) | Ionising Radiation (with accessories) | Ionising Radiation (without accessories) | EF-Particulate Matter (with accessories) | EF-Particulate Matter (without accessories) | Photochemical Oxidant Formation (with accessories) | Photochemical Oxidant Formation (without accessories) |
|-----------------------------|-------------------------------|----------------------------------|-----------------------------------|--------------------------------------|---------------------------------------|--|--|---|--|---|
| Polyethylene (HDPE/LDPE) | 51.43% | 56.51% | 61.73% | 63.52% | 2.93% | 3.47% | 25.09% | 25.82% | 6.50% | 9.55% |
| Polyester | 23.92% | 10.42% | 13.12% | 5.35% | 38.07% | 17.91% | 24.42% | 9.96% | 63.88% | 37.21% |
| Silicon Coated Fabric Fiber | | | | | | | | | | |
| Glass | 0.44% | 0.76% | 0.00% | 0.00% | 1.68% | 3.17% | 1.10% | 1.79% | 0.63% | 1.46% |
| Polypropylene | 0.82% | 1.44% | 0.03% | 0.05% | 0.08% | 0.16% | 0.70% | 1.15% | 1.22% | 2.85% |
| PVC | 0.02% | 0.03% | 0.06% | 0.10% | 0.00% | 0.00% | 0.02% | 0.03% | 0.02% | 0.04% |
| Aluminum | 13.44% | 23.42% | 14.41% | 23.52% | 27.04% | 50.92% | 29.16% | 47.60% | 15.88% | 37.03% |
| Steel | 9.94% | 7.42% | 10.66% | 7.45% | 30.19% | 24.36% | 19.51% | 13.65% | 11.87% | 11.86% |

- Top contributors: PE tarpaulin > Aluminium > Polyester
- Subsequent scenario analysis focuses on these dominant materials to assess the potential benefits of **reuse**, **material substitution**, and **extended lifespan**.

Scenario Insights - GWP



- **Lifetime ×2 (to 8 years): –50%** (annualised per shelter).
- **Air vs sea: >+200%** (>3x increase) GWP.
- **Recycled aluminium: ~–16%**
- **Higher EOL reuse rate: ~–9%.**
- **Different destinations? (Philippines)**
 - Air freight: 286.15 kgCO₂eq/FU
 - Sea freight: 189.61 kgCO₂eq/FU

Recommendations



- **Prioritise the extension of tent's service life.** Specify durability requirements, plan maintenance/repair programmes, and reuse components to maximise service life.
- **Default low-carbon transport mode.** Plan and pre-arrange sea freight or multimodal transport solutions, reserve aviation for life-threatening emergencies.
- **Specify low-impact and circular materials.** Establish recycled content requirements (e.g., recycled aluminium and polyester) and require suppliers to provide Environmental Product Declarations (EPDs) or equivalent documentation.
- **Design for reuse.** Prefer mechanical connections and single-material components, set and track actual reuse targets.
- **Issue accessories only when needed.** Set simple climate thresholds for winter covers and inner liners to avoid unnecessary material loss and associated extra emissions.

Conclusions

- The **IOM Geodesic Tent** has an estimated footprint of **~195 kg CO₂-eq per unit (4-year use)**, driven mainly by polyethylene tarpaulin and aluminium frame production, which together account for **> 80 %** of total emissions.
- **Extending lifespan** and **recycled aluminium** deliver the greatest benefits (>50%), while **recycled polyester** and **increasing material reuse rate** further lower manufacturing impacts.
- **Logistics** changes such as port relocation or transport mode shifts have very limited influence, and **air freight** would sharply increase emissions and should be avoided.
- Combining **lifespan extension + reuse + recycled materials** could reduce total GWP by **~ 75%**, emphasising that durability and circularity interventions represent the most effective strategies for climate mitigation.
- Future work should focus on **validating field reuse rates and improving component manufacturing data**, to strengthen IOM's circular procurement and forthcoming Scope 3 reporting.



Thank you!