WP3: Life cycle assessment of ICRC new woven PE tarpaulin

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Overview current and new tarpaulin

Current ICRC tarpaulin

- 100% virgin PE
- Weight: 190 g/m^2
- Size: 6 m x 4 m
- Reinforcement bands

New ICRC tarpaulin (intended design and specifications)

- 85% virgin PE, 15% recycled PE
- Weight: 170 g/m^2
- Size: 6 m x 4 m
- PE eyelets

Included additional end of life (EoL) scenarios to consider the improvement in the recycling process for the tarpaulin that ICRC might implement in the future.

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Goal and scope

- Evaluate the evironmental impacts of the new design of the ICRC tarpaulin from cradle to grave (i.e. raw materials extraction, manufacturing of tarpaulin, use phase, and end of life of the new tarpaulin).
- Note that the production of the new tarpaulin is not implemented and collected data are based on experience and assumptions from producers, not on measurements.

Methodology

- The environmental performance of ICRC new woven tarpaulin was evaluated using life cycle assessment, following the framework of ISO 14040/14044 standard; however, this study has not been reviewed by third party[1].

- Sensitivity analysis focusses on the recycling scenarios[2] for the new tarpaulin, where

  - Tarpaulin is collected and transported(100km) to recycling station to produce PE granulates. The PE granulates recovered is assumed to have higher quality, and can replace 50% of the virgin PE.

  - Local recycling (no transport), no pretreatment (washing and shredding), tarpaulin is thermoformed into new plastics (5 kWh per piece), which can replace 80% of virgin PE (considering quality losses and sourcing supply). Assumed that electricity comes from PV panels.

- As an additional information, to understand the environmental benefits of the new tarpaulin, the current tarpaulin models (phase 1) were re-run with updated background data (Ecoinvent v3.8) and serve as a baseline for the results of the new tarpaulin with different end of life scenarios.

[1]Please note that ISO standard required to perform critical review for a LCA study if it includes a comparative assertion to be published. https://lca-net.com/services-and-solutions/perform-critical-review-lca/
[2]See appendix for diagram that described the recycling scenarios in this study.

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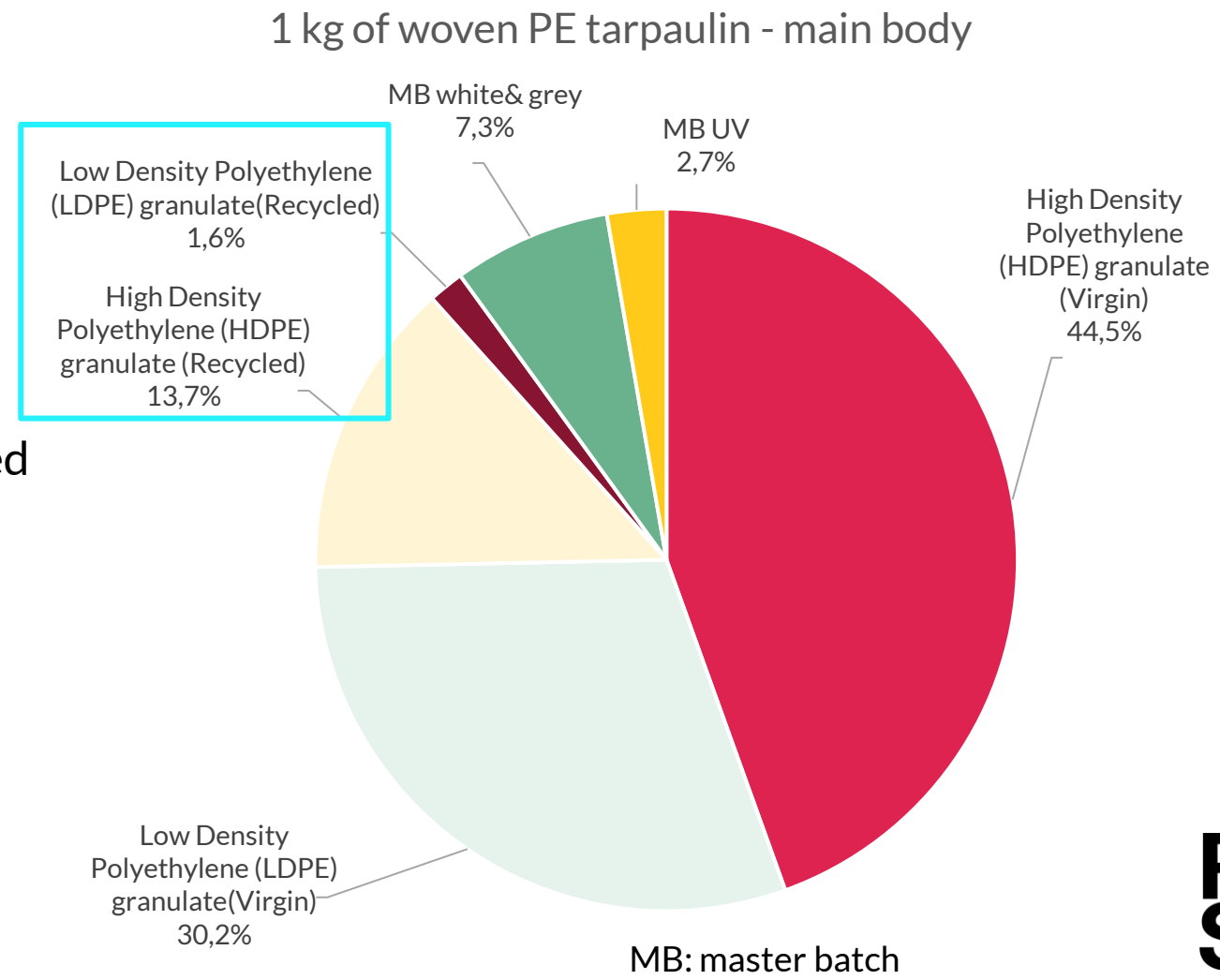
New woven PE tarpaulin

- Mainbody + eyelets (size: 6x4m)
- Weight : 170g/m^2 +/-10g
- Materials information
  - Main body, contains 15% recycled HDPE/LDPE (see chart)
  - Eyelets (made of polyethylene)



Functional unit

- The functional unit is 1 piece of plastic tarpaulin (6X4m) with an expected service life of 2 years , this is valid also for the baseline product
- Required components are woven high density polyethylene (HDPE), black fabric laminated on both sides with white low density polyethylene (LDPE) coating, and 14 black eyelets, made of PE. Average weight is 4.157kg

Data collection (new tarpaulin)

- The new specification and requirements of tarpaulin were provided by ICRC including RISE recommendations.
- The inventory data was obtained from experienced tarpaulin manufacturers, who are capable to produce this new tarpaulin. They currently do not produce this product. They have produced samples that are currently under lab testing.
- Four potential manufacturers were contacted and all responded to provide the inventory data.
- Generic database Ecoinvent 3.8 used as background data.

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Assumptions and allocations

Raw material production

- Virgin HDPE and LDPE- Global (GLO) and Rest of World (RoW), market datasets from Ecoinvent 3.8 are used, and these datasets representing the average global and rest of the world market processes, which include transportation.
- 15% of recycled HDPE and LDPE – RoW databases for post-consumer of recycled plastics are used.

Manufacturing of tarpaulin

- Taking average data for material inputs, electricity mix assumed to be 78% Chinese **Shandong electricity** mix, 22% solar power, and no water is used as it is recycled in the process.
- Capital goods (construction of the manufacturing plant) are not included.
- All plastics wastes from the process are recycled and used for packaging.

Transportation and distribution

- Regular (transoceanic ships, trucks)
- Destination: Somalia/Kenya

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Assumptions and allocations

Use phase

- No maintenance or repair.
- It is assumed that the new tarpaulin has same performance as the current tarpaulin, 2 years.

End of life

- Two scenarios

a) Littering – approximated by open, uncontrolled dump for municipal solid waste in arid condition, without transportation to site.

b) Recycling - assumed it is collected and transported 100km to recycling station, sorted, washed and granulated, and replace half of the mass of the **recycled PE granulate** (System expansion is applied); quality loss due to degradation and impurities is assumed.

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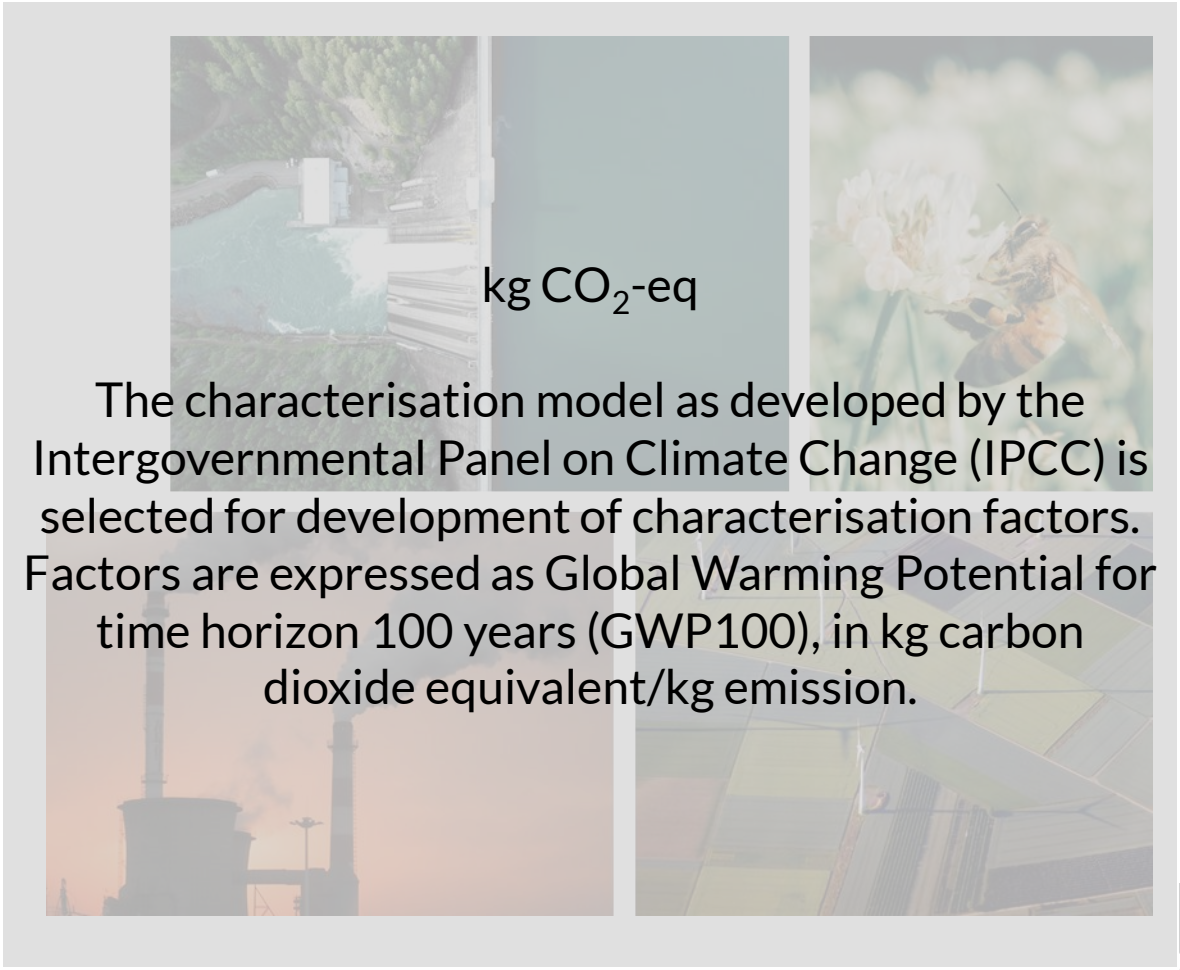
Environmental impact assessment

- **A set of impact assessment categories suggested by Dutch researchers (CML-IA baseline V3.06 / World)** was used to evaluate a broad set of impacts related to the new PE tarpaulin.

- This method includes 11 impact categories (same as LCA study in phase 1).

- Categories are included from different sources and updated accordingly.



The characterisation model as developed by the Intergovernmental Panel on Climate Change (IPCC) is selected for development of characterisation factors. Factors are expressed as Global Warming Potential for time horizon 100 years (GWP100), in kg carbon dioxide equivalent/kg emission.

Results

Estimated Impact assessment results

– Environmental impact of ICRC new woven PE tarpaulin with different end of life scenarios, 1 piece of new tarpaulin (6x4m) with approximate weight 4,157 kg.

Impact category	Unit	New Tarpaulin - Littering	New Tarpaulin – Recycling, credit 50% recycled PE
Resource use (minerals and metals)	kg Sb eq	9,16E-05	8,31E-05
Resource use (fossil fuels)	MJ	323,8	306,3
Global warming (GWP100a)	kg CO2 eq	16,8	14,7
Ozone layer depletion (ODP)	kg CFC-11 eq	5,44E-07	4,75E-07
Human toxicity	kg 1,4-DB eq	10,61	6,28
Fresh water aquatic ecotox.	kg 1,4-DB eq	6,29	4,26
Marine aquatic ecotoxicity	kg 1,4-DB eq	19602,7	15626,7
Terrestrial ecotoxicity	kg 1,4-DB eq	0,11	0,01
Photochemical oxidation (summer smog)	kg C2H4 eq	0,006	0,005
Acidification	kg SO2 eq	0,083	0,077
Eutrophication	kg PO4--- eq	0,019	0,014

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Normalized impact category results

– Environmental impact of ICRC new woven PE tarpaulin with different end of life scenarios, normalized with World background values (x1E-13)

Impact category	Unit	New Tarpaulin - Littering	New Tarpaulin – Recycling, credit 50% recycled PE
Resource use (minerals and metals)	kg Sb eq	4,39	3,97
Resource use (fossil fuels)	MJ	8,52	8,05
Global warming (GWP100a)	kg CO2 eq	4,03	3,51
Ozone layer depletion (ODP)	kg CFC-11 eq	0,02	0,02
Human toxicity	kg 1,4-DB eq	41,08	24,35
Fresh water aquatic ecotox.	kg 1,4-DB eq	26,72	18,00
Marine aquatic ecotoxicity	kg 1,4-DB eq	1013,14	806,34
Terrestrial ecotoxicity	kg 1,4-DB eq	1,00	0,09
Photochemical oxidation (summer smog)	kg C2H4 eq	1,56	1,43
Acidification	kg SO2 eq	3,47	3,21
Eutrophication	kg PO4--- eq	1,24	0,87

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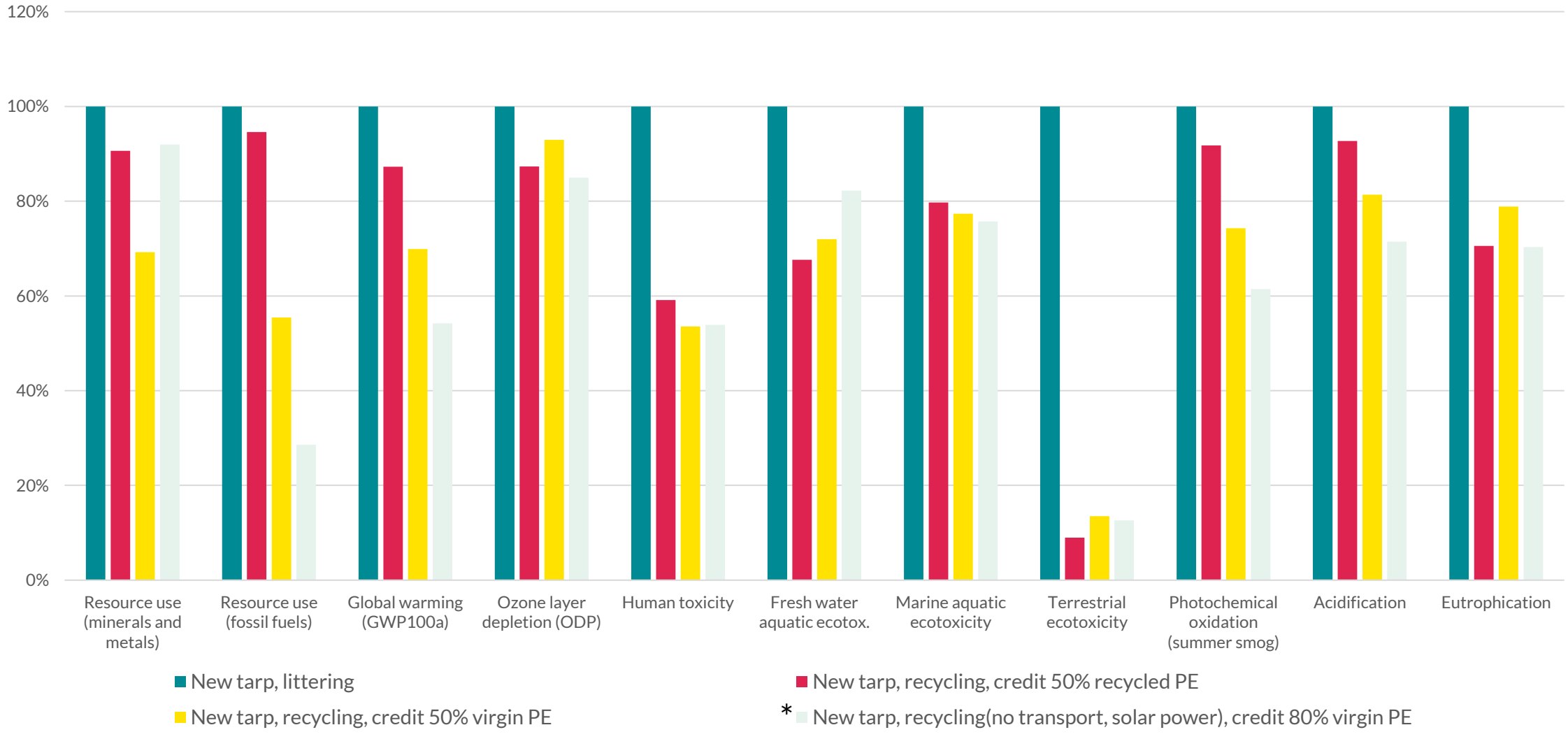
Sensitivity analysis – considering improvement in the recycling process, 1 piece of ICRC new tarpaulin (6x4m)



* This is an idealized hypothetical scenario.

Conclusion

- The environmental impacts of the new tarpaulin were evaluated. The global warming potential of the new tarpaulin is calculated approximately 15-17 kg CO_2eq.
- Comparing different options for EoL treatment for new tarpaulin (see slide 14), the highest absolute value is set to 100%, other options are shown as comparison/reduction potential.
- Littering of new tarpaulin overall has higher environmental impact than the recycling of new tarpaulin. Note that littering has long term effects that are not shown here.
- Recycling of the new tarpaulin helps to reduce environmental impacts if secondary products are used and replace primary production with mining, processing and transportation (production of virgin PE/recycled PE).
- Sensitivity analysis showed that
  - Recycling of new tarpaulin that recovers for higher quality PE granulates, which can replace 50% virgin PE can further reduced in 5 out of 11 impact categories compared to the baseline recycling scenario (replace 50% recycled PE), e.g. resource use (minerals and metals), resource use (fossils), GWP, photochemical oxidation, and acidification decreased by 11-39%.
  - For the local recycling scenario, where the tarpaulin is thermoformed to a new plastics(e.g. roof sheet), which can replace 80% virgin PE, the results also showed 4 out of 11 impact categories have significant lower emissions than the baseline recycling scenario (i.e. replace 50% recycled PE).e.g. resource use (fossil) 66%, GWP 33%, photochemical oxidation 30% and acidification 21%. However, due to the use of electricity that sourced from solar panel in recycling the new tarpaulin, the results showed that the freshwater aquatic ecotoxicity increased by 15%, compared to the baseline recycling scenario.

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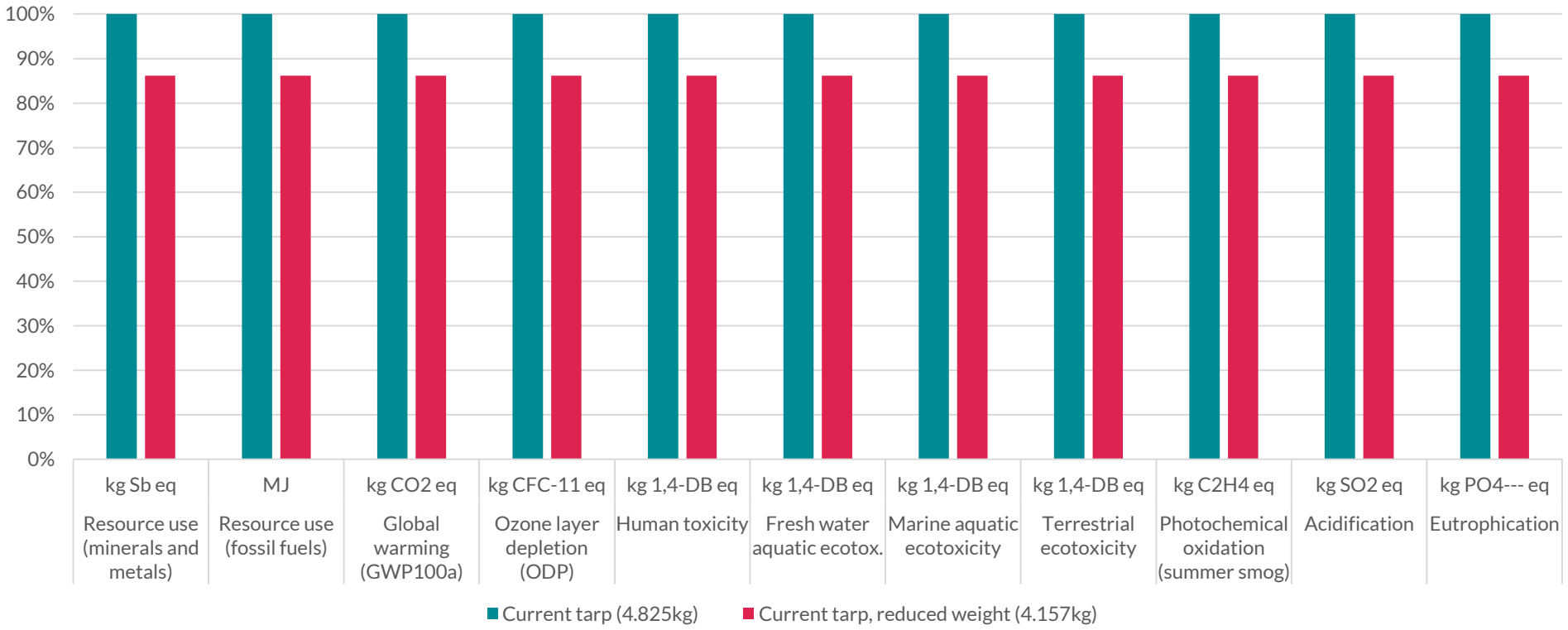
Additional information

Use phase

- It is expected that the new tarpaulin is more durable and can be used for 4years.
- That means ICRC can reduce emissions by reducing the number of tarpaulin distribute to the people as the new tarpaulin has longer life span.
  - E.g. ICRC distributes tarpaulin to 100 people. With current tarpaulin: 200 pieces of tarpaulins in 4 years; while new tarpaulin: 100 pieces in 4 years.
  - GWP saving= no. of current tarp x 20 kg CO_2 eq – no. of new tarpaulin x 17 kg CO_2 eq = 2300 kg CO_2eq.
- The quality of the new tarpaulin are awaiting for testing.

Decision for eco-design new tarpaulin

–Impact of weight reduction, 1 piece of tarpaulin (6x4m)

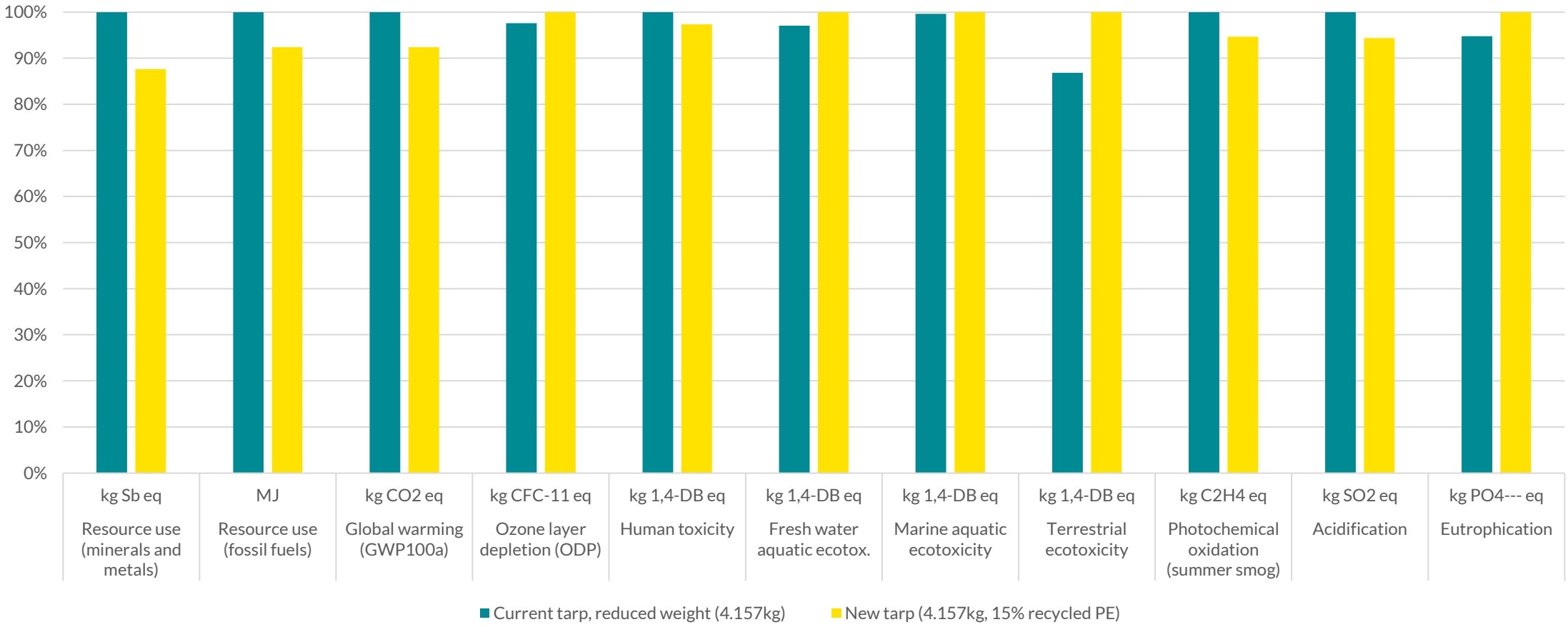


If the current tarpaulin reduce weight (190gsm to 170gsm), it reduced the emissions in the whole life cycle stage (raw materials production, manufacturing of tarpaulin, transportation, EoL) and all impact categories will reduced by approximately 14%.

Decision for eco-design new tarpaulin

–Impacts of substituting 15% recycled PE, 1 piece of tarpaulin(6x4m)

Cradle to gate (raw material production)



(Slide 20)

- For substituting 15% recycled PE, it is predicted only the life stage of raw material production will be affected. The results showed that there are 6 out of 11 impact categories reduced impacts, ranging 3-12% when 15% recycled PE is used. E.g. reduction can be observed in resource use (minerals and metals) by 12%, resource use (fossils) and GWP, both by 8%; while human toxicity, photochemical oxidation and acidification only reduced by 3-6%.

- However, there are 4 out of 11 impact categories have higher impacts than the current tarpaulin (170gsm) , ranging 2-13% (i.e. ozone layer depletion 2%, terrestrial ecotoxicity13%, freshwater aqua ecotoxicity 3% and eutrophication 5%) . This is mainly due to the recycled PE comes from plastic waste that recovered from the waste streams (landfilling/open dump) and need to be cleaned and sorted.

- Meanwhile, there is no change in marine aquatic ecotoxicity.

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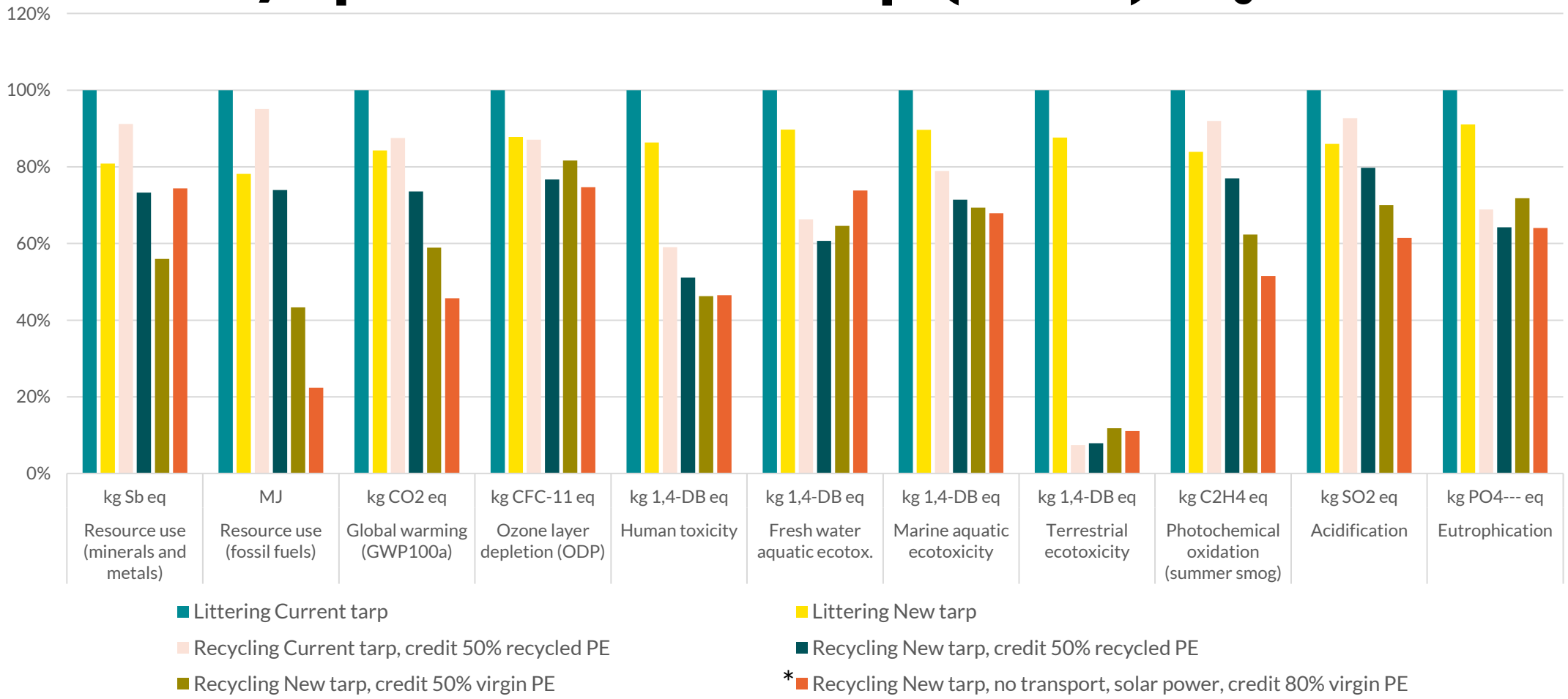
Comparison of environmental impact of current and new ICRC PE tarpaulin with different end of life scenarios, 1 piece of ICRC tarp (6x4m) – highest value set to 100%



* This is an idealized hypothetical scenario.
Please note that the results are calculated using Ecoinvent v3.8.

(Slide 22)

- If we considered the whole life cycle and compared the same EOL scenario for the new and current tarpaulin, e.g. For the case of littering, significant reductions can be observed in all impact categories, ranging 9- 22%.

- For recycling scenario that credit 50% recycled PE, the new tarpaulin have lower emissions in all impact categories, ranging 5-21%, compared to the current tarpaulin.

- These reductions are mainly due to the new tarpaulin is lighter, and also use of 15% recycled PE. In addition, the new tarpaulin required slightly higher energy consumption (per kg) than the current tarpaulin, which partially offsets the reductions in some impact categories when the full life cycle of tarpaulin is considered.

- Recycling is important as it reduces the environmental performance of the tarpaulin. Consumption of renewable solar power can contribute less GWP, however, it caused higher emissions on other impact categories, e.g. freshwater aquatic ecotoxicity. Note that assumptions made in the recycling activities (e.g. recycling efficiency) highly influence the results.

- Note that the toxicity of microplastics and additives used in the recycled PE to function as virgin PE are not considered in the inventory or the LCIA, so it cannot be shown in the results.

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Thank you!

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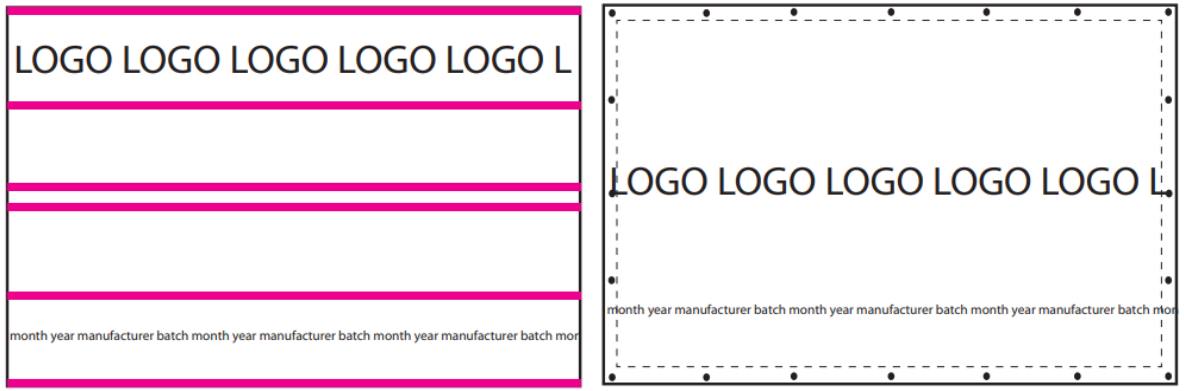
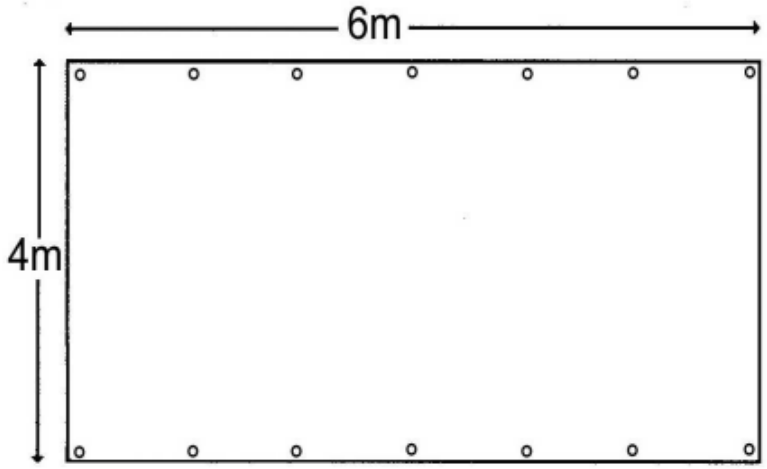
Appendix – ICRC woven PE tarpaulin

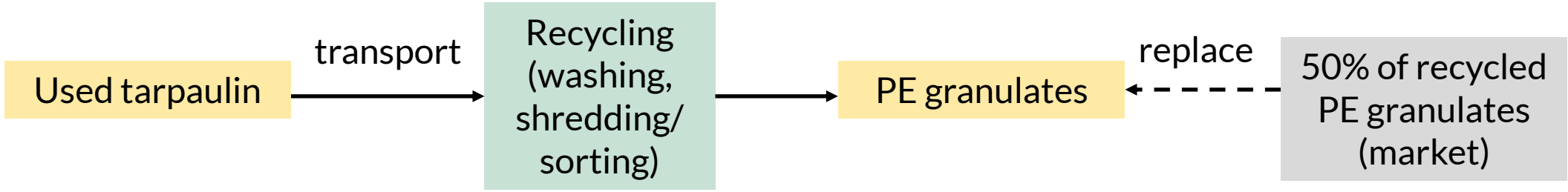


plastic sheets: left with reinforcement bands, right with seamed edges and eyelets



Appendix – Recycling scenarios

Baseline (current and new tarpaulin)



Sensitivity analysis(new tarpaulin)