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RedFR – Gnosys Summary

Work Package D – Life Cycle Assessment

RedFR Final Consortium Meeting

2nd February 2011

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Introduction

- The goal of this life cycle assessment (LCA) is to evaluate the environmental performance of recycled short fibres and sustainable flame retardant filling pads for potential use in a mattress application in comparison with a chosen industry standard.
- This is a comparative LCA and the functional unit is:
  - *The production of one filling pad for use in construction of 1 double sized mattress, dimensions 135cm in width and 190cm in length, to meet specific standards, for example with respect to UK fire performance standards (BS 5852: Part 1 (1979) and BS 5852: Part 2 (1982)) and also functionality and comfort, when installed in a mattress. The nonwoven pad is polypropylene backed and has a filling loading of 1050 g/m^2*
- The study could be classified as a cradle to gate LCA, with the system boundary beginning with the collection and sorting of recycled textiles and ending at the factory gate, with the non-woven pads produced.

"A Guide to the Furniture and Furnishings (Fire) (Safety) Regulations", published by BERR, http://www.berr.gov.uk/files/file24685.pdf

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Cases Examined

- Three scenarios represent options that are possible utilising current materials and technologies
- Current situation
  - Utilising wool, available within recycled textiles, as the fire retardant component
- Virgin wool case
  - This scenario assumes that the volume of wool available in the mixed textile waste stream has diminished to a point where it is contributing negligible amounts to the available fibre types. Therefore, the virgin wool is added to augment the “recycled” as it is added to meet current requirements in nonwoven pad production, to achieve the same fire retardancy
- Conventional FR
  - An ammonium phosphate salt, currently used in some applications, can be applied to the nonwoven pad, which is then dried conventionally, in an industrial oven

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Cases Examined

- Investigation into fire retardants marketed as sustainable and green options yielded a number of potential candidates which were narrowed down in actual trials to result three additional case studies for comparison against the benchmarks:
  - Ecoflam
  - Apyrum 201/MHE – potassium salt option
  - Apyrum 101/MHE – sodium salt option
- These three fire retardants are applied topically to the nonwoven pad (as with the conventional FR) and dried using Infrared lamps.

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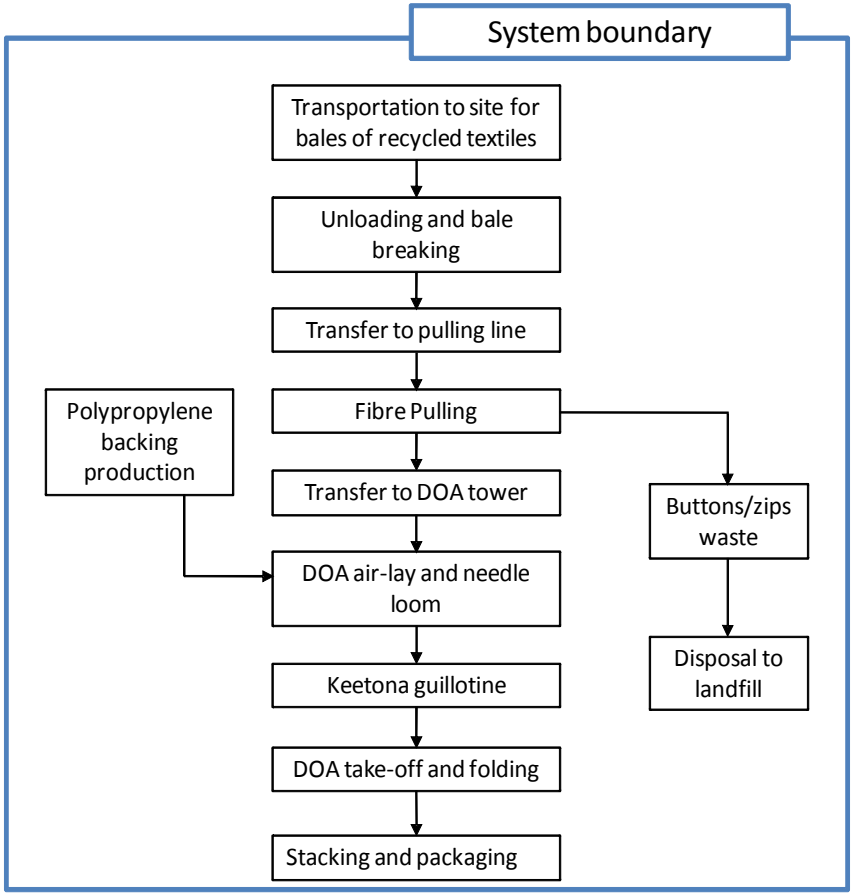
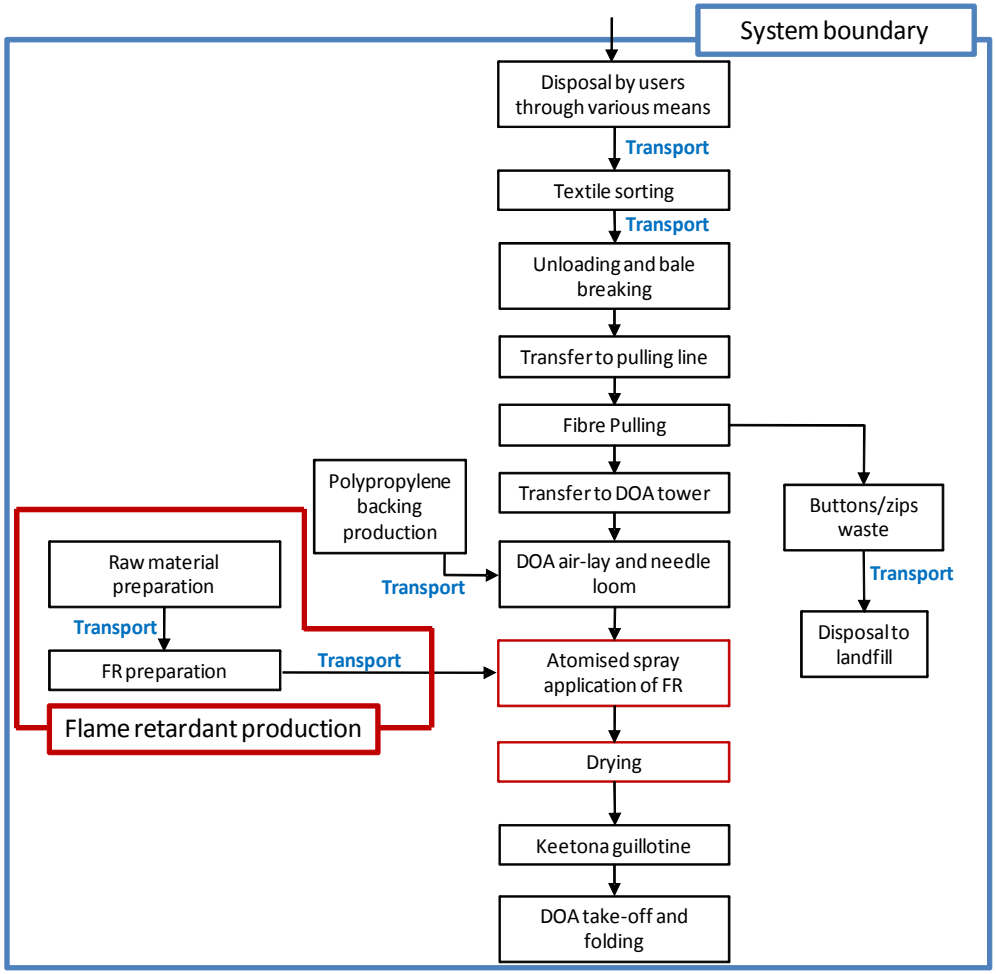
Impact categories

- The method used to calculate the impacts of the case studies was the CML 2001 which considers the following impact categories:
  - Abiotic depletion – related to the depletion of non-renewable resources
  - Acidification – contribution to acidification via e.g. acid rain
  - Eutrophication – promotion of excessive algae growth leading to damage of water ways
  - Global warming potential (GWP100) – emissions contributing to global warming
  - Ozone layer depletion – contribution to stratospheric ozone depletion
  - Human toxicity - emissions impacting on human health, detrimentally
  - Fresh water aquatic ecotoxicity – emissions impacting on aquatic life
  - Marine aquatic ecotoxicity – emissions impacting on aquatic life
  - Terrestrial ecotoxicity – emissions impacting on terrestrial life
  - Photochemical oxidation – emissions contributing to smog formation

System boundary





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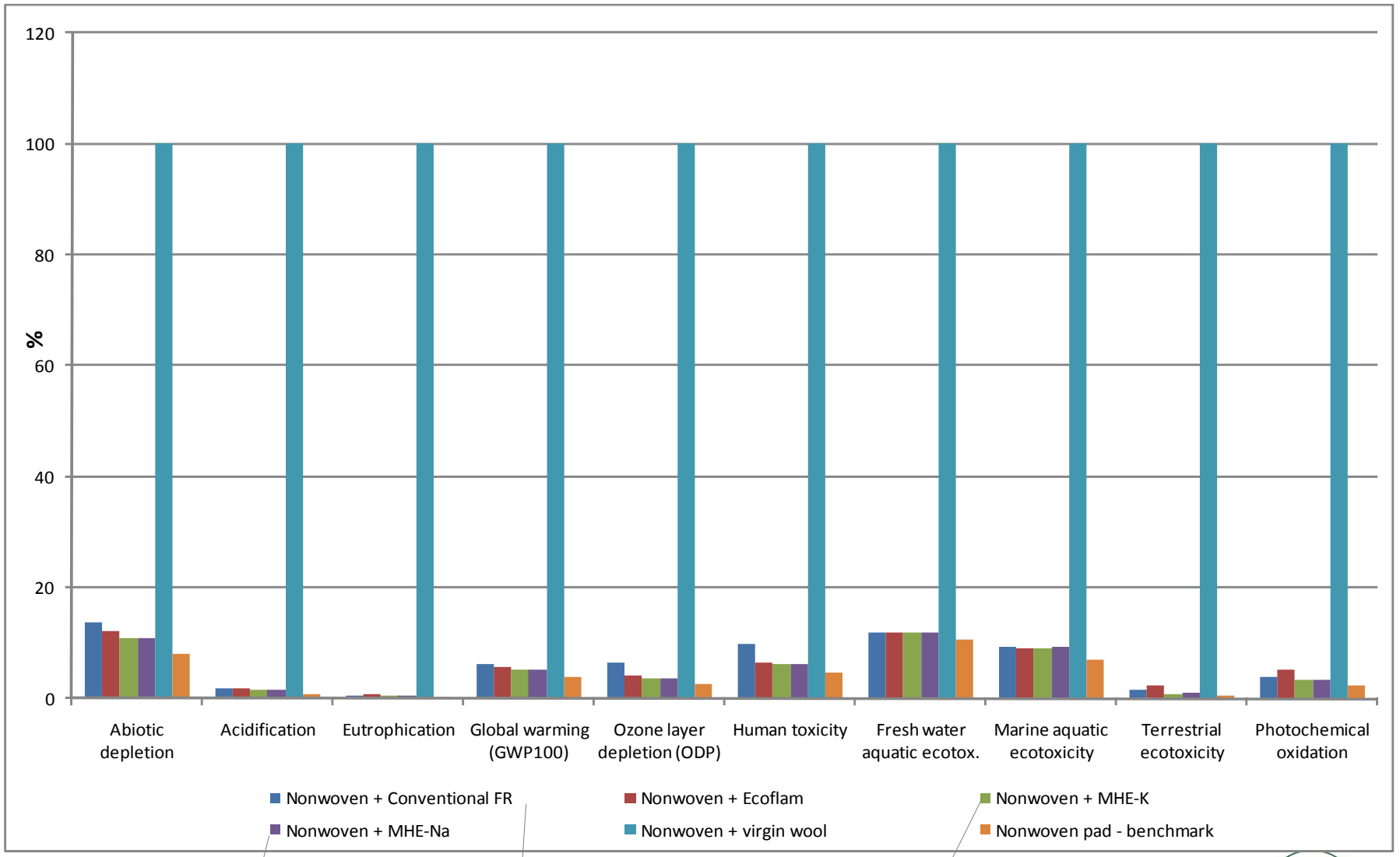
Comparison of all scenarios I



Apyrum 101

Ammonium phosphate salt

Apyrum 201

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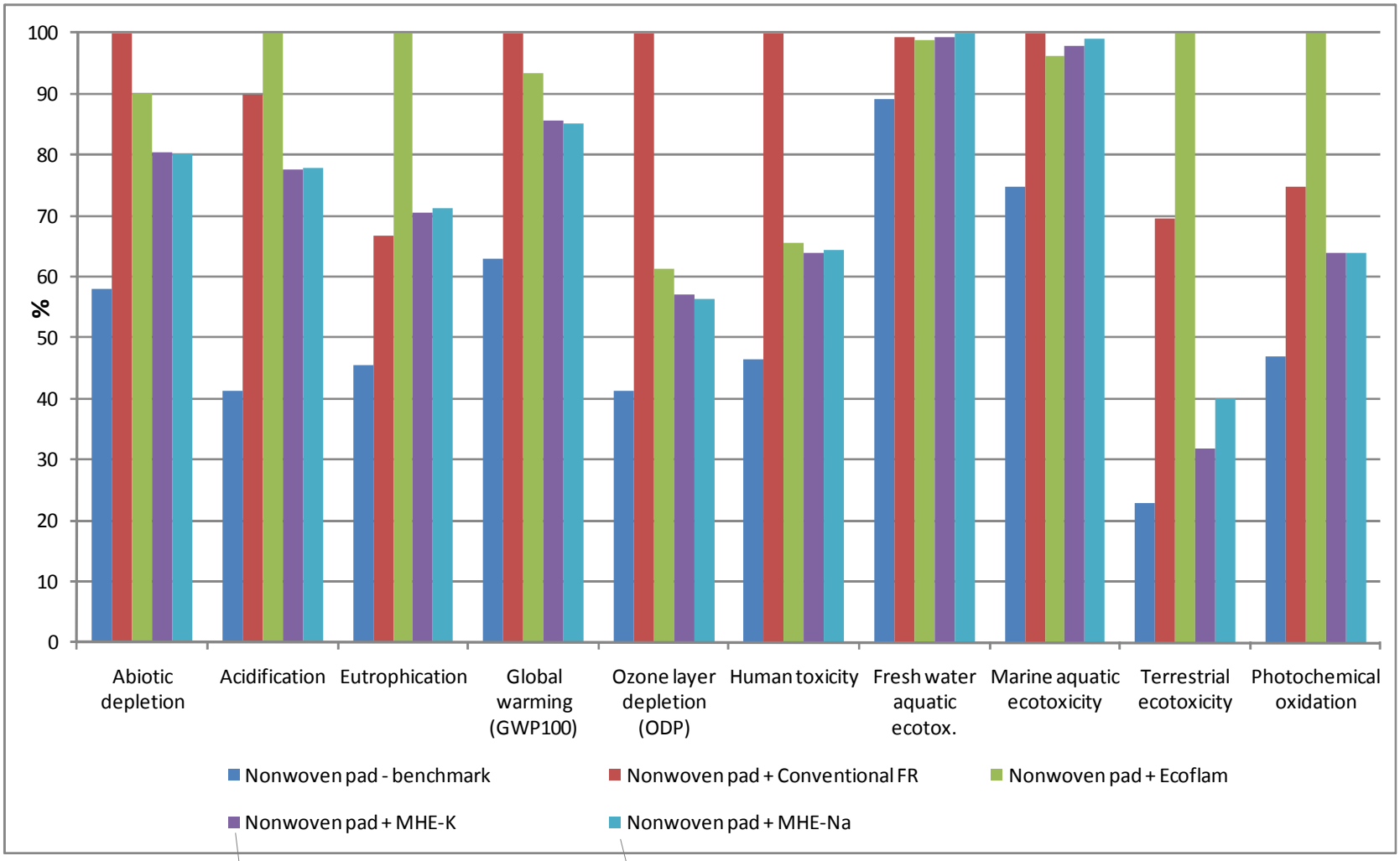
Comparison of all scenarios II



Apyrum 201

Apyrum 101

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Sensitivity Analysis

- Assumptions made in the main body of the report need to be examined to test the "sensitivity" of these issues, i.e. If a different assumption had been made, how would this have impacted on the results
- Some examples of the sensitivity analyses done are:
  - **Physical state of Apyrum/MHE**
    - Apyrum/MHE can be provided as a solid or liquid product, there are additional impacts associated with producing a solid product, however, these may be offset by the difference in delivery volumes and associated impacts
  - **Application concentration**
    - Application at 20g/m^2 of solid product was assumed. For Eco-flam this was sufficient to achieve the required fire retardancy. In Apyrum/MHE the results were more variable and a higher application concentration may be required
  - **Apyrum/MHE binders**
    - It was also suggested that addition of a binder to Apyrum/MHE may increase its fire retardancy in this application. The impacts of a number of suggestions were examined

Sensitivity Analysis:
Physical state of Apyrum/MHE

Scenario I:

Delivery of Apyrum/ MHE-Na as an aqueous solution, at 50% solid by weight. Diluted further for application (at 60 g/m^2, 20g/m^2 of which are solid). Sourced locally (UK)

Scenario II:

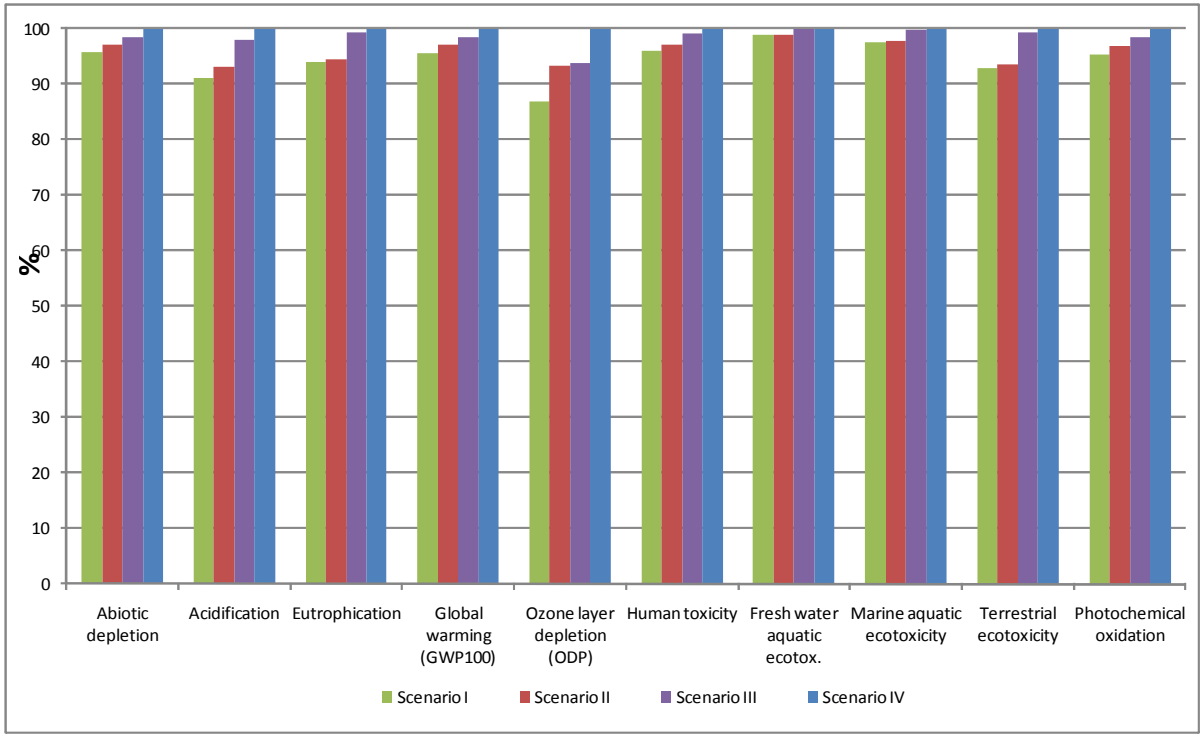
Production and delivery of Apyrum/MHE-Na as a solid product for dilution on-site. Requires a drying stage (assumed heating the solution using gas) Sourced locally (UK)

Scenario III:

Delivered as an aqueous solution, as above. Sourced from Sweden (Trulstech) transported 1060 km by sea and 600 km by road.

Scenario IV:

Supplied as a solid product . Sourced from Sweden (Trulstech), transported 1060 km by sea and 600 km by road).



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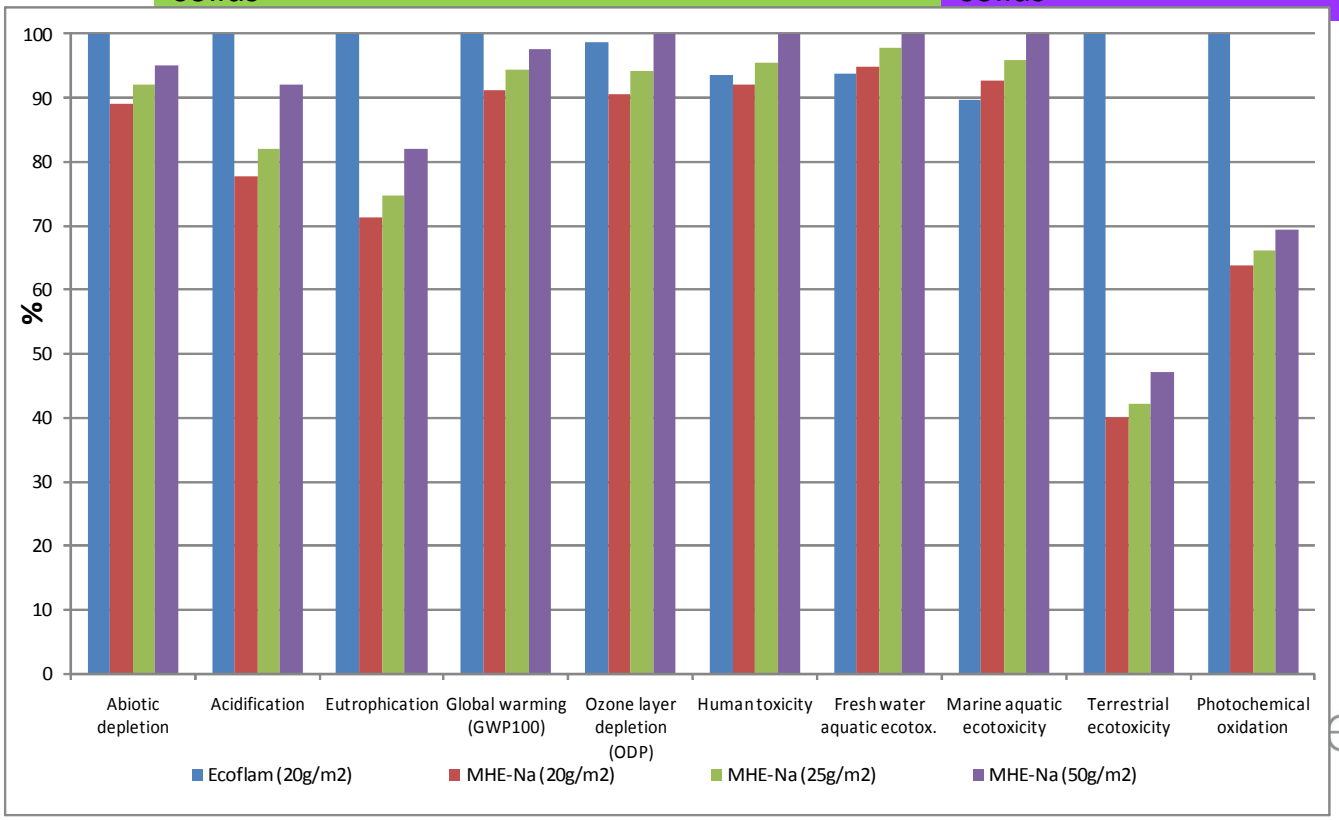
Sensitivity Analysis:
Application concentration

Scenario 1: Nonwoven pad + Ecoflam – at benchmark application levels (20 g/m² solids)	**Scenario 2:** Nonwoven pad + Apyrum/MHE-Na – at benchmark application levels (20 g/m² solids)
Scenario 3: Nonwoven pad + Apyrum/MHE-Na – at 25 g/m² solids	**Scenario 4:** Nonwoven pad + Apyrum/MHE-Na – at 50 g/m² solids



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Sensitivity Analysis: Apyrum/MHE binder

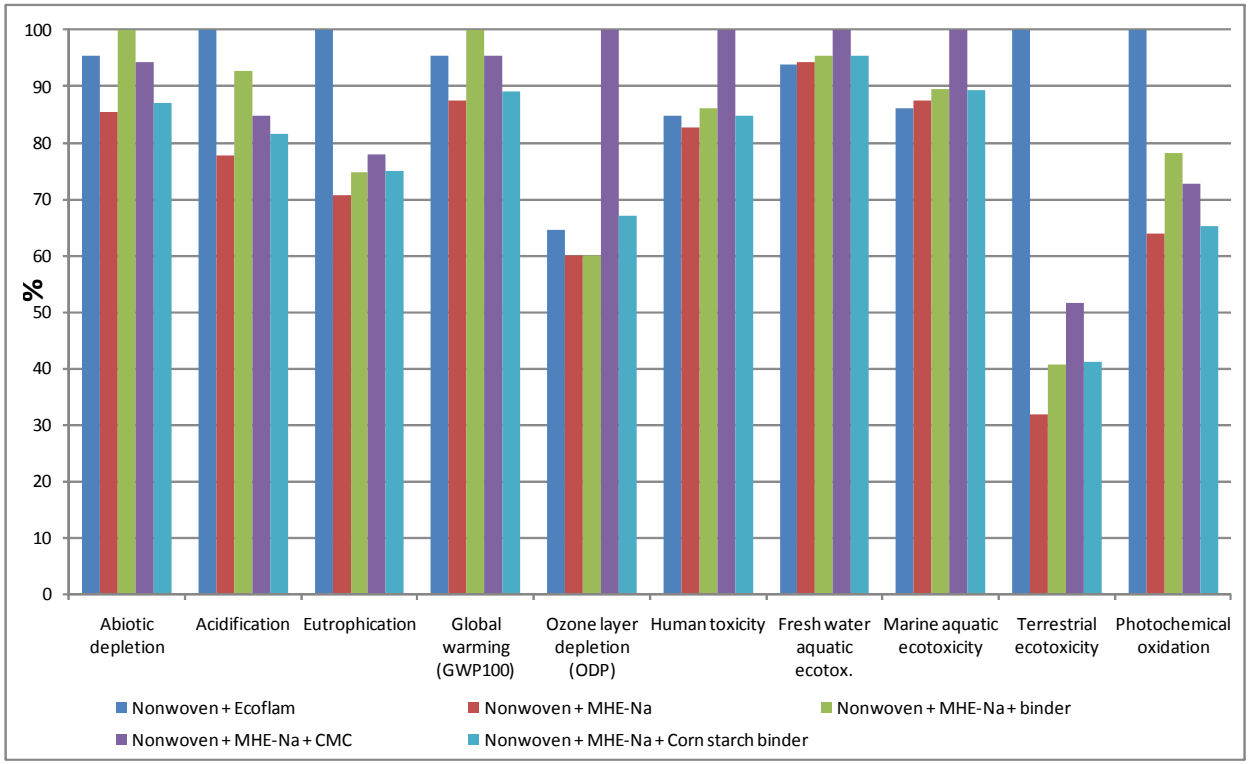
Ecoflam treated:
Treated with Ecoflam at 20 g/m²

Apyrum/MHE-Na treated:
Treated with Apyrum/MHE-Na at 20 g/m² with no binder present

Apyrum/MHE-Na treated, with binder:
The binder in this scenario is the same as that used in the Ecoflam product, at 20% weight

Apyrum/MHE-Na treated, with CMC binder:
CMC binder is present at 20% weight

Apyrum/MHE 201sv treated:
Available product which contains a binder, in this case corn starch, assumed to be present at 20% weight



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Conclusions I

1. Results suggests that using virgin wool in these product is not environmentally viable.
2. Of the three fire retardant systems examined Ecoflam shows the highest environmental impact, while the two Apyrum/MHE products are very similar given the assumptions made in this work.
3. On comparison of all the cases examined (excluding the virgin wool case) the two with the highest environmental impacts are use of the conventional fire retardant (ammonium phosphate salt) and use of Ecoflam to treat the nonwoven pads.
    a. The conventional FR dominates abiotic depletion, global warming potential, ozone layer depletion, and human and aquatic toxicity categories. Use of Ecoflam dominates acidification and eutrophication, terrestrial ecotoxicity and photochemical oxidation.
    b. Further classification of these impact categories to determine the most significant or relevant impacts would be very subjective, however, simply considering the number of impact categories, the conventional FR system contributes the most to the greater number.

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Conclusions II

- On examination of the sensitivity of the assumptions made:
  1. The transportation of materials appears to have a very small influence on the impact assessment.
  2. On the physical state of the Apyrum/MHE, it was found that the additional drying processes required to produce solid Apyrum/MHE increase the environmental impacts of the FR, which is not offset sufficiently by the reduction of loading in transport (as the solid product is not shipped in solution). This suggests that utilising aqueous Apyrum/MHE is the more environmentally favourable procedure.
  3. Application levels of Apyrum/MHE products, results suggest that the application level of Apyrum/MHE-Na could be increased by at least double before reaching an equivalent environmental impact to Ecoflam, at 20g/m^2.
  4. Impacts of adding binders to Apyrum/MHE-Na suggests that environmentally the product still performs relatively well against Ecoflam regardless of the binder used.

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