Life Cycle Assessment of A&I Packaging.

Greg Ganczewski

COBRO – Packaging Research Institute

ActInPak

COST
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

COST is supported by
the EU Framework Programme
Horizon 2020

COST Action FP1405

Active and intelligent fibre-based packaging – innovation and market introduction **(ActInPak)**

ActInPak is a pan European (COST) network of the leading experts in active and intelligent packaging of over 150 institutes, universities and companies from 37 countries. Main goal of action is to develop a knowledge-based network on sustainable, active and intelligent fibre-based packaging in order to facilitate its introduction on the market.

http://www.actinpak.eu
http://www.cost.eu/COST_Actions/fps/Actions/FP1405
https://www.linkedin.com/groups/COST-FP1405-ActInPak-8254568/about

COBRO – PACKAGING RESEARCH INSTITUTE

State, self-supporting research institution subordinated to the Ministry of Economy, founded in 1973.

Member of:

- World Packaging Organisation,
- International Association of Packaging Research Institutes,
- Polish Chamber of Packaging,
- European Bioplastics.

- Packaging R&D Department:
  - ✓ Packaging and Environment Department
  - ✓ Laboratory for Packaging Materials and Consumer Packaging Testing
- Laboratory for Transport Packaging Testing
- Certification Centre
- Standardization Department
- *Packaging Spectrum* Magazine

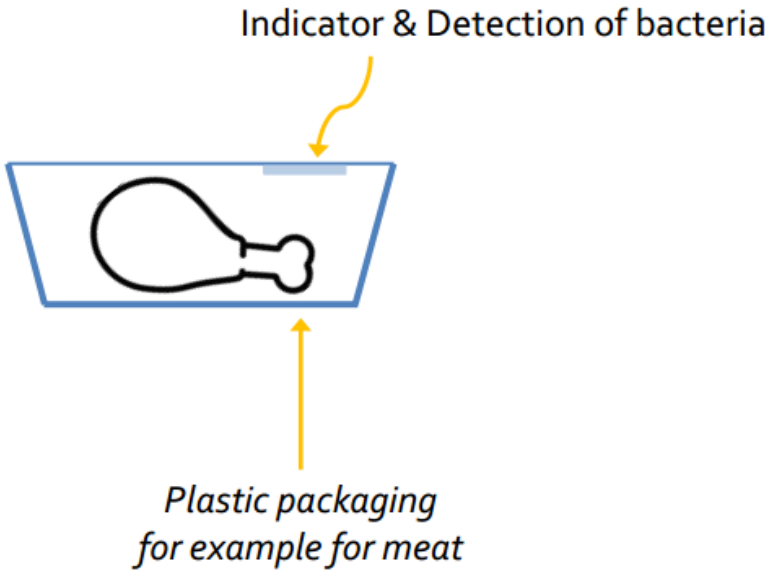
COST Action LCA

Presentation of demonstrator products

- 3 products - 1 intelligent / 2 active
- Products chosen and agreed upon in previous **ActInPak COST action** meetings
- Demonstrator products refined for LCA purposes:
  1. Intelligent indicator for meat products – assumptions that the indicator is binary – it either shows that the meat is fresh, or not.
  2. Packed bread active packaging – bread in active packaging does not have preservatives
  3. Fruits/Vegetables active corrugated box – strawberries chosen as the packed product.

ActInPak Demonstrators

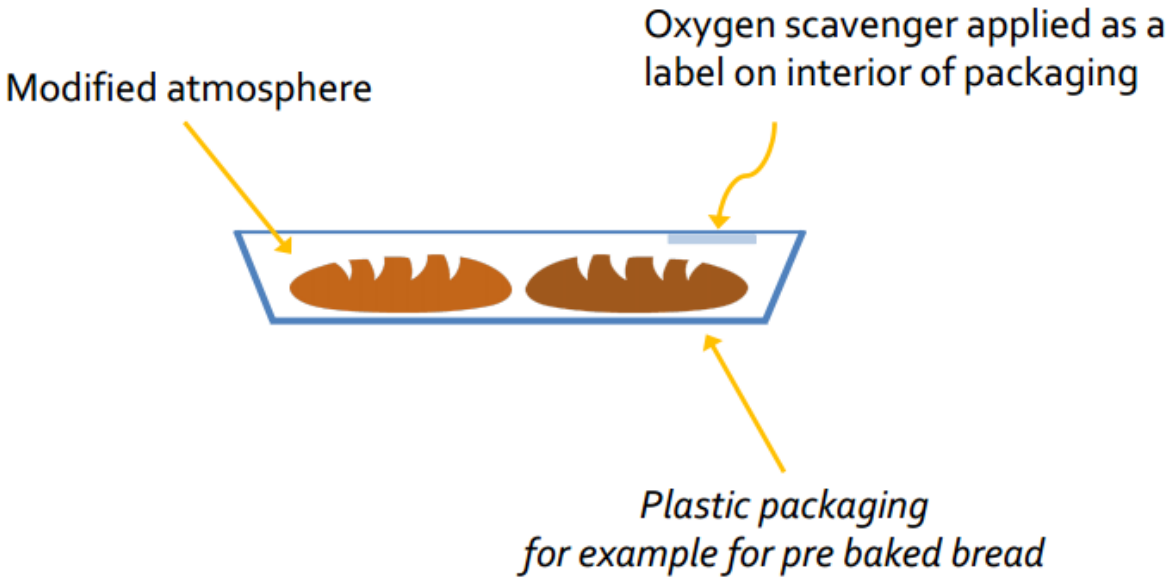
Demonstrator 1 – Intelligent



ActInPak Demonstrators

ActInPak Demonstrators

Demonstrator 2 – Active



ActInPak Demonstrators

ActInPak Demonstrators

Demonstrator 3 – Active

Antibacterial / anti mould
Corrugated layer sandwiched
between inner and outer layer

Corrugated box
for example for fruits

ActInPak Demonstrators

COST Action LCA

Discussion on the goal and target group of LCA - *Brain storm in 3 groups*

Common group decision:

Target of the LCA:

Brand Owner / Retailer / Packer

COST Action LCA

Discussion on the scope of LCA for all 3 demonstrator products - *Brain storm in 3 groups*

<u>Common group decision:</u>

Scope of all three LCA's:

Cradle to Grave – Product + Packaging – including three end of life scenarios

COST Action LCA

Discussion on the scope of LCA for all 3 demonstrator products - *Brain storm in 3 groups*

End of life scenarios:

- Recycling heavy
- Mixed
- Landfill heavy

COST Action LCA

Discussion on the functional unit for all 3 demonstrator products - *Brain storm in 2 groups*

1. **Intelligent meat packaging:**
   - ***100 kg of meat consumed***
2. **Active bread packaging:**
   - **100 kg of packed bread sold**
3. **Active strawberries packaging:**
   - **100 kg of strawberries consumed**

COST Action LCA

Intelligent meat packaging:

- ***100 kg of meat consumed***

Assumptions:

- **Packaging with indicator:**
  - Some loss before best before date (due to non optimal storage conditions)
  - Savings after best before date – indicator not activated after x days after best before date = increased consumption
- **Packaging without indicator:**
  - Certain loss after best before date

Meat Packaging (Indicator)

Assumptions:

- Meat chosen – **Fresh Beef – 500 g**
- Usual best before date if refrigerated is 3-5 day -> **4 days on average**
- According to *http://www.eatbydate.com* fresh meat can last **1 to 2 days** PAST its best before date before it begins to spoil

Meat Packaging (Indicator)

Assumptions:

We will test two scenarios:

- Indicator will show that the meat went bad **1 day after** best before date
- Indictor will show that the meat went bad **2 days after** best before date

Meat Packaging (Indicator)

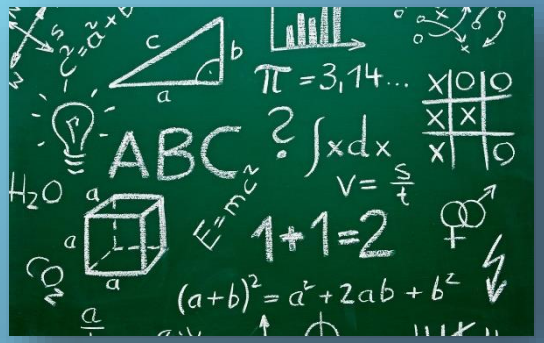
Assumptions:

- There is a possibility that the indicator will show that meat went bad **BEFORE** best before date (due to bad storing conditions or bad packaging, other error along the value chain)
- Let's assume that this will happen in **10% of cases**
- According to different sources about 15-30% of beef is wasted -> **20% on average**

Meat Packaging (Indicator)

Maths:

- 4 days average best before date:
  - *1 extra day = 25% more time to eat*
  - *2 extra days = 50% more time to eat*
- Adjusting to 10% chance of accidental early indicator firing off, that gives us:
  - *1 extra day = 15% more time to eat*
  - *2 extra days = 40% more time to eat*



Meat Packaging (Indicator)

Maths:

With 20% of beef being wasted the functional units for our three cases are the following:

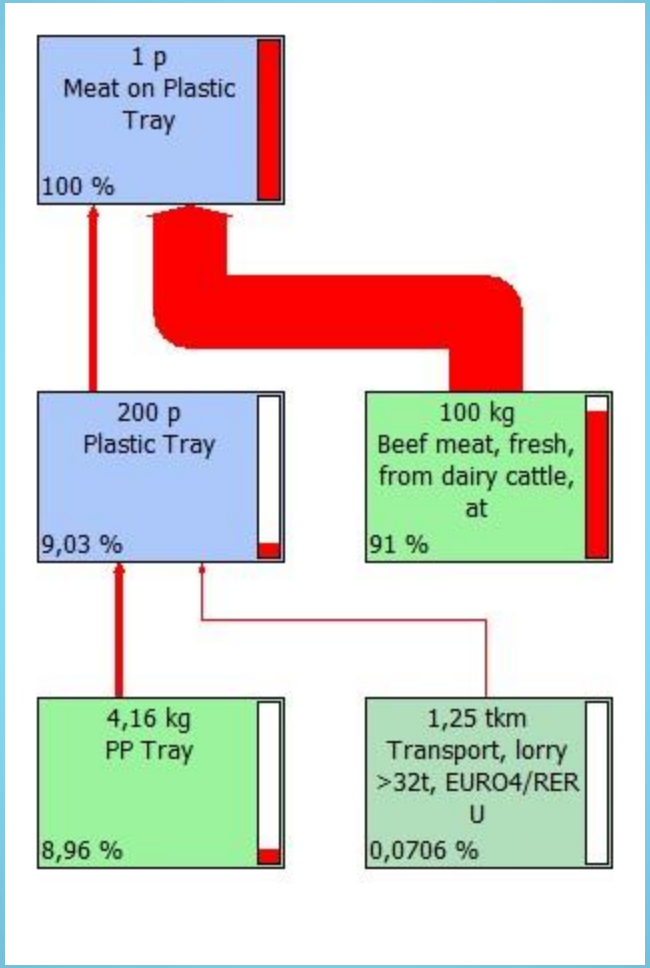
1. **Beef in normal packaging:**
   125 kg produced for consumption of 100 kg
2. **Beef with freshness indicator – 1 extra day:**
   121,25 kg produced for consumption of 100 kg
3. **Beef with freshness indicator – 2 extra days:**
   115 kg produced for consumption of 100 kg

Meat Packaging (Indicator)

Data Limitations:

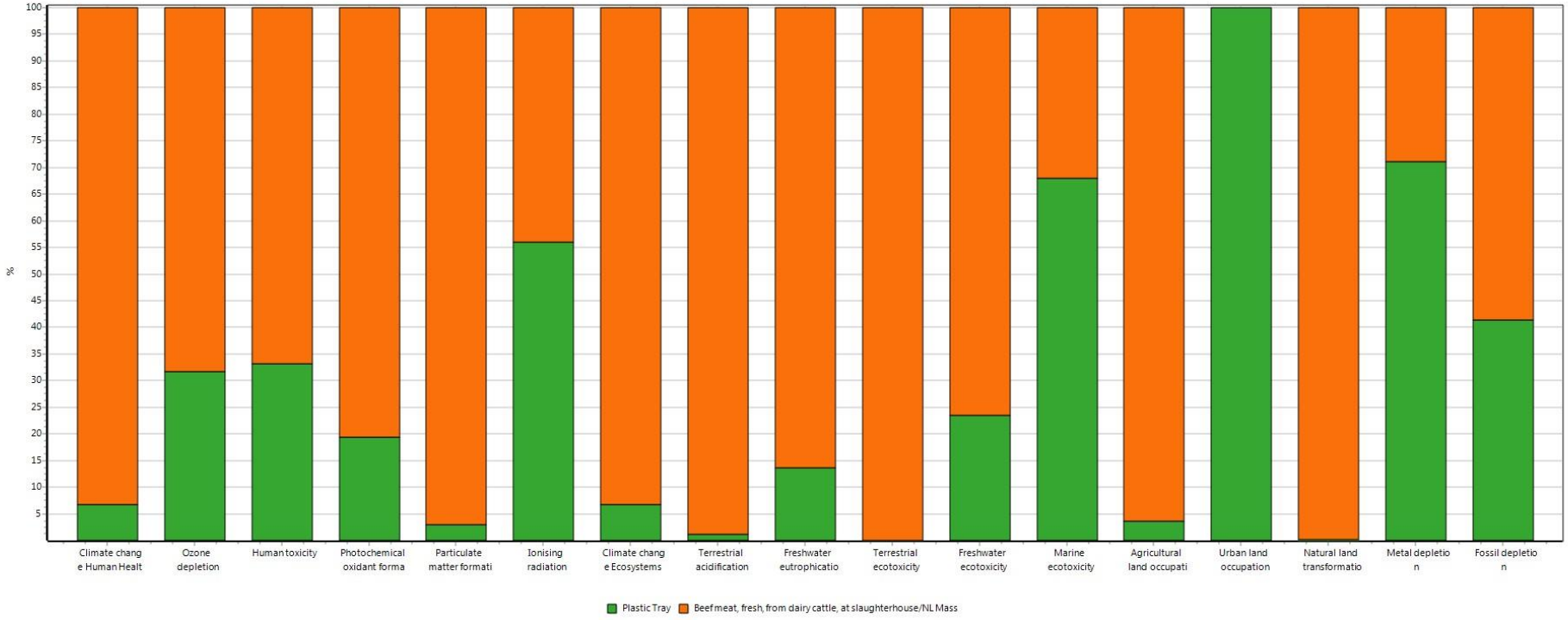
- No data about the actual indicator itself!!
  - Even though, it is probable that it will not have a very significant impact on the whole analysis, we need this urgently for the LCA to have sense!!
- Assumptions made can be changed, we can even devise more scenarios – we have to make a list
- End of life impact is still missing – I will model it very soon!!

Meat Packaging (Indicator)



Process Tree

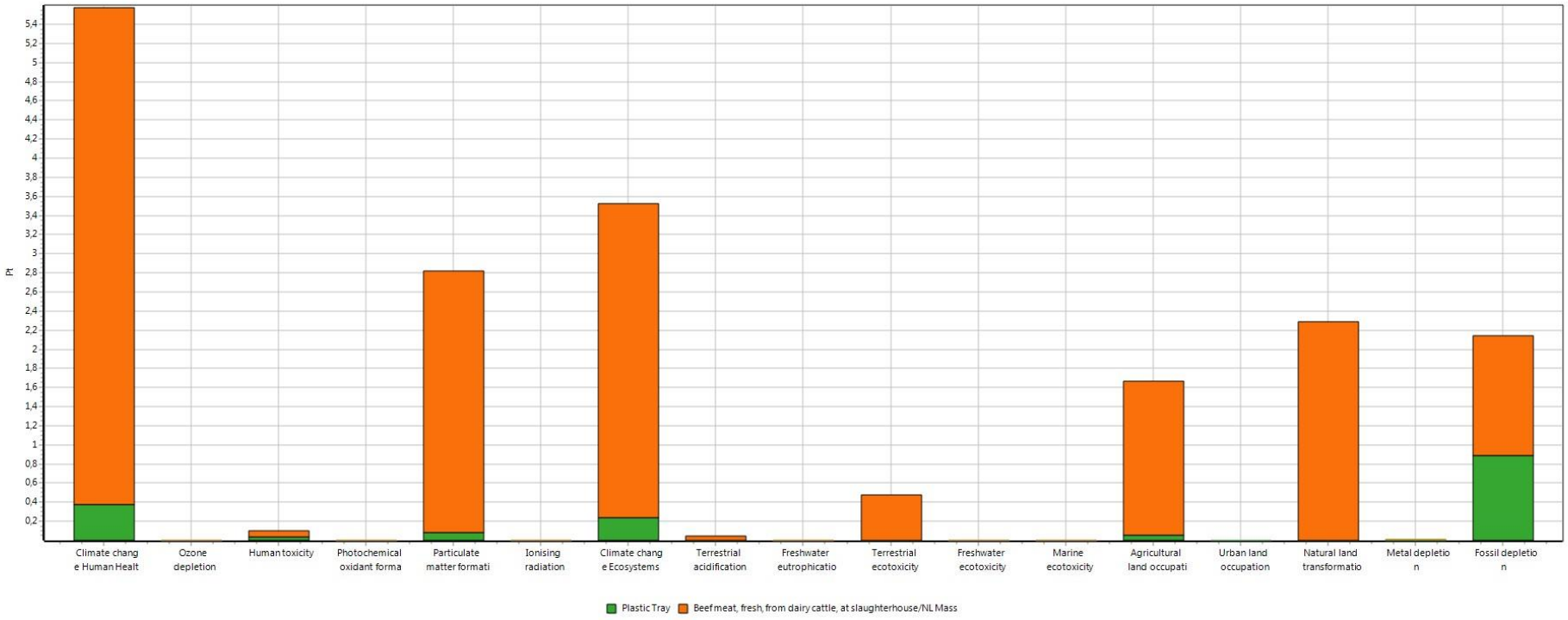
Meat Packaging (Indicator)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Damage assessment
Analysing 1 p 'Meat on Plastic Tray';

Damage Assessment

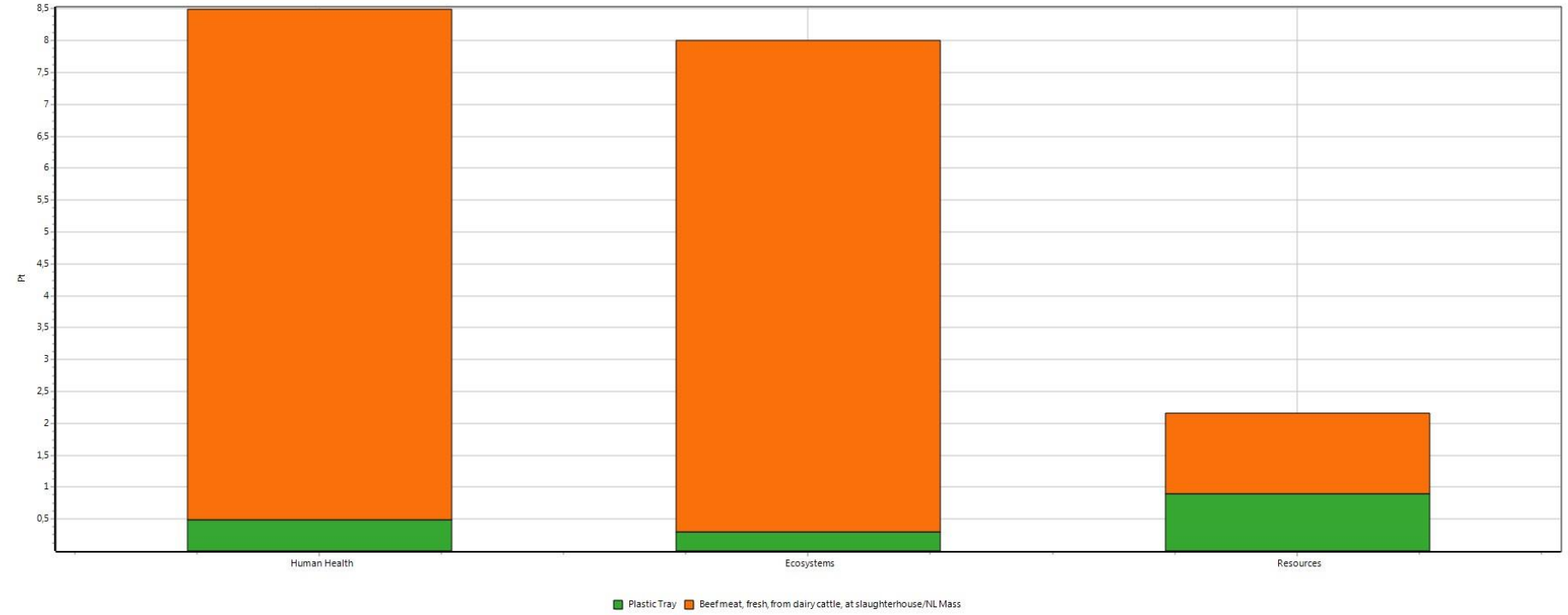
Meat Packaging (Indicator)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Analysing 1 p 'Meat on Plastic Tray';

Weighting

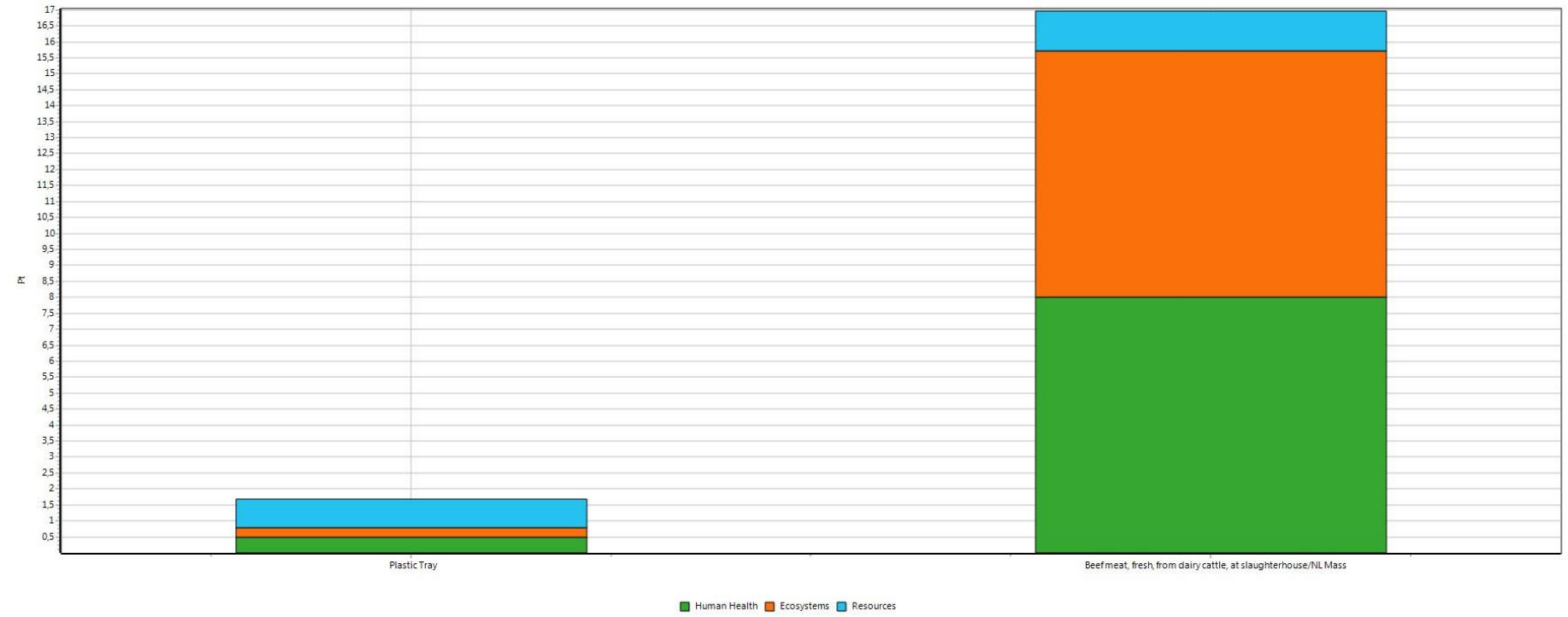
Meat Packaging (Indicator)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Analysing 1 p 'Meat on Plastic Tray';

Weighting – End-Point

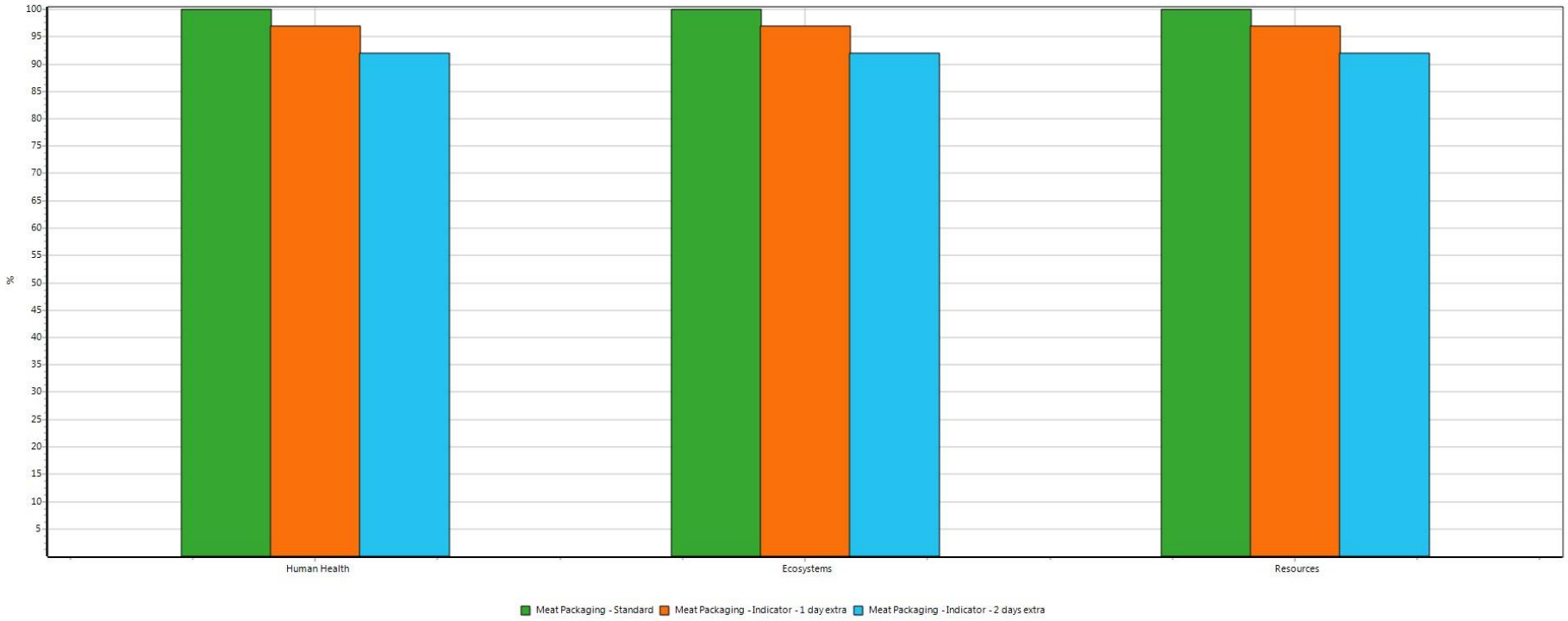
Meat Packaging (Indicator)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Single score
Analysing 1 p 'Meat on Plastic Tray';

Single Score

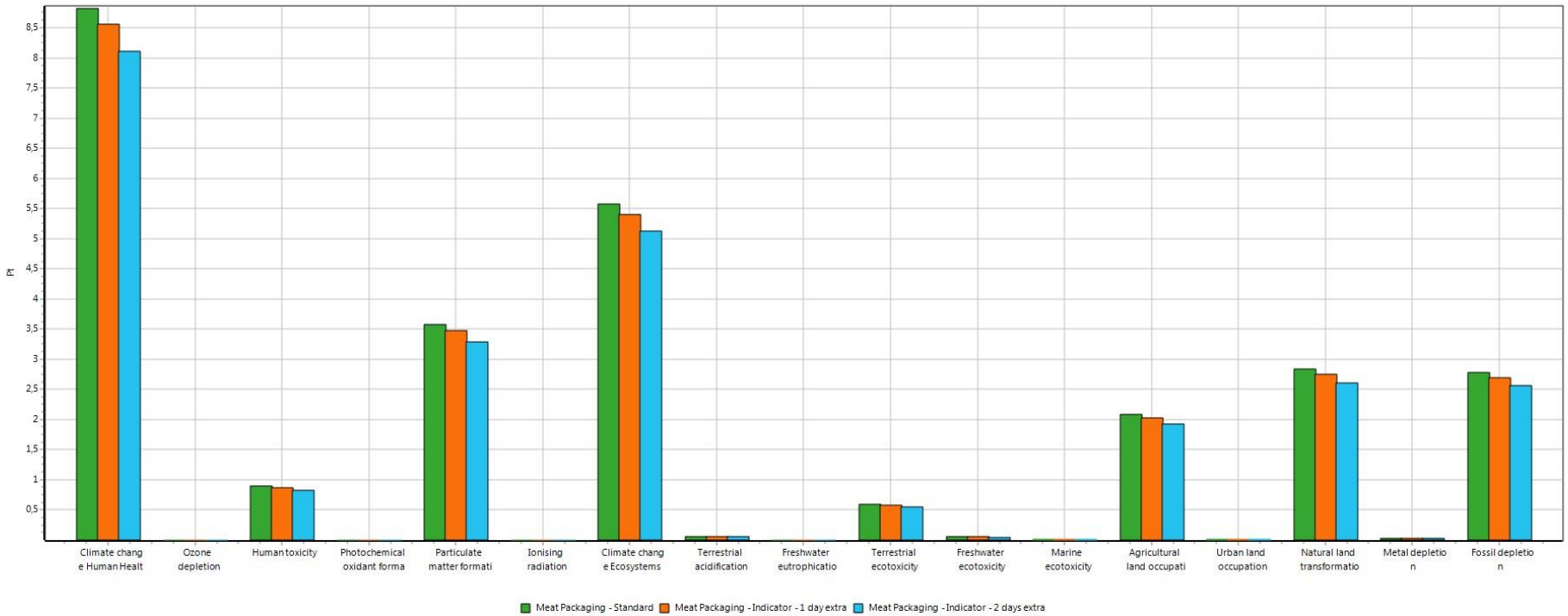
Meat Packaging (Indicator)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Damage assessment
Comparing 1 p 'Meat Packaging - Standard', 1 p 'Meat Packaging - Indicator - 1 day extra' and 1 p 'Meat Packaging - Indicator - 2 days extra';

Comparison – Damage Assessment – End Point

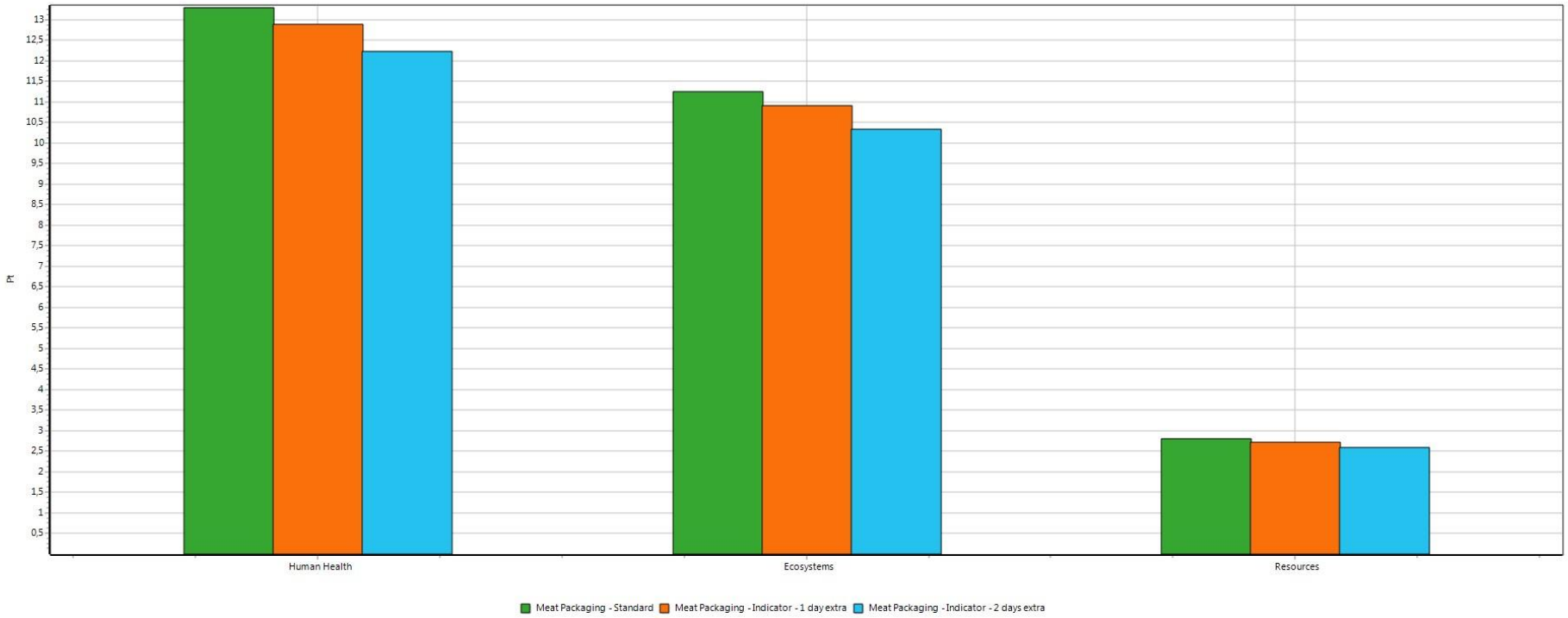
Meat Packaging (Indicator)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Comparing 1 p 'Meat Packaging - Standard', 1 p 'Meat Packaging - Indicator - 1 day extra' and 1 p 'Meat Packaging - Indicator - 2 days extra';

Comparison - Weighting

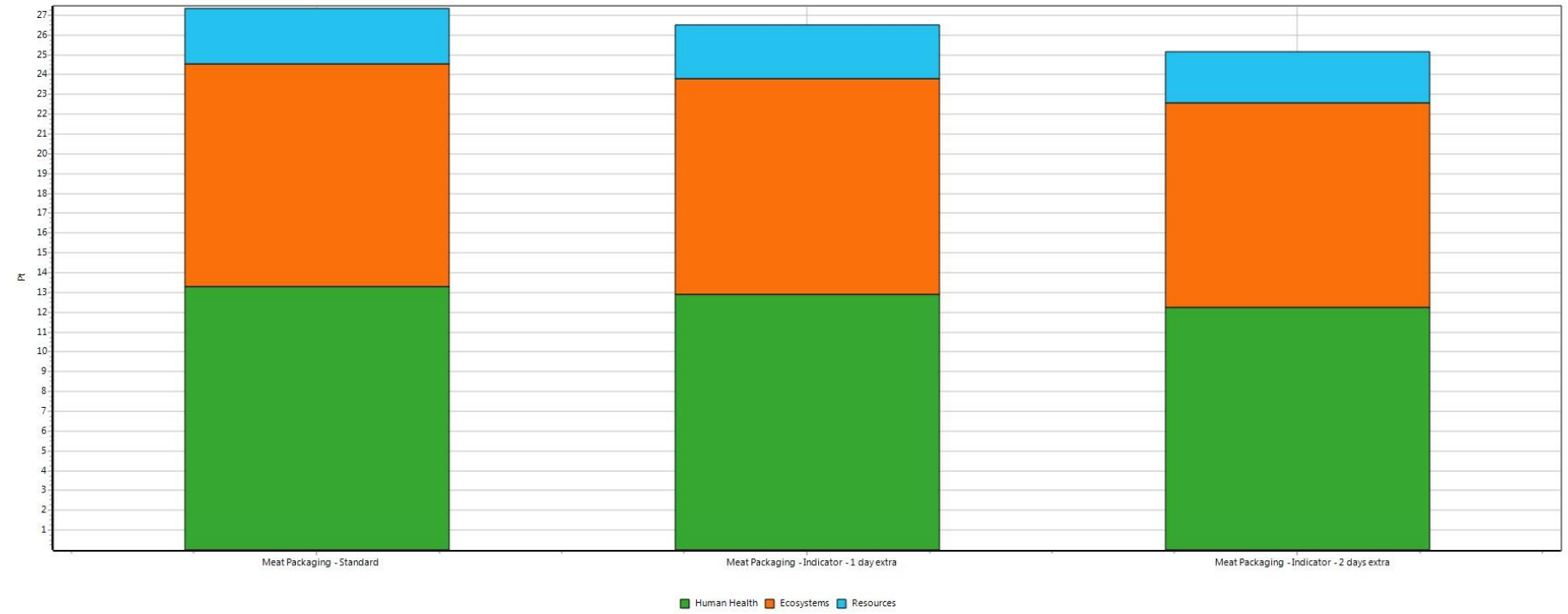
Meat Packaging (Indicator)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Comparing 1 p 'Meat Packaging - Standard', 1 p 'Meat Packaging - Indicator - 1 day extra' and 1 p 'Meat Packaging - Indicator - 2 days extra';

Comparison – Weighting – End Point

Meat Packaging (Indicator)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Single score
Comparing 1 p 'Meat Packaging - Standard', 1 p 'Meat Packaging - Indicator - 1 day extra' and 1 p 'Meat Packaging - Indicator - 2 days extra';

Comparison –Single Score

Bread Packaging

Active bread packaging:

- ***100 kg of packed bread sold***

Assumptions:

- **Packaging with active component:**
  - Bread without preservatives
  - Shelf life is the same as in packaging without active component
- **Packaging without active component:**
  - Bread with preservatives
  - Shelf life is the same as in packaging with active component

Bread Packaging

Assumptions:

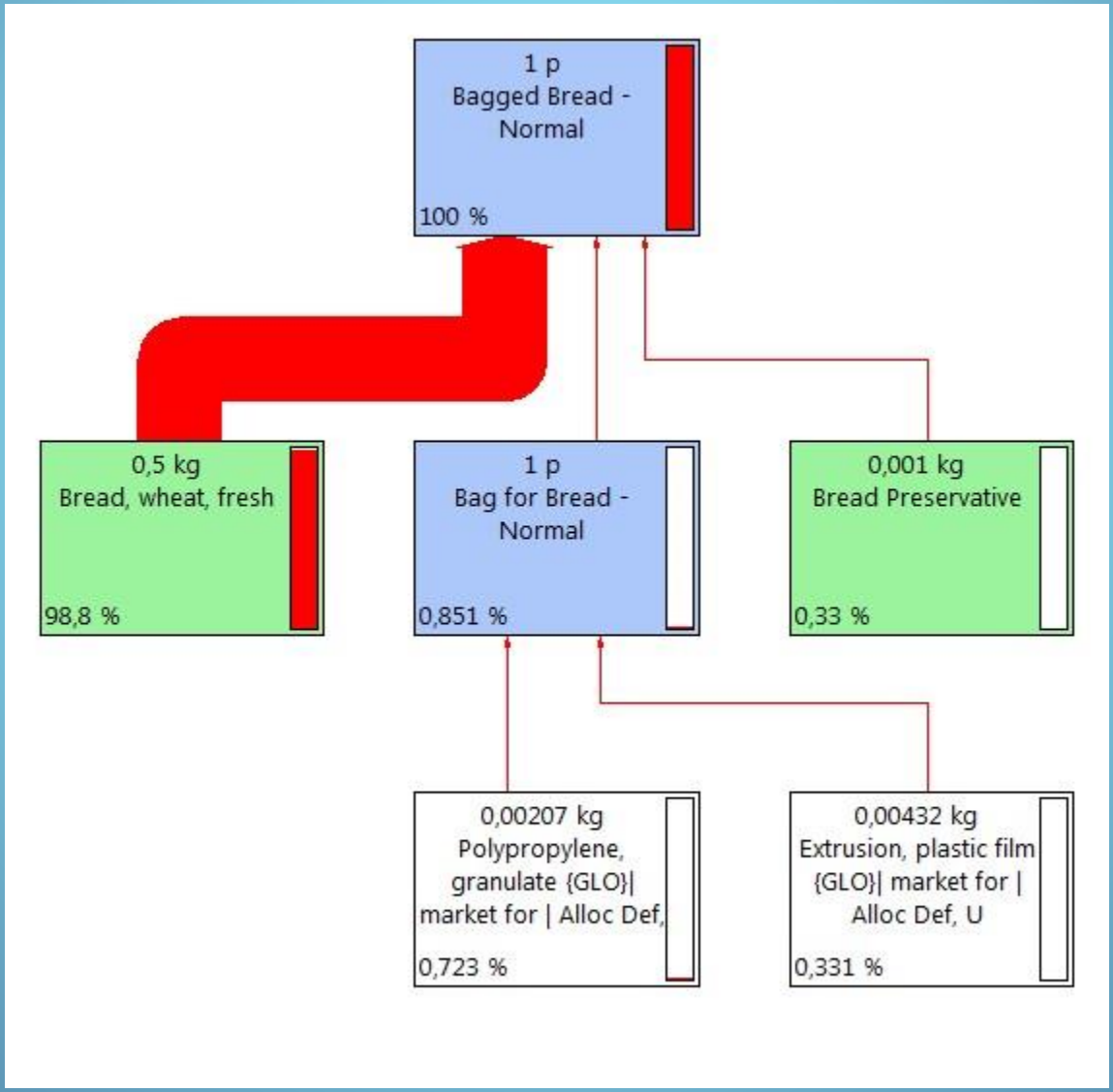
- Loaf – **500 g**
- Packaging – **PP film**
- Bread preservative – Propionic Acid:
  - **MAX allowed - 2000 mg/kg**

Bread Packaging

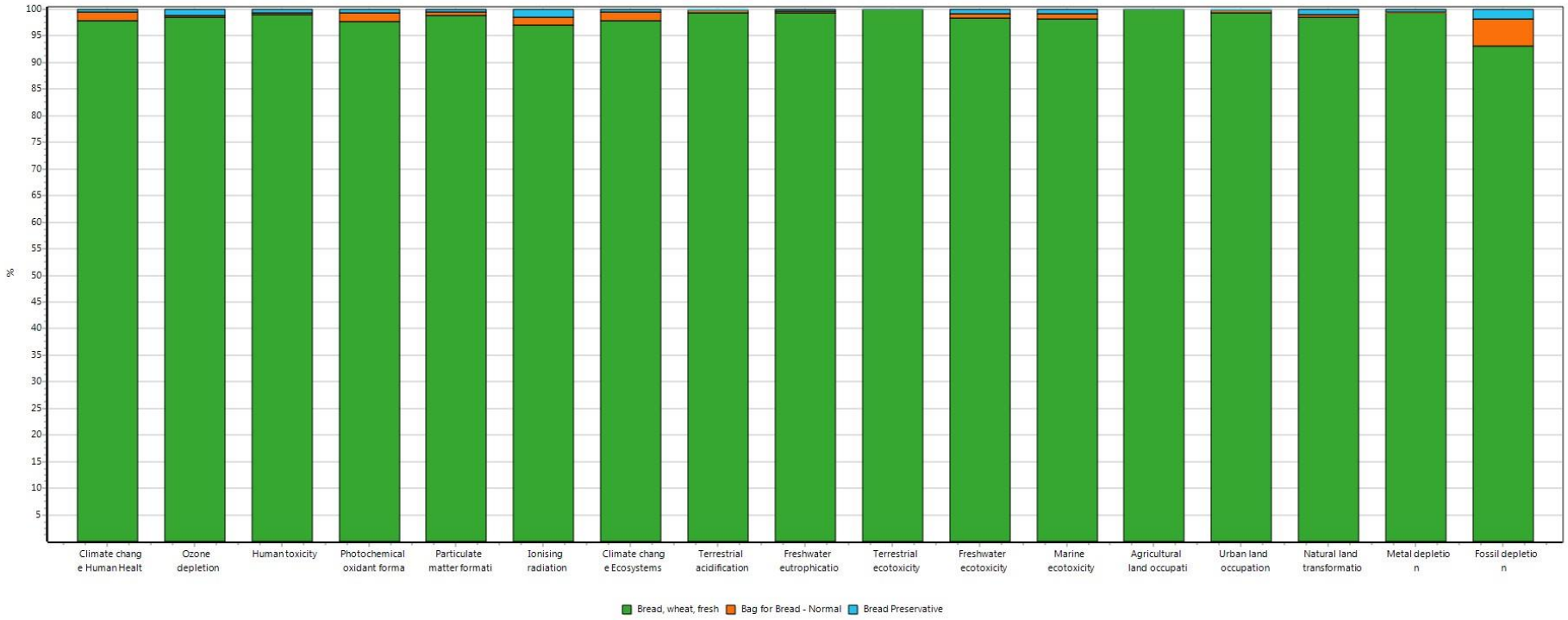
Data Limitations:

- Data about Oxygen Scavenger obtained!! However – processing data – energy consumption – is still missing.
- Missing data about bread preservatives processing – i.e. how and when the preservative is inserted into the flour – is it a separate step in bread production?
- End of life impact is still missing – I will model it very soon!!

Bread Packaging (Normal)



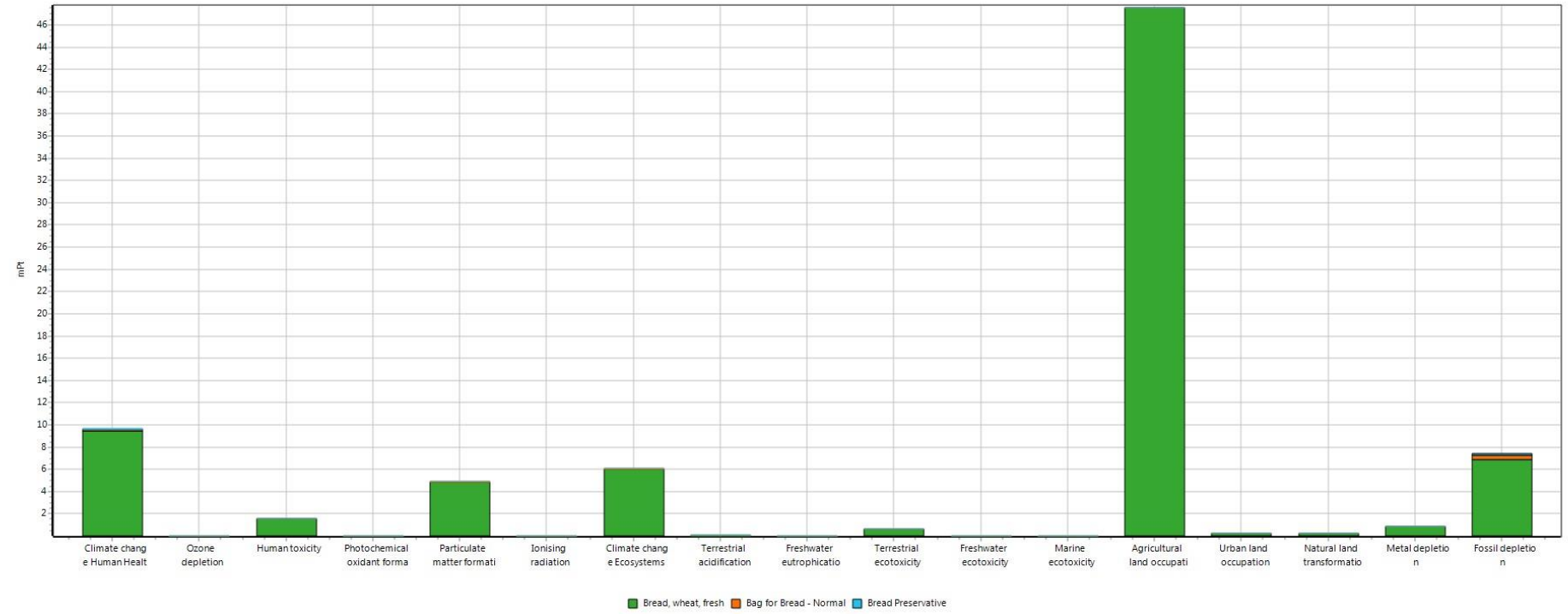
Bread Packaging (Normal)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Damage assessment
Analysing 1 p 'Bagged Bread - Normal';

Damage Assessment

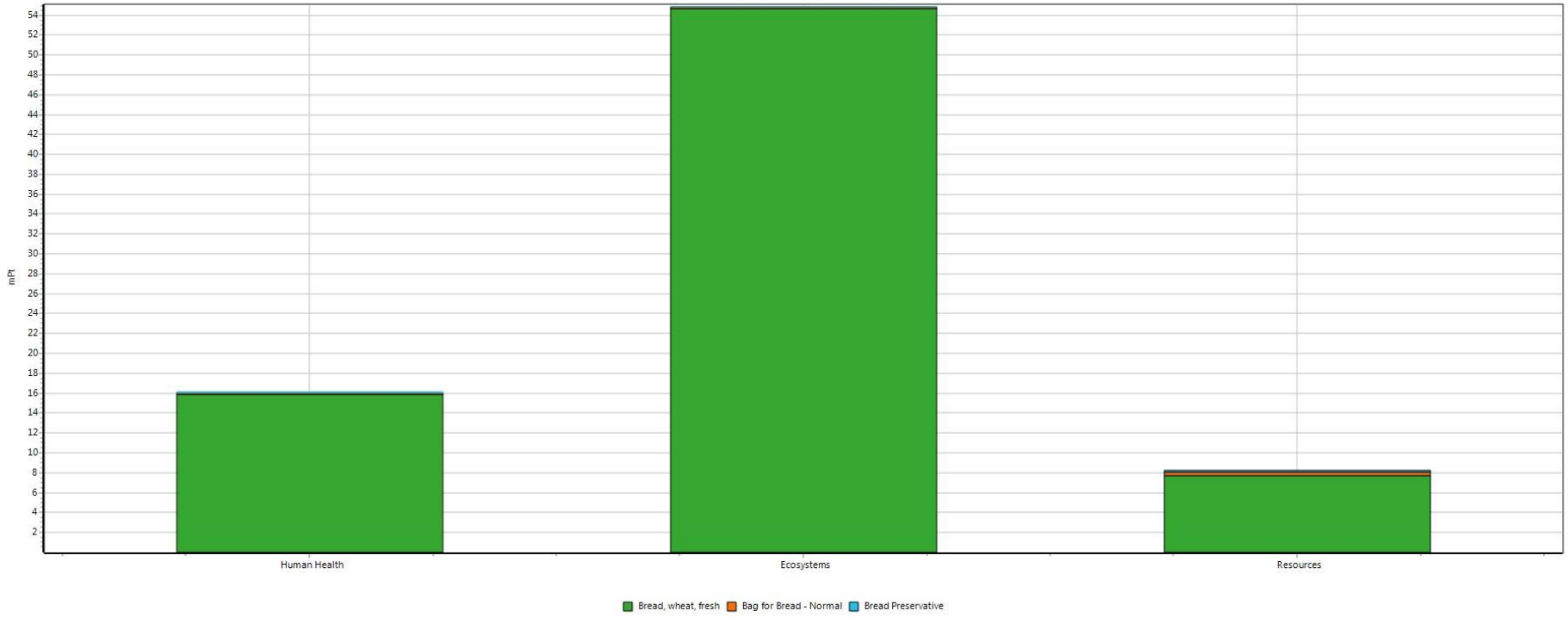
Bread Packaging (Normal)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Analysing 1 p 'Bagged Bread - Normal';

Weighting

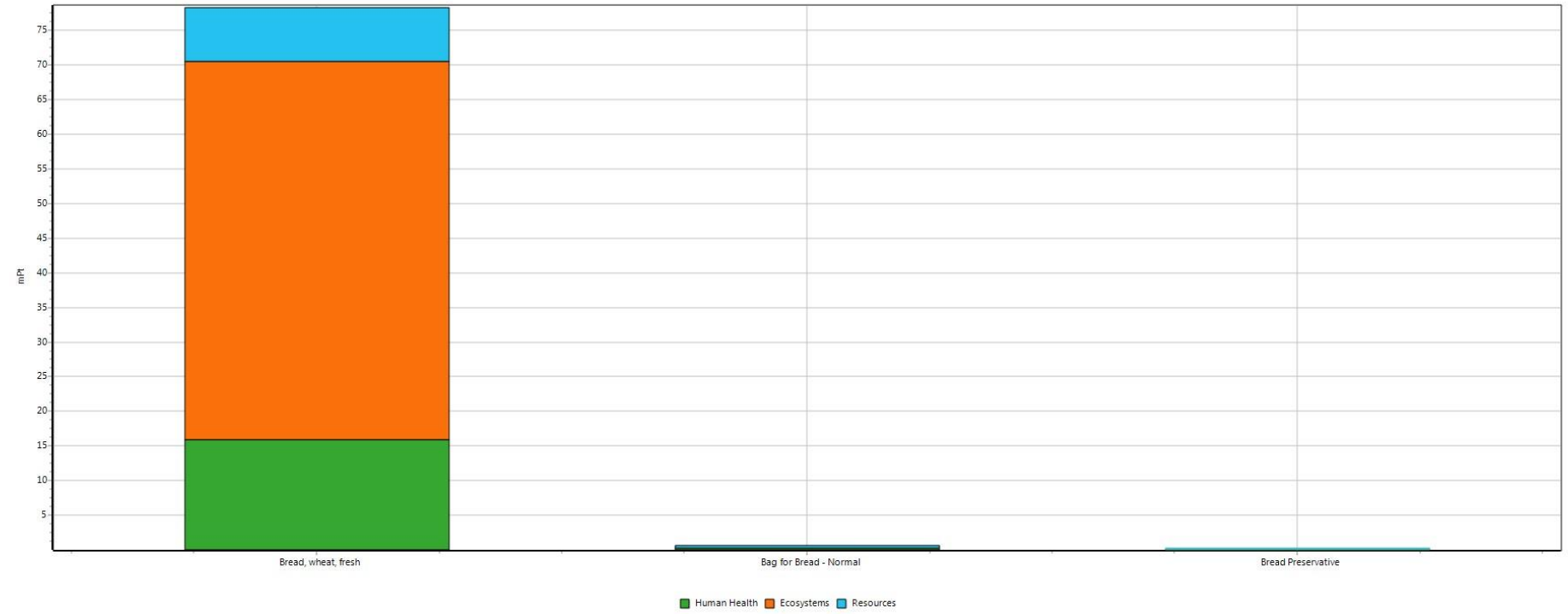
Bread Packaging (Normal)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Analysing 1 p 'Bagged Bread - Normal';

Weighting – End Point

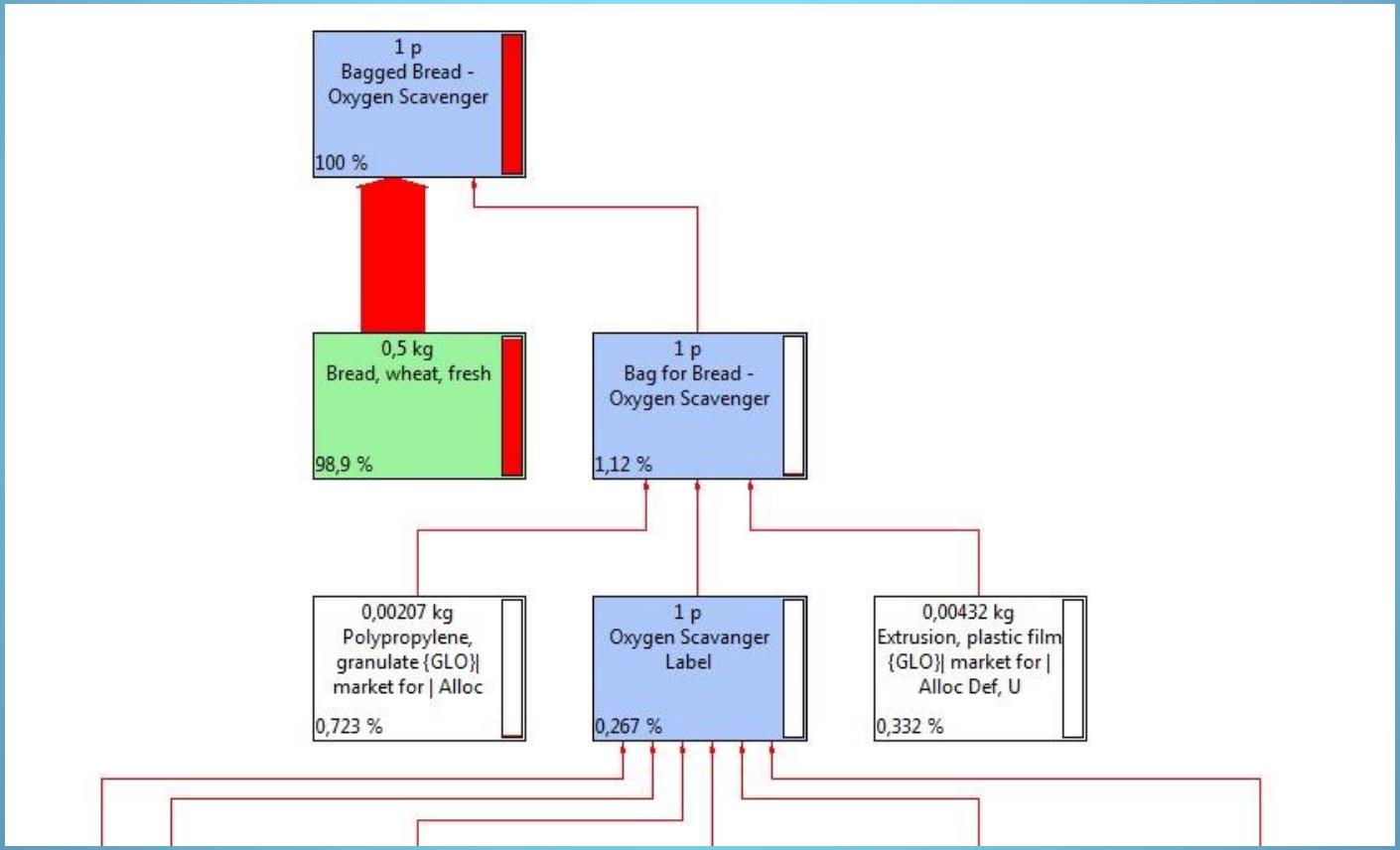
Bread Packaging (Normal)



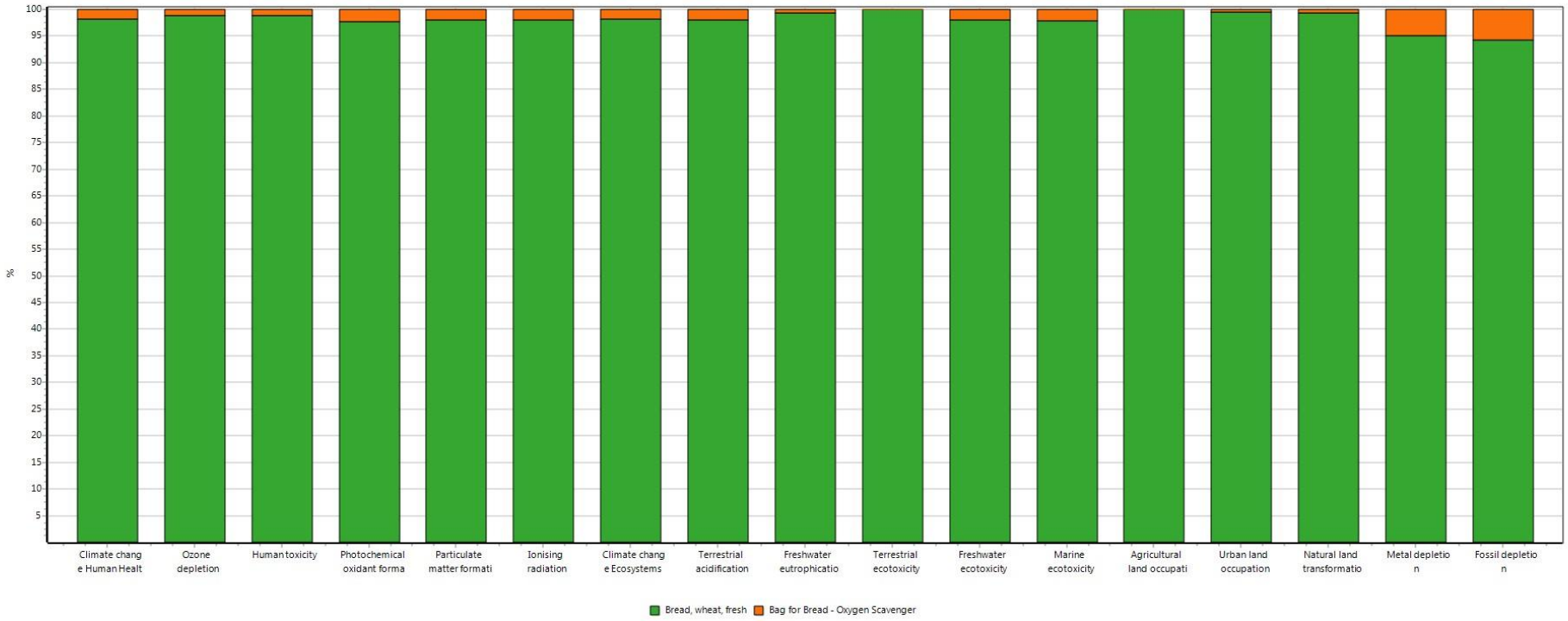
Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Single score
Analysing 1 p 'Bagged Bread - Normal';

Single Score

Bread Packaging (Oxygen Scavanger)



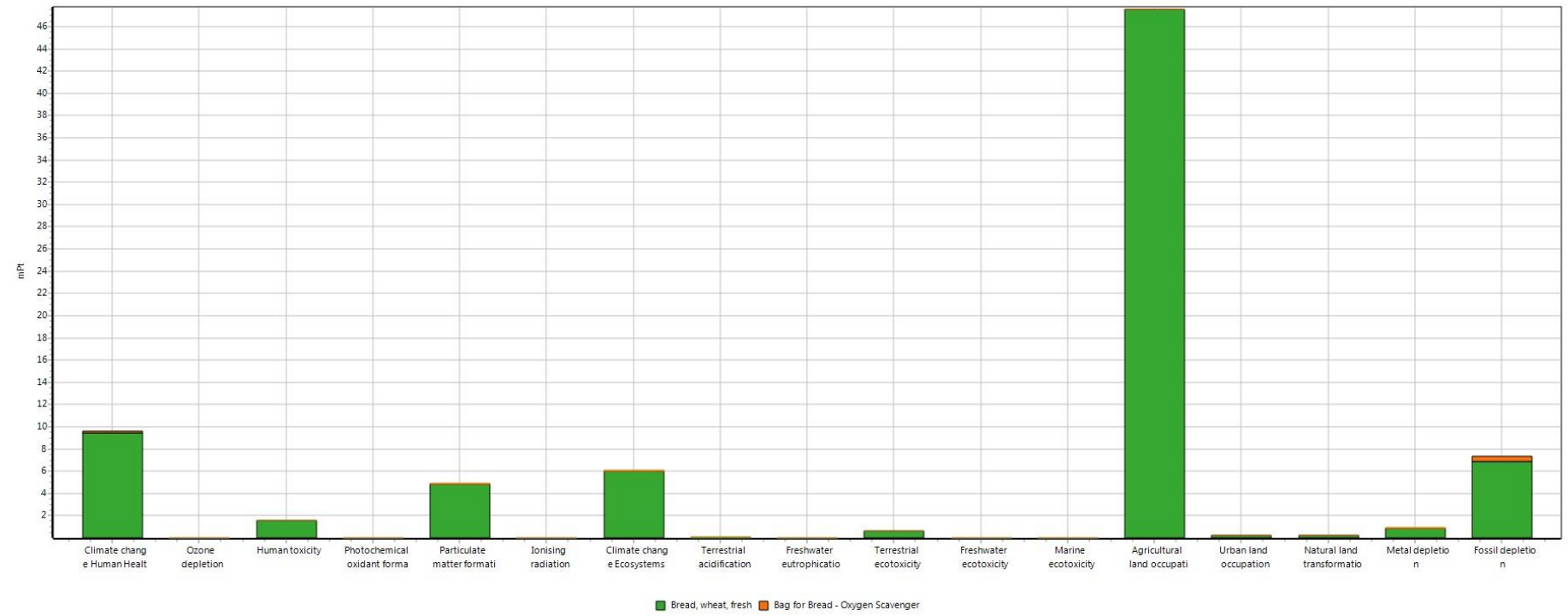
Bread Packaging (Oxygen Scavanger)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Damage assessment
Analysing 1 p 'Bagged Bread - Oxygen Scavenger';

Damage Assessment

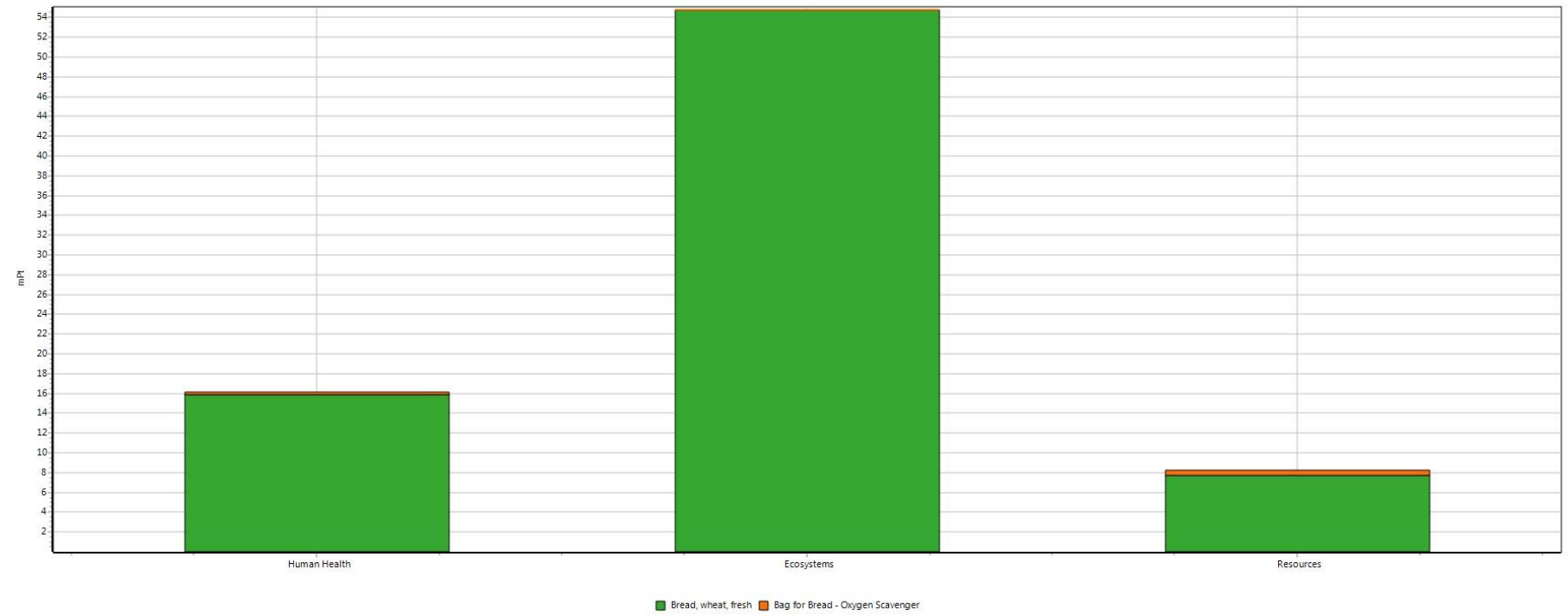
Bread Packaging (Oxygen Scavanger)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Analysing 1 p 'Bagged Bread - Oxygen Scavenger';

Weighting

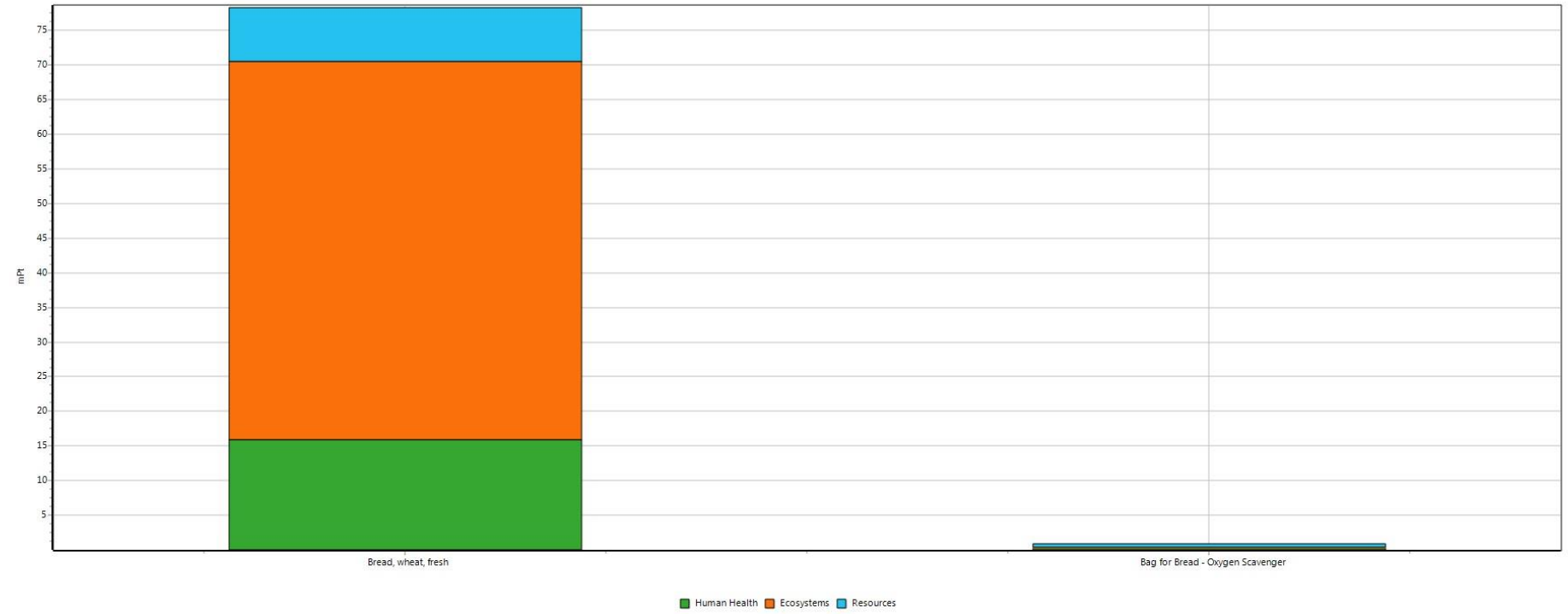
Bread Packaging (Oxygen Scavanger)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Analysing 1 p 'Bagged Bread - Oxygen Scavenger';

Weighting – End Point

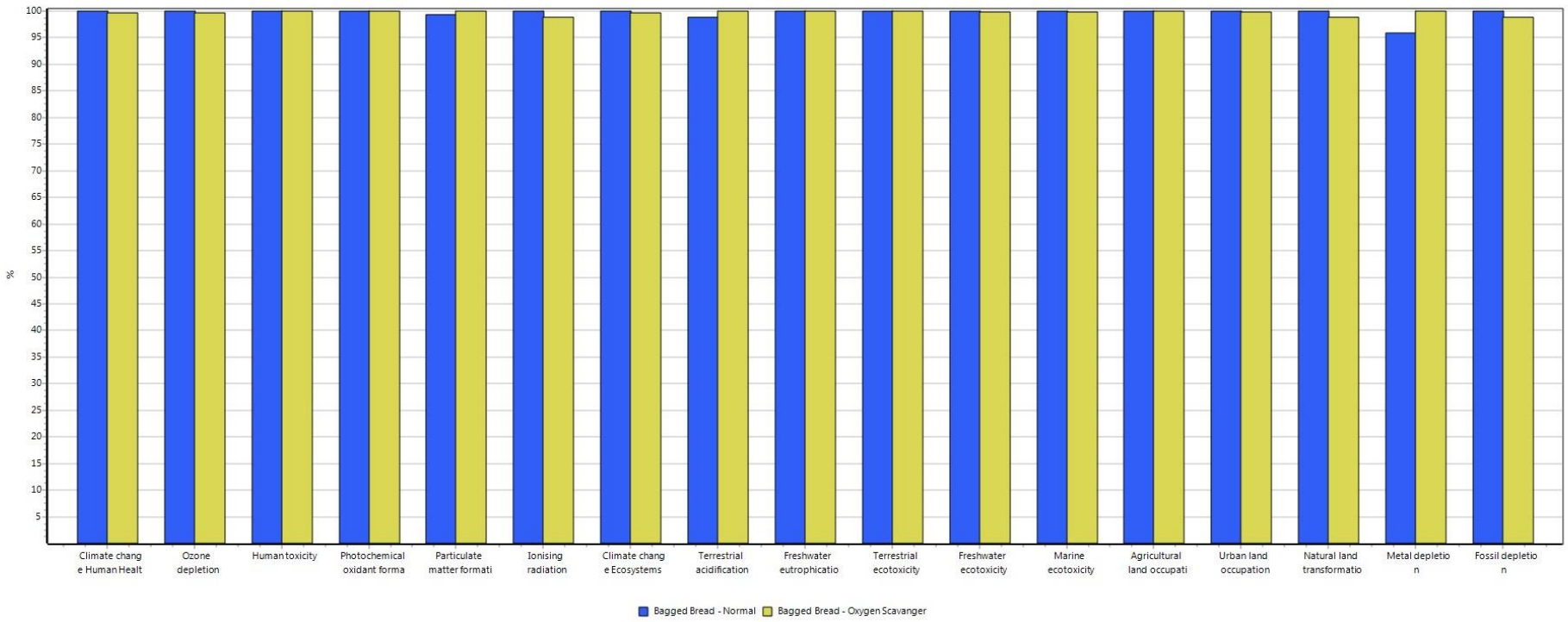
Bread Packaging (Normal)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Single score
Analysing 1 p 'Bagged Bread - Oxygen Scavenger';

Single Score

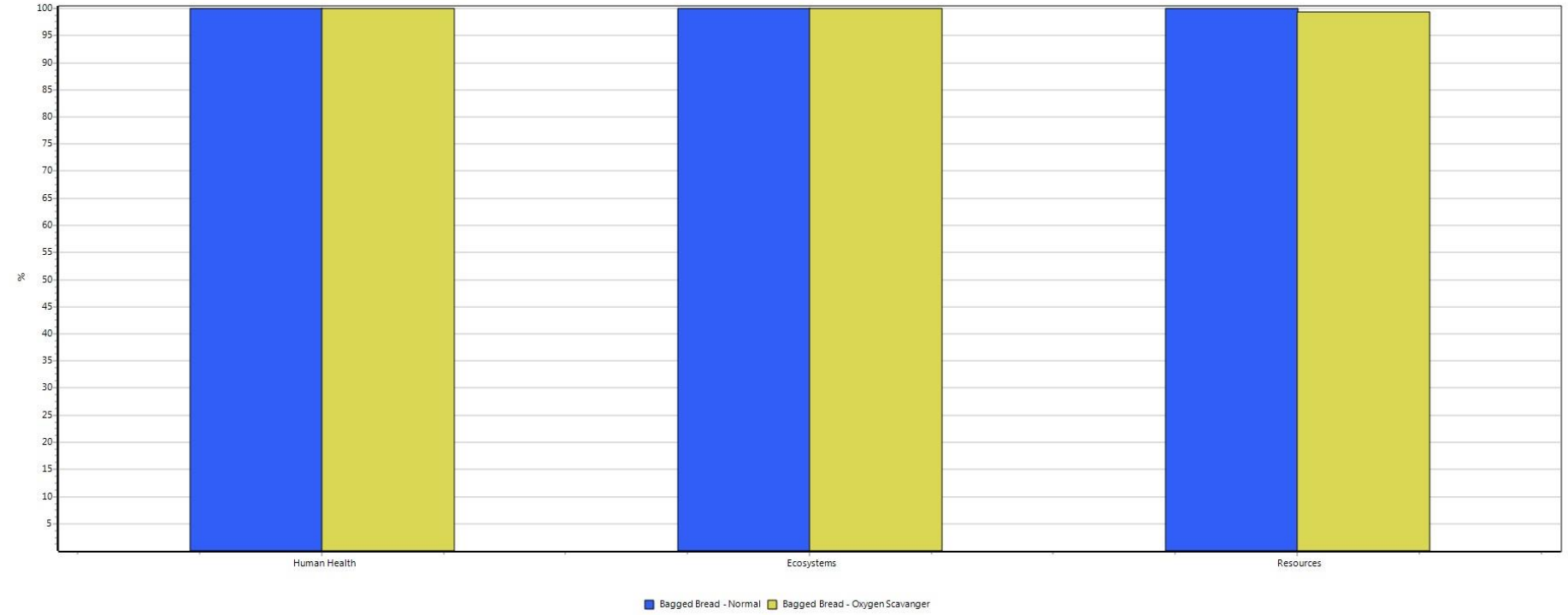
Bread Packaging (Comparison)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Damage assessment
Comparing 1 p 'Bagged Bread - Normal' with 1 p 'Bagged Bread - Oxygen Scavanger';

Damage Assessment

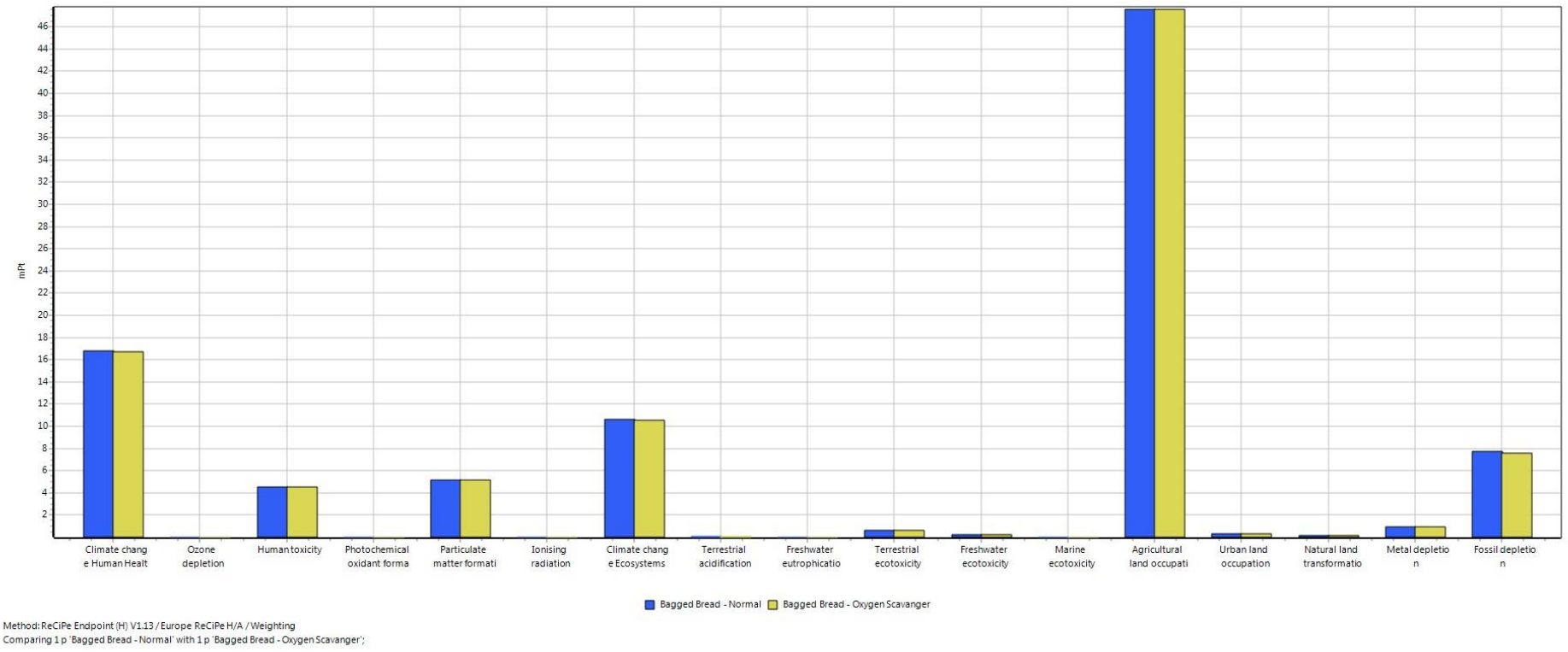
Bread Packaging (Comparison)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Damage assessment
Comparing 1 p 'Bagged Bread - Normal' with 1 p 'Bagged Bread - Oxygen Scavanger';

Damage Assessment – End Point

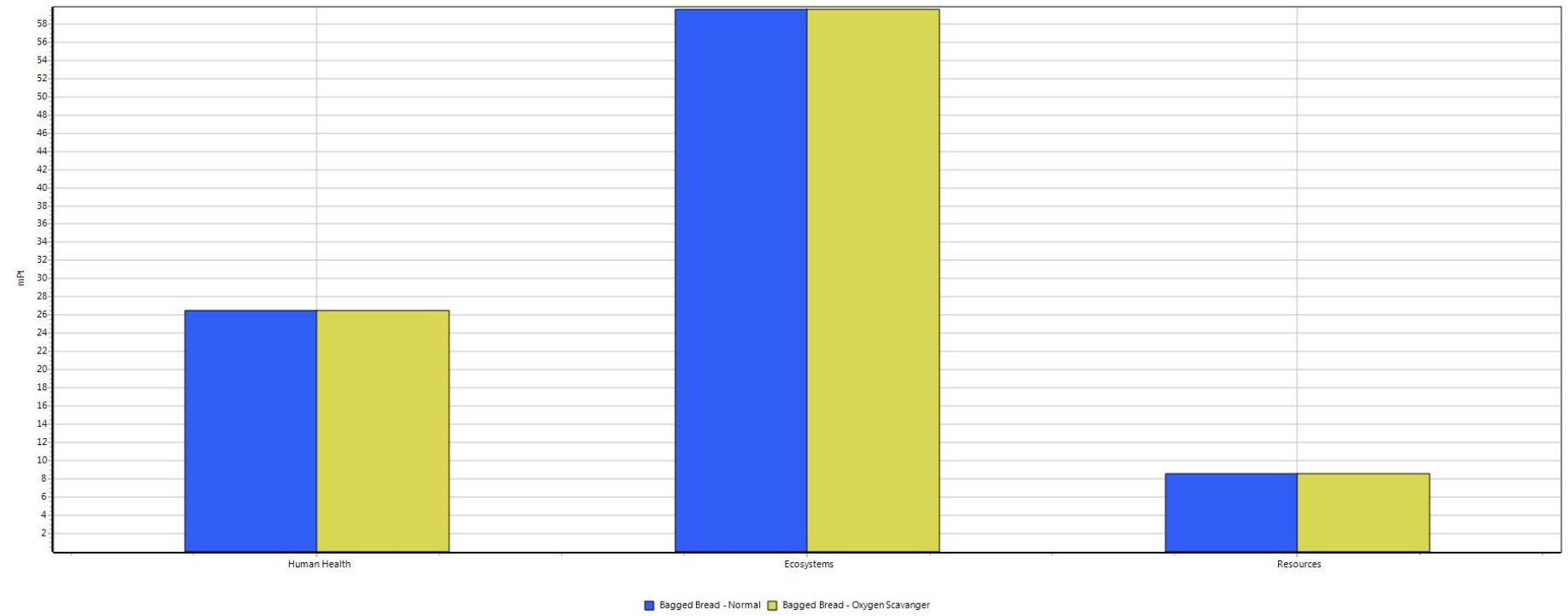
Bread Packaging (Comparison)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Comparing 1 p 'Bagged Bread - Normal' with 1 p 'Bagged Bread - Oxygen Scavanger';

Weighting

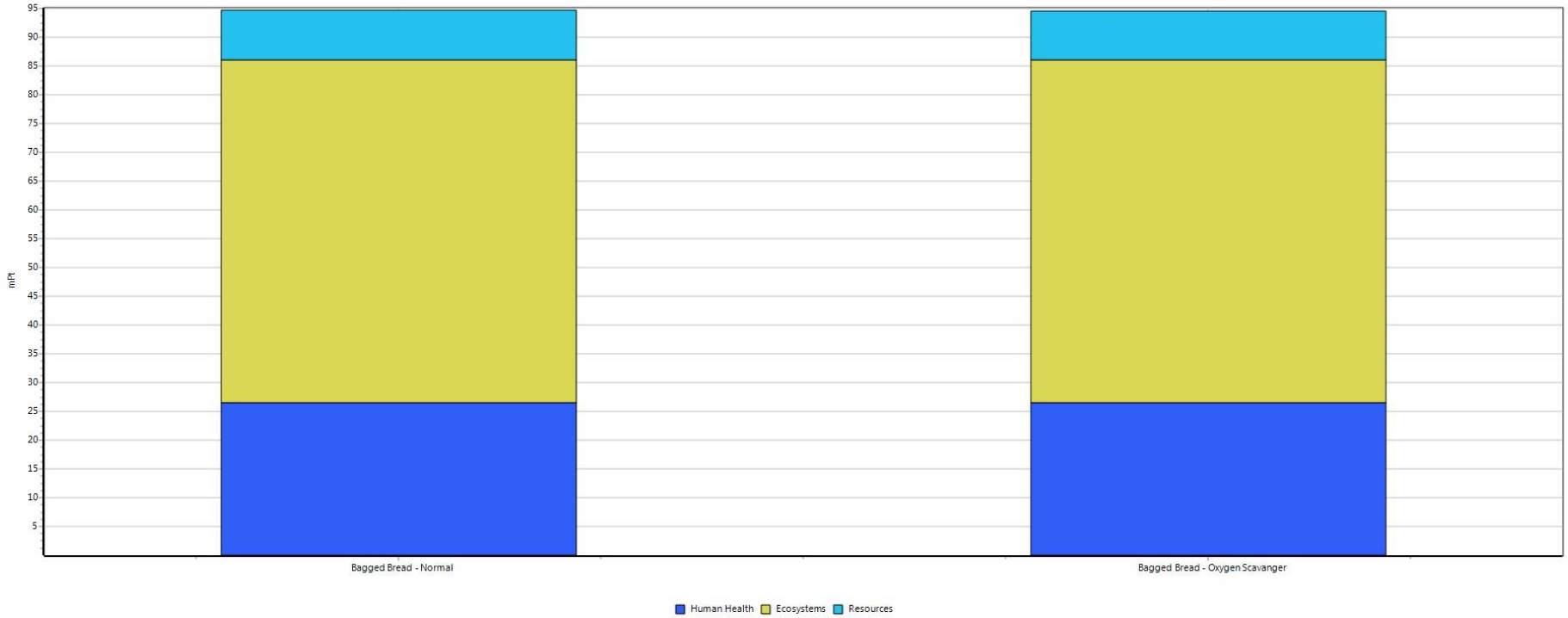
Bread Packaging (Comparison)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Comparing 1 p 'Bagged Bread - Normal' with 1 p 'Bagged Bread - Oxygen Scavanger';

Weighting – End Point

Bread Packaging (Comparison)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Single score
Comparing 1 p 'Bagged Bread - Normal' with 1 p 'Bagged Bread - Oxygen Scavanger';

Single Score

Strawberries Packaging (Active)

Active strawberries packaging:

- **100 kg of strawberries consumed**

Assumptions:

- **Packaging with active component:**
  - Direct impact on a shelf life- shelf life is longer
- **Packaging without active component:**
  - shelf life is normal

Strawberries Packaging (Active)

Assumptions:

- Corrugated board fruit display tray:
  - Dimensions: **300 mm x 400 mm** (*FEFCO CF standard*)
  - Mass: **0,4 kg**
  - Max capacity: **3,6 kg**
- Strawberries shelf life = 3-7 days refrigerated -> **5 days on average**
- Shelf life extension of active component – up to 30%
  - 30% + 5 days = **6,5 days**

Strawberries Packaging (Active)

Assumptions:

- 30% of strawberries is wasted
- Increased shelf life will not ensure that there will not be any more waste!!
- Two scenarios:
  - Additional shelf life allow us to reduce the wastage by **70%**
  - Additional shelf life allow us to reduce the wastage by **35%**

Strawberries Packaging (Active)

Maths:

With 30% of strawberries being wasted the functional units for our three cases are the following:

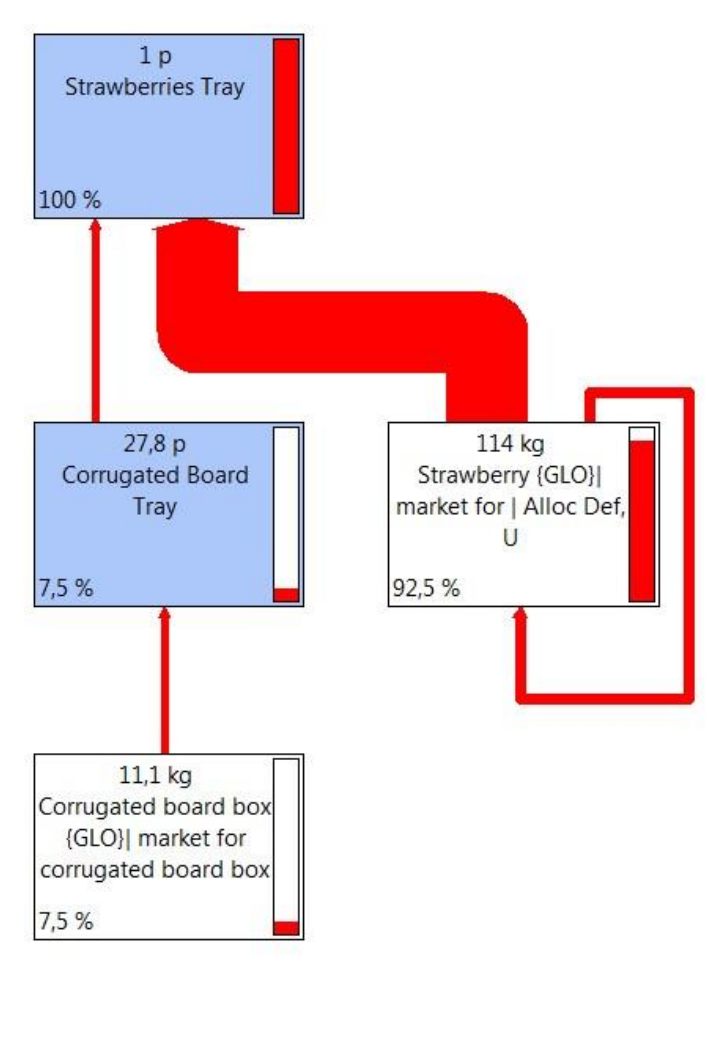
1. **Strawberries in normal packaging:**
   142,85 kg produced for consumption of 100 kg
2. **Strawberries with active packaging - 35% waste reduction:**
   127,85 kg produced for consumption of 100 kg
3. **Strawberries with active packaging - 70% waste reduction:**
   115 kg produced for consumption of 100 kg

Strawberries Packaging (Active)

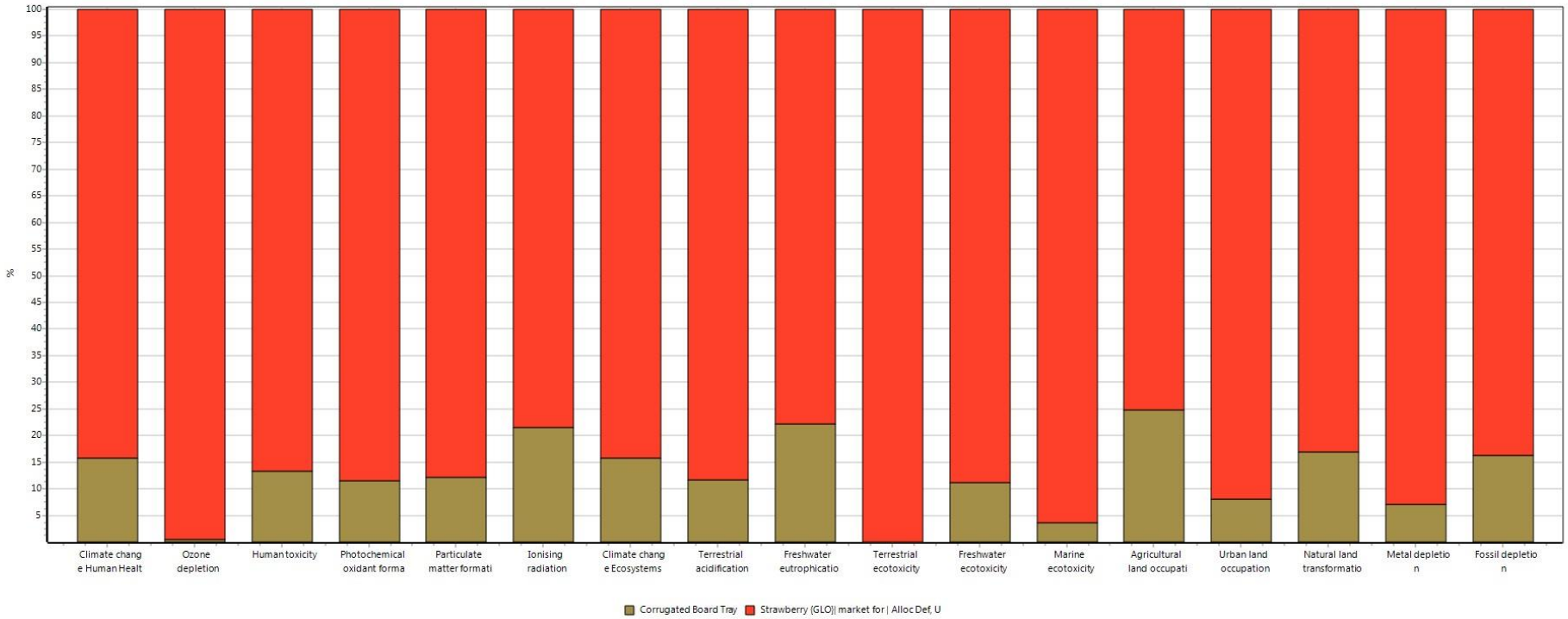
Data Limitations:

- No data about the actual indicator itself!!
  - Even though, it is probable that it will not have a very significant impact on the whole analysis, we need this urgently for the LCA to have sense!!
- Assumptions made can be changed, we can even devise more scenarios – we have to make a list
- End of life impact is still missing – I will model it very soon!!

Strawberries Packaging (Active)



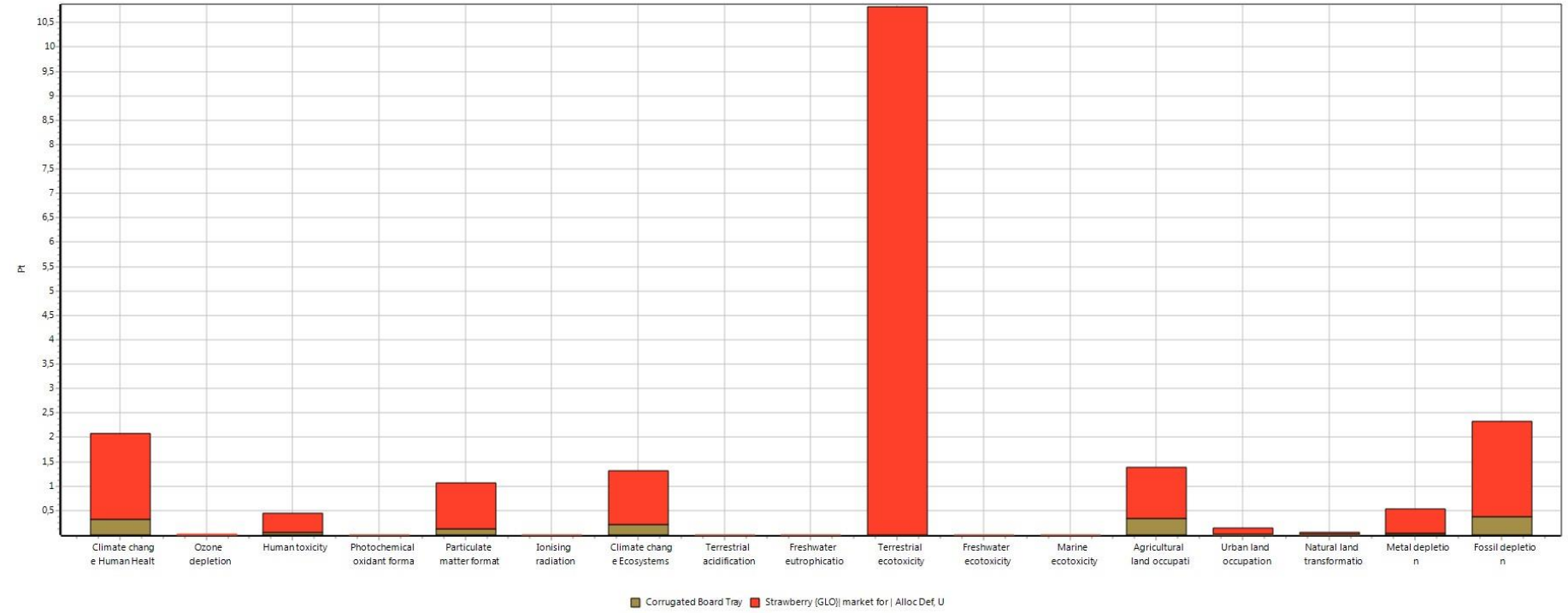
Strawberries Packaging (Active)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Damage assessment
Analysing 1 p 'Strawberries Tray';

Damage Assessment

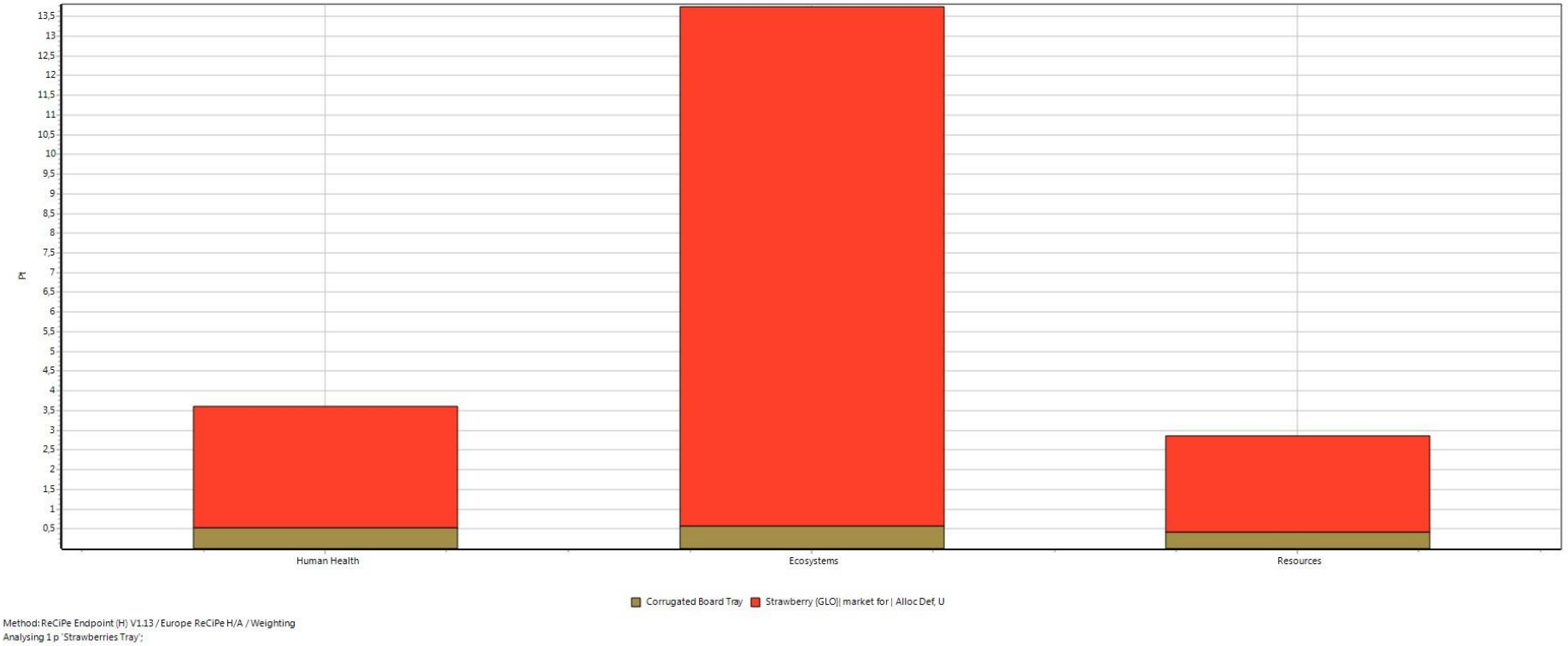
Strawberries Packaging (Active)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Analysing 1 p 'Strawberries Tray';

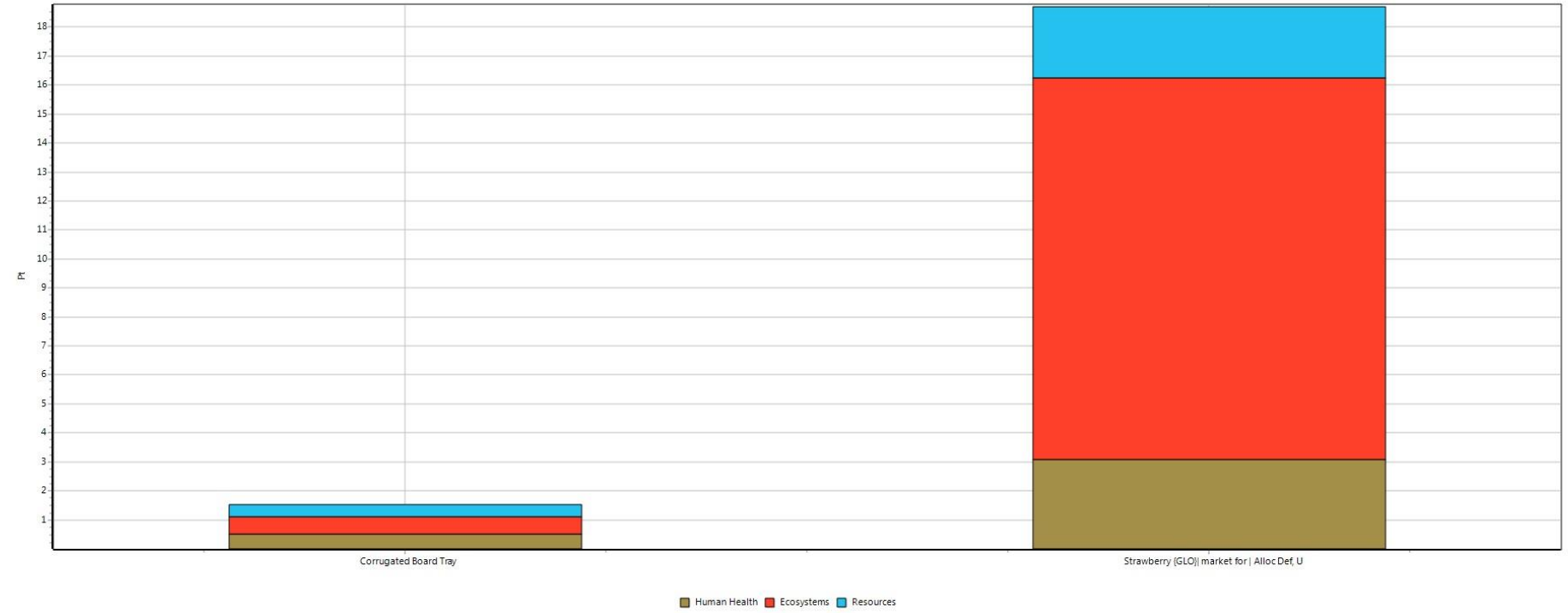
Weighting

Strawberries Packaging (Active)



Weighting – End Point

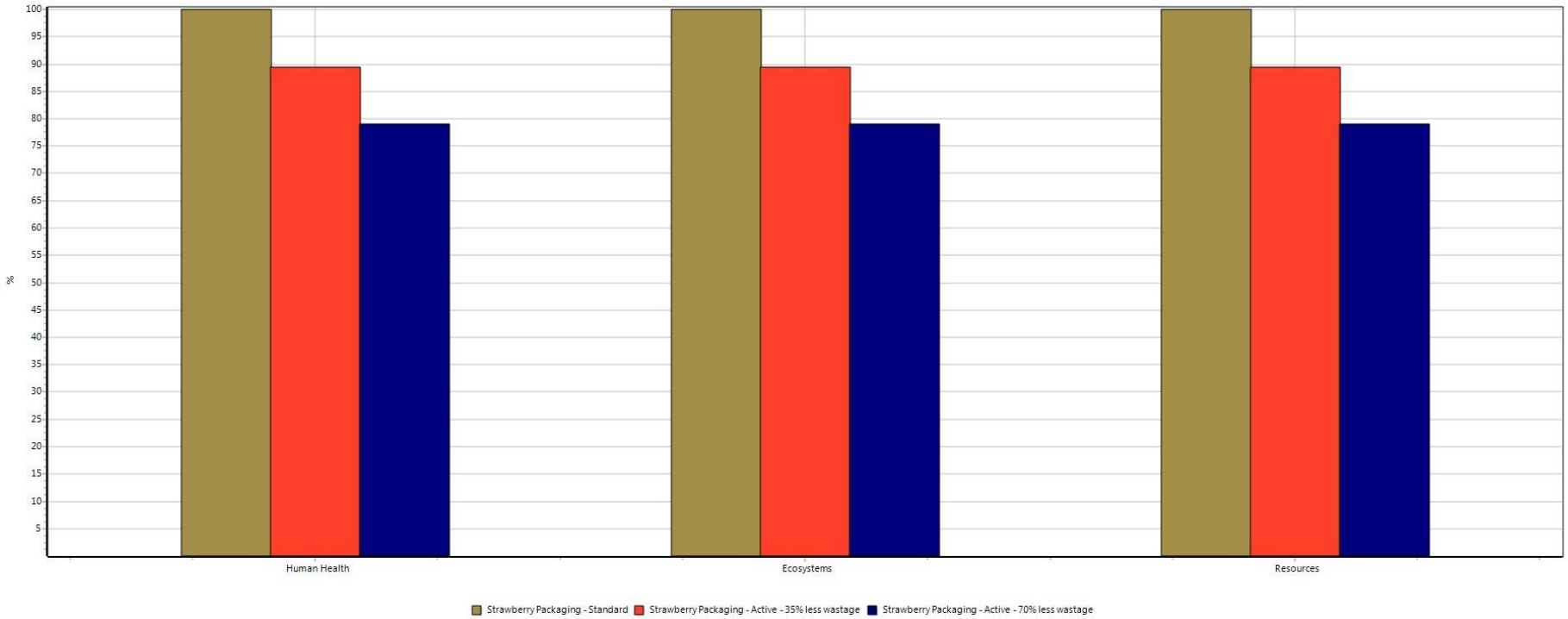
Strawberries Packaging (Active)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Single score
Analysing 1 p 'Strawberries Tray';

Single Score

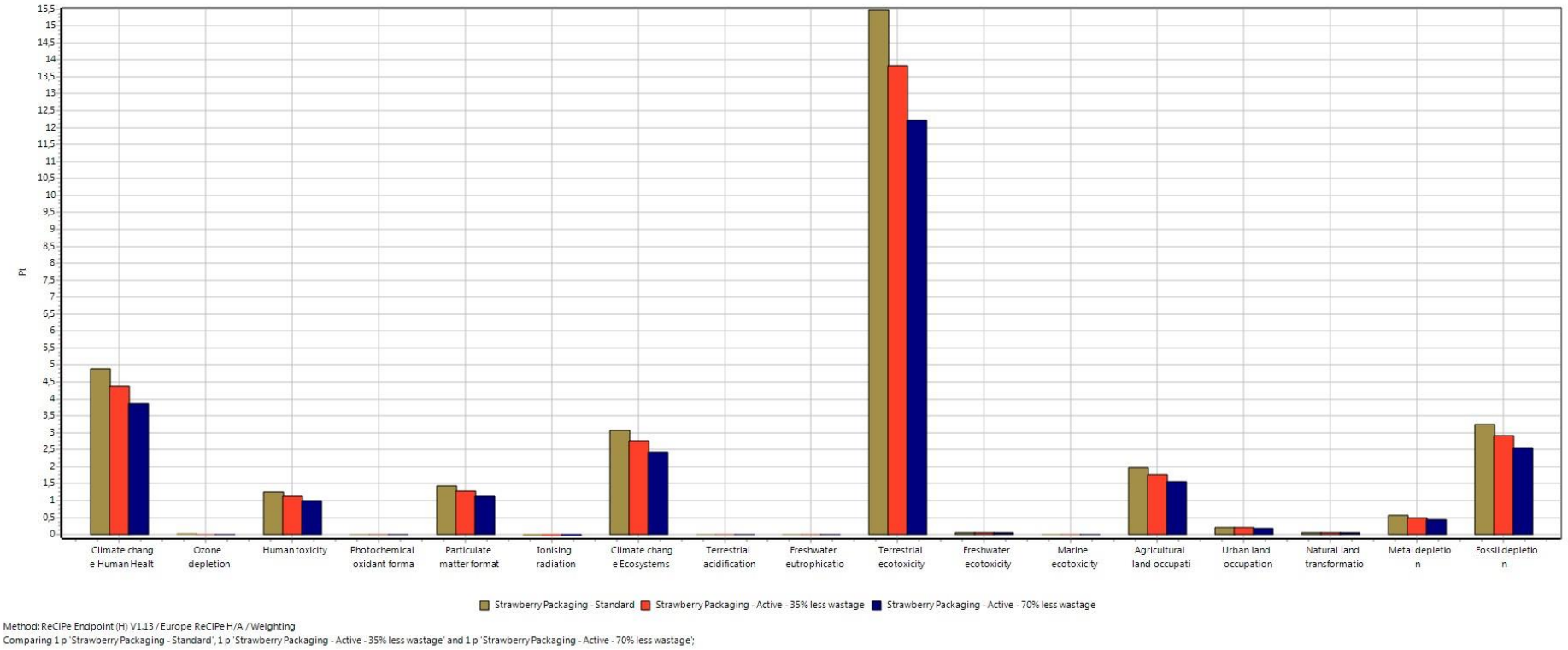
Strawberries Packaging (Active)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Damage assessment
Comparing 1 p 'Strawberry Packaging - Standard', 1 p 'Strawberry Packaging - Active - 35% less wastage' and 1 p 'Strawberry Packaging - Active - 70% less wastage';

Comparison – Damage Assessment – End Point

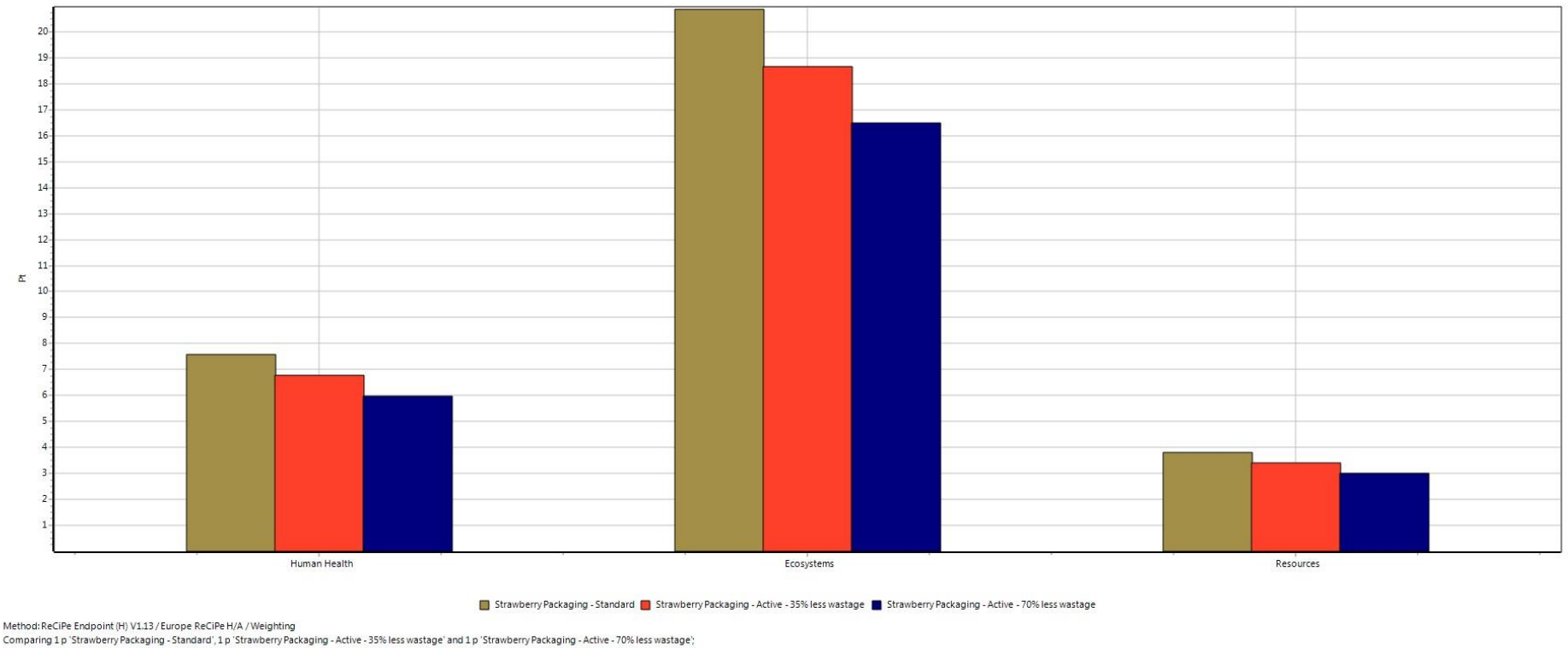
Strawberries Packaging (Active)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Comparing 1 p 'Strawberry Packaging - Standard', 1 p 'Strawberry Packaging - Active - 35% less wastage' and 1 p 'Strawberry Packaging - Active - 70% less wastage';

Comparison – Weighting

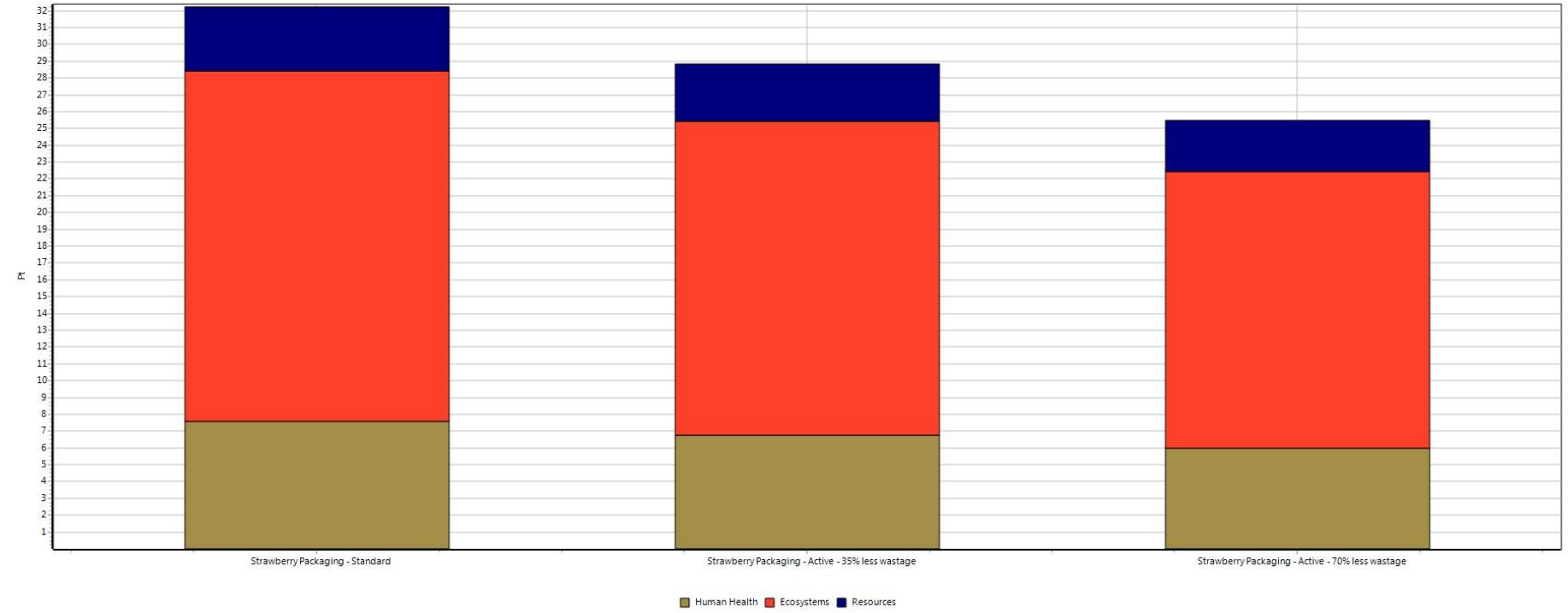
Strawberries Packaging (Active)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Weighting
Comparing 1 p 'Strawberry Packaging - Standard', 1 p 'Strawberry Packaging - Active - 35% less wastage' and 1 p 'Strawberry Packaging - Active - 70% less wastage';

Comparison – Weighting – End Point

Strawberries Packaging (Active)



Method: ReCiPe Endpoint (H) V1.13 / Europe ReCiPe H/A / Single score
Comparing 1 p 'Strawberry Packaging - Standard', 1 p 'Strawberry Packaging - Active - 35% less wastage' and 1 p 'Strawberry Packaging - Active - 70% less wastage';

Comparison – Single Score

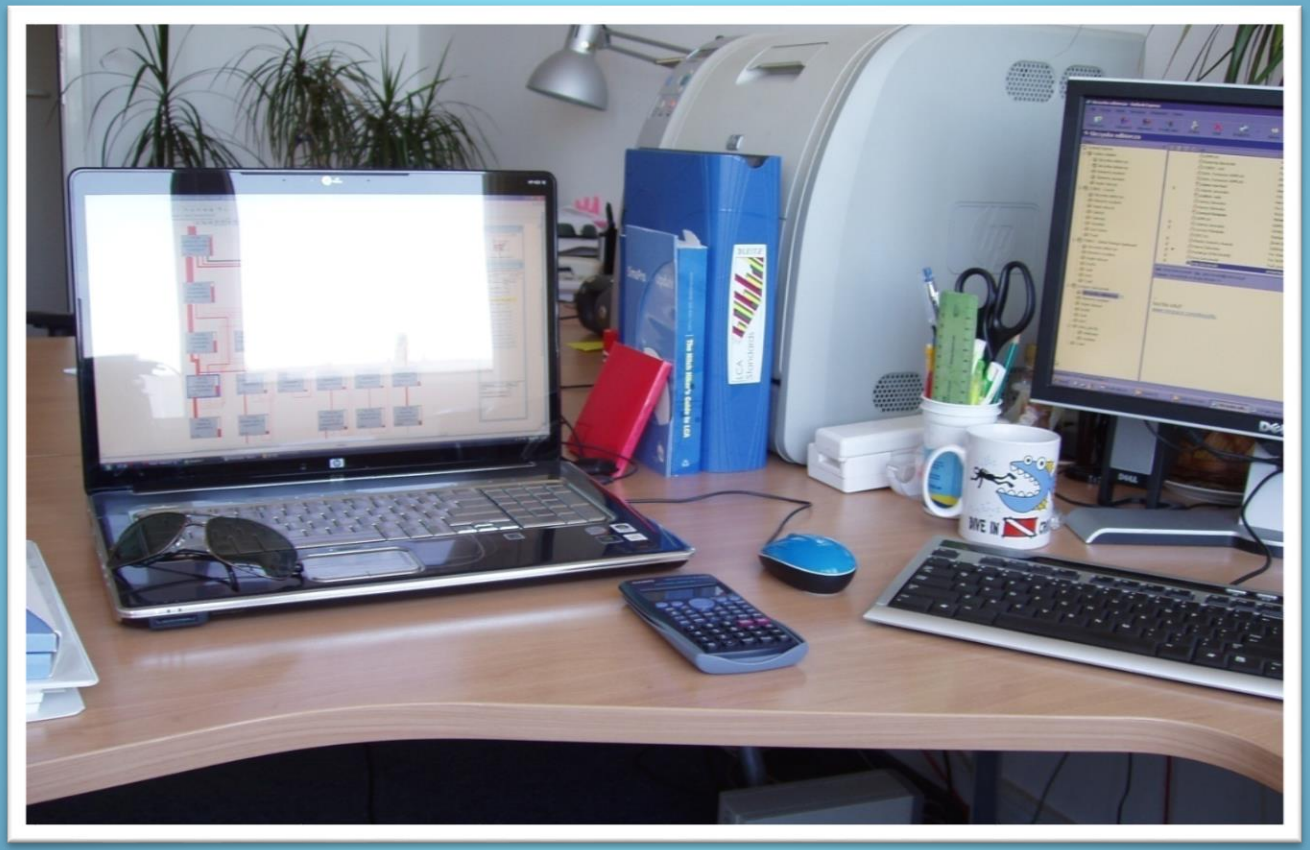
Results so far - Conclusions

- Majority of environmental impacts (70-99% is attributed to food products – not the packaging
- Assumptions are very important – major influence on results:
  - We need viable and realistic scenarios
- We desperately need data on actual A&I materials and production processes

WG3 – Other Deliverables

- Leaflet – in a style similar to other WG's – I made a rough draft – who will be able to help me with it?
- Review Paper – in a form of popular science piece (per request of WG4) – elaborations on the leaflet
- Road Map – Comprehensible list of issues relating to sustainability + LCA general conclusions
- LCA – need more data – publication opportunity!!

Thank you!!



LCA Workstation