Apparecchiature Elettriche ed Elettroniche (AEE) nuove e ricondizionate.

Come cambia la performance ambientale?

Martina Pini

WEEEN MODELS

Waste Electric and Electronic Equipment New MODELs for Logistic Solutions

Progetto WEEENmodels LIFE12 ENV/IT/001058

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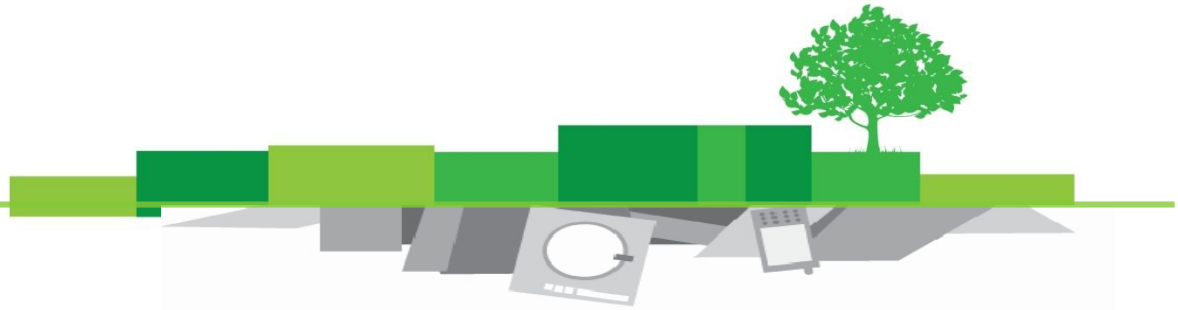

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WEEE management system

Criteria adopted for the LCA modeling

- Scenario: Genoa City (592'507 inhabitants).
- Reuse rate of WEEE: 10%.
- For each WEEE typology, a representative product has been considered, assuming that it generates the same environmental damage of the other products belonging to the same category:

  R1 - refrigerator 

  R2 – washing machine 

  R3 – CRT 

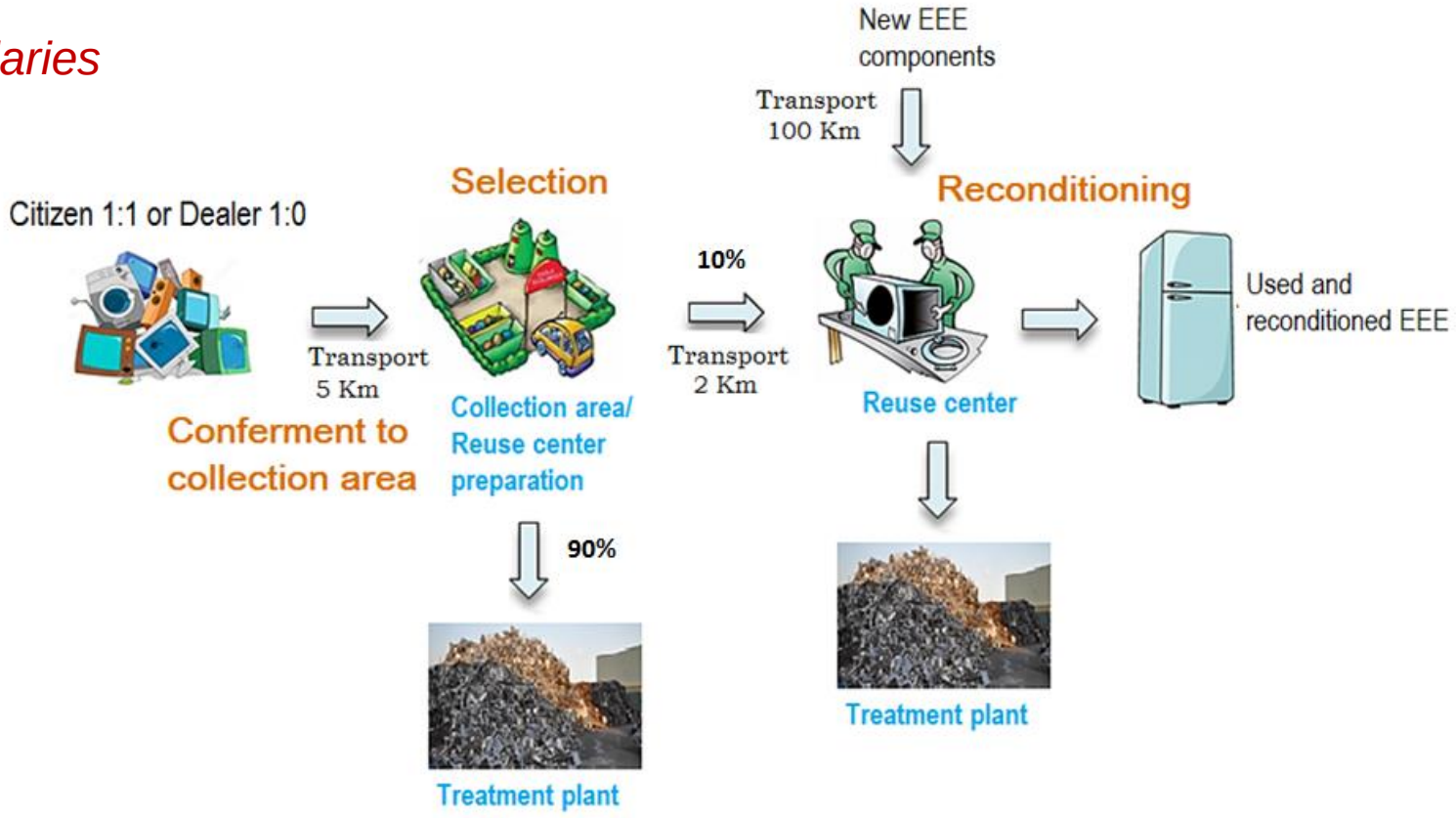
  R4 – laptop 

  R5 – fluorescent lamp 

- The life time of the reused product has been assumed equal to half of the life time of an equivalent new product. The increase of energy consumption for reconditioned EEE have been assessed.
- The social benefits derived from the introduction of a new activity (Reuse activity) have been assessed (e.g. the increasing of employment).

LCA of WEEE management and their potential reuse

System boundaries



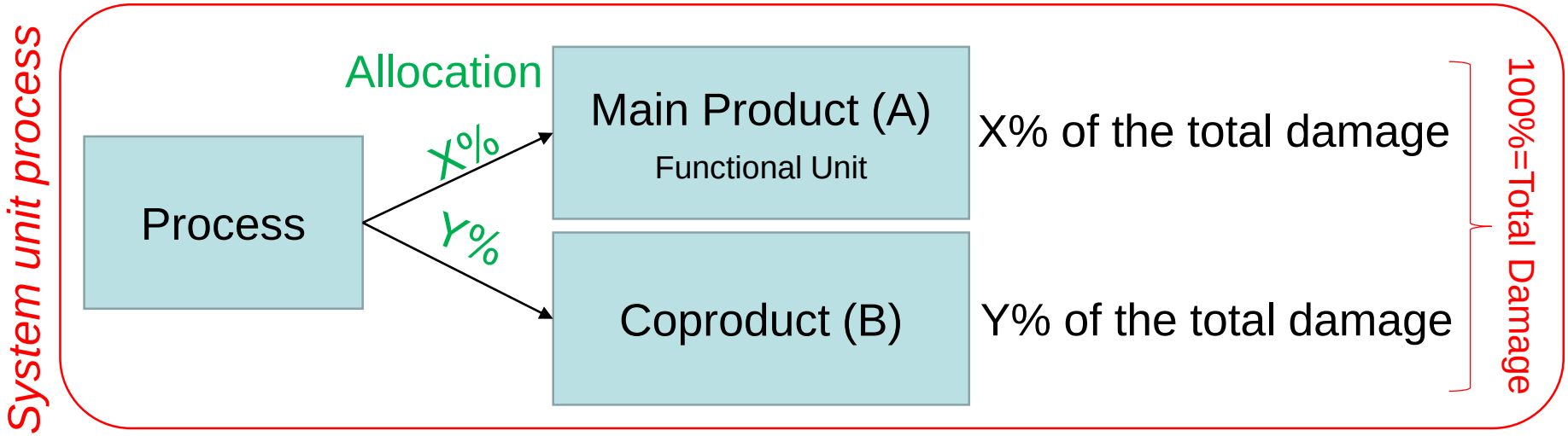
Functional unit: amount of WEEE produced by Genoa city (**9326.4 kg/d**)
Software: Simapro 8
Database: Ecoinvent v3 and internal database *LCA_DatabaseUNIMORE*
Life cycle impact assessment method: modified IMPACT 2002+

LCA models adopted

1. Multi-output (Attributional)

2. System expansion

Multi-output model



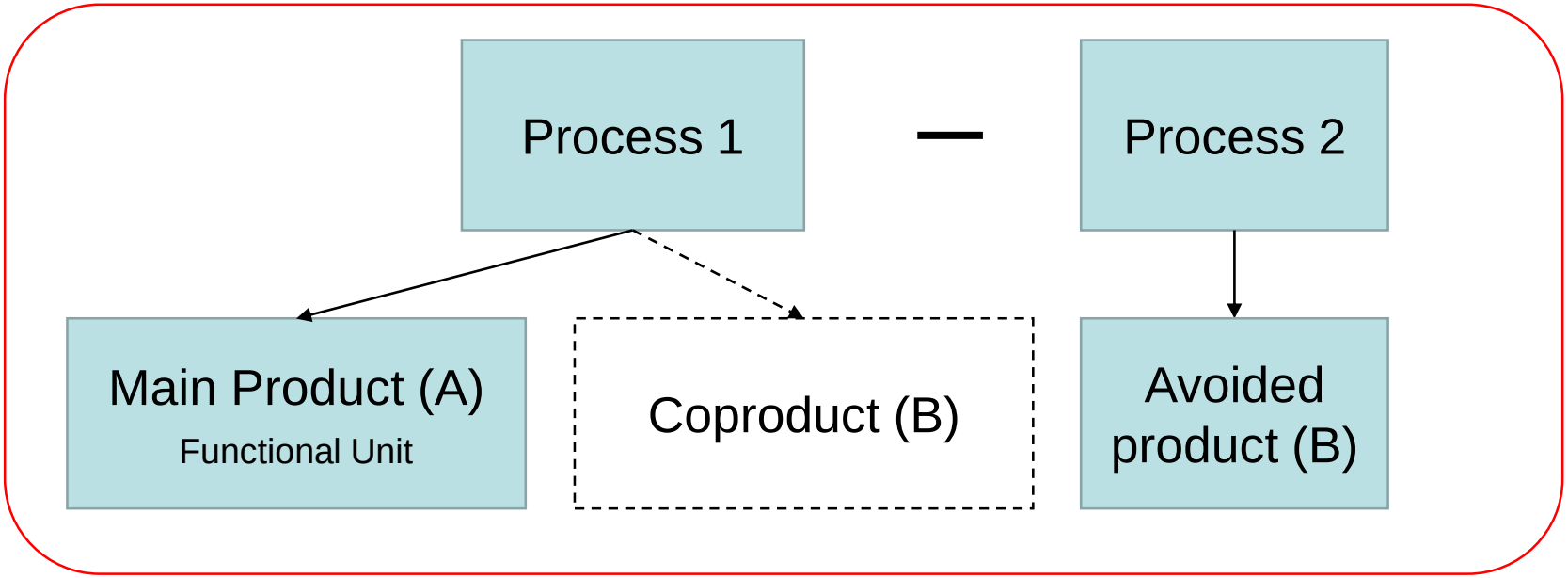
Inputs and outputs of process are partitioned over A and B based on a certain partitioning coefficient.

Types of Allocation: mass, energy, exergy, economic

Conseguenze dell'allocazione

- L'allocazione riduce il danno dovuto al prodotto principale o alla funzione e il coprodotto porta con sé, nella suo ciclo di vita successivo, la parte di danno corrispondente alla sua allocazione.
- L'allocazione di massa può non esprimere correttamente l'importanza del prodotto rispetto a quella del coprodotto (frumento e paglia).
- L'allocazione energetica può non esprimere correttamente la diversa possibilità di utilizzo dell'energia (energia elettrica e energia termica).
- L'allocazione economica esce dall'ambito scientifico nel quale dovrebbe rimanere l'LCA. Infatti l'economia dovrebbe considerare il livello di richiesta che il prodotto ha sul mercato (vantaggio o utilità). Ma può accadere che se la richiesta è grande e il prodotto ha un valore strategico il suo prezzo può essere modificato con la forza (petrolio). Tale allocazione può non essere costante.

System expansion model



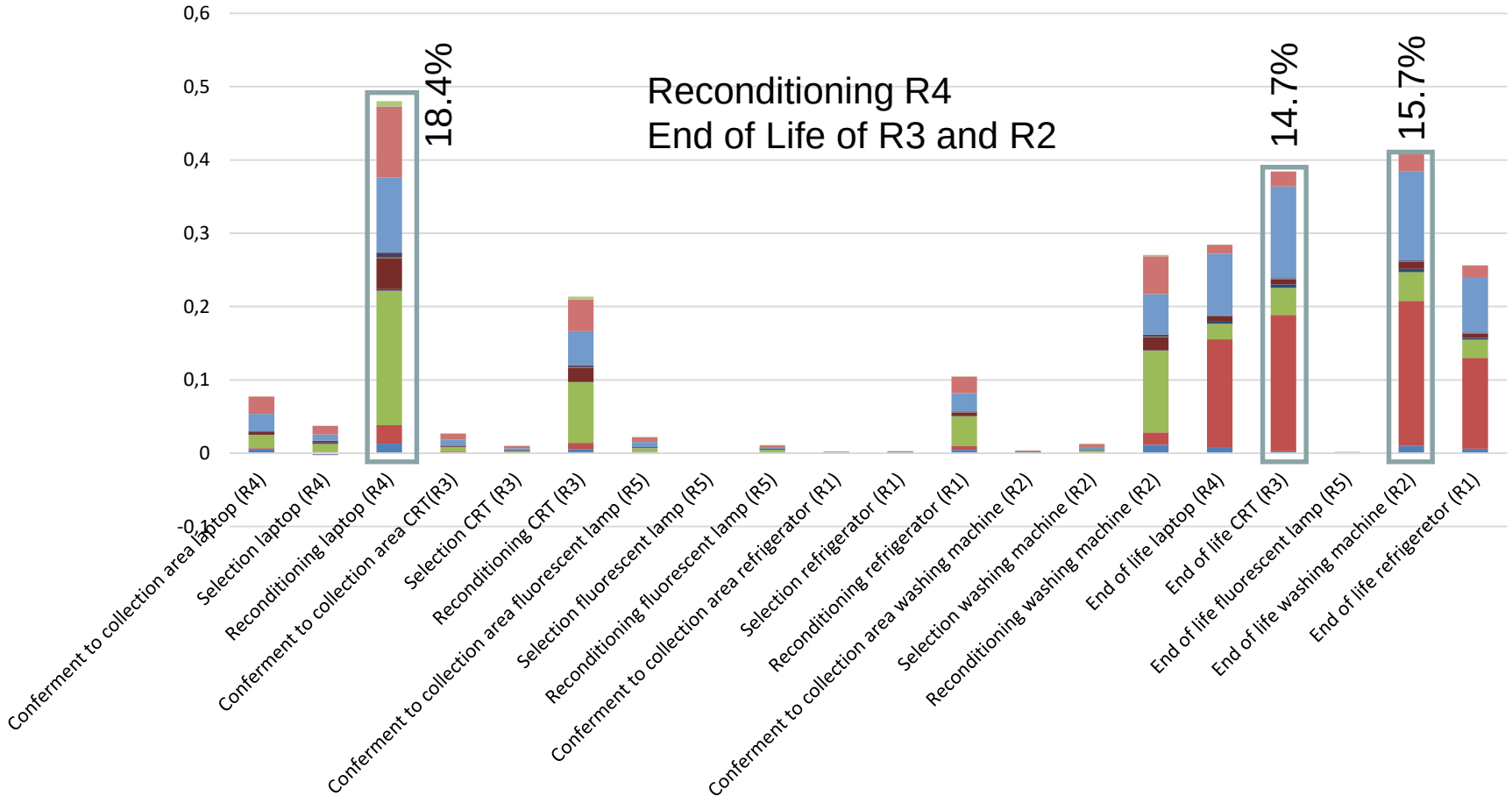
Il prodotto evitato sottrae al prodotto principale o funzione del sistema una parte di danno che quasi sempre è superiore a quello del prodotto in quanto è rappresentato da un prodotto primario.

Conseguenze dell'espansione del sistema

- Il risultato di questa modellizzazione è che il danno del prodotto è spesso un vantaggio ambientale. E quindi in contrasto con il secondo principio della termodinamica.
- Il risultato è corretto se il prodotto evitato viene usato nel processo stesso.
- Il risultato diventa corretto se si allarga il sistema fino a comprendere in esso l'uso del prodotto evitato.

Environmental results of WEEE management – *Multi-output*

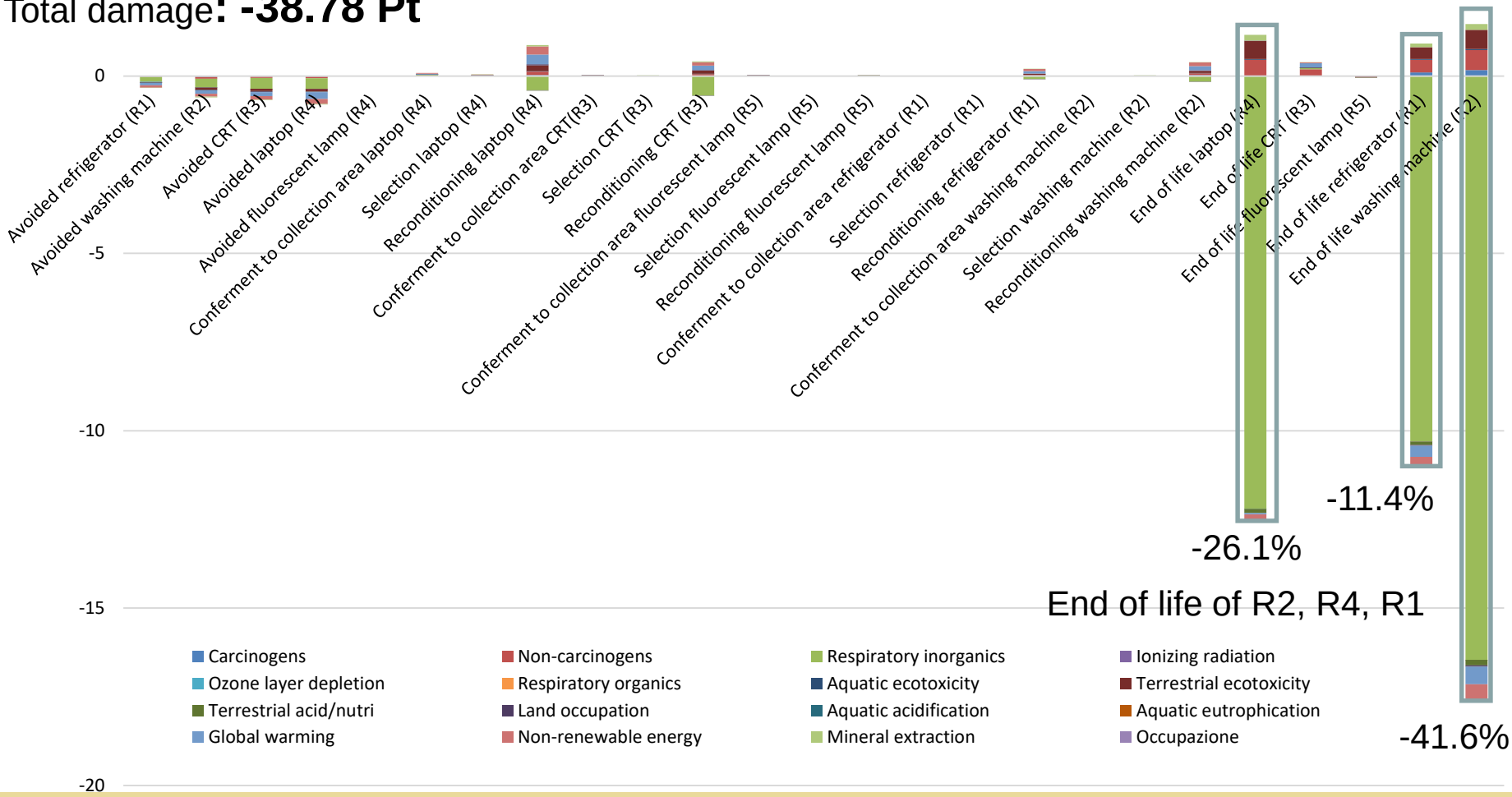
Total damage: **2.6 Pt**



53% **Human health** (*Antimony* in water e *Particulates < 2.5μm* in air)	26.6% **Climate change** (6864.4 kg $CO2_{eq}$)	14% **Resources** (*Oil, crude, Coal, hard , Gas, natural*)	6.4% **Ecosystem quality** (*Aluminium* in air)

Environmental results WEEE management - *System Expansion (economic allocation)*

Total damage: **-38.78 Pt**



New WEEE vs Reused WEEE

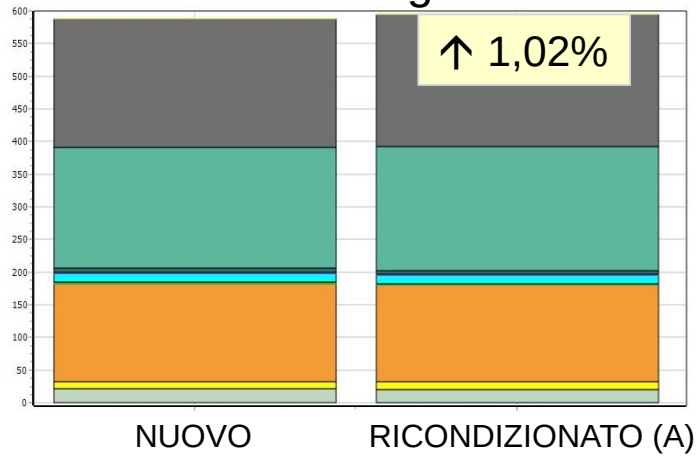
Different scenario of replaced components

Product	WEEE amount kg/day	Scenario A Replaced components
R1 -Refrigerator	2486,8	Compressor Refrigerator liquid Gaskets
R2 -Washing machine	3972,9	1 printed wiring board Engine Belt
R3 - CRT	1930,8	4 Printed wiring board Electron gun
R4 - Laptop	915,92	Li-ion battery NiMH battery 4 Printed wiring board
R5 – Fluorescent lamp	19,98	2 Capacitors

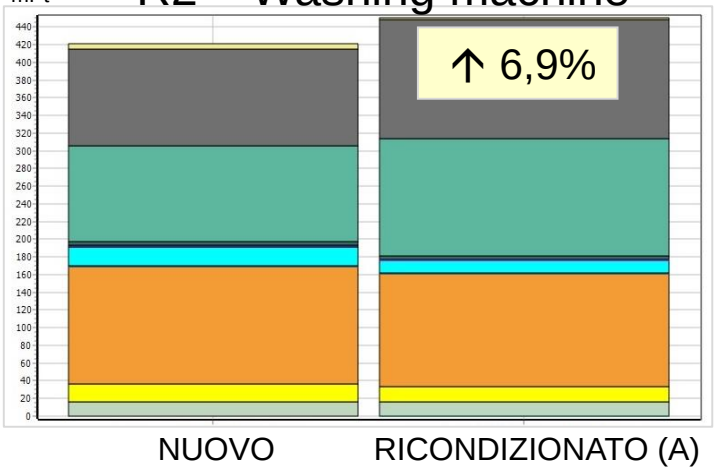
Nuovo vs Ricondizionato (Scenario A)

multi-output model

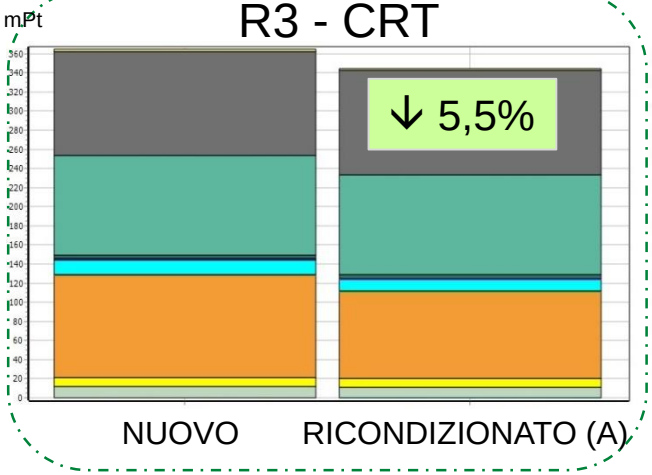
R1 - Refrigerator



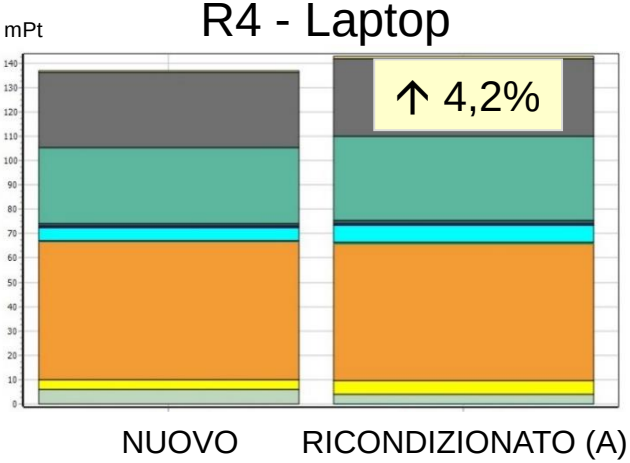
R2 – Washing machine



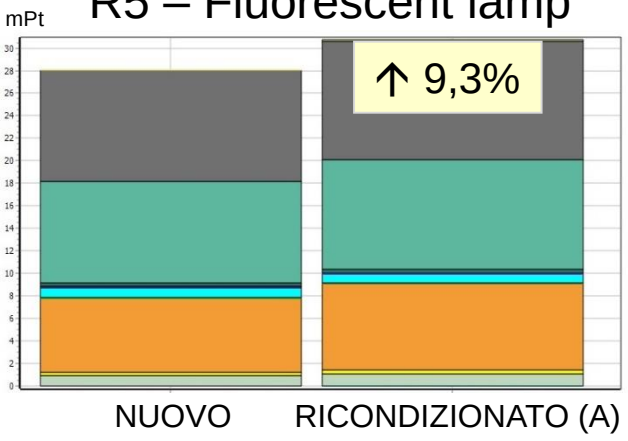
R3 - CRT



R4 - Laptop



R5 – Fluorescent lamp

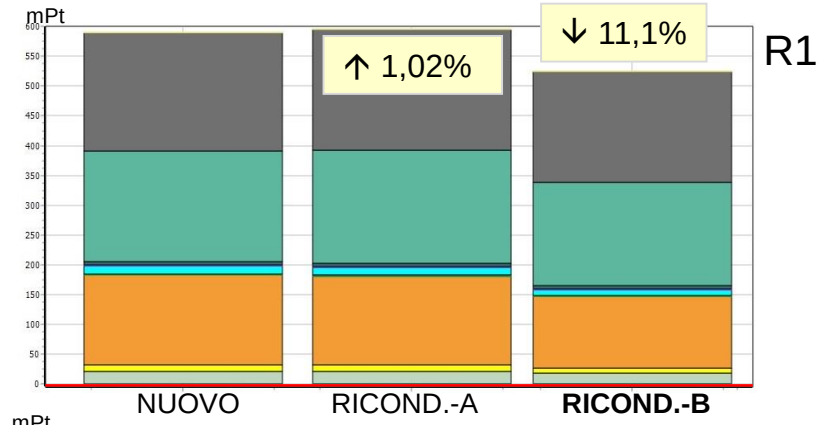


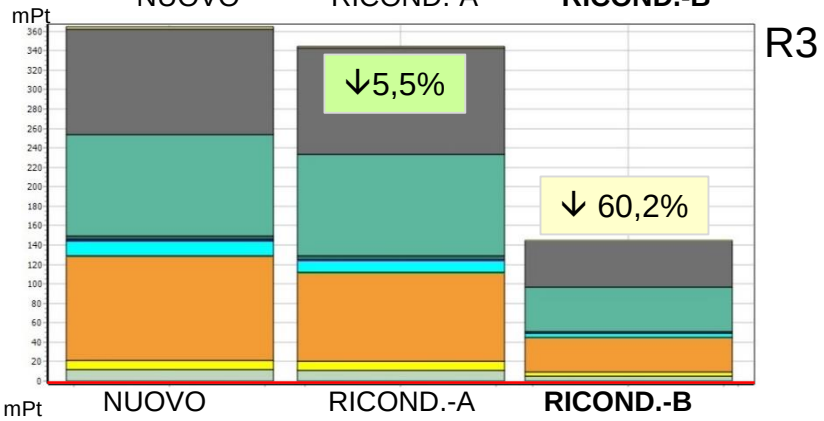
Carcinogens
Land occupation
Aquatic ecotoxicity
Non-carcinogens
Aquatic acidification
Terrestrial ecotoxicity
Respiratory inorganics
Aquatic eutrophication
Terrestrial acid/nutri
Ionizing radiation
Global warming
Occupazione
Ozone layer depletion
Non-renewable energy
Energia rinnovabile
Respiratory organics
Mineral extraction

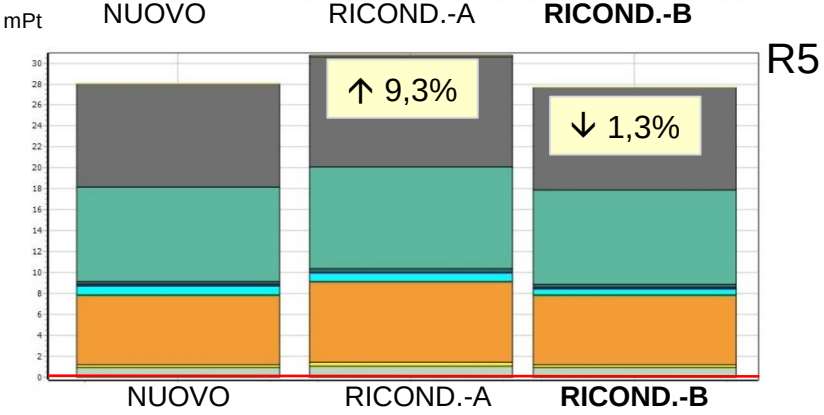
Different scenario of replaced components

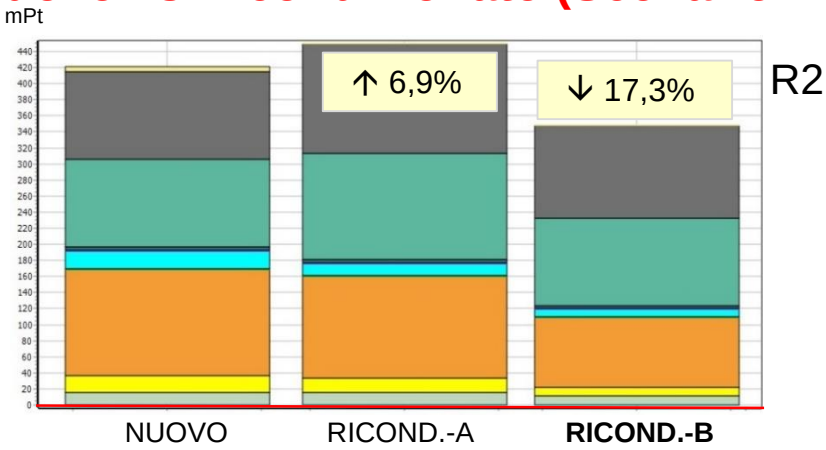
Product	WEEE amount kg/day	Scenario A Replaced components	Scenario B Replaced components
R1 -Refrigerator	2486,8	Compressor Refrigerator liquid Gaskets	1 printed wiring board Resistor Thermostat
R2 -Washing machine	3972,9	1 printed wiring board Engine Belt	1 printed wiring board Water pump Filter
R3 - CRT	1930,8	4 Printed wiring board Electron gun	Funnel glass Panel glass
R4 - Laptop	915,92	Li-ion battery NiMH battery 4 Printed wiring board	Power pack Hard disk
R5 – Fluorescent lamp	19,98	2 Capacitors	2 Resistors

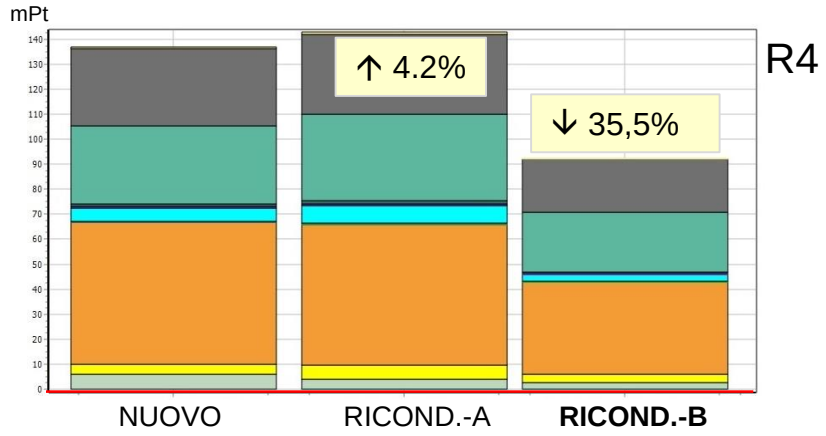
Nuovo vs Ricondizionato (Scenario A e B)



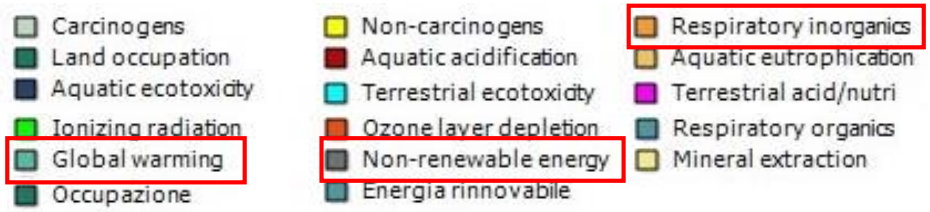




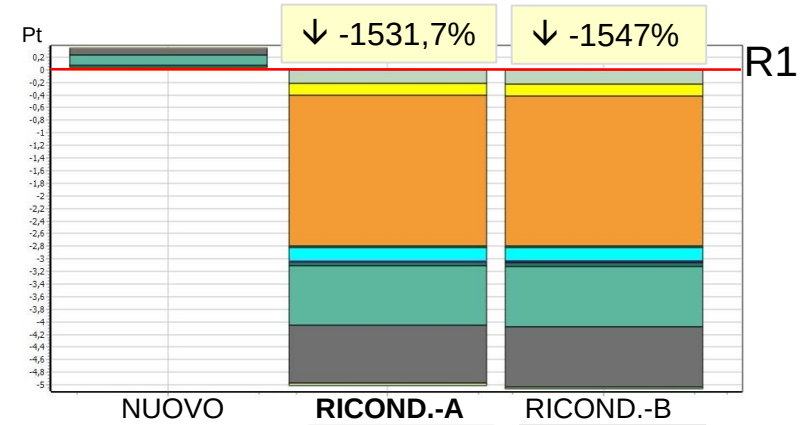


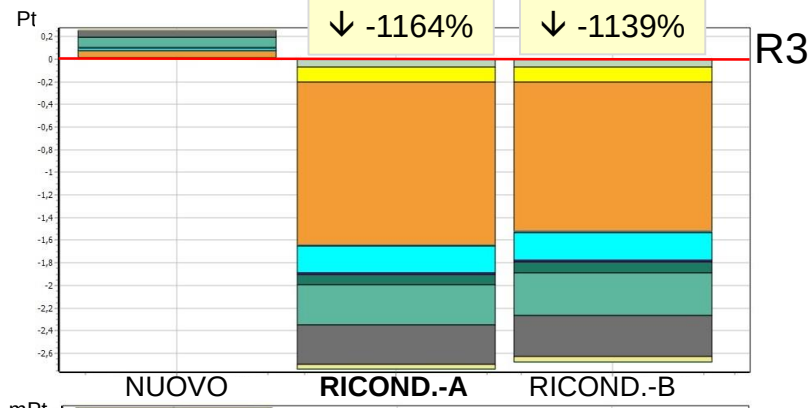


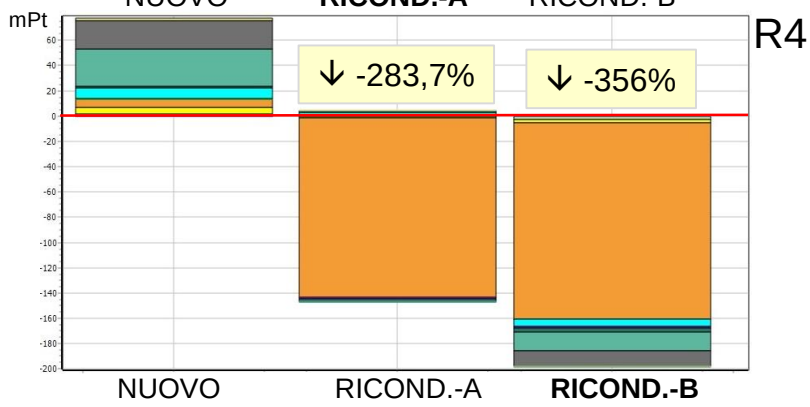
multi-output model

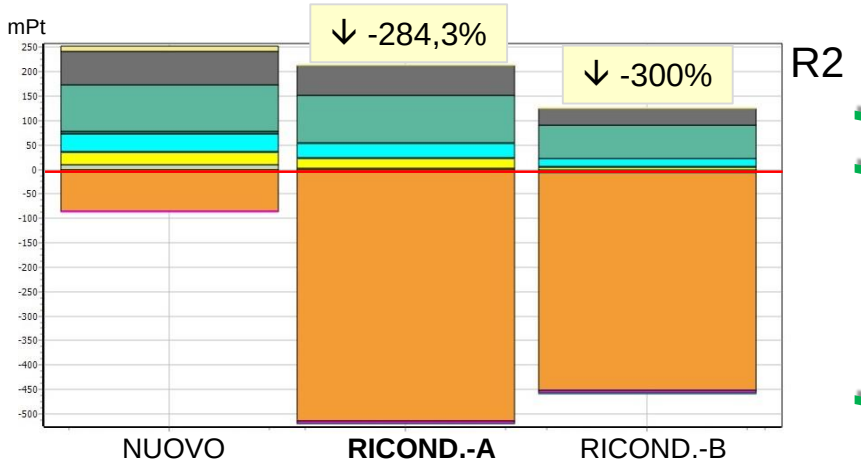


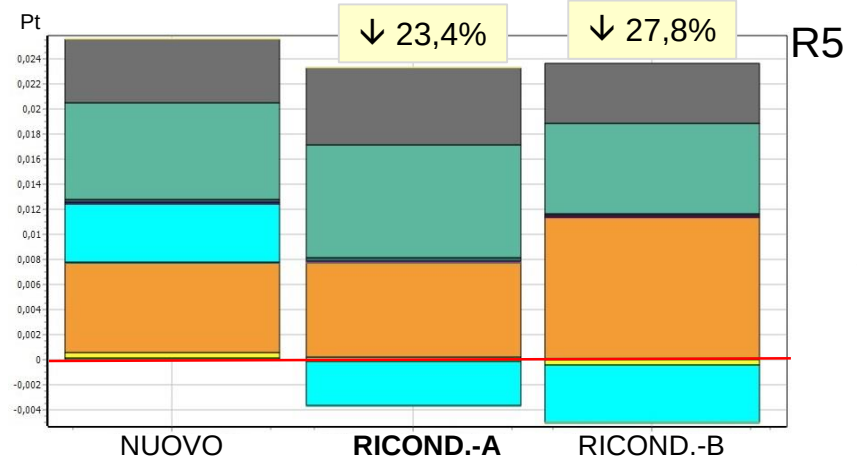
Nuovo vs Ricondizionato (Scenario A e B)



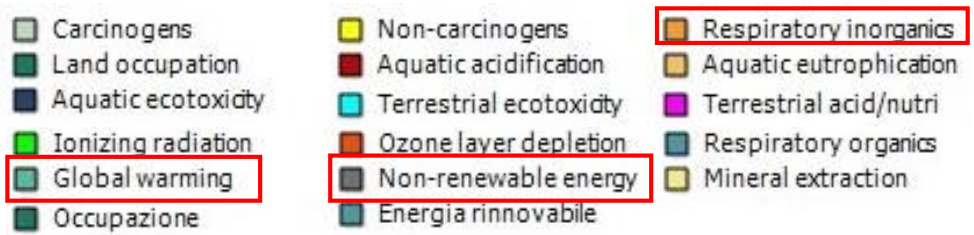




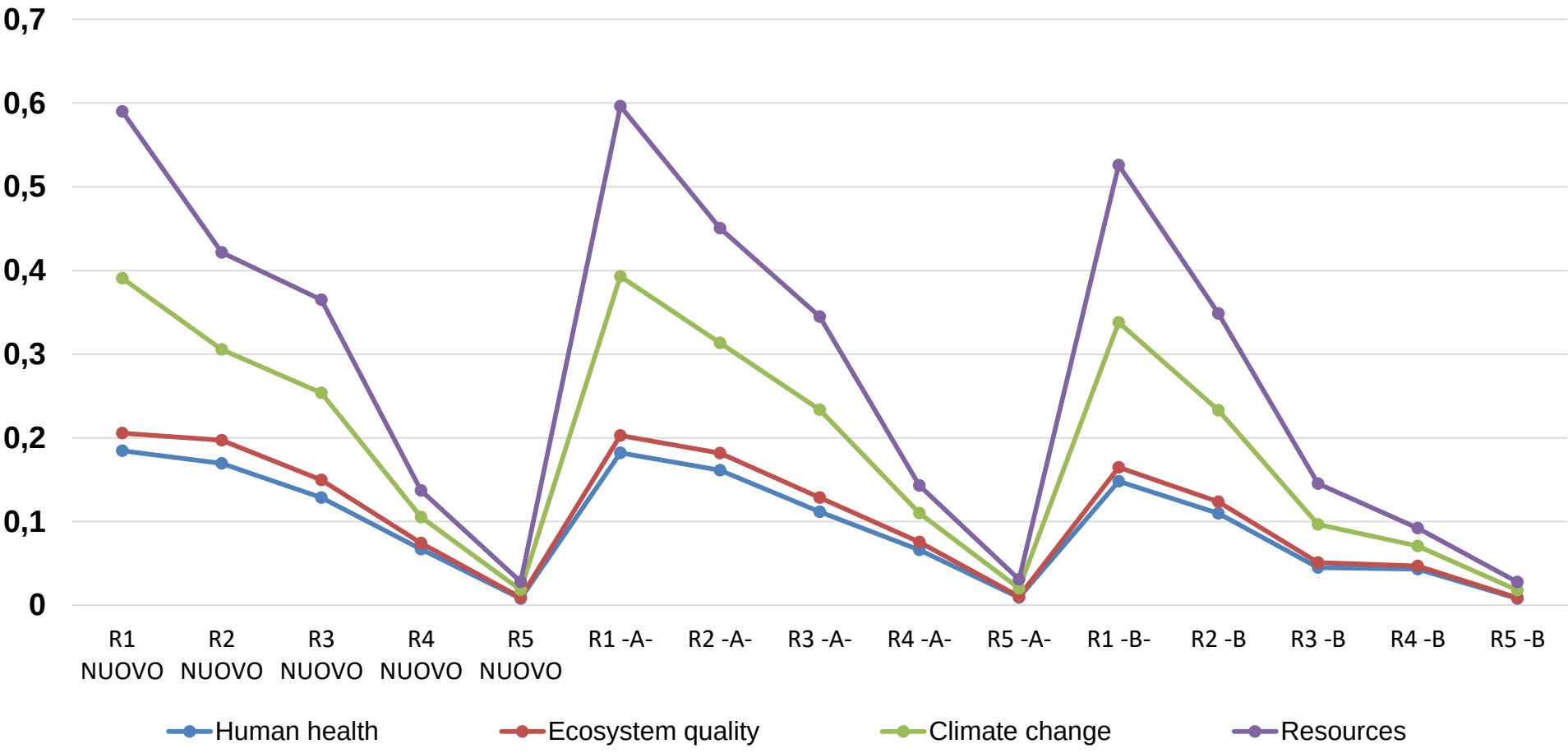




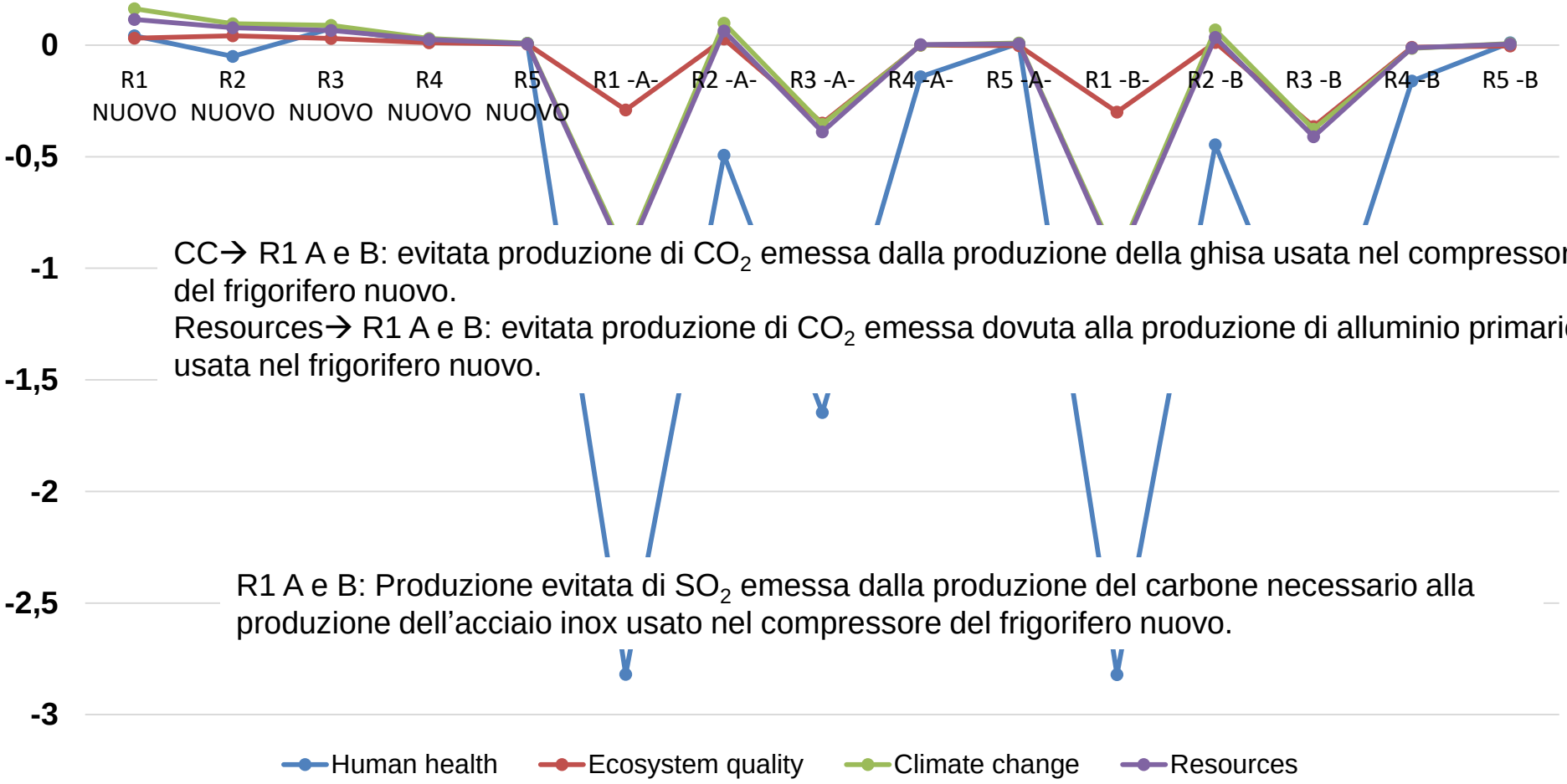
system expansion model



Environmental trends - multi-output model



Environmental trends – system expansion model



CC→ R1 A e B: evitata produzione di CO_2 emessa dalla produzione della ghisa usata nel compressore del frigorifero nuovo.
Resources→ R1 A e B: evitata produzione di CO_2 emessa dovuta alla produzione di alluminio primario usata nel frigorifero nuovo.

R1 A e B: Produzione evitata di SO_2 emessa dalla produzione del carbone necessario alla produzione dell'acciaio inox usato nel compressore del frigorifero nuovo.

Conclusions

- The enviromental damage determined by the life cycles of new EEE and reused one depends on the LCA model adopted (multi-output and system expansion).
- In the reconditioning activity changing the set and therefore the quality of replaced components the environmental performance can decrease.
- Total damage of WEEE management in Genoa city is equal to 2.6Pt (multi-output model) and -38.78 Pt (system expansion).
- System boundaries: Reuse activity is part of waste management?
- The total damage generated by the only reuse activity contributes to 42% on the total damage of WEEE management in Genoa city.
- The reuse activity determines an environmental advantage of 0.15% in terms of new jobs.

Thank for your attention

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