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Integrated environmental analysis of urban waste separate collection in the Sorrento peninsula, in Italy

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Life Cycle Assessment and Other Assessment Tools for Waste Management and Resource Optimization

INTEGRATED ENVIRONMENTAL ANALYSIS OF URBAN WASTE SEPARATE COLLECTION IN THE SORRENTO PENINSULA, IN ITALY

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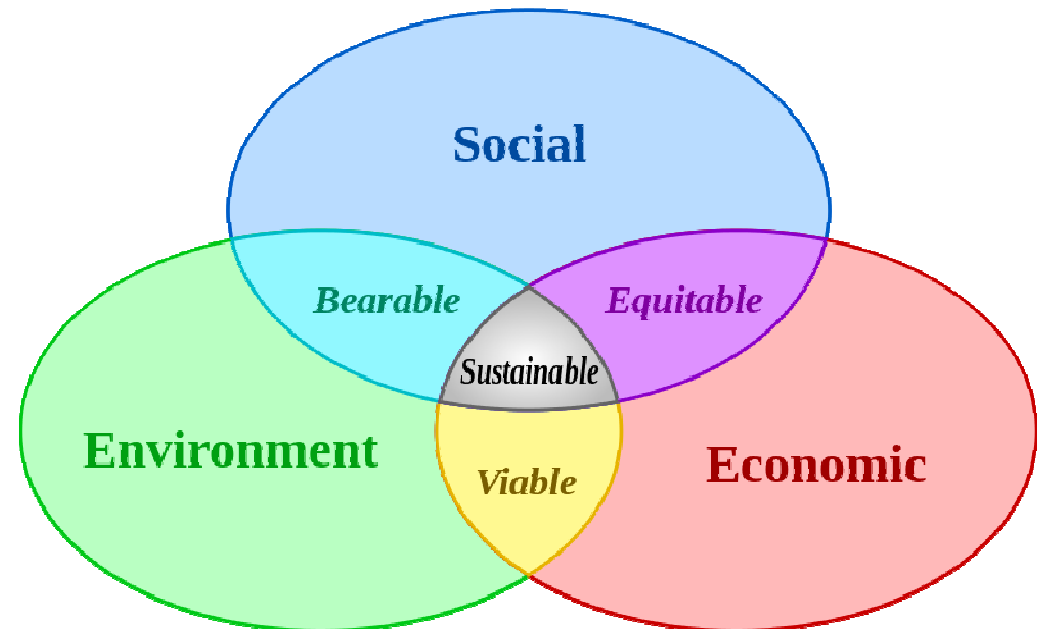
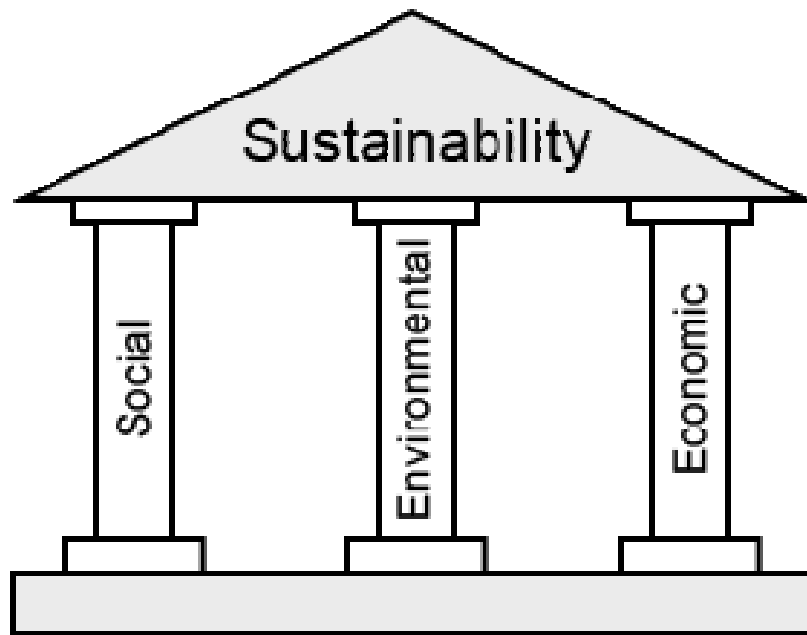
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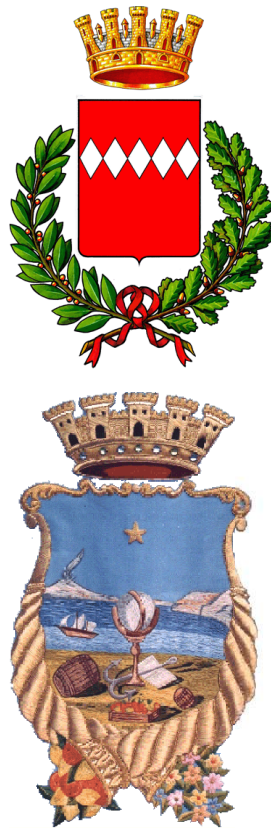
Main aim of the study

- The main aim of this work was to study the **kerbside collection system** of two municipalities in the **Sorrento peninsula** (in Italy) with an **integrated approach** based on the three pillars of **sustainability**: **society**, **environment** and **economy**.



The two studied municipalities

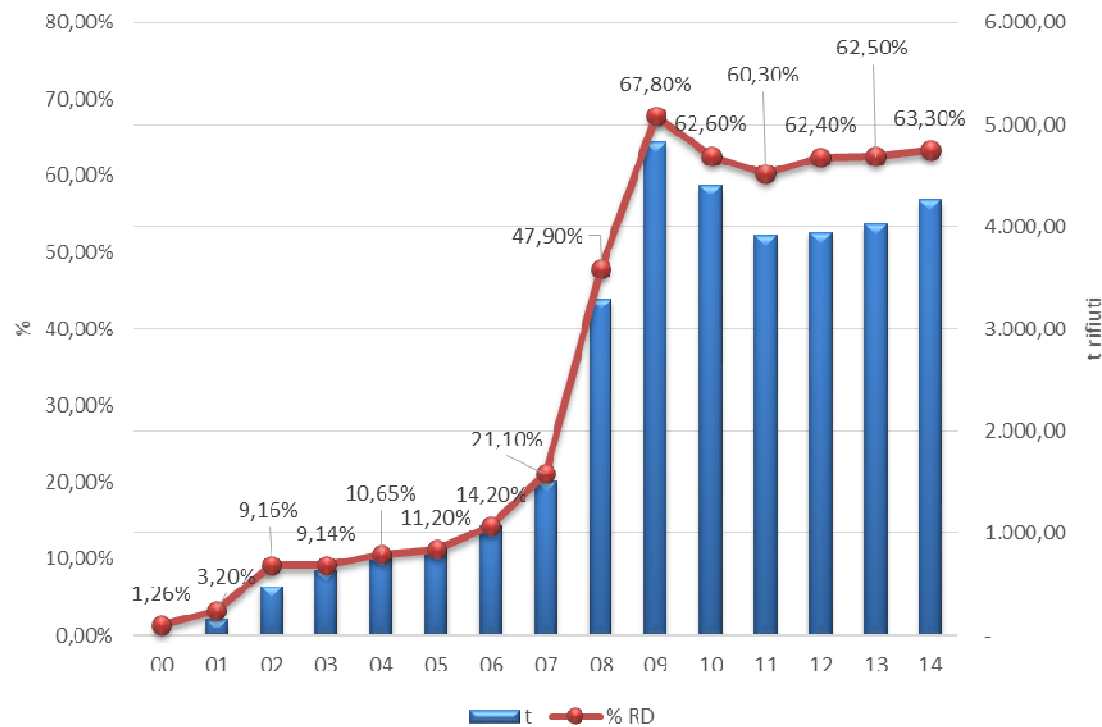
- The studied municipality are **Sorrento** (16,745 inhabitants, 1,681 inhabitants/km²) and **Piano di Sorrento** (13,159 inhabitants, 1,793 inhabitants/km²).



Materials and methods

The two studied municipalities

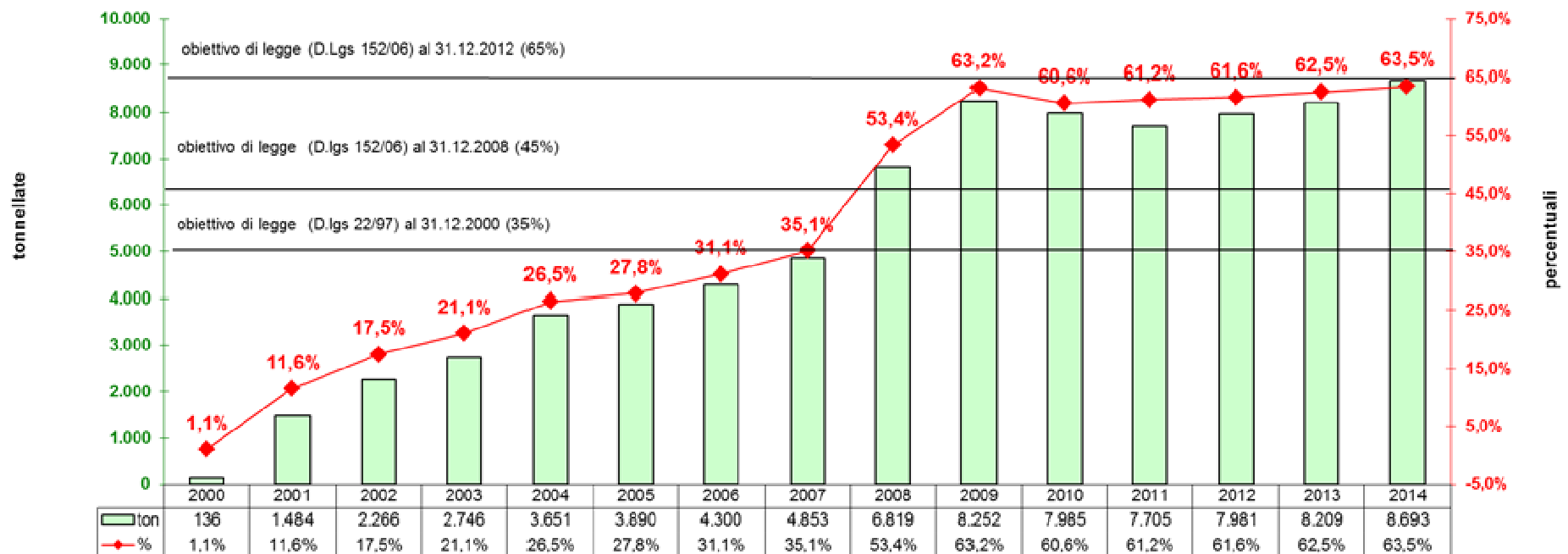
- **Piano di Sorrento** and especially **Sorrento** are **tourist towns** and this obviously has an impact on the **quantity** and **quality** of **urban waste**.
- In **2014**, the percentage of separate collection was **63.3%** in **Piano di Sorrento** with a per capita production of **465.7 kg/inhabitant/year**.



Materials and methods

The two studied municipalities

- In **2014**, the percentage of separate collection was **63.8%** in **Sorrento** with a per capita production of **775 kg/inhabitant/year**.



Materials and methods

The two studied municipalities

- In every municipality, there is a **Separate Collection Centre (SCC)** where the citizens can deliver the **recyclables** from urban waste obtaining **economic benefits** similarly to the system described in De Feo and Polito (2015).



Materials and methods

The sociological analysis

- The **sociological analysis** was developed by means of a **structured questionnaire** similar to that developed by De Feo and Polito (2015).

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Tutor strutturato organizzatore: Dott. Luigi Casano

Università del Salento
Corso di Laurea Magistrale in Scienze Ambientali
Allievi: Anna Rita Polito e Daria Milone

QUESTIONARIO ANONIMO

PER FAVORE COMPILI IL QUESTIONARIO DANDO UNA SOLA RISPOSTA AD OGNI DOMANDA (BARRARE UNA SOLA CASELLA)

Data _____ Luogo di compilazione: Piano di Sorrento Sorrento
Età: _____ Sesso: F M Stato civile: Coniugato Single
Zona di residenza: Zona verde Zona extra verde Zona rossa Zona extra rossa

Qual è la sua professione?
 Casalingo/a Commerciante Disoccupato/a
 Impiegato/a Insegnante Libero professionista
 Operario/a Pensionato/a Studente/ssa
 Altro (specificare) _____

Qual è il suo titolo di studio?
 Nessuno Licenza elementare Licenza media
 Diploma Laurea Altro _____

1. Come giudica la qualità del servizio di raccolta differenziata dei rifiuti nel proprio comune?
 Molto buona Buona Media Scarsa Scarsissima

2. Come giudica la qualità del servizio offerto presso il centro di raccolta?
 Molto buona Buona Media Scarsa Scarsissima

3. Come si potrebbe migliorare la qualità del servizio presso il centro di raccolta?

4. A casa sua, è l'unico che si reca presso il centro di raccolta?
 SI NO

5. Con che frequenza si reca presso il centro di raccolta?
 1 volta al mese 2/3 volte al mese 1 volta a settimana più volte a settimana

6. Quando va al centro di raccolta, prima o dopo svolge anche altri servizi (ad es. supermercato, lavoro, etc.)?
 SI NO

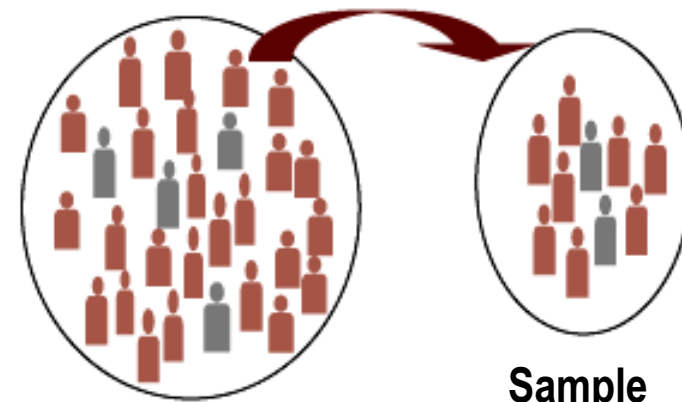
7. Lei si reca presso il centro di raccolta perché così non deve rispettare il calendario della raccolta porta a porta?
 Molto d'accordo D'accordo Indifferente Disaccordo Per niente d'accordo

8. Lei si reca presso il centro di raccolta perché si ottengono incentivi economici?
 Molto d'accordo D'accordo Indifferente Disaccordo Per niente d'accordo

9. Se non ci fosse il premio dell'olio extravergine Lei recupererebbe ugualmente l'olio?
 Molto d'accordo D'accordo Indifferente Disaccordo Per niente d'accordo

10. Lei si reca presso il centro di raccolta perché così facendo ritiene di rispettare di più l'ambiente?
 Molto d'accordo D'accordo Indifferente Disaccordo Per niente d'accordo

11. Cosa La indurrebbe a recarsi più spesso al centro di raccolta?
 Maggiori incentivi Ampliamento degli orari di apertura Altro _____



Population

Sample



Materials and methods

The economic analysis

- The **economic analysis** was conducted in the light of the Extended Producer Responsibility (EPR) system, evaluating the **money recovery** from the **recyclable materials theoretically contained in the residual waste**.



Materials	2000	2008	2014
Steel	50.00 €/t	60.35 €/t	76.65 €/t
Aluminum	170.00 €/t	284.17 €/t	350.67 €/t
Paper and cardboard	40.00 €/t	90.98 €/t	74.39 €/t
Plastic	150.00 €/t	198.48 €/t	237.45 €/t
Glass	23.20 €/t	23.20 €/t	25.30 €/t

Materials and methods

The environmental analysis

- The **environmental analysis** was performed applying the **Life Cycle Assessment (LCA)** approach to:



- ✓ the **urban waste treatment and disposal facilities**

- ✓ Recycling (modified from Ecoinvent v.2)
- ✓ Composting (modified from Ecoinvent v.2)
- ✓ Incineration (modified from Ecoinvent v.2)
- ✓ Landfilling (modified from Ecoinvent v.2)

- ✓ the **internal collection**

- Transport lorry > 32 t, EURO3
- Transport lorry 3,5 –7,5 t EURO3
- Load factor 0.75

- ✓ the **external transport systems**

- Transport lorry > 32 t, EURO3
- Load factor 0.5



Materials and methods

The considered scenarios

- The analysis was carried out considering three real scenarios:
 1. **2000, without separate collection;**
 2. **2008, when the Campania region of Southern Italy was suffering serious problems with the management of urban waste** because the region did not have enough waste management facilities;
 3. **2014, when there was an effective kerbside collection system** in the two municipalities.
- **Two different composition analysis** were considered:

Materials	Scenario 1 - Regione Campania (RC)	Scenario 2 - Arpac (A)
Putrescibles	50%	51%
Paper and cardboard	20%	18%
Glass	10%	8%
Plastic	14%	18%
Steel	5.4%	4%
Aluminum	0.6%	1%

Materials and methods

Sociological (main) results

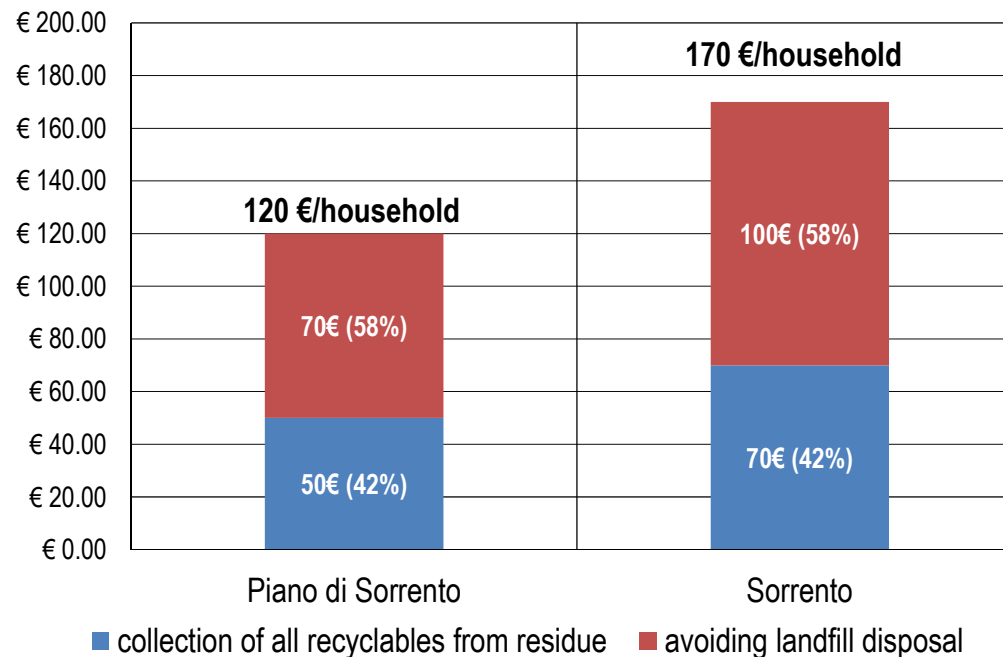
- The **quality of the kerbside separate collection system** in the Sorrento peninsula was evaluated **good or very good** from **90.6% of respondents**, compared to **95.8%** of the **benchmark town of Baronissi** (De Feo and Polito, 2015).
- Around **75% of respondents** declared that **they go to the SCC before or after doing other tasks** (this question wanted to verify if in the future the **recyclables could be only collected to the SCC**).
- **89.4% of respondents** in the Sorrento peninsula declared **that they go to the SCC mainly due to environmental reasons**, compared to **91.0%** of the **benchmark town of Baronissi** (De Feo and Polito, 2015).



Results

Economic (main) results

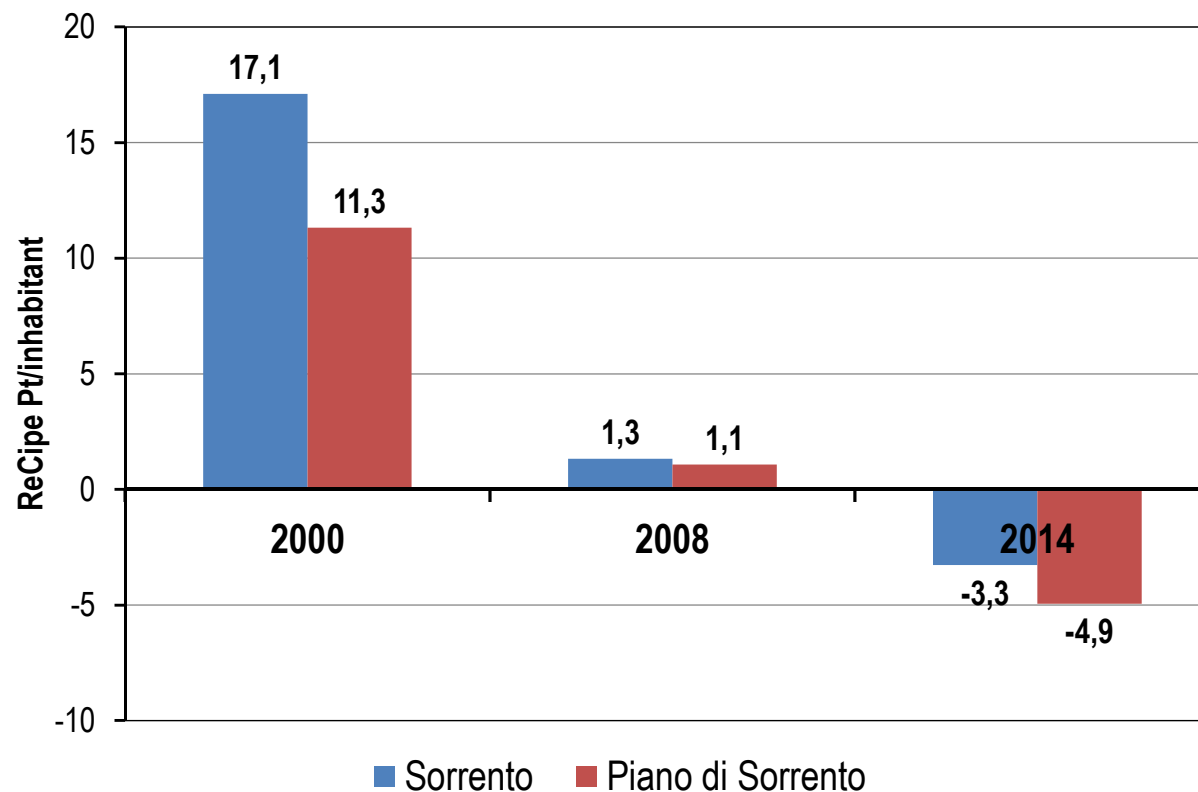
- In 2014, the **theoretical maximum economic saving** with the **separate collection of all the recyclables** and the **avoided payment of the landfilling disposal fee** (170 €/ton), was:
 - ✓ **120 Euro/household** for **Piano di Sorrento**,
 - ✓ **170 Euro/household** for **Sorrento**.



Results

Environmental (main) results

- The **increasing percentages of separate collection** allowed to avoid the production of environmental impacts, with **greater benefits for the citizens of Piano di Sorrento**.



Results

“Zero Waste” Hotel in Sorrento

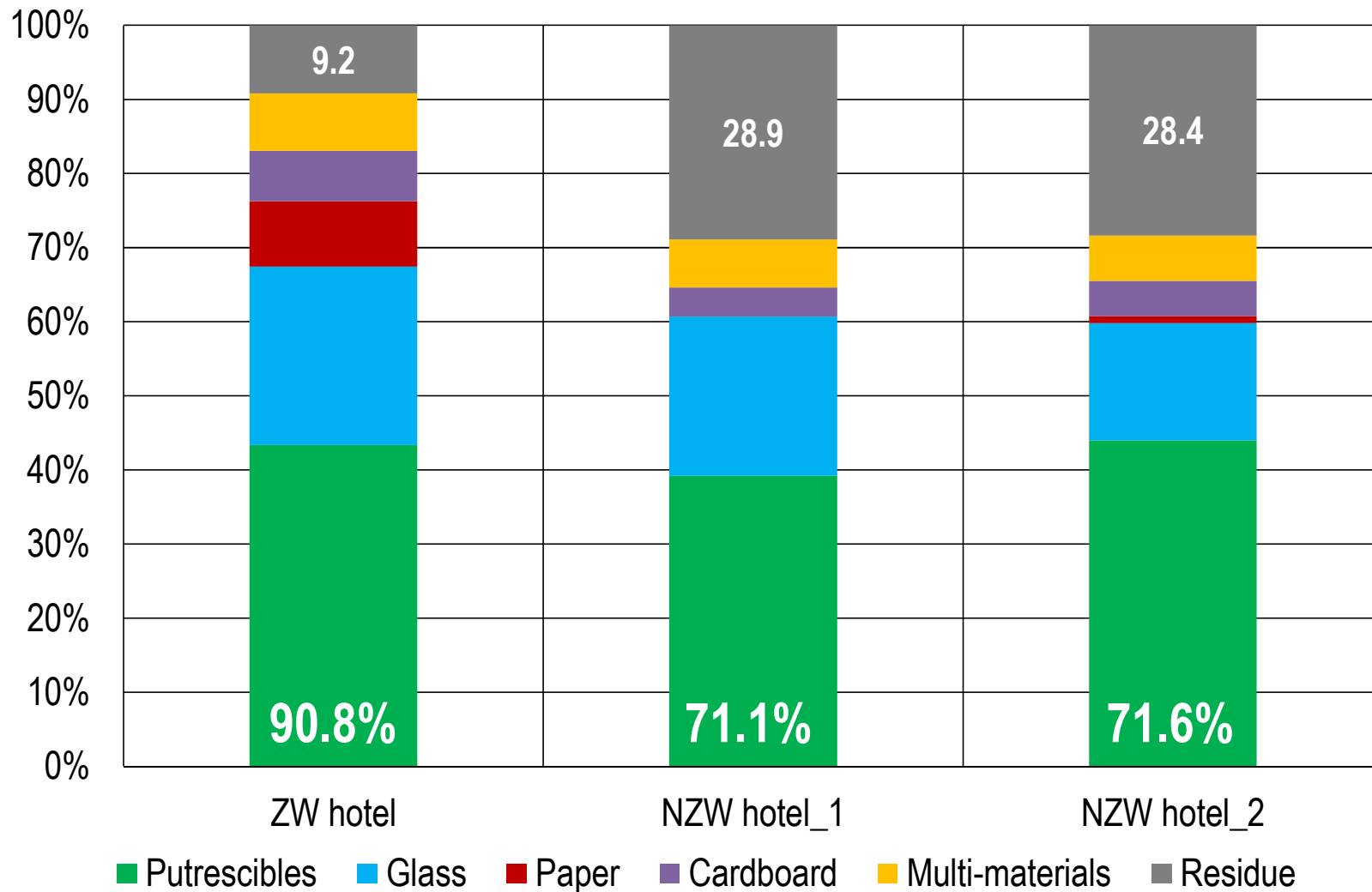
- For Sorrento it was calculated the **number of theoretical touristic bus/day** whose **impact in terms of CO_{2,eq.}** could be **compensated** in the case of a **“Zero Waste” (ZW) management of all the hotels.**



- 90% of separate collection;
- Elimination of all the disposable and single portions;
- Elimination of plastic and introduction of a series of reusable and compostable materials;
- Introduction of dispensers for limiting water consumption.

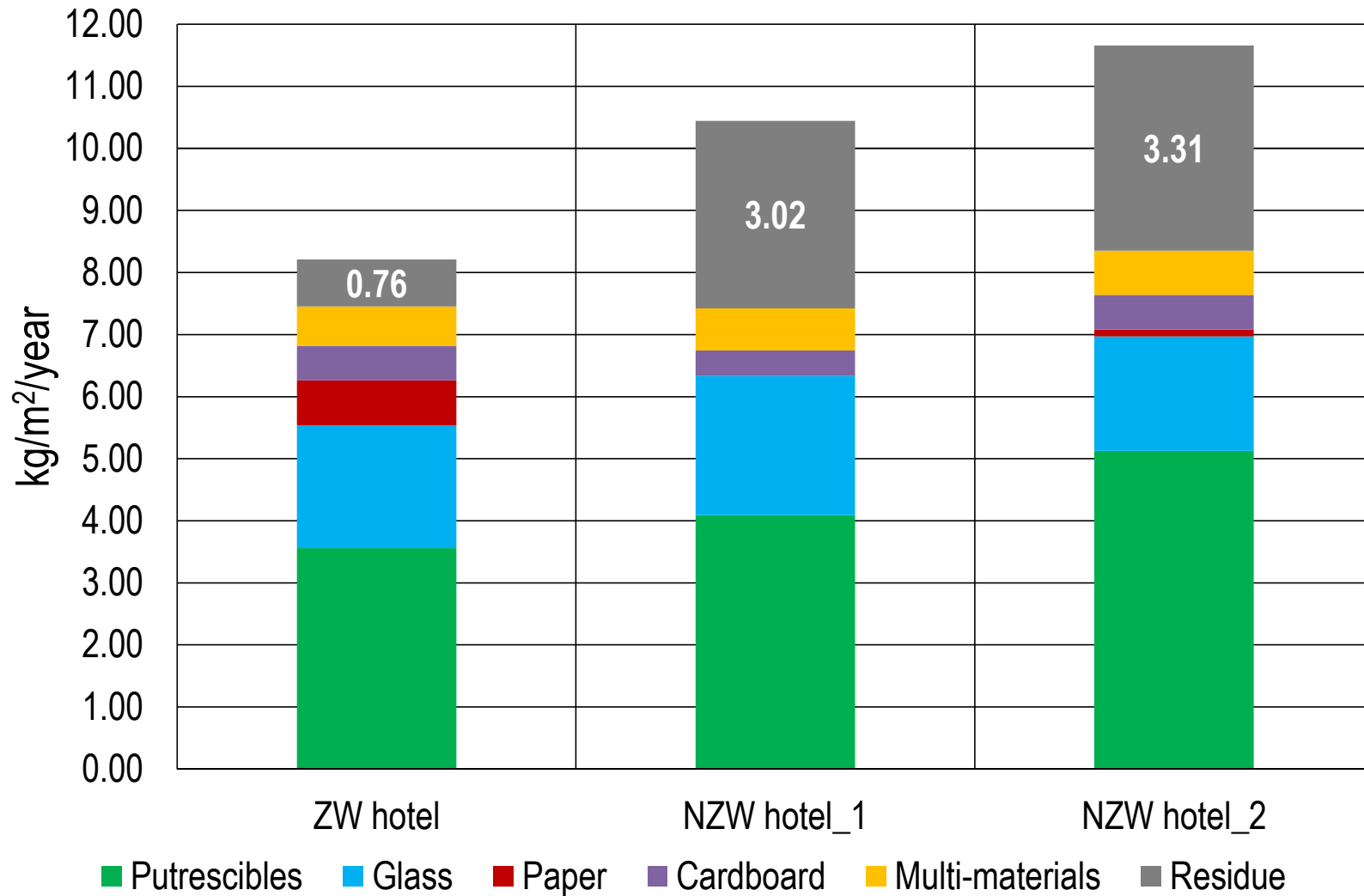
Results

% of separate collection in the hotel of Sorrento



Results

Specific production of recyclables and residue



Results

Environmental (main) results

- The result was obtained as the **ratio** between the **difference** of the **impact produced by the hotels all operated in a normal way** (No Zero Waste, NZW) and the **hotels all managed with a ZW approach**

$$\Delta \text{Impact (kg CO}_{2,\text{eq}}) = \text{Impact (NZW)} - \text{Impact (ZW)} = 859,042.48 \text{ kgCO}_{2,\text{eq}}$$

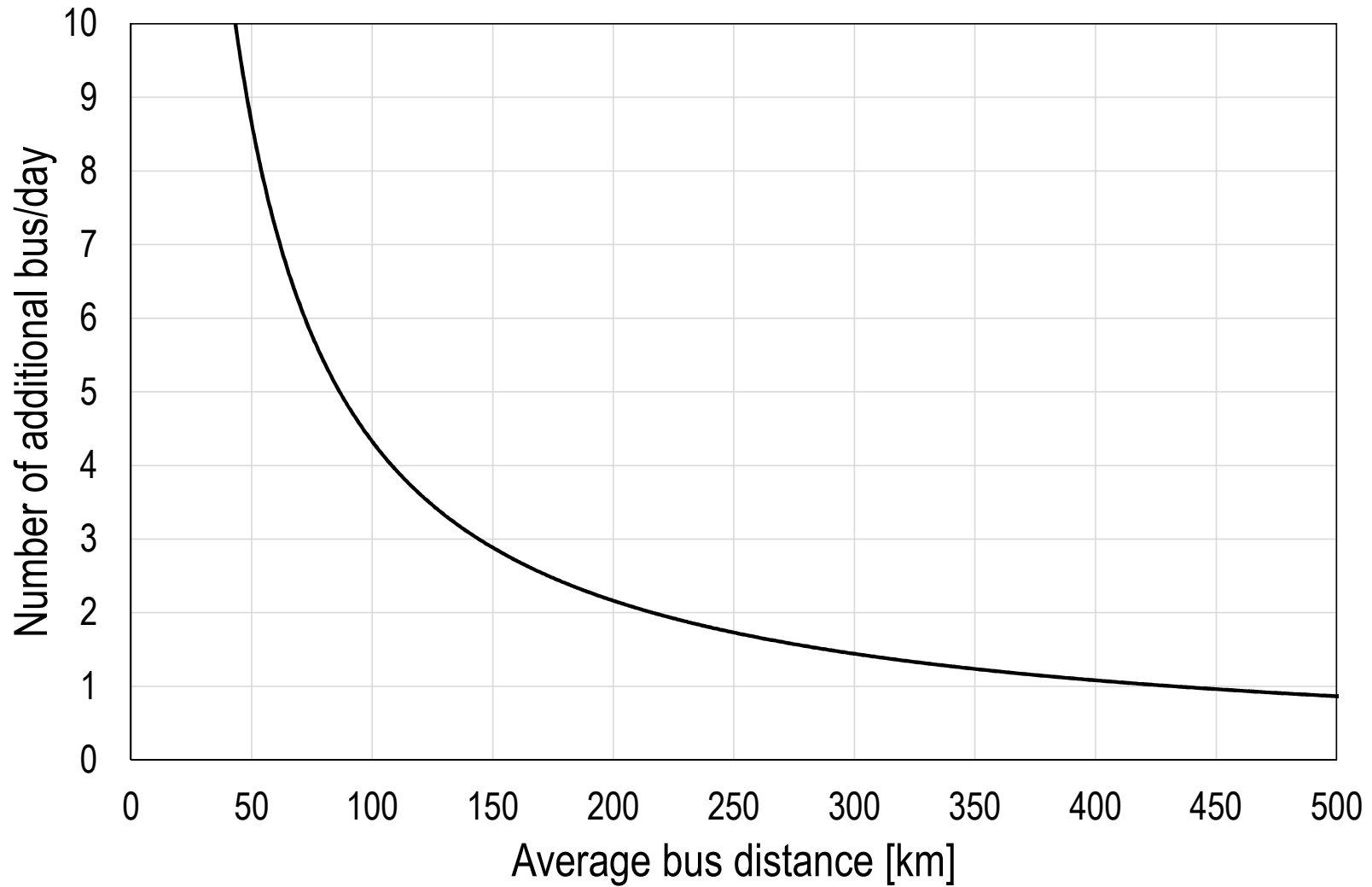
and the **impact of a single 50 passengers bus** (as a function of the distance)

$$\text{Impact bus (kg CO}_{2,\text{eq}}/\text{bus}) = 5.4405151 \text{ (kg CO}_{2,\text{eq}}/\text{bus/km}) \times \text{distance (km)}$$

$$\begin{aligned} \text{Number of bus} &= \Delta \text{Impact (kg CO}_{2,\text{eq}}) / \text{Impact bus (kg CO}_{2,\text{eq}}/\text{bus}) = \\ &= 859,042.48 \text{ kgCO}_{2,\text{eq}} / 5.4405151 \text{ (kg CO}_{2,\text{eq}}/\text{bus/km}) \times \text{distance (km)} = \\ &= 157,897.3 \text{ (bus} \times \text{km)} / \text{distance (km)} \end{aligned}$$

Results

Environmental (main) results



Results

Environmental (main) results



Results

From “waste” to “exhausted materials”

- Those we call “**waste**” are mainly **materials that have momentarily “exhausted” their function** becoming a sort of “**exhausted materials**”. In the light of this consideration, on the base of their origin, we could have:
 - ✓ **Normal Exhausted Materials (NEM)**, corresponding to the **Municipal Solid Waste (MSW)**, and
 - ✓ **Special Exhausted Materials (SEM)**, mainly corresponding to the industrial, agricultural, demolition and construction waste, etc.
- Definitively, taking into account the concept of **hazard**, there will be four kind of exhausted materials:
 - ✓ **Non Hazardous NEM**
 - ✓ **Hazardous NEM**
 - ✓ **Non Hazardous SEM**
 - ✓ **Hazardous SEM**

Final comment and proposal

Many thanks for your attention!



Giovanni
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The “green” team of this research (www.greenopoli.it)