

# Environmental evaluation of a composting plant facility: bioplastics analysis, environmental and economic life cycle assessment



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## Introduction



Figure 1. Quartering method procedure

The case study proposed is an environmental evaluation of a composting facility, "La Città Verde", located in the Emilia – Romagna region (Italy). A waste characterization analysis was developed to detect undesirable plastic residues entering in the composting process. The *quartering method* was used according to the plant characteristics and the amount of material involved (Figure 1). Subsequently, an environmental and economic assessment was performed following a life cycle approach. The Life Cycle Assessment (LCA) was developed using the SimaPro 8.5 software and applying CML – IA baseline methodology. Mostly primary data were gathered and additional secondary data were used from the Ecoinvent v.3 database. A cradle to gate analysis considering the total amount of waste delivered to the facility in a year as a functional unit (FU) was selected in both assessments: the LCA and the life cycle costing (LCC).

## Results & Discussion

The waste characterization analysis was conducted by comparing the fresh organic waste and the mature compost (Table 1).

Table 1. Plastic and bioplastic characterization analysis

Waste sample classification before the composting treatment		
Type of waste	Mass (kg)	Percentage (%)
Organic biodegradable	101	87.8
Biodegradable plastic	5.5	4.78
Plastic	4	3.5
Other non-degradable waste	3	2.6
<b>Total organic fresh waste</b>	<b>115</b>	<b>100</b>
<b>Loss</b>	<b>1.5</b>	<b>1.3</b>
Waste sample classification after composting		
Type of waste	Mass (kg)	Percentage (%)
Organic biodegradable	36	90
Biodegradable plastic	0.250	0.63
Plastic	1.5	3.75
Other non-degradable waste	1.2	3
<b>Total compost unsieved</b>	<b>40</b>	<b>100</b>
<b>Loss</b>	<b>1.05</b>	<b>2.63</b>

Bioplastic is the only fraction that almost entirely disappears, whereas the conventional plastic percentage but also extraneous waste are basically constant. The results confirmed that biodegradable bioplastic is indeed a good solution to plastic pollution issues. On the other hand, the analysis also confirmed that conventional plastic represents a serious issue in composting facilities due to its chemical characteristics.

As far as the life cycle assessment (LCA) is concerned, the shredding and the mixing stage resulted to be the main contributors to almost each impact category (Figure 2). This because of different factors e.g. the intensive use of energy, the use of fossil fuel-based machineries and the leachate and air emissions generated. On the other hand, due to the fact that only local and regional collections were considered in the area of interest transportation resulted to be the least impacting phase.

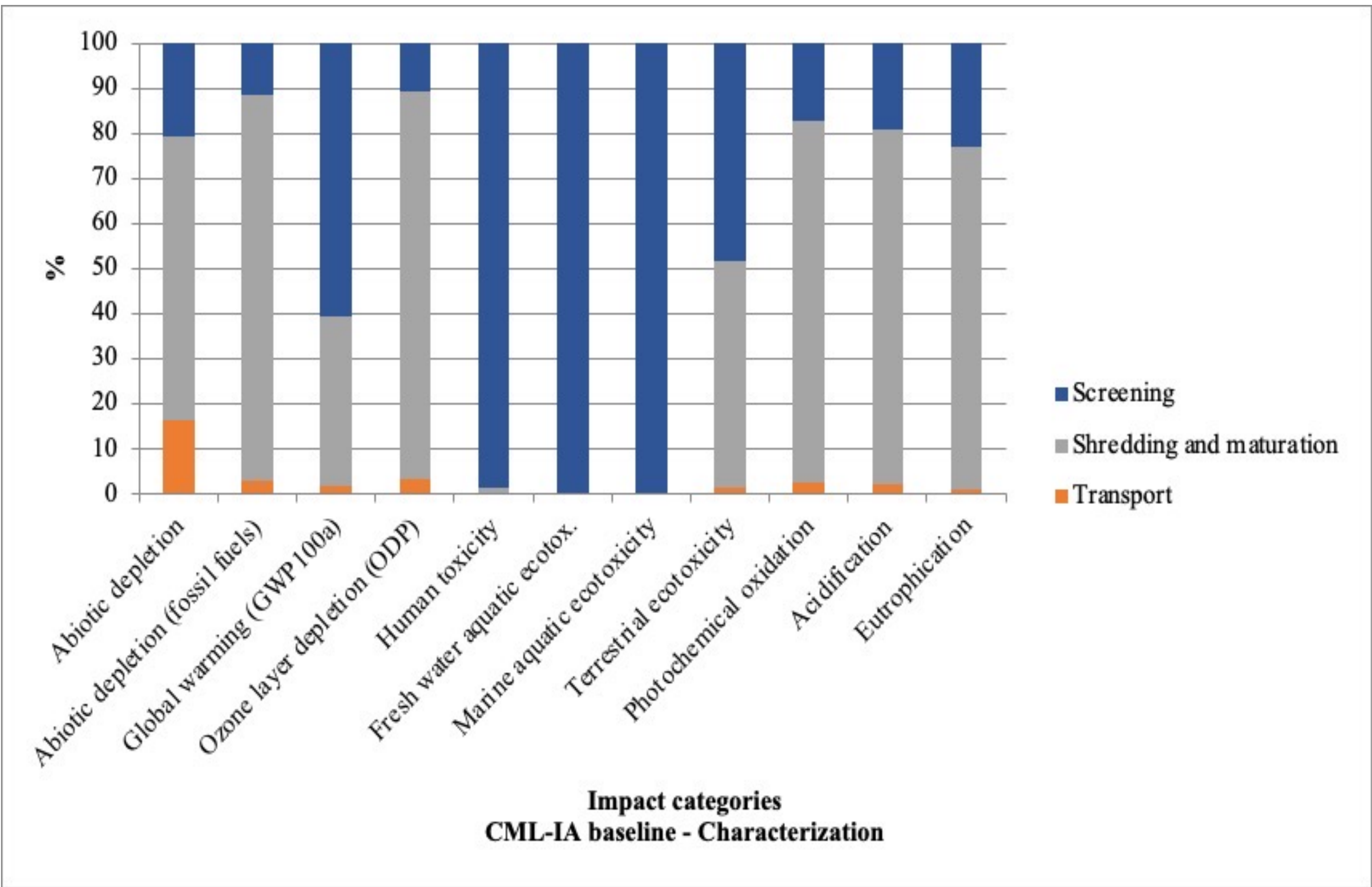


Figure 2. LCA results

Consistently to the LCIA results, production cost represented the main expenses for "La Città Verde", based on 2018 data (Figure 3). This is a reasonable result also due to the fact that all the machineries in the plant work yearlong at intensive energy rate.

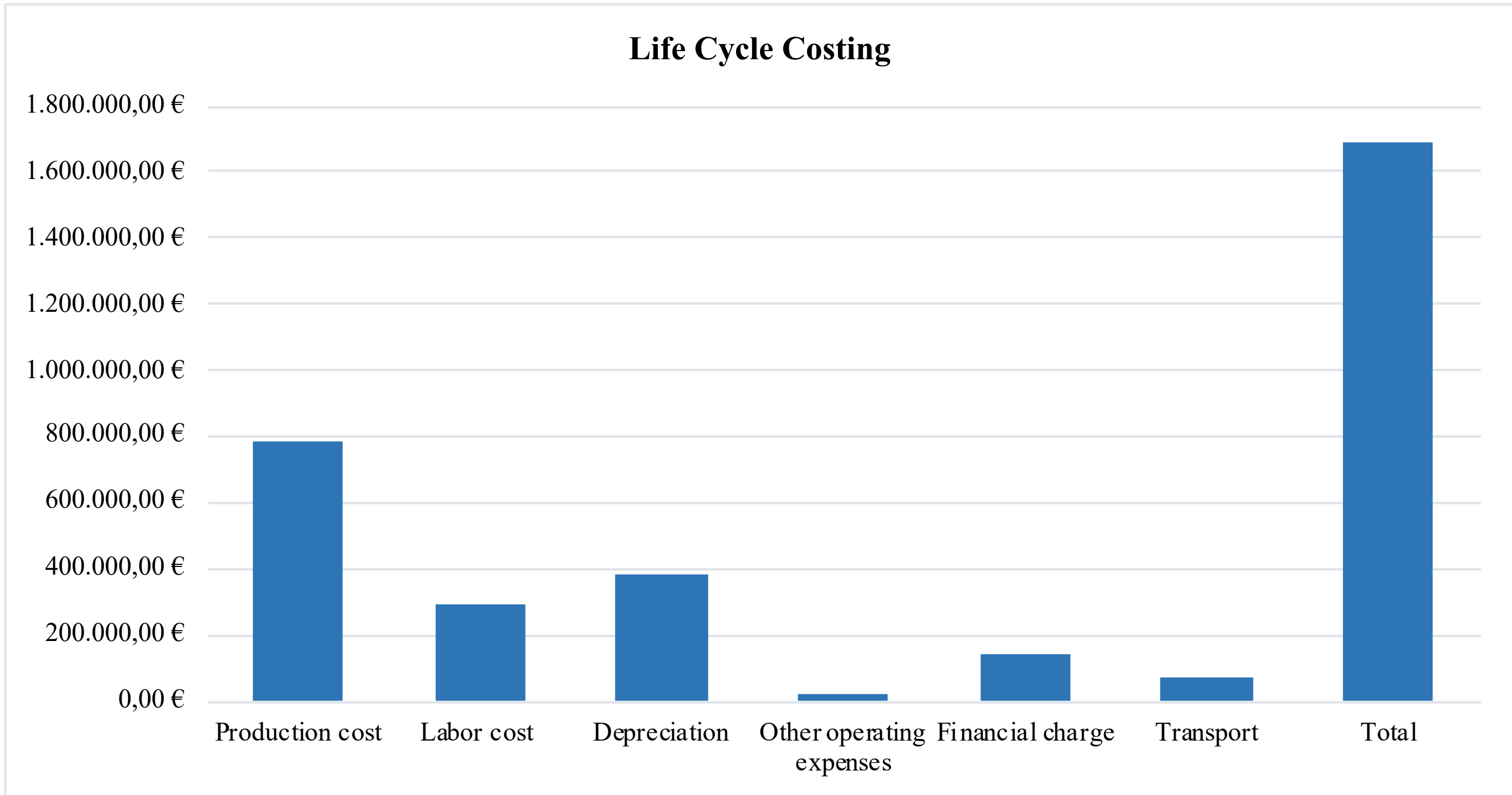


Figure 3. LCC results

## Conclusions

The study conducted was intended to be an initial evaluation of a wider analysis. Consequently, it encourages to undertake further research with the purpose to develop additional and complementary investigations. A comparison analysis between different waste management systems could be necessary to inquire and likely prove the degree of sustainability of the composting alternative. Furthermore, a suggestion for a more comprehensive research is to conduct also sensitivity and uncertainty analyses in order to assess the robustness and reliability of the LCA and LCC performed.

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