

OPTIMISATION OF MATERIAL WASTE FLUXES OF A PORTUGUESE CITY FROM A LIFE-CYCLE COSTING PERSPECTIVE

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The logo for 'HERAKLION 2019' features the word 'HERAKLION' in a bold, dark blue sans-serif font, followed by '2019' in a large, green sans-serif font. A small blue butterfly is positioned to the right of the year. Below the main title, the text '7th International Conference on Sustainable Solid Waste Management' is written in a smaller, dark blue sans-serif font. The dates '26-29 June 2019' are displayed in a bold, dark blue sans-serif font. The location 'Aquila Atlantis Hotel, Heraklion Crete Island, Greece' is written in a smaller, dark blue sans-serif font at the bottom. The entire logo is set against a light blue background with a white curved shape on the right side.

Case of study

- Life cycle assessment of MSW management in the city of Aveiro (Portugal)
 - Located in Atlantic coast
 - Medium sized city in Portugal: 80,000 inhabitants
 - Industrial, trade, academic and touristic hub

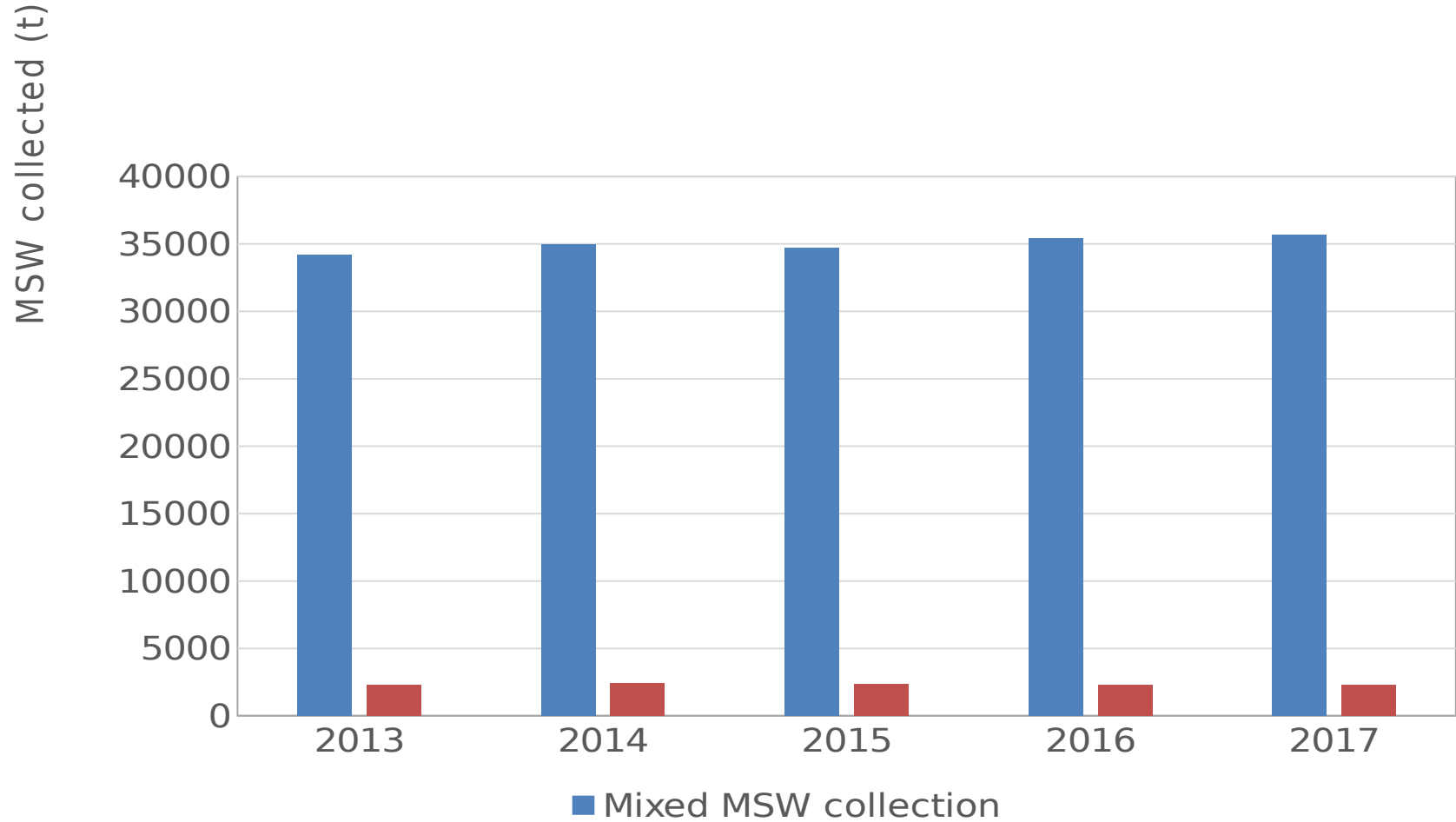


Case of study

- Source separation in Aveiro has not been able to meet the expectations: 6 % in Aveiro, compared to 16.5 % in Portugal (2017).
- Moreover, this percentage of separation remains stagnated in last years, and even slightly decreasing: 6.3 % in 2015, 6.1 % in 2016, 6.0 % in 2017.
- Meanwhile, the overall generation of MSW is growing along with economic recovery after the previous crisis.



Case of study

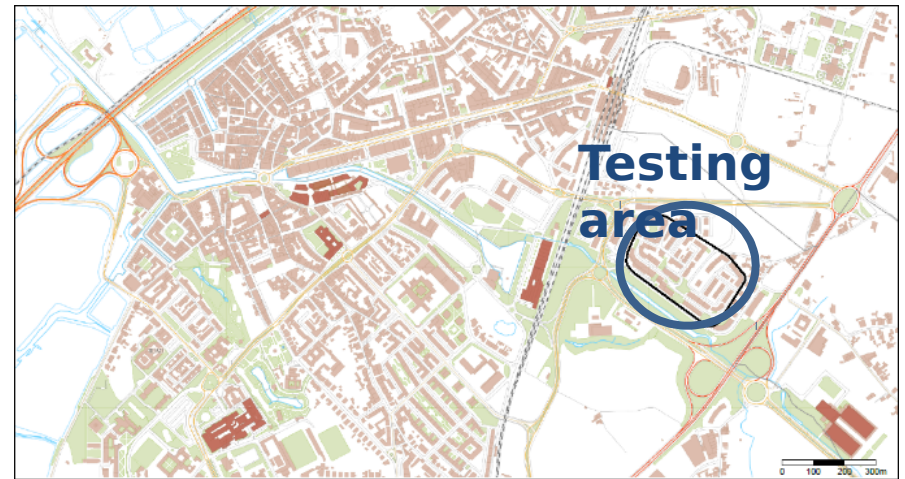


Case of study

- Poor source separation of MSW leads not only to losing recyclable materials, but also to a worse technical performance of MBT facilities, and finally to more landfilling (more than 50% in Aveiro).
- Regarding financial situation: although it has been required by environmental authorities that municipalities must recover 100% of their MSW management expenses, there is no evaluation of utilities performance, therefore citizens might be financing inefficient systems.

Case of study

- In view of the situation, the city is currently interested in a transition towards a *pay-as-you-throw* pricing scheme for mixed MSW collection.
- A neighbourhood (Forca Vouga), separated from main urban core, was designated as pilot testing area.
- Residential area: roughly 1200 inhabitants, mainly young medium-income families. There are also some shops, offices and bars / cafes.



Goal and scope

- Prior to the implementation of the new policy, a thorough assessment of the waste management environmental and economic performance is required in order to set a starting baseline.
- This study comprehends the environmental assessment of the whole management system in the considered pilot area, encompassing collection + treatments of the various MSW streams, and also an analysis of the costs involved.

Goal and scope

- The selected functional unit corresponds to the **annual collected amount of MSW** in the neighbourhood, obtained from both field measurements and municipal data records.
- Results (year 2017):
- **449 tonnes residual MSW**
- **54 tonnes recyclable MSW:**
 - **29 tonnes paper and cardboard**
 - **20 tonnes metal and plastic packaging**
 - **6 tonnes glass**



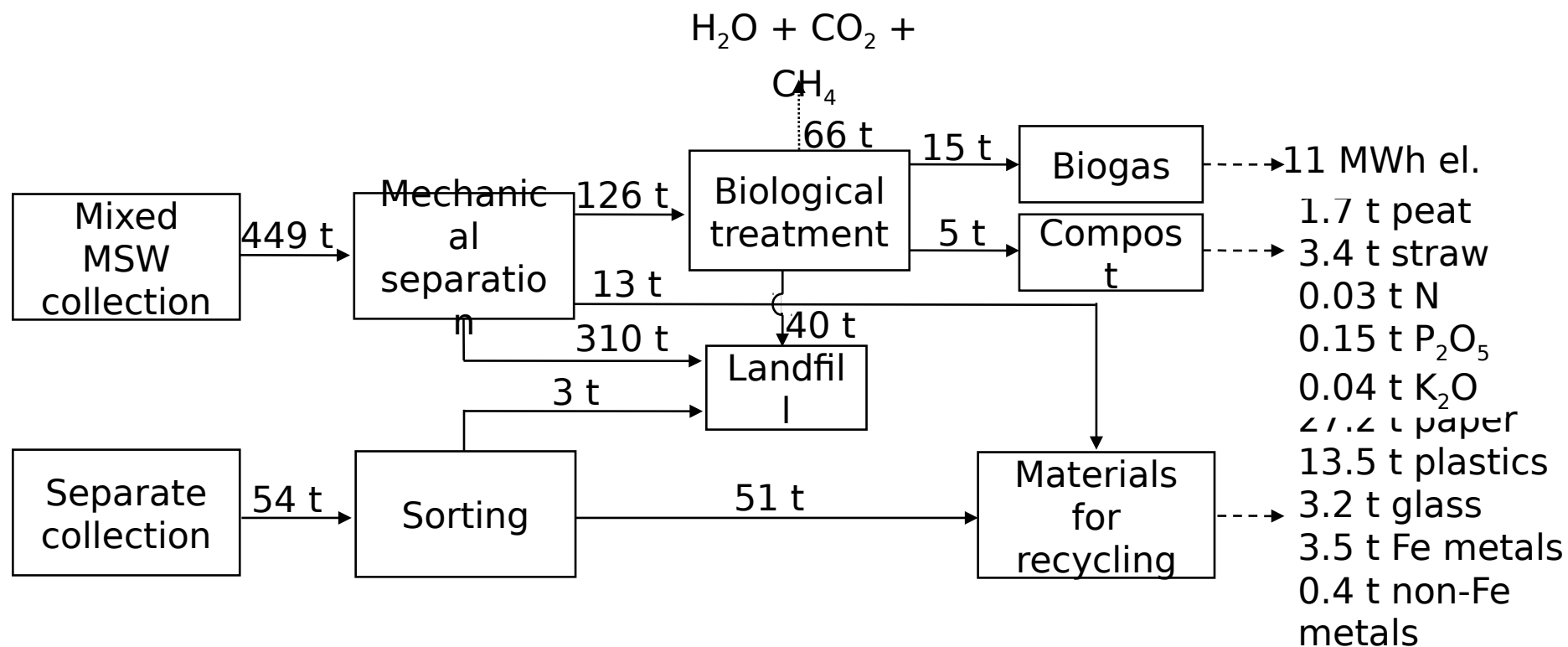
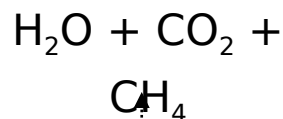
Life cycle inventory

- Data concerning MSW collection were obtained from the municipality:

Assets	Materials	Amount per FU
Carrier bags	HDPE	1435 kg
Household bins	PP	332 kg
Street containers (800 L)	HDPE	214 kg
	Steel	11 kg
	Rubber	3 kg
Collection with lorry	Fuel	3699 L

- Information relative to MBT was based on the company reports.
- Data for raw materials, processing and emissions was obtained from the producers and lifecycle databases (ecoinvent 3.3).

Life cycle inventory



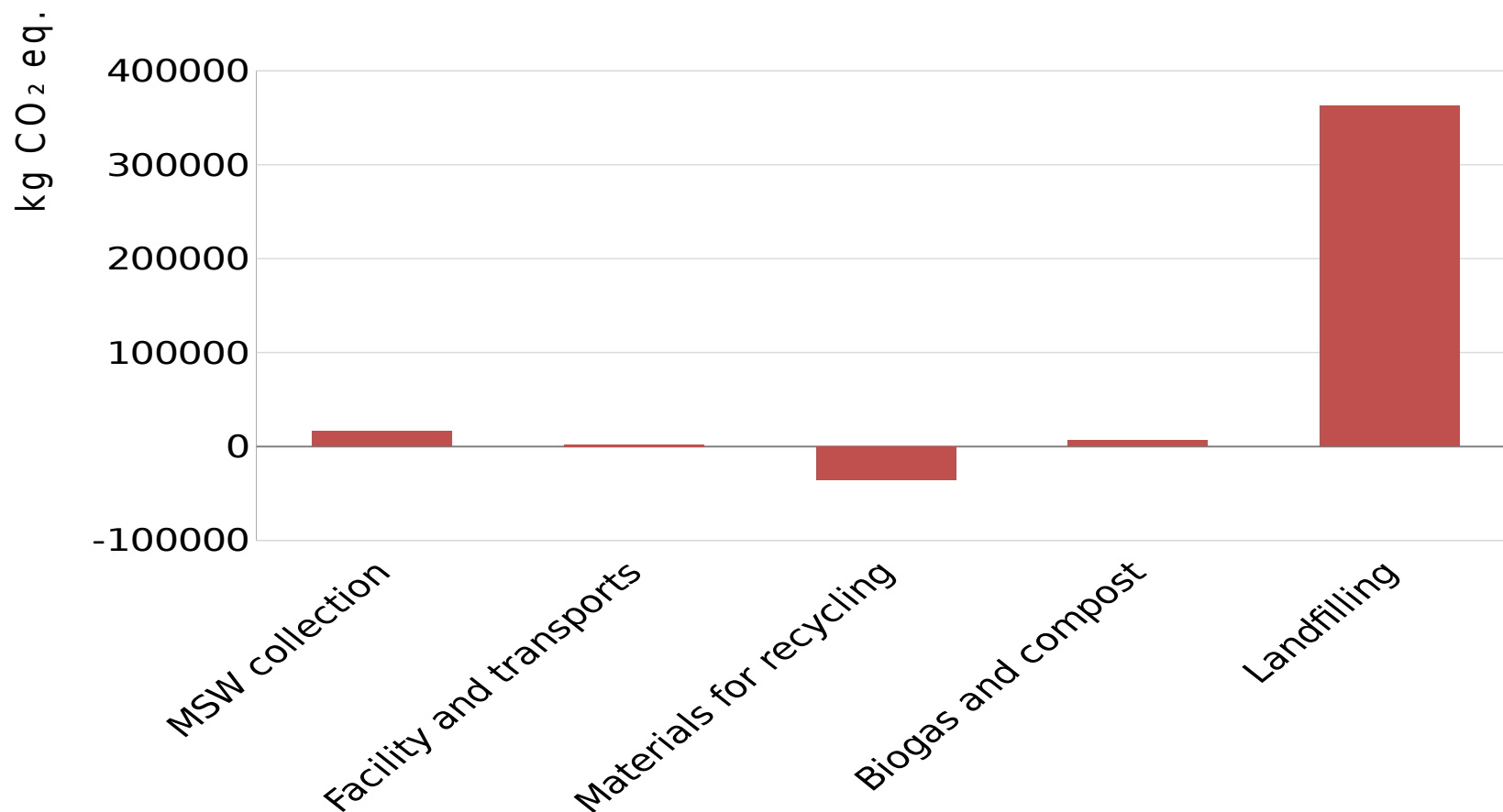
Life cycle costing: costs

Costs (per FU)		
Expenses	Unitary cost	Total
Municipal administrative staff	3 €/t	1457€
Mixed MSW collection	46 €/t	20862€
Gate fee for mixed MW	27 €/t	12256€
Separate MSW collection & sorting	225 €/t	12192€
Landfill tax	5 €/t	2421€
TOTAL COSTS		49187€

Life cycle costing: revenues

Revenues (per FU)		
Incomes (sales)	Unitary price	Total
Beverage cardboard	564 €/t	1289€
Glass	36 €/t	207€
Paper/cardboard	173 €/t	4890€
Fe metals (from mixed MW)	131 €/t	564€
Fe metals (from separate MW)	649 €/t	1752€
Non-Fe metals (from mixed MW)	180 €/t	59€
Non-Fe metals (from separate MW)	761 €/t	184€
Plastics (from mixed MW)	136 €/t	1080€
Plastics (from separate MW)	545 €/t	6377€
Compost	10 €/t	51€
Electricity production	115 €/MWh	1292€
TOTAL REVENUES		17744€

Carbon footprint: baseline

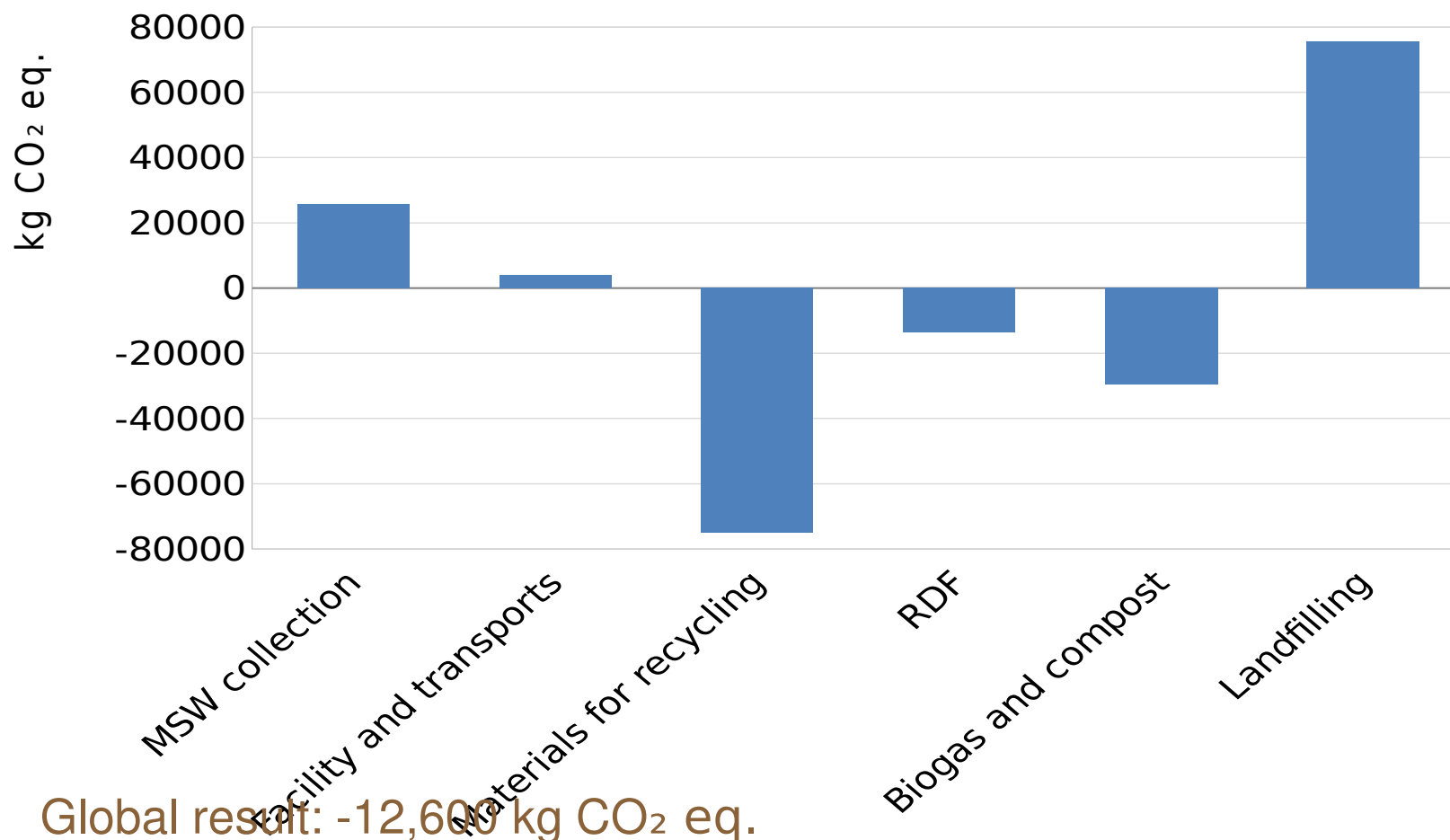


- Global result: +352,000 kg CO₂ eq.

Alternative scenario

- What would be necessary to achieve carbon neutrality?
- Source separation increased from 12% until 33% (although with more contamination).
- Increased biogas production from 15 t to 30 t (less biowaste lost in the MBT).
- Reactivation of RDF production (12 MJ/kg)

Carbon footprint: improved scenario



Life cycle costing: costs (improved)

Costs (per FU)		
Expenses	Baseline	Improved
Municipal administrative staff	1457€	1457€
Mixed MSW collection	20862 €	15503€
Gate fee for mixed MW	12256 €	9108€
Separate MSW collection & sorting	12192 €	38148€
Landfill tax	2421 €	1799€
TOTAL COSTS	49187€	66014€

Life cycle costing (improved)

Revenues (per FU)

Incomes (sales)	Baseline	Improved
Beverage cardboard	1289€	3472€
Glass	207€	1033€
Paper/cardboard	4890€	11882€
Fe metals (from mixed MW)	564€	----
Fe metals (from separate MW)	1752€	4724€
Non-Fe metals (from mixed MW)	59€	----
Non-Fe metals (from separate MW)	184€	495€
Plastics (from mixed MW)	1080€	----
Plastics (from separate MW)	6377€	19928€
Compost	51€	719€
Electricity production	1292€	4975€
RDF	----	634€
TOTAL REVENUES	17744€	47875€

Conclusions

- The dominant benefit is the environmental one, not economic.
- However, economic performance presents a different behaviour than environmental: e.g. collection presents a not so great environmental impact when compared to treatment, but it represents a great part of costs.
- Recovery of recyclable materials is the most beneficial process, but the best result can be only achieved with a proper combination of options.

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