MORE CIRCULARITY
LESS CARBON
-25% BY 2025

Carbon impact assessment of municipal waste in Navarra

2016, 2019, and 2020

ACR+

ZERO WASTE SCOTLAND

ACR+ is an international network of cities and regions sharing the aim of promoting a sustainable resource management and accelerating the transition towards a circular economy on their territories and beyond.

Circular economy calling for cooperation between all actors, ACR+ is open to other key players in the field of material resource management such as NGOs, academic institutions, consultancy, or private organisations.

Find out more at www.acrplus.org

Zero Waste Scotland exists to lead Scotland to use products and resources responsibly, focusing on where we can have the greatest impact on climate change.

Using evidence and insight, our goal is to inform policy, and motivate individuals and businesses to embrace the environmental, economic, and social benefits of a circular economy.

We are a not-for-profit environmental organisation, funded by the Scottish Government and European Regional Development Fund.

Find out more at www.zerowastescotland.org.uk/

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INTRODUCTION

Navarra joined the 2nd cohort of the "More Circularity, Less Carbon" campaign led by ACR+ with the support of its member Zero Waste Scotland. This campaign provided support to several ACR+ members so that they could assess the carbon footprint of their municipal waste, including the emissions generated during the production of products that became waste, as well as the impact of the collection and treatment processes.

Navarra's participation allowed the identification of the main contributors, including the most carbon-intensive fractions and the room for improvement. Like for the other participants, the main contribution comes from the generation of waste, meaning the impact linked with the extraction of resources and production of the products that then became municipal waste. The most carbon-intensive fractions are textile waste, food waste, and plastic waste.

1.1 ACR+ 'More Circularity Less Carbon' campaign

ACR+ has partnered with its member Zero Waste Scotland to launch the 'More Circularity Less Carbon' campaign in November 2019 to reduce the carbon impact of municipal waste among its members by 25 per cent by 2025.

Zero Waste Scotland's Carbon Metric International (CMI) tool, developed from Scotland's ground-breaking Carbon Metric, enables ACR+ members to measure the carbon impact of their municipal waste, take effective actions to reduce it, and track their progress towards the 2025 target.

Navarra is one of ACR+ members that benefited from this project and received support use the CMI to quantify the whole-life carbon impacts of its municipal waste. The results were summarised in a report[1], which has three main objectives:

- Enable Navarra to establish its 2025 carbon reduction target.
- Provide a detailed breakdown of waste carbon impacts by materials and management process; and
- Assess several carbon reduction scenarios that can help Navarra achieve its target.

1.2 Zero Waste Scotland's Carbon Metric International

Zero Waste Scotland has developed a tool in the fight against global climate change. The Carbon Metric measures the whole-life carbon impacts of Scotland's waste, from resource extraction and manufacturing emissions right through to waste management emissions, regardless of where in the world these impacts occur (Figure 1).

Figure 1: Schematic diagram presenting the lifecycle emissions of waste

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[1] ACR+ and Zero Waste Scotland (2022), the Carbon Footprint of Waste - Navarra

The Carbon Metric provides policymakers and business leaders with an alternative to weight-based waste measurement, allowing them to identify and focus specifically on those waste materials with the highest carbon impacts and greatest potential carbon savings. Scotland's 33% per capita food waste reduction target is an example of a policy informed by the Carbon Metric[2].

Further details on the Carbon Metric methodology can be found on Zero Waste Scotland's website[3].

1.3 Context of this study

In December 2016, the Government of Navarra approved the Navarra Waste Plan 2017-2027. This policy instrument is based on the circular economy principles and aims to make Navarra a reference in the prevention of waste generation, leadership in public management and the capacity to generate quality employment.

The Waste Plan indicates that the calculation of the carbon footprint associated with waste management is a necessary indicator for decision-making processes and to establish future environmental criteria in the management of waste, as well as to conceptualise the extent to which the sector can contribute to the reduction of greenhouse gases (GHG) through the recycling and the material and energy recovery of waste. The fulfilment of objectives in prevention, re-use and recycling, as well as in minimization of landfilling, is associated with a notable decrease in the carbon footprint associated with waste management, so this is the forecast for the 2027 horizon in Navarra.

This Plan establishes that actions related to waste management must be accompanied by a carbon footprint analysis that guarantees progress towards an optimal value, or at least, towards a lower value. Therefore, the present carbon footprint analysis will help Government of Navarra to evaluate the plan progresses and to achieve the 25 per cent carbon reduction target by 2025 set in the 'More Circularity Less Carbon' campaign.

The carbon footprint analysis period of this report, 2016-2020, has been chosen because 2016 is the year prior to the start of the plan and therefore the baseline to compare the evolution of the indicators before and after its implementation, and to evaluate how the plan is impacting the generation and management of municipal waste. Additionally, 2020 is a key year, since there are a good number of objectives to be met, some as important as preparation for reuse and recycling (50%), selective collection of biowaste (50%) or reduction of waste (10%), this last one compared to year 2010.

1.4 Method

The same method and key assumptions regarding the type of waste and category of treatment were considered as in previous report[4]. Some details as follows:

- Waste generated: all waste generated by households in Navarra during the reporting years (i.e., 2016, 2019, 2020). Embodied carbon impacts linked to the production of material (resource extraction, manufacturing, and transport emissions) are included in this category. Impacts associated with the product's use are excluded.
- Waste recycled: all recycled (or reused) materials including biodegradable materials that have been composted or anaerobically digested. The analysis covers all activities linked to recycling

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[2] Scottish Government (2016) Making Things Last

[3] Zero Waste Scotland (2020) Carbon Metric Publications.

[4] ACR+ and Zero Waste Scotland (2022) The Carbon Footprint of Waste - Navarra

waste, namely waste collection, sorting, recycling, and displacement benefits as recycled content substitutes virgin materials.

- <u>Waste landfilled</u>: all landfilled waste, including incinerator ash and any recycling and composting rejects that occur during collection, sorting or further treatment that are landfilled. The analysis covers the carbon impacts of waste collection and disposal.

The Region of Navarra compiled waste data for the years 2016, 2019, and 2020. The same carbon factors were used for the three years, since the update of such data is resource intensive, and the collection of data might be challenging. Carbon factors are the values that allow to “translate” waste quantities into carbon emissions (e.g. the carbon factor of food waste recycling indicates how much carbon is emitted or saved when recycling one tonne of food waste). Keeping similar carbon factors overtime means that the following assumptions are made:

- The composition of the different waste fractions did not change too much over the considered years (same distribution of fibres for textile waste, etc.)
- The recycling routes used for the different sorted waste fractions did not significantly change. For instance, it is assumed that the distribution between reuse and recycling for e.g. textile waste or WEEE was unchanged.
- The performances of the treatment units (energy recovery, capture of biogas in landfills, efficiency of sorting units, etc.) did not significantly change.

This means that the changes in the carbon impact analysed here will be mostly associated with the evolution of waste generation (quantities, composition), and the improvement brought to waste management (e.g. how much waste is sent to recycling vs. landfilling).

It is important to note that, for this report, some changes were brought to the waste data used in the 2022 report presenting the carbon footprint of waste management in the Region of Navarra[4]. Indeed, there were some small inconsistencies for several key waste fractions that were highlighted when comparing the 2019 data with the 2020 data. While these changes do not impact the overall conclusions of the 2022 report, they lead to different figures regarding the assessment of the carbon footprint.

EVOLUTION OF WASTE GENERATION AND MANAGEMENT BETWEEN 2016 AND 2020

The generated quantities of municipal waste (i.e. household waste) experienced a slight increase: from 273,083 t in 2016 to respectively 283,605 t and 282,008 t in 2019 and 2020. When considering the generation per capita, it is rather stable and remains around 430 kg/cap. However, it must be reminded that 2020 was a particular year with the start of the COVID-19 pandemics, with lockdown periods possibly impacting municipal waste generation and management.

> ACR+ published a report in 2021 analysing the impact of the COVID-19 pandemic on municipal waste, based on a review of report and a survey to its members. Overall, the local collection services were quite impacted by the first waves of contamination and the lockdown measures implemented in early 2020. The main observed impacts concerned municipal waste generation, for which the most common trend was a decrease of generated quantities linked with a decrease of assimilated commercial waste that was not necessarily compensated by the increase of household waste. Other observed impacts included the increase of fly-tipping. However, the pandemic did not necessarily entail a reduction of sorting performances, especially in territories that could maintain selective collection rounds.
>
> *ACR+ (2021), The impact of the COVID-19 on municipal waste management systems*

There are some evolutions regarding the composition of municipal waste, as shown on the following graph:

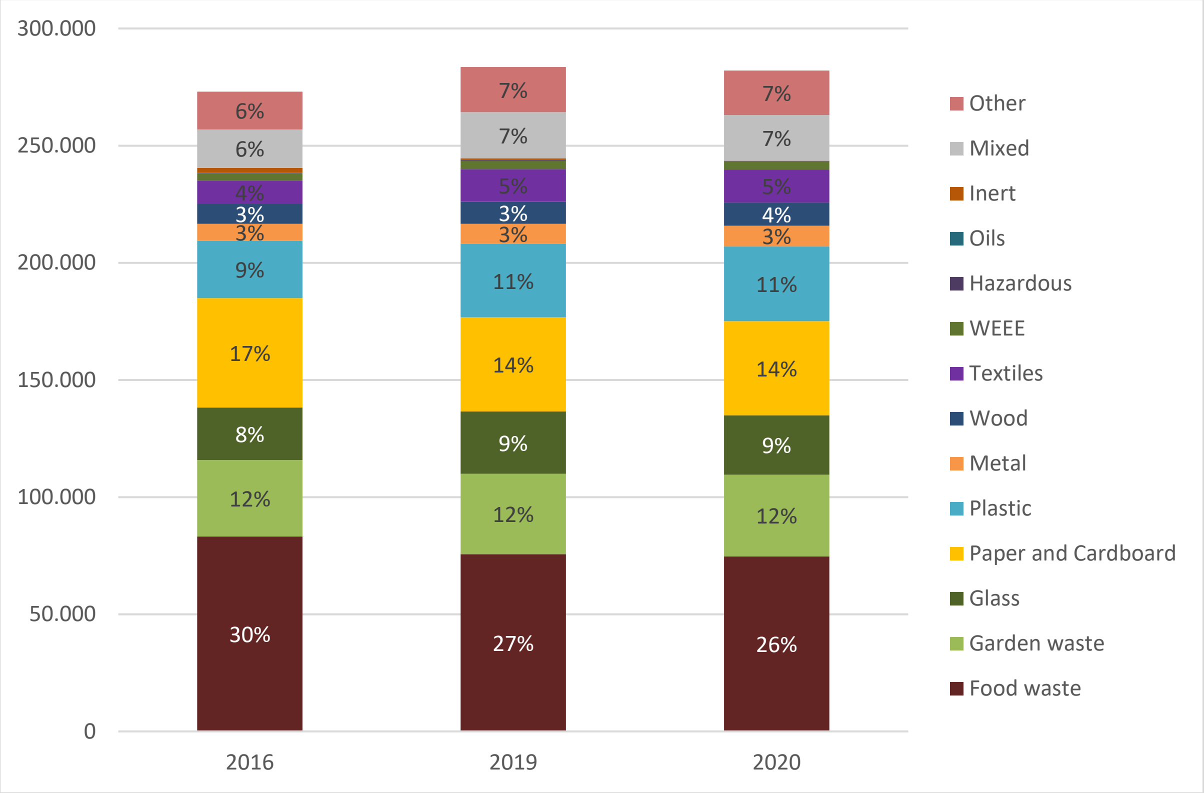

Figure 2: generated quantities of municipal waste by waste fractions (in tonnes)

There are several waste fractions that experienced significant changes, for the most part between 2016 and 2019:

- Food waste was reduced by 10% between 2016 and 2020, with the main decrease occurring between 2016 and 2019.
- Dry recyclables (including paper and cardboard, metal, glass, and plastic waste) had different evolutions: plastic and metal had a strong increase of respectively 30 and 20%, while glass generation increased of 13% (with a sharp increase between 2016 and 2019 and a decrease in 2020), and paper/cardboard quantities decreased by 14%
- Textile waste increased by 40% between 2016 and 2019 and remained stable in 2020
- Inert waste significantly decreased between 2016 and 2020
- Mixed waste increased by 20% between 2016 and 2019 and remained stable in 2020.

It is unclear if these evolutions reflect actual changes of waste generation linked with different consumption patterns or prevention efforts, or if they reflect changes in waste management or in waste monitoring. Some of the evolution can be attributed to a better knowledge of the composition of mixed bulky waste, which explains the increase of plastic waste and metal waste between 2016 and 2019. Besides, the method for mixed waste composition analysis changed between 2016 and 2019, which can also explain part of the evolutions.

When it comes to waste treatment, significant progresses were achieved between 2016 and 2019, with an 25% increase of the recycled quantities, leading to a decrease of the quantities sent to landfilling:

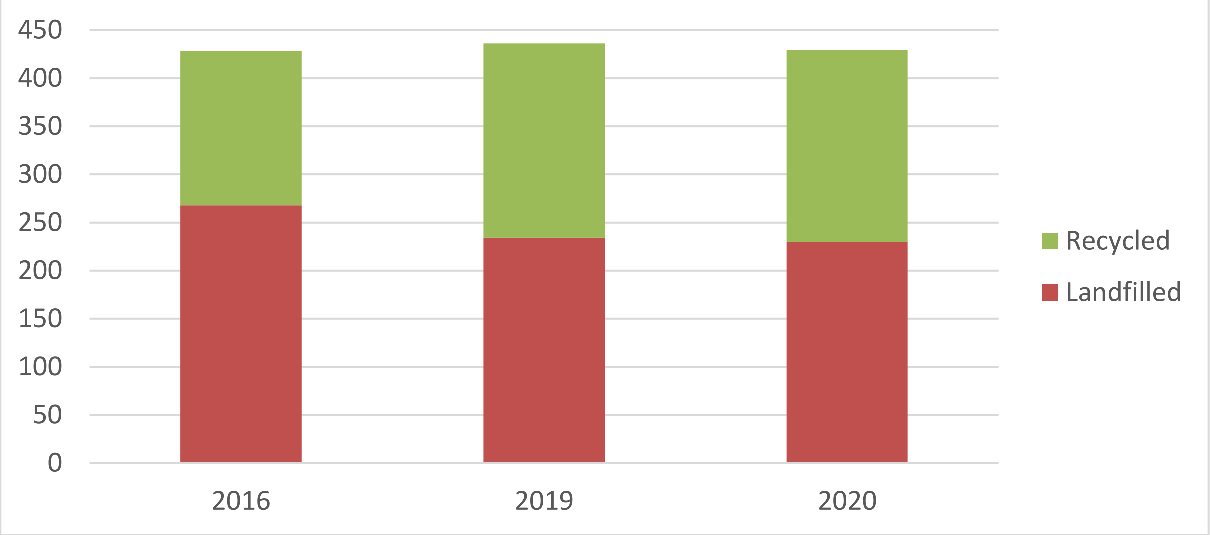

Figure 3: treated quantities per capita in kg/cap/yr

Significant improvements can be noted for food waste (+67% of recycled quantities), garden waste (+36%), plastic waste (+33%), metal (+63%) or textiles (+67%). Other fractions present slight decreases or stable recycled quantities (glass, paper and cardboard). As said above, some of the evolutions might be attributed to a better knowledge of the recycled fractions out of the mixed bulky waste. In 2016, the composition of mixed bulky waste is unknown, meaning that the recycled quantities are assigned to the mixed fraction, while in 2019 and 2020, the share of plastic and metal extracted from bulky waste and sent to recycling is known, leading to an increase in the total recycled quantities for both fractions.

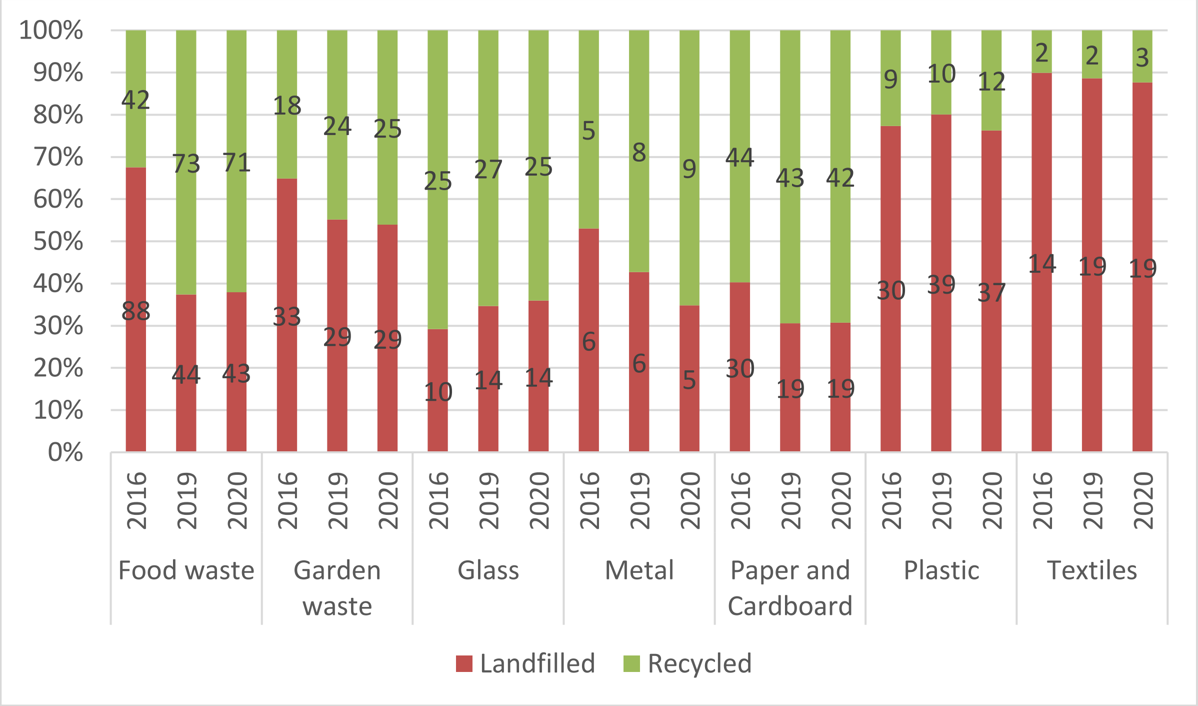

Figure 4: share of recycled and landfilled quantities for key waste fractions, with quantities in kg/cap indicated in data labels

These evolutions of recycled quantities do not necessarily lead to the same observations when considering recycling rates (i.e. the quantities of recycled waste compared to the generated quantities). While the recycling rate for food waste increased from 32% to 62%, the recycling rates of garden waste slightly decreased from 55% to 45%. The recycling of metal waste increased from 47% to 65%. The recycling of textile waste and plastic waste is actually quite stable, due to the increase of the associated generated quantities in parallel with the increase of recycled quantities. For glass, the recycling rate experienced a slight decrease.

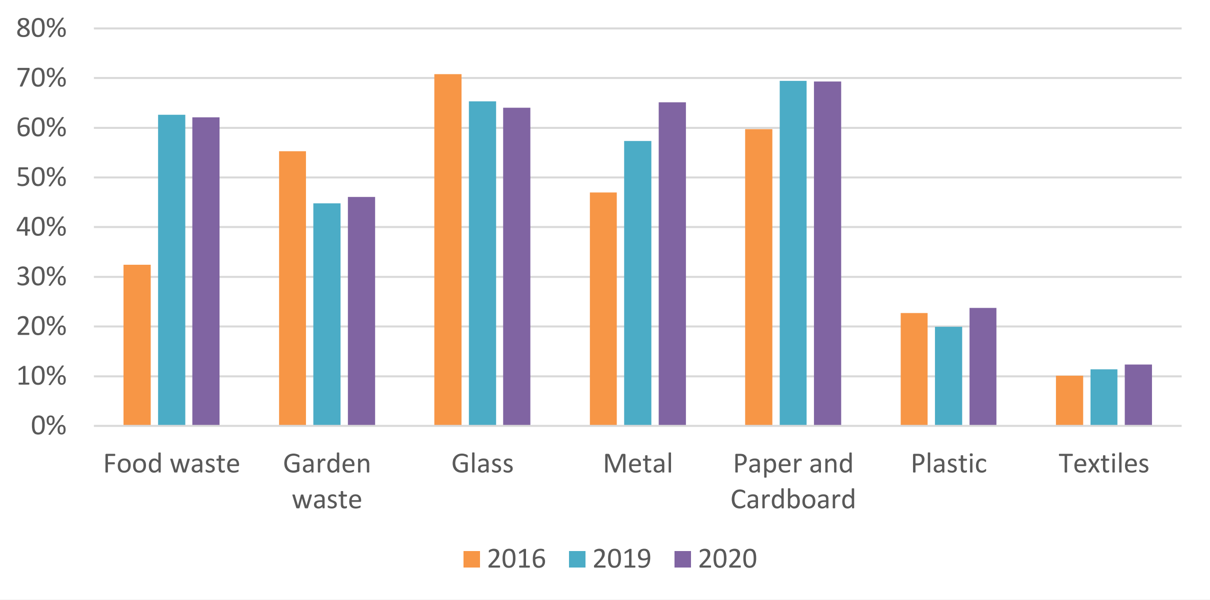

Figure 5: evolution of recycling rates for key municipal waste fractions (in %)

Finally, it can be interesting to detail the evolution of the composition of landfilled waste:

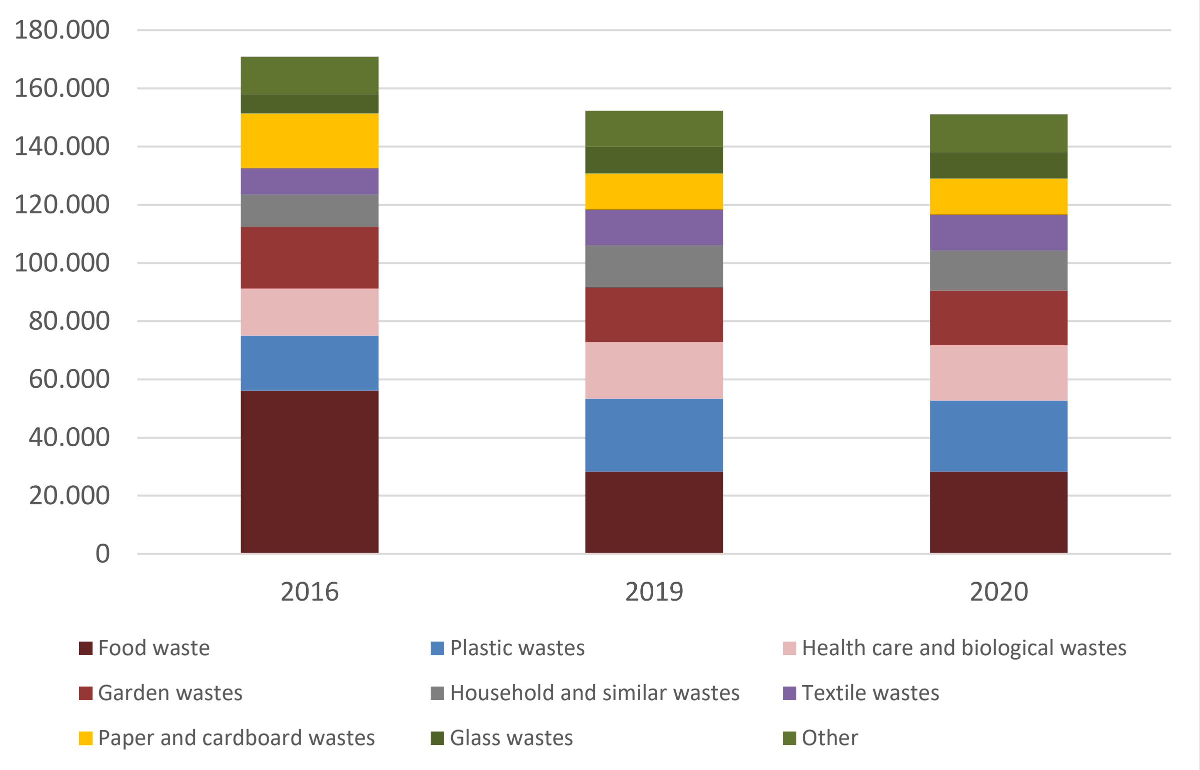

Figure 6: composition of landfilled waste in 2016, 2019, and 2020 (in tonnes)

Food waste remains the most significant fraction sent to landfilling, yet the landfilled quantities have significantly decreased between 2016 and 2020. In parallel, the quantities of garden waste sent to landfilling slightly decreased. Plastic waste is the second most landfilled waste fraction, and the landfilled quantities increased between 2016 and 2020, followed by sanitary textiles, whose landfilled quantities slightly increased between 2016 and 2020.

Overall, waste management experienced many positive improvements. The main one is the diversion of food waste from landfills to recycling, with very significant progresses achieved. The recycling rates of several key material fractions also increased. However, recycled quantities of plastic and textile waste did not increase significantly and remain low.

Waste generation slightly increased over the considered period, but it is difficult to establish whether this is due to contextual factors (such as the evolution of consumption patterns of the COVID-19 pandemic), changes in the general collection system, or if waste prevention initiatives had little impact on the production of waste.

EVOLUTION OF THE CARBON IMPACT OF MUNICIPAL WASTE BETWEEN 2016 AND 2020

The Carbon Metrics International developed by Zero Waste Scotland allows to “translate” the waste data into carbon impacts by applying the above-mentioned carbon factors. It is therefore possible to analyse the evolution of the carbon footprint of municipal waste between 2016 and 2020, as presented in the following graph:

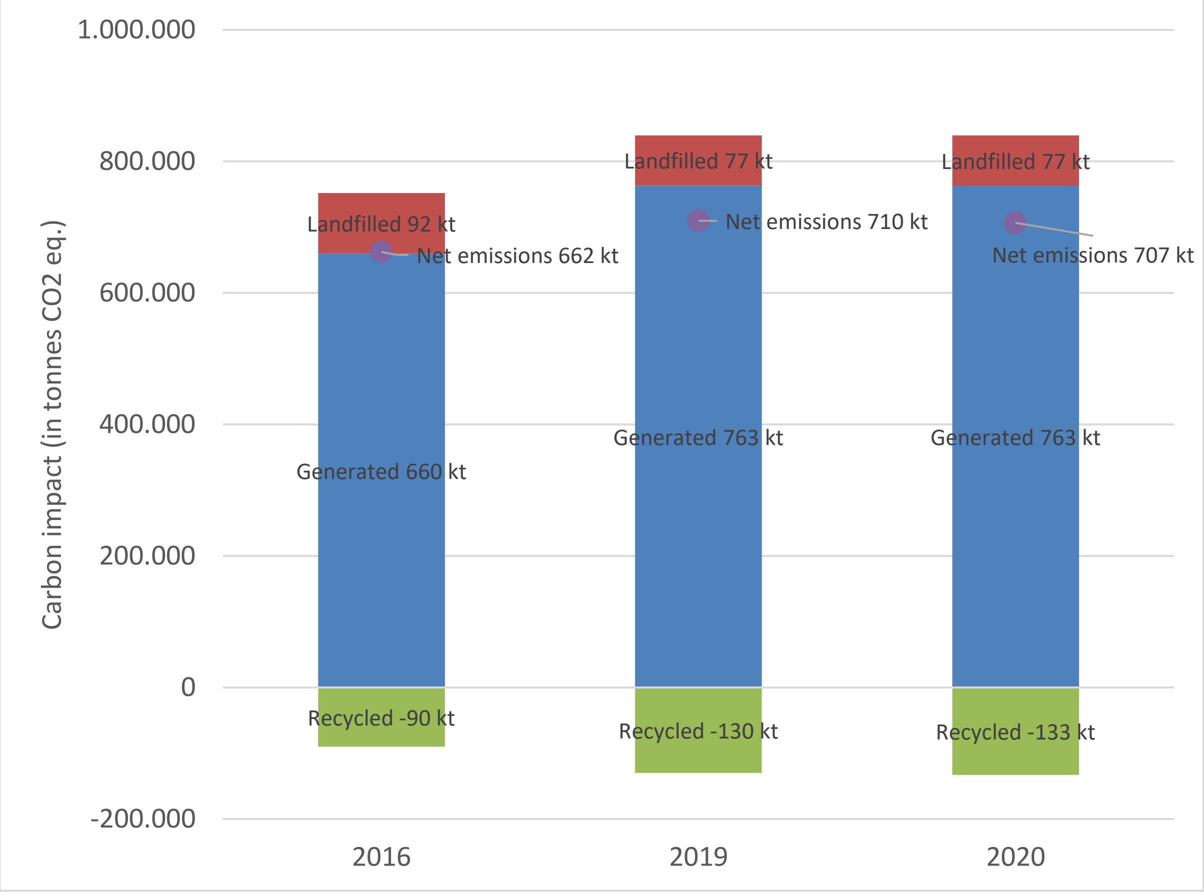

Figure 7: carbon impact of municipal waste in 2016, 2019, and 2020 (in t CO2 eq.)

It is interesting to note that despite the improvements of waste management, which led to a decrease of the impact of landfilling, and an increase of the carbon savings thanks to recycling, the net emissions (meaning the difference between the emissions produced by waste generation and landfilling and the emissions “saved” thanks to waste recovery and recycling) slightly increased between 2016 and 2020, from 686 kt CO_2 eq. to 707 kt CO_2 eq. This is because the impact linked with waste generation (i.e. the impacts linked with the extraction of resources and with the production of goods that became municipal waste) is significantly higher than the impact of their end-of-life. A first explanation for the overall increase of the net emissions is that municipal waste generation increased between 2016 and 2020, as highlighted in Figure 2.

When considering the impact per inhabitant, the net emissions experienced a slightly less important increase between 2016 and 2020. This can be linked with the fact that waste generation per capita was stable between 2016 and 2020. The total increase is partly explained by the increase of population. Interestingly, this stability hides an increase of the impact linked with waste generation, with a small compensation by the improvements of waste recycling and the reduction of landfilling.

Figure 8: carbon impact per capita of municipal waste in 2016, 2019, and 2020 (in t CO2 eq. per capita)

It is also interesting to consider the carbon impact per tonne of waste generated or treated. The overall figures are presented below:

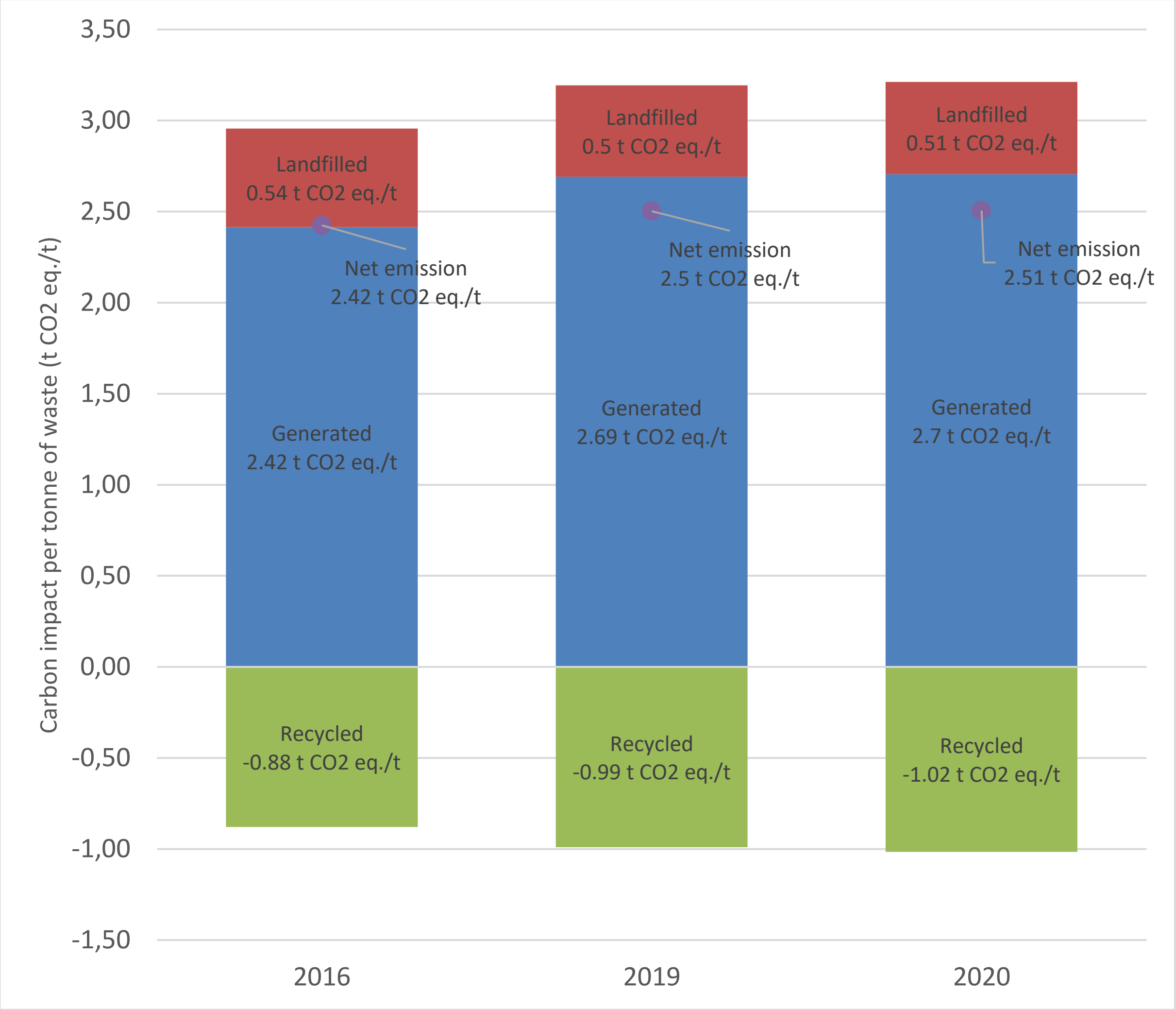

Figure 9: carbon impact per tonne of municipal waste in 2016, 2019, and 2020 (in t CO2 eq. per capita)

The graph shows that the carbon intensity of the municipal waste generation increased overtime, which might reflect that the share of more carbon-intensive fractions increased between 2016 and 2020. The impact of landfilling per tonne of waste landfilled decreased, which can be linked with the reduction of food waste in the municipal waste sent to landfill.

3.1 The impact of waste generation

It is interesting to consider how the different waste fractions contribute to the total impact. The following graph shows the impact of the different waste fractions when it comes to the impact of waste generation:

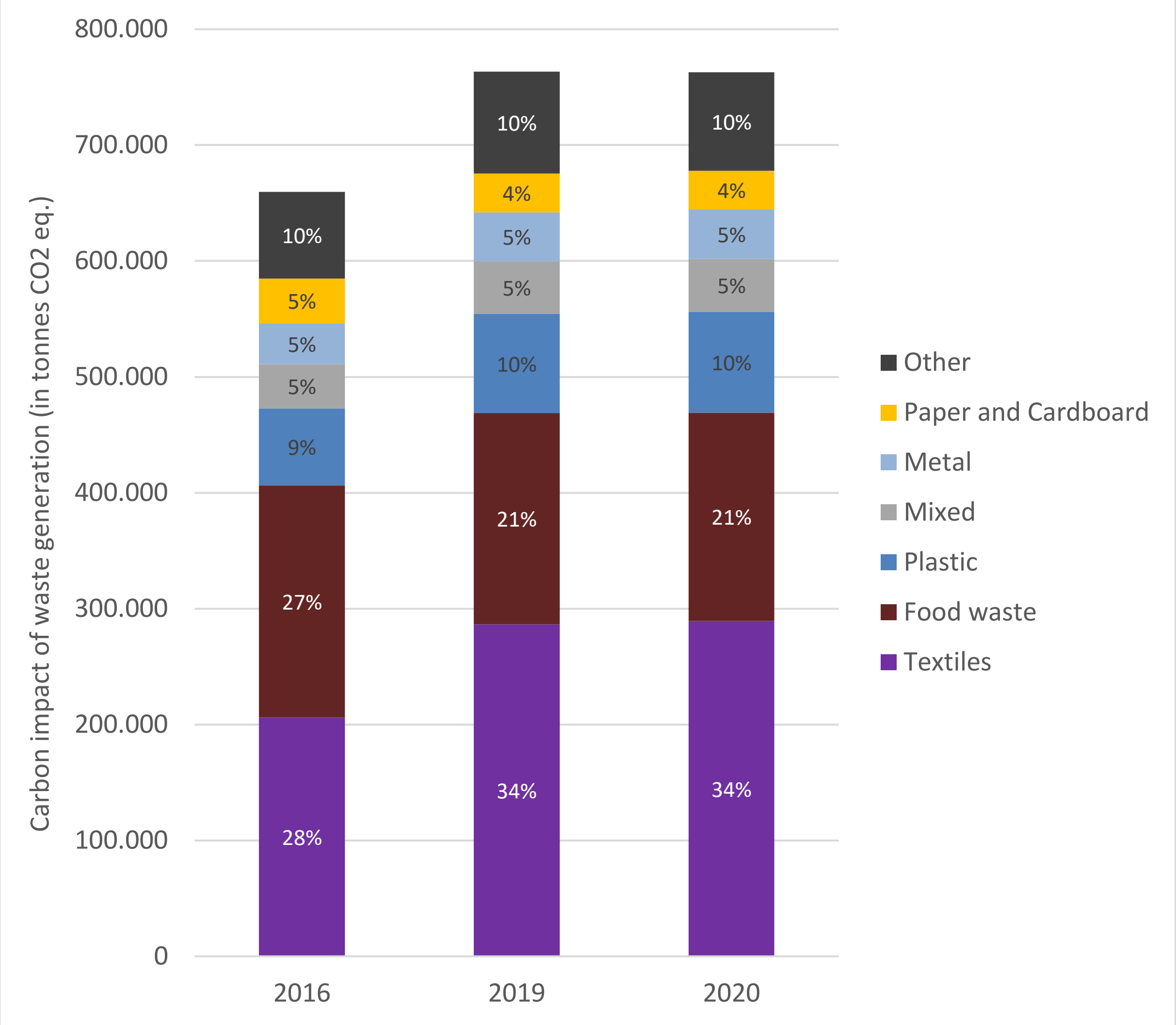

Figure 10: contribution of the main waste fractions to the total carbon impact of waste generation (in t CO2 eq.)

The increase of the impact linked with waste generation can be linked with the total increase of waste generation, but it also reflects the change of composition of municipal waste between 2016 and 2020. The main reason appears to be the increase of textile waste quantities, which led to an increase of about 85 kt CO_2 eq. The same observation can be made for plastic waste, while the impact of food waste decreased due to the reduction of the generated quantities. The increase of the carbon impact linked with the waste generation is not only explained by the total increase of waste generation due to population growth, but also by the increase of carbon-intensive fractions such as textile waste.

As mentioned in the introduction, the carbon factors associated with waste generation were not updated for the different years, as the 2019 values were used for 2016 and 2020. This means that the assessment does not take into consideration the possible changes of composition of each waste fraction; for instance, if the share of meat-based products has decreased within food waste, the carbon factor for food waste generation would have decreased as well. This is a limitation of this analysis, even if it is unlikely that significant changes occurred within four years.

Besides, the fact that more mixed waste was reported in 2016 might indicate that there are more uncertainties regarding the composition of municipal waste; this might mean that some quantities of carbon-intensive waste fractions were underestimated for 2016. The precision of composition analyses also improved between 2016 and 2020, meaning that the carbon footprint of waste generation in 2016 might be less precise than for 2019 and 2020.

However, the analysis of the evolution of the carbon impact of waste generation shows the importance to closely monitor waste generation and to aim at reducing the most carbon-intensive fractions. The increase of the impact of textile waste represents more than 10% of the 2020 carbon footprint of municipal waste, while the 10% reduction of food waste quantities represents a reduction of 20kt CO2 eq. of carbon emissions (3% of the carbon footprint of municipal waste generation).

3.2 The impact of waste management

As presented before, recycling improved between 2016 and 2020, and the quantities sent to landfilling decreased at the same time. This significantly impacted the carbon footprint of municipal waste management, as presented below:

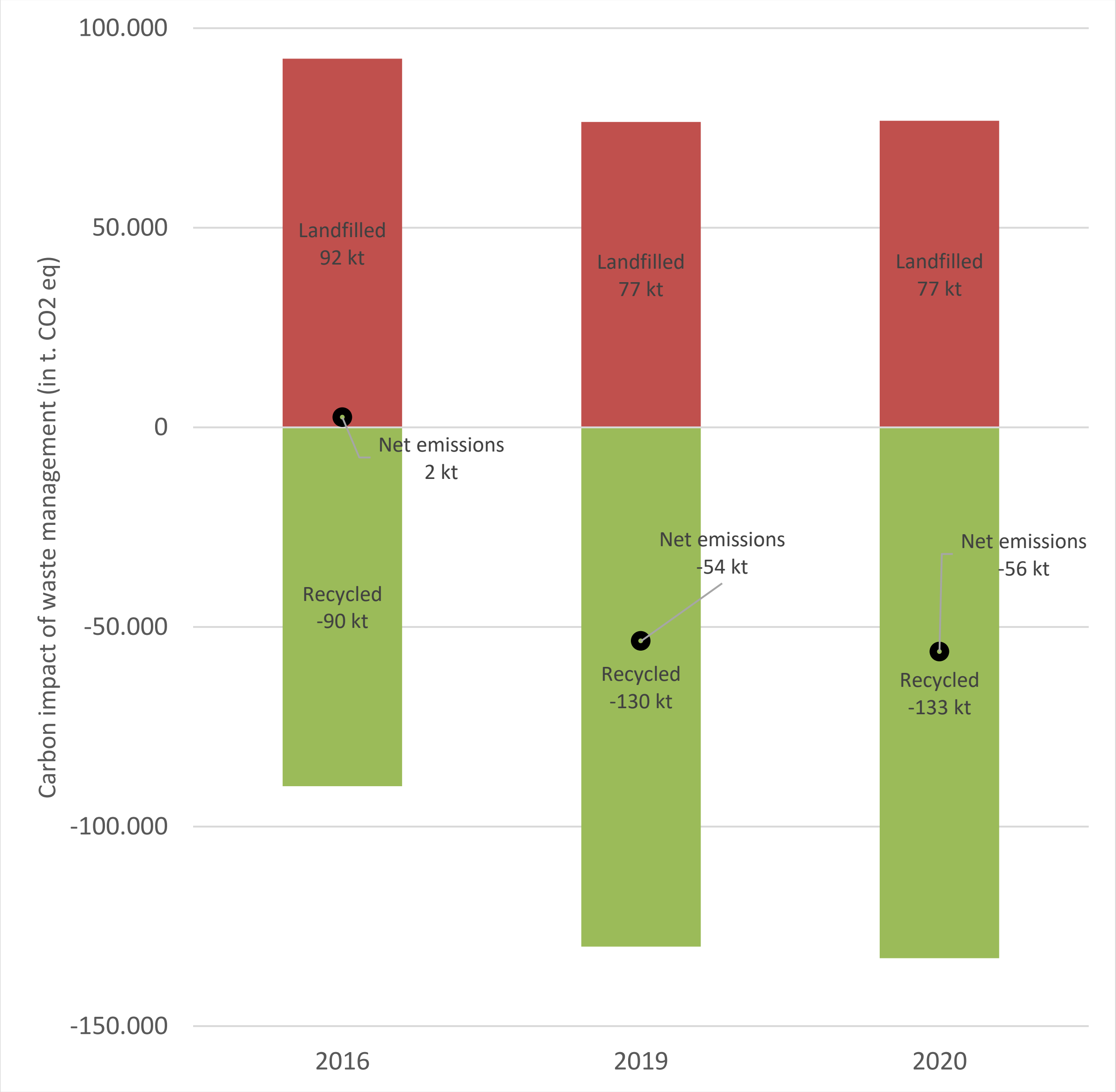

Figure 11: carbon footprint of municipal waste management (in t. CO2 eq.)

The impact of landfilling decreased by 20%, while the carbon emissions offset by recycling increased by 35%. This led to a significant decrease of the net emissions of waste management: in 2016, waste management was carbon neutral, whereas in 2020 it saves about 56 kt CO2 eq.

The impact of landfilling is presented in the following graph:

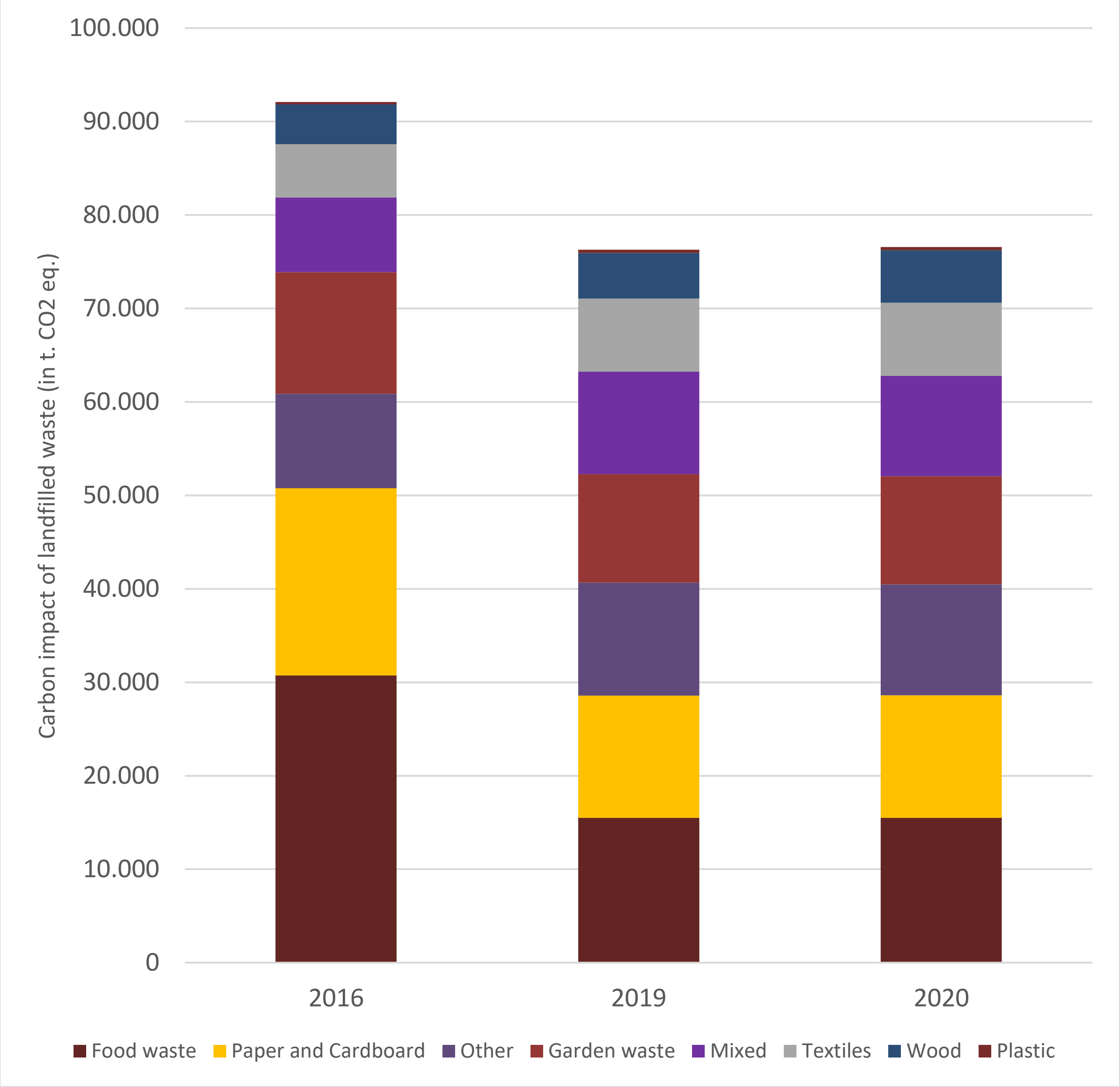

Figure 12: impact of landfilled waste by waste fraction (in t. CO2 eq.)

The decrease of carbon emissions linked with landfilling can be mostly attributed to the diversion from landfilling of food waste and paper and cardboard.

In 2020, the most impactful fractions are food waste and garden waste, paper and cardboard, and healthcare waste (mostly nappies), while textiles, mixed waste, and wood, have a more limited impact.

It seems still relevant to pursue the efforts of reducing the quantities of biowaste and paper and cardboard waste going to landfills, which represents a potential of respectively 29 kt and 13 kt of saved emissions, representing more than half of the current emissions linked with landfilling.

The same analysis is proposed for recycling, whose impact by key fractions is presented below:

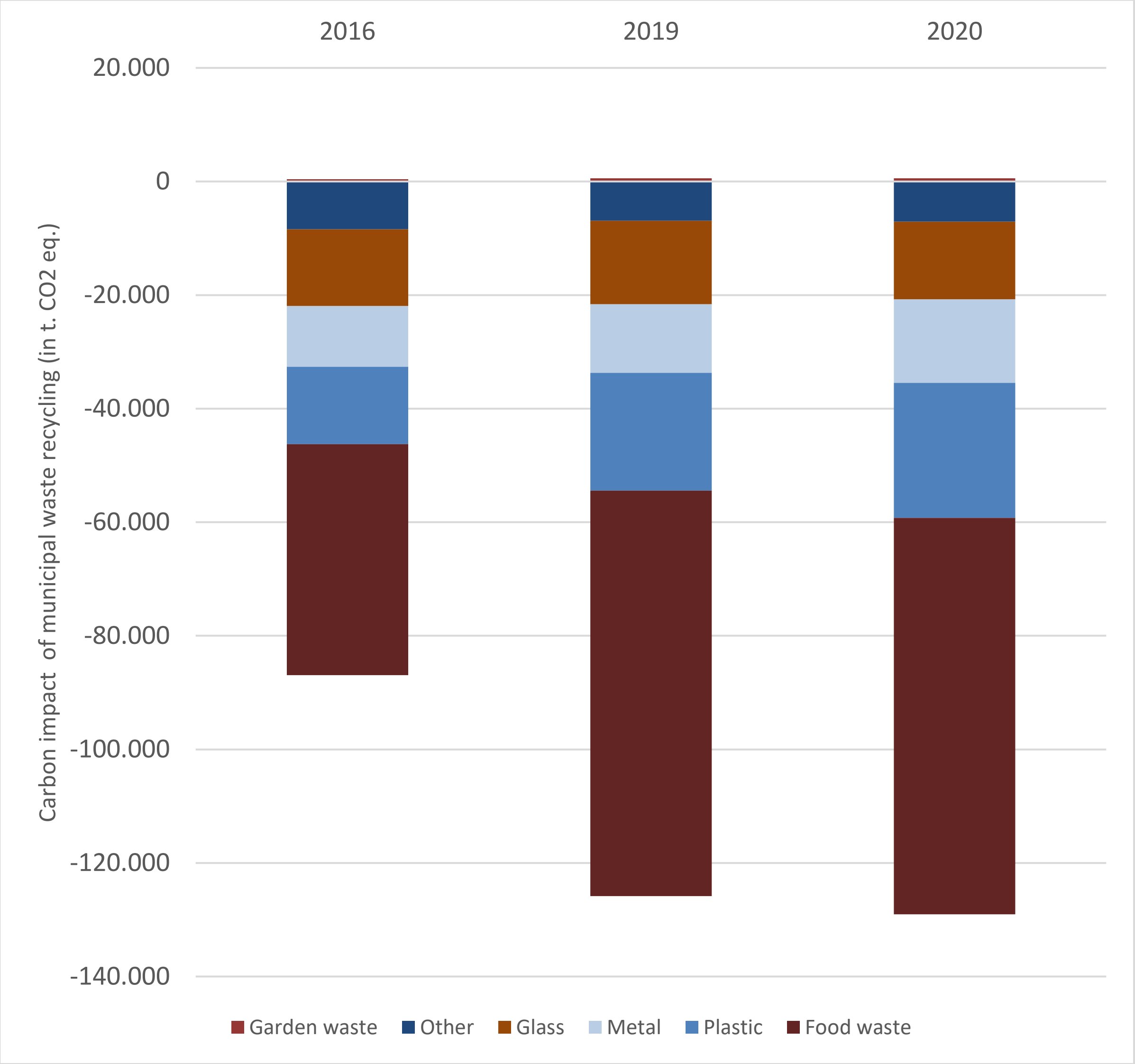

Figure 13: impact of recycling waste by waste fraction (in t. CO2 eq.)

The increase of carbon savings can mostly be associated with the increase of food waste diverted from landfilling and recycled via anaerobic digestion. As indicated in "Cross analysis of the second cohort" report[5], these savings are associated with the production of heat and of biofertilisers through anaerobic digestion. High benefits are also linked with the recycling of plastic waste, metal, and glass, but the recycled quantities decreased between 2019 and 2020, limiting the carbon savings.

Overall, there is a strong potential of carbon savings by increasing the recycling of food waste, and plastic, metal, and glass waste. Interestingly, the benefits associated with textile recycling are currently quite limited; this is because of the low re-use rate of textile, meaning that most sorted textile waste goes to recycling, whose carbon benefits are way less significant than for re-use.

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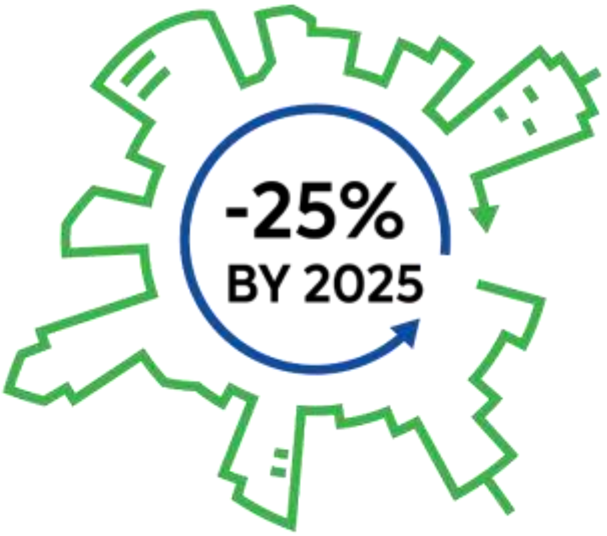
[5] ACR+ (2022) Cross Analysis of the second Cohort

CONCLUSION

The improvement brought to municipal waste management in Navarra entailed quite significant reduction of the carbon impact of waste management, mostly due to the diversion of food waste from landfill and its recycling in anaerobic digestion. However, these carbon savings had limited impact on the global net emissions of municipal waste, due to the increase of the generated quantities over the same period, especially concerning textile waste.

Further carbon reduction can be achieved by pursuing the efforts on food waste recycling, as well as with paper and cardboard, plastic, metal, and glass sorting and recycling. Current recycling rates for plastic, metal, glass, and garden waste can be considered low to average, meaning that there is a potential to reduce the associated carbon emissions.

However, the main potential for carbon emissions mitigation lies in waste prevention and re-use, especially for textile waste. Food waste generation decreased between 2016 and 2020 with positive impact on the total carbon footprint and pursuing this trend will also contribute to the reduction of climate emissions. Identifying actions to address textile waste generation and promoting its re-use is also believed to lead to significant savings.



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