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THE CARBON FOOTPRINT OF WASTE

How local waste strategies can cut emissions: Lessons from the **"More Circularity, Less Carbon"** campaign

EXECUTIVE SUMMARY

Belfast - Odense - Ireland - Province of Navarra
Pays de la Loire - Genoa - Brussels-Capital Region

-25% BY 2025

MORE CIRCULARITY
LESS CARBON

June 2025

-25% BY 2025

MORE CIRCULARITY
LESS CARBON

The "More Circularity, Less Carbon" campaign ran from 2019 to 2025 to help ACR+ members to better understand the carbon footprint of material resources and to identify key circular economy actions and policies to mitigate these carbon emissions. Partnering with Zero Waste Scotland, ACR+ assessed how seven territories could reduce the carbon impact of municipal waste among by 25% by 2025. Individual reports and cross-analysis of each cohort are available on the campaign's website.

More at www.acrplus.org/morecircularitylesscarbon

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 (ZWS) 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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ZWS & ACR+ partnership

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We thank the representatives of the different participating territories and their local waste companies for their availability and precious assistance in data collection.

This is the executive summary of the report «The carbon footprint of waste», available in full to ACR+ members.

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KEY TAKEAWAY MESSAGES

ACR+ coordinated the **"More Circularity, Less Carbon" campaign**, aiming to support several of its members with the assessment of their municipal waste carbon footprint. The campaign was made possible by the active support of ACR+ member Zero Waste Scotland that conducted the conversion of waste data into carbon emissions with its **"Carbon Metrics International"**.

Seven ACR+ members participated in the campaign, during three different cohorts: the Pays de la Loire Region, the City of Genoa, the Brussels Capital Region, the City of Odense, Ireland, the Province of Navarra, and the City of Belfast.

Overall, **the carbon footprints of municipal waste present strong similarities in all seven territories**: the embodied impact of waste, meaning the emissions generated by the extraction of resources and production processes of the products that became waste, is much more significant than the emissions linked with waste collection, treatment, and recovery. The **differences** between the local carbon footprints are **mostly linked with the composition of the waste generated**, especially the presence of carbon-intensive fractions.

Municipal waste management does have an impact on the total emissions: **landfilling of food waste and paper/cardboard waste, and incineration of plastic waste generally lead to important emissions**. On the other hand, the **energy recovered by incineration or anaerobic digestion**, the production of **biofertilizer**, or the **re-use of textiles or EEE** have the potential to **"save" significant emissions. Applying the higher steps of the waste hierarchy will lead to more carbon savings**. Prevention and re-use yield considerably higher benefits than material or energy recovery.

It is also interesting to note that **the potential of re-use and recycling really depends on the type of waste, but also on the actual recycling routes**.

Local and regional authorities do have the capacity to implement actions leading to important reductions: establishing ambitious food waste prevention strategies focusing on actual reductions, supporting the implementation of an integrated management of used textiles prioritising local re-use, or any policy or action banning single-use plastics.

Other interventions might fall out of the scope of local and regional authorities. Calling for more stringent regulations and obligations for products put on the market, either by making them more durable, re-usable, or recyclable, or even putting caps on the most carbon-intensive fractions, especially when there are no adequate recovery options, might be relevant options to consider.

Envisioning waste management within a circular economy approach is a proper way to ensure that it delivers better performances in terms of climate change mitigation. The key is to put more emphasis on waste generation and on what is done with sorted materials.

MORE CIRCULARITY
LESS CARBON
-25% BY 2025

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EXECUTIVE SUMMARY

The "More Circularity, Less Carbon" (MCLC) campaign has been launched by ACR+ in November 2019 to help its members in addressing the carbon footprint of their waste. ACR+ has partnered with its member Zero Waste Scotland to assess how individual territories can reduce the carbon impact of municipal waste by 25%.

To do so, Zero Waste Scotland adapted its own carbon assessment tool to develop the Carbon Metric International (CMI). It allows the assessment of the carbon footprint linked with material resources by using local waste data: generation, composition, and treatment. The tool assesses the impact linked with waste management, but also the impact embodied in waste, i.e. impacts linked with the production of the products that became waste. To summarise, the CMI allows the assessment of both "direct" and "indirect" emissions of the consumption of material resources and products at local level thanks to local waste data.

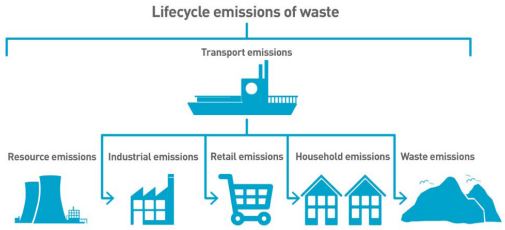


Figure 1: Schematic diagram presenting the lifecycle emissions of waste.

The MCLC campaign consists of different cohorts, in which several territories collected data and assessed their carbon footprint with the assistance of Zero Waste Scotland and ACR+. A first cohort has been launched in early 2020, a second one has been launched in 2021, and a third one in 2023. Overall, seven ACR+ members took part in the campaign. The territories they represent include cities, regions, and a country, encompassing quite different contexts and typologies.

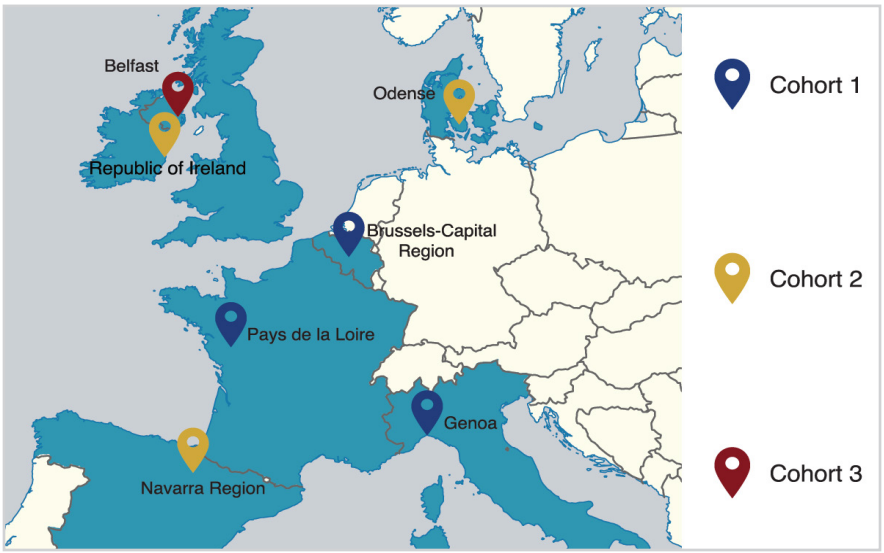


Figure 2: The seven territories involved in the «More Circularity, Less Carbon» campaign.

All participants provided data on municipal waste generation and treatment, along with more detailed data on the composition of key fractions, current treatment and recycling routes, or the performance of the treatment units. This allowed to determine "carbon factors". These carbon factors make possible the "conversion" of generated or treated quantities for one given fraction to an associated carbon footprint, that includes the emissions generated by the different processes (collection, sorting, treatment, etc.) and the emissions "saved" by the different recovery operations. These saved emissions are the avoided emissions linked to the fact that the products, materials, or energy recovered from waste are substituted to new or conventional ones. The level of precision that could be obtained for the different territories varies depending on the exhaustivity and the quality of available data.

THE IMPACT OF LOCAL SPECIFICITIES ON WASTE DATA AND CARBON FACTORS

The seven participating territories present quite different data when it comes to waste generation, composition, and treatment. These differences are linked with local specificities, but also the fact that the scope of municipal waste slightly differs from one territory to another. For instance, some territories only reported household waste, while other included a share of commercial waste. Some of the participants also include construction and demolition waste in municipal waste. Finally, beverage packaging waste can be partly collected in a deposit-refund system which means that the associated quantities are not included in the reported local data.

There are also important differences regarding waste management, with recycling rates ranging from 35% to 53%. The treatment of mixed fractions often differs, with landfilling being dominant in some territories, and incineration in others. Important discrepancies are observed for individual fractions, with sorting rates for e.g. food waste ranging from 1% to 42%. On average, collection rates are higher for glass and paper/cardboard waste, and lower for plastic or textile waste.

Some participants shared more detailed data on composition and treatment/recycling routes. These also display important differences. Composition of food waste shows more meat products in Navarra, or an overrepresentation of hard plastics in Ireland's plastic waste. Differences can be observed in the energy efficiency and type of energy produced by incineration and anaerobic digestion plants, or on the nature of organic products generated by organic recycling (soil conditioner, biofertilizer, etc.). This leads to different carbon factors, making some specific fractions more carbon intensive in some territories, or recycling of specific waste streams more impactful in others.

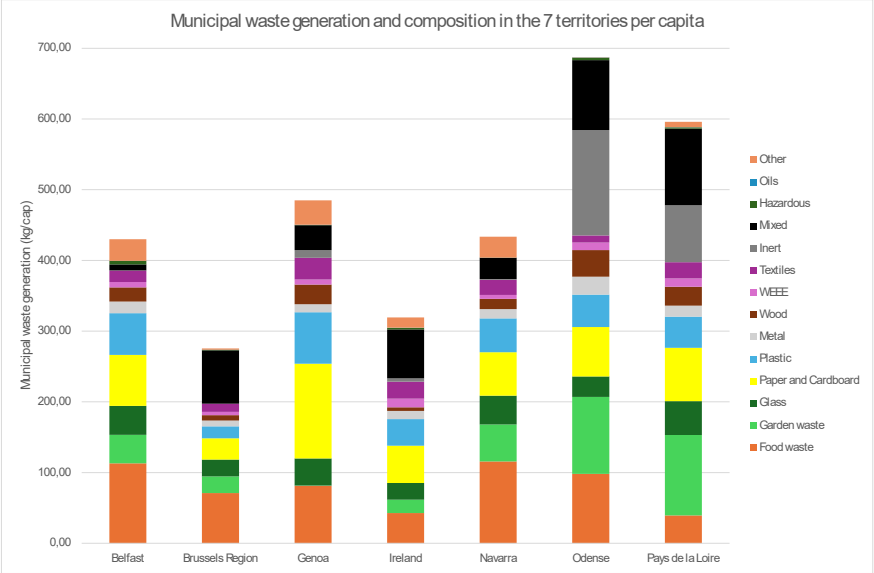


Figure 3: Municipal waste generation and composition.

DIFFERENT CARBON FOOTPRINTS YET SIMILAR CARBON-INTENSIVE FRACTIONS

Overall carbon footprints

Discrepancies in waste generation, composition, and treatment lead to different carbon footprints. Yet, for all territories, the emissions embodied in the waste, meaning all the emissions related to the extraction of resources, manufacturing, and transport of the products before they became waste, are the most significant contribution to the total carbon footprint. Comparatively, the carbon footprint of municipal waste management is rather limited.

The fact that some territories have a smaller carbon footprint per capita generally reflects lower waste generation, but more generally it shows the generation of less carbon-intensive waste (meaning a smaller share of carbon intensive fractions). As an illustration, Odense presents the higher waste generation in the panel, but one of the lowest carbon footprints per capita. It is linked to the fact that large quantities of construction waste are reported, with a very low associated carbon footprint.

In all territories, waste management entails negative emissions, meaning that the emissions saved by waste recovery operations outweigh the ones generated by waste collection and treatment operations. However, these saved emissions have a rather limited impact on the overall carbon footprint and are far from compensating for the embodied emissions. Odense is the territory that saves the most emissions thanks to a very efficient incinerator generating large quantities of heat being substituted to a carbon intensive energy mix, and large savings linked with the recycling of metal waste. Both Navarra and Pays de la Loire manage to save large quantities of carbon with recycling (in Navara, food waste biomethanisation leads to significant savings), yet these benefits are limited due to the impact of landfilling of biowaste and incineration of plastic waste.

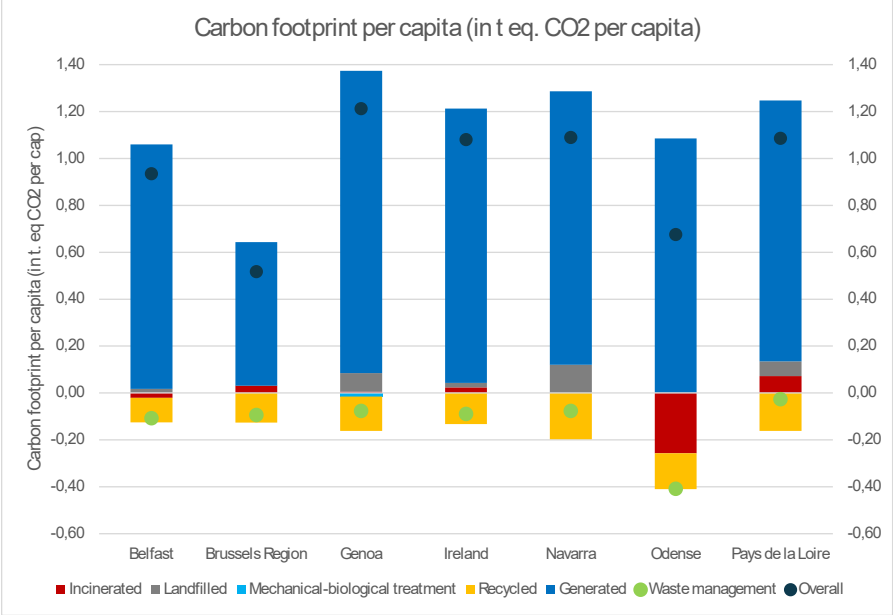


Figure 4: Carbon footprint of municipal waste per capita.

Similar impactful waste fractions

Despite the differences mentioned earlier, all the participating territories present very similar results when it comes to the most impactful waste fractions.

In all territories, textile waste, food waste, plastic waste, and paper and cardboard waste represent a very large proportion of the total carbon footprint. This is due to the fact that these waste fractions have significant embodied emissions; but it is also because, for most of them, re-use, recycling, and incineration yield little benefits, due to low recycling rates, the unavailability of carbon-saving recycling routes, or both.

It is interesting to note that the benefits of current recycling routes greatly differ from one waste fraction to another. For instance, glass or metal recycling almost has the potential to compensate the embodied emissions, when the potential of recycling for plastic waste or textile waste seems much more limited in most territories. Finally, it is worth mentioning that re-use represents a very interesting source of "avoided emissions" compared to recycling.

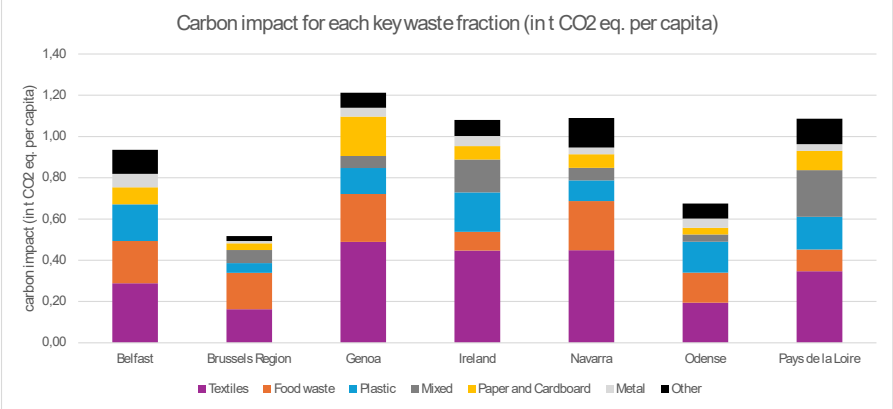


Figure 5: Carbon impact for each key waste fraction.

The impact of municipal waste in the total carbon footprint of territories

For some of the participating territories, it is possible to assess a total carbon footprint, i.e. the carbon emissions associated with the consumption of goods and services used by the inhabitants (housing, food, etc.). Interestingly, very similar figures could be found in all four territories where data are available: the impact of municipal waste amounts to about 10% of the total carbon footprint reported. Prevention of municipal waste does represent a relevant potential for reduction, especially since the impact linked to food and products consumption amounts to 20% to 30% in these four territories.

HOW CAN THE -25% TARGET BE REACHED?

Reaching the target in the participating territories

Considerable efforts are required to reach the -25% target, which would be only a first step toward carbon neutrality. For all territories, the model shows that this would require significantly reducing by 30 to 40% two key target fractions, such as textile waste or food waste, which calls for much more ambitious prevention targets and strategies. While improving waste management will help to reduce the overall carbon footprint, the associated potential might be limited. The analysis of the evolution of the municipal waste carbon footprint in Navarra between 2016 and 2020 shows that the benefits associated with the improvement of recycling were nullified by the increased generated quantities of carbon intensive fractions such as textile. This shows that improving municipal waste management will not have a significant impact if nothing is done to prevent waste production. In Belfast, increasing the recycling rate for plastic waste, glass waste, and food waste up to 90% (compared to respectively 25%, 46%, and 47% in 2022) would lead to a reduction of the total carbon footprint of only 10%.

How to reduce the carbon footprint of municipal waste?

Even though the carbon assessment was only performed for 7 territories, the diversity of the panel leads to believe that the identified common findings could apply to most European territories. The following are general recommendations for decreasing the carbon footprint of municipal waste:

- **Apply the waste hierarchy**: the waste hierarchy seems strongly correlated with carbon savings. Re-use yields considerably higher benefits than recycling, and waste prevention (especially strict avoidance of waste generation) seems to yield considerably higher benefits than any waste management activity.

- **Focus on key fractions**: even if their actual production and composition might vary locally, it seems that food waste, textile waste, and plastic waste are priority fractions to consider. Documenting the actual composition of these key fractions and understanding how they can be prevented, re-used, recycled in an optimal way, is crucial to effectively reduce municipal waste carbon footprint.

- **Improve waste management**: Although the potential of waste management is relatively limited, there remain untapped opportunities worth exploring. Promoting the diversion of food waste and paper/cardboard waste from landfill, increasing the separation and recycling of several key fractions such as glass, metal, and plastic, do represent a significant potential for carbon

mitigation. It seems that energy recovery can also yield significant benefits in specific cases: heat production combined with a high energy efficiency, for instance. However, the associated benefits will decrease if the energy mix to which it is substituted is progressively decarbonised. Moreover, the incineration of non-biogenic fractions might limit the overall balance of energy recovery. Finally, for several fractions such as used textiles and WEEE, focusing on re-use seems to be the main way to tackle the associated carbon emissions, considering the comparably lower benefits associated with current recycling routes.

Overall, the main message is **to move away from purely weight-based indicators and strategies**, and to **give more attention to smaller, but more carbon-intensive fractions and valorisation routes**.

More practical recommendations

Local and regional authorities have the potential to effectively decrease the carbon footprint of waste:

- **Reducing food waste from household and assimilated producers** can be achieved through ambitious prevention strategies mixing larger awareness raising campaigns with more targeted interventions. Helping food waste producers to assess their own production along with the impact of few, specific changes of behaviours proves to be an effective solution to make them durably reduce their food waste. Improving the information on food labels or facilitating food donations also represent significant potential to decrease food waste generation.

- **Addressing used textiles**: currently, textile waste management is underdeveloped in most territories. Local and regional authorities can improve its management by implementing consistent strategies and governance, strengthening the existing collection schemes and identifying alternative ones in more challenging areas, or promoting second-hand purchasing.

- **Management of plastic waste**: improving both the quality and quantity of collected plastic waste shall enable more quality recycling leading to more carbon savings. Improving sorting centres, enforcing quality controls during collection, or using more incentivising mechanisms such pay-as-you-throw generally lead to higher performances. Deposit refund systems are also known to enable high capture rates and quality for beverage packaging. Finally, several regions have successfully enforced regulations and provisions to reduce the use of single-use plastics.

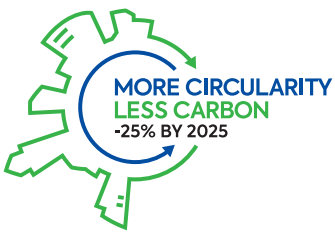
However, other useful interventions might fall out of the scope of local and regional authorities. Calling for more stringent regulations and obligations for products put on the market, either by making them more durable, re-usable, or recyclable, or even putting production caps on the most carbon-intensive fractions, especially when there are no adequate recovery options, might be relevant options to consider.

How to better align municipal waste strategies with climate change?

Overall, it seems that envisioning waste management within a circular economy approach is a proper way to ensure that it delivers better performances in terms of climate change mitigation. Putting more emphasis on waste generation and on what is done with sorted materials serves both a more ambitious circular economy and climate change objectives. However, it is important to note that most prevention actions might fall out of the scope of waste policies and require differentiated approaches: the reasons behind e.g. food waste generation and textile waste generation are quite different and require different interventions, focusing on both the production and consumption steps. It is therefore important to connect local waste strategies with other strategies, such as local food policies.

Main recommendations to reduce the carbon footprint of municipal waste:

- Apply the waste hierarchy: re-use yields considerably higher benefits than recycling, and waste prevention seems to yield considerably higher benefits than any waste management activity.
- Improve waste management by diverting food waste and paper/cardboard waste from landfill and increasing the separation and recycling of several key fractions such as glass, metal, and plastic.
- Focus on key fractions, most often food waste, textile waste and plastic waste. In particular:
  - Reduce food waste from household and assimilated producers by developing ambitious prevention strategies mixing larger awareness raising campaigns with more targeted interventions.
  - Address used textiles by implementing consistent strategies and governance, strengthening the existing collection schemes and identifying alternative ones in more challenging areas, or promoting second-hand purchasing.
  - Improve both the quality and quantity of collected plastic waste to enable more quality recycling leading to more carbon savings.



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