Local Authority Waste Management Data Analysis Challenges and the Circular Economy

Project title: BLUEPRINT to a Circular Economy

Project acronym: BLUEPRINT

Starting date of project: April 2020

Duration: 38 Months

Funding scheme: European Regional Development Fund

Executive Summary

The BLUEPRINT to a Circular Economy Project is an Interreg-funded project with a total budget of €5.5M, of which €3.8M were contributed by the European Regional Development Fund. Led by Essex County Council, it will help local authorities in France and England to implement a circular economy. Working with local authorities, social enterprises, schools and households, the project will unlock circular economy growth opportunities within the France (Channel) England (FCE) region.

This report provides an overview of specific activities, taken from the full version available on request, carried out between November 2020 and June 2021 (the first year period), and focuses on the following activities:

- An assessment of **product and material data availability.**
- **Challenges facing local authorities around data analysis which must** be solved to unlock a circular economy.

This combined approach offers a comprehensive understanding of the challenges and potential solutions to help local authorities accelerate towards a circular economy. Specific findings from the assessments are summarised below.

Product and material data availability, and challenges around data analysis

An assessment of publicly available information, websites and internal sources raised the following key challenges:

- Substantial waste flow data is available for materials, but not in a sophisticated manner to enable a localised understanding to assess performance, such as local recycling improvements.
- There is a lack of data on residual waste composition due to time and cost constraints associated with regular composition analysis. While there is more data on recycling bag composition due to the sorting process, neither residual nor recycling kerbside collections can provide data down to a local level (e.g., by postcode). There is no information available on product acquisition, use and disposal for durable products. This information is necessary to improve reuse and recycling infrastructure and campaigns.

Three recommendations are made to solve these data availability and analysis challenges, with more information available in the report:

- **Recommendation 1 -** To introduce onboard bin-weighing systems across refuse vehicles and utilise this information to create a spatial map using ordnance survey and ward data. This can be done in-house or via a waste collection vendor contractual requirement. This is only feasible for bin-based collection.
- **Recommendation 2 -** To evaluate investments in lower cost machine camera vision and AI infrastructure. This would enable near continuous automated waste composition analysis for collected recyclates and residual waste prior to sorting and disposal (Energy from Waste (EfW), landfill). This can be done via engagement with providers of such technology in the UK and France.
- **Recommendation 3** - To devise and deploy an annual household survey per product category (e.g., textiles, furniture and appliances). This would enhance information to improve reuse, repair, refurbishment and remanufacturing strategies via campaigns and infrastructure. This approach will be directly implemented in BLUEPRINT.

The BLUEPRINT project will suggest solutions based on real-life challenges faced by local authorities when trying to reduce waste and increase recycling rates. This will be done through a series of activities, including:

- **Activity 1 -** Reviewing existing circular economy solutions and examining how they can be integrated into local authorities' strategies.
- **Activity 2 -** Creating a service platform for data management that will enable local authorities to monitor their transition towards the circular economy.

Contents

1. Introduction

1.1. What is the BLUEPRINT Project?

The BLUEPRINT to a Circular Economy Project is an Interreg-funded project with a total budget of €5.5M, of which the European Regional Development Fund contributed €3.8M. Led by Essex County Council and working with local authorities, social enterprises, schools and households, the project will unlock circular economy growth opportunities within the France (Channel) England (FCE) region. The project will create a:

- new BLUEPRINT Model to enable local authorities to initiate policies, strategies and approaches to transition to a circular economy;
- local authority management, monitoring and evaluation framework to evaluate performance based around the BLUEPRINT Model;
- cross-border network of local authorities who complete the BLUEPRINT training programme;
- social enterprise training scheme to help individuals to secure jobs in the circular economy sector;
- online accelerator cluster for social innovation, helping to accelerate the rollout of the social enterprise training scheme; and
- series of behaviour change campaigns (SHIFT pilots), which will encourage 78,000 individuals to increase their recycling rates and reduce waste.

1.2. What is a circular economy?

Since the 2000s, numerous initiatives have appeared to exploit waste streams leading to the implementation of the circular economy concept. This concept is illustrated under different names (industrial ecology, industrial symbiosis, circular economy, cradle to cradle, etc.) and different approaches that aim to optimise the circulation of materials in the economy to minimise inputs and waste. A circular economy also focusses on material cycles and prioritises the end-of-life or disposal of durable products, as opposed to short-lived products. It decouples economic flows from physical flows and emphasises the concept of longevity.

The circular economy has been defined by Eurostat (2019) as "aiming *to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimising the generation of waste".*[1]

Another key definition is by the French ministry ADEME which defines the circular economy as *"an economic system of exchange and production which, at all stages of the life cycle of products (goods and services) aims to increase the use efficiency of resources, reduces environmental impacts, while developing the well-being of individuals".*[2]

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[1] "Circular Economy Overview", European Commission, https://ec.europa.eu/eurostat/web/circular-economy (last accessed 10 August 2021).

[2] "Économie circulaire", ADEME, https://www.ademe.fr/expertises/economie-circulaire (last accessed 10 August 2021).

To summarise, the circular economy promotes the reuse, repair, refurbishment and recycling of products for as long as possible with minimal waste. The circular economy originated as an umbrella concept for decoupling economic growth from natural resource use, thus creating low carbon societies.[3] [4] It was first popularised by the Ellen MacArthur Foundation shown in Figure 1 to demonstrate how manufacturing loops can be closed to reduce the use of virgin materials .

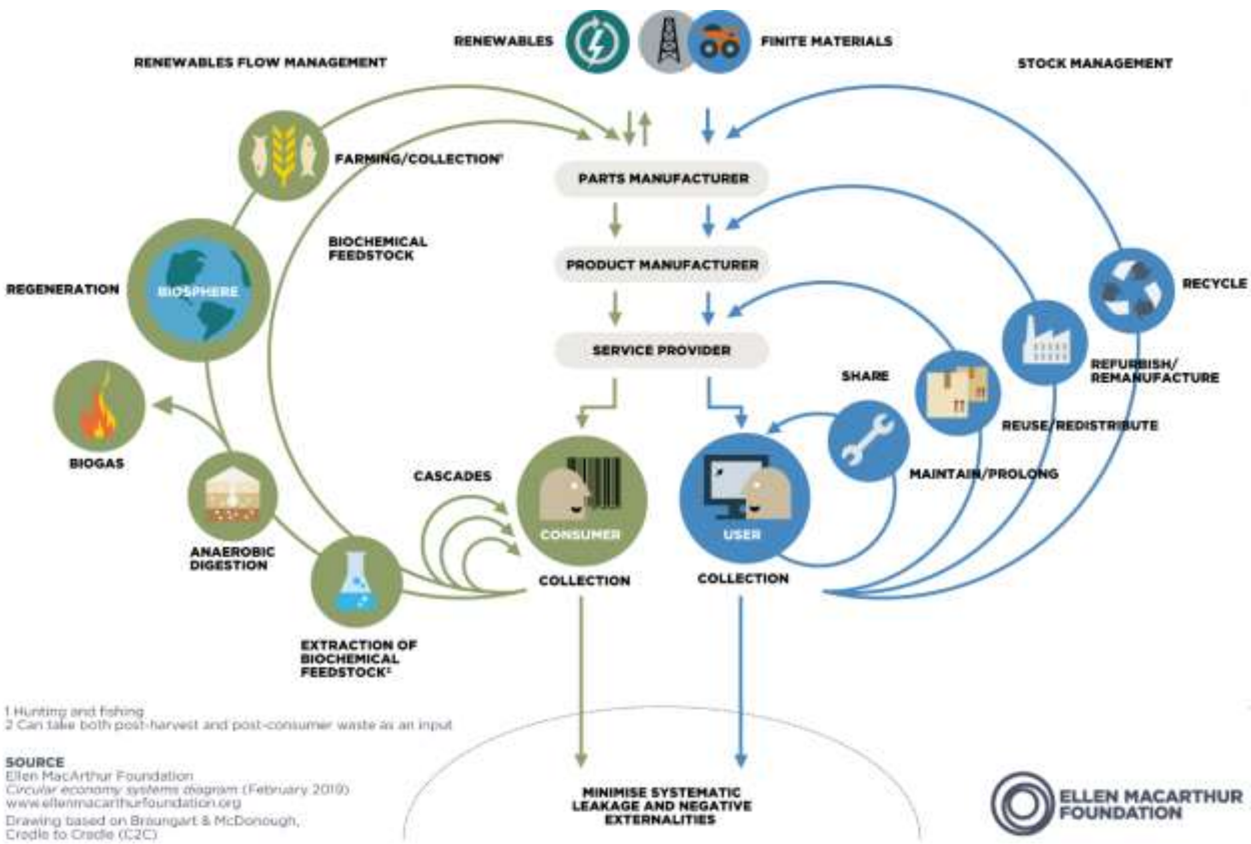

Figure 1. Circular economy systems diagram (Ellen MacArthur Foundation, 2013)

1.3. Purpose of this report

The first step to creating the BLUEPRINT model (defined in section 1.1) is understanding the current challenges in the FCE region that may hinder the implementation of circular economy practices. This report will outline those challenges and propose measures to solve them. It will draw on data and information provided by the data analysis of local authority waste management activities.

[3] "Indicators for a Circular Economy", European Academics Science Advisory Council, 2016, https://easac.eu/fileadmin/PDF_s/reports_statements/Circular_Economy/EASAC_Indicators_web_complete.pdf (last accessed 10 August 2021).

[4] "Circular Economy in Europe: Developing the Knowledge Base", European Environment Agency, 2016, https://www.eea.europa.eu/publications/circular-economy-in-europe (last accessed 10 August 2021).

2. Circular economy data analysis challenges

2.1. Introduction

The acceleration to a circular economy requires an understanding of how local authorities currently perform in circular economy approaches, such as product reuse and material recycling. By understanding how much waste is sent for recycling and how many products are reused (at individual product or waste category level), actions (such as campaigns, infrastructure and rules) can be accurately developed and targeted. This understanding also makes it easier to track a local authority's progress against its targets and shape its priorities.

BLUEPRINT has identified several challenges around creating and analysing data. Predominantly, it is difficult for local authorities to create a fine-grained baseline understanding of material flows and product stocks. This would enable local authorities to highlight areas in which circularity could be improved and inform decisions as to where investments are best placed.

Additionally, a baseline understanding, and supply of quality data will be vital for monitoring and evaluating the effectiveness of the BLUEPRINT model. Quality and spatial precision of the data will determine the ability to pinpoint the causality of improvements. This will be vital for assessing the scaling potential of social circularity initiatives and determining feasibility of implementation alongside predicting the potential impact. Furthermore, this data will evidence the success of the BLUEPRINT, thereby aiding the replicability and roll-out of the model across other local authorities.

2.2. Methodology

The purpose of the work described in this report is two-fold:

1. To understand how information can be obtained to create a baseline understanding for driving forward circular economy actions.
2. To enable the setting up of information collection and updating mechanisms to evaluate progress over time. The scope is to look at both material flows from waste and product information in terms of their useful life cycle, due to the combined importance for the circular economy as described in Appendix A.

Four approaches were undertaken to deliver this pillar of the BLUEPRINT:

1. Existing data from local authorities in England and France were assessed. This included a series of web searches and screenings of databases across industry and local authority sources.
2. The local authorities involved in the project (Kent County Council, Essex County Council and Brighton & Hove City Council) were asked about their existing datasets and processes to uncover more data and datasets.
3. Novel approaches were examined to uncover key developments by solution providers.
4. A new survey method was developed by EcoWise to fill information recovery gaps specifically relating to product data.

The combination of the four methods makes it possible to understand what data is currently available, how to enhance it and how it can be utilised in the acceleration to a circular economy. The findings from this report will be used to deliver the BLUEPRINT data analysis pillar. They will also become part of the tool for local authorities to plan, monitor and evaluate circular economy actions.

2.3. Current data analysis challenges

2.3.1. England

There are four main publicly available datasets for waste data, shown in Table 1:

- The Waste Data Interrogator, developed by England's Environment Agency, which contains the following information for all facilities in England with a waste management permit:[5]
    - A log of waste received from facilities and their origin.
    - Waste removed from facilities and their destination.
- These two datasets are produced annually. They have around 320,000 entries each and offer an annual granularity and geographic detail for each local authority. The data comes from companies that are licensed to process waste and are legally obliged to report the information to the Environment Agency.
- Waste Data Flow, developed by the UK Department for Environment, Food and Rural Affairs (DEFRA), which contains municipal waste data managed by UK local authorities, either directly by in-house services, or indirectly by contracted services.[6] This is referred to as Local Authority Collected Waste (LACW) and primarily covers household waste per local authority. This data has a quarterly granularity and is produced annually by local authorities.
- National Household Waste Composition, developed by WRAP, local authorities and waste management companies, is the most up to date insight into the composition of waste in
- England across both materials and products for the year 2017.[7] This one-off study can help to determine the average composition of mixed residual waste but will rapidly become outdated in contrast to an annual study.
- WRAP Materials Facility Reporting Portal, developed by WRAP with data inputs from UK material processors, contains waste data samples to help users understand their composition across most materials recovery facilities (MRFs).[8] It also contains information about the composition of outputs, split by glass, paper and card, plastics, metals, non-target, and non-recyclable material.

Table 1. Overview of information contained in four main datasets.

Data information **Dataset**	**Local authority waste collection approaches** (what is collected and how)	**Household waste flows**	**Company and business waste flows**	**Waste composition**
Waste Data Interrogator			X	X (by flow)
Waste Data Flow	X	X	Incomplete Only those collected by local authority	

[5] "Waste Data Interrogator", UK Government Environment Agency, 2019, https://data.gov.uk/dataset/d409b2ba-796c-4436-82c7-eb1831a9ef25/2019-waste-data-interrogator (last accessed 10 August 2021).
[6] "WasteDataFlow – Local Authority waste management", Department for Environment, Food and Rural Affairs, 2021, https://data.gov.uk/dataset/0e0c12d8-24f6-461f-b4bc-f6d6a5bf2de5/wastedataflow-local-authority-waste-management (last accessed 10 August 2021).
[7] "National Household Waste Composition", WRAP, 2017, https://www.wrap.org.uk/content/quantifying-composition-municipal-waste (last accessed 10 August 2021).
[8] "Materials Facility Reporting Portal", WRAP, https://mfrp.wrap.org.uk/ (last accessed 10 August 2021).

National Household Waste Composition		X (total England)	X (total England)	X (by composition)
WRAP Materials Facility Reporting Portal				X

A methodology was developed as part of this work to enable analyses of the above datasets in an integrated manner, as described in Appendix B of this report.

After evaluating these main datasets, English local authorities were asked which data is routinely and non-routinely collected and utilised. The findings from these interviews generalised across local authorities are:

- Local authority waste flow data for both residual waste and collected recyclables is collected routinely. This is based on information from vehicle weighbridges at refuse vehicle depots after a collection round, at waste transfer stations, at waste sorting facilities (MRFs) and at waste disposal sites including landfill and Energy from Waste incinerators. The most detailed granularity that can be obtained is at the level of individual refuse vehicle rounds, however this does not yet exist. Local authority waste flow data excludes commercial and industrial waste collected by waste management companies. Some local authorities utilise tracking systems, such as the OpenSky intelligence Waste Disposal Data Management System (iWDMS) to manage these waste data flows,[9] [10] whilst others rely only on spreadsheets.
- Comprehensive local authority waste composition data for residual waste is collected non-routinely (every five to ten years). The main reason for this is the cost of collecting such information, which requires manual sorting of waste bags, as well as classifying and weighing each piece of waste within them. This data is managed in a bespoke manner in spreadsheets.
- Local authority waste composition data for dry recyclables is estimated at MRFs on a quarterly basis. The evaluation is usually carried out based on the outflows into different streams which are weighed. The main categories include plastics, paper and card, metals, and glass, as well as non-target materials (recyclable materials currently not being recycled due to limited infrastructure or limited economic value) and non-recyclable materials.
- Local authority product stock data is not collected and so no datasets currently exist. Such datasets would include information on what garments, furniture and electrical appliances are in use by households and companies, how they are acquired (first-hand, second-hand etc.) and what happens to them at end of their use cycle (repair, reuse, disassembly, recycling, landfill, incineration etc.).

2.3.2. France

The screening of datasets for France uncovered that there are also four main publicly available datasets for waste data, shown in Table 2:

- The Sinoe Dechets database — managed by ADEM — contains detailed figures per region on collected waste and waste treatment.[11] Licenses are granted to public organisations at three levels of detail:

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[9] "Waste Disposal Data Management System", OpenSky, https://www.openskydata.com/transformation/waste-data-management (last accessed 10 August 2021).
[10] "Gov360 OpenSky: Integrated Waste Data Management System (iWDMS)", Digital Marketplace, 2021, https://www.digitalmarketplace.service.gov.uk/g-cloud/services/412536238186704 (last accessed 10 August 2021).
[11] "Sinoe Dechets Database", Sinoe, https://www.sinoe.org/ (last accessed 10 August 2021).

- Level 1 license: ability to consult the data aggregated by department, by region or at national level (regional perspective).
- Level 2 license: ability to access individual data at waste collection level from general councils, regional councils and local observatories (local authority perspective).
- Level 3 license: ability to access individual data on the flows and costs of waste disposal from inter-municipal structures (local authority waste management collaborations perspective).

- Libraries of reports with waste figures and information managed by the French government/Ministry of Ecology/ADEME. These reports contain information on waste composition and details on local collection systems and approaches.[12] [13]
- The French pollutant release and transfer register (IREP)[14] managed by ADEME contains information on the amount of waste processed, as well as the related environmental pollutants released at each industrial site. It is codified with the European Waste Classification. The database cannot be accessed in full — it is only possible to look up individual sites of interest.

Table 2. Overview of information contained in four main datasets.

Data information **Dataset**	**Local authority waste collection approaches** (what is collected and how)	**Household waste flows**	**Company and business waste flows**	**Waste composition**
Sinoe Dechets		X		
Individual report library managed by ADEME	X	X		
Regional reports from local organisations		X	X	X
Industry data - pollutant release and transfer register (IREP)			X	

A methodology was developed to enable analyses of the above datasets in an integrated manner, as described in Appendix C of this report.

[12] "La Librarie: Déchets/Economie circulaire ", ADEME. https://librairie.ademe.fr/2903-dechets-economie-circulaire (last accessed 10 August 2021).
[13] "Open platform for French public data", data.gouv.fr, https://www.data.gouv.fr/en/, (last accessed 10 August 2021).
[14] "Registre des émissions polluantes", GEORISQUE, https://www.georisques.gouv.fr/risques/registre-des-emissions-polluantes (last accessed 10 August 2021).

2.3.3. Summary of data analysis challenges

The examination of existing databases and conversations with local authorities highlighted five data availability and analysis challenges for both England and France:

- Waste flow data is available from collection vehicles when weighed at weighbridges. Current data collection methods mean residual waste, organic waste and dry recycling cannot be attributed to individual districts, neighbourhoods or postcodes. Part of the challenge lies in the sophistication of the data processing, as it is collected per vehicle round spanning multiple districts. Another challenge arises from the absence of in-vehicle weighing solutions, which are not commonly used at present.
- Dry recycling waste composition data is available in a standard form on a quarterly basis as it is sorted in an MRF. However, the recycling is only sorted at main category levels, with limited understanding of the detailed composition. For example, local authorities are unable to determine what types of plastics are in the plastics stream. They are also unable to identify the main contaminants in each of the recycling streams.
- Residual waste composition data is only collected once every five years at the local authority level. This is due to the high cost of collecting this data. This makes it challenging to understand the success or failure of specific actions. Examples include reducing dry recyclables contamination by better separation, or efforts to open soft plastics collection points at supermarkets. The main challenge here lies in developing affordable approaches to collecting residual waste composition data on at least an annual basis.
- Local authority product data is not currently collected. There is nothing to analyse to understand how local authority actions enhance repair and reuse or influence recycling and waste disposal. The main solution lies in developing affordable methods to enable residents to provide product information to local authorities in relation to acquisition, use, and end-of-use/disposal.

The next chapter will further analyse these challenges and identify solutions that can be incorporated as part of the BLUEPRINT Project.

2.4. Potential solutions and recommendations for BLUEPRINT

2.4.1. Waste flow data solutions: improving analytics and vehicle weighing information

A key challenge at present is that collected residual waste, organic waste and dry recycling cannot be localised to the level of district, neighbourhood, or postcode. This means that it is not possible to understand the impact of local changes and initiatives. This includes behavioural campaigns targeting waste prevention, infrastructure changes such as growth in reuse and recycling banks or sweeping system changes such as a ban on single use plastic items.

On-board vehicle weighing solutions would address this challenge. The weight of collected bins could be assessed during the collection round and spatially attributed to a street or postcode. When combined with spatial data processing capabilities, it is possible to understand how much is collected at a sophisticated and fine-grained level and generate heatmaps per type of collected recycling bin or refuse bin. If collected over time, this becomes a powerful tool to understand the impact of campaigns, infrastructure changes and regulatory/policy changes over time. Collection disruptions can be filtered out based on GPS data.

To effectuate this change, local authorities must list this functionality as a requirement in their tendered waste collection contracts with private providers. Alternatively, local authorities can develop this solution as part of in-house waste services.
It will also require working with:

- Vehicle weighing solutions providers to understand systems, costs and potential.
- Connected digital systems to gather data processing and spatial information insights in dashboards.

In the UK, the main company providing on-board vehicle weighing solutions is Vehicle Weighing Solutions (VWS).[15] Such systems also have the advantage of enabling pay-by-weight options for commercial collections of larger containers.[16] This option includes scanning bins and containers based on an RFID tag or other container identification option. It also features time, date, location and weight data to ensure the correct identification of the container/bin to the right customer.

Other solution providers for on-board weighing solutions in the UK include MOBA Mobile Automation, Avery Weigh-Tronix and AMCS Group.[17] [18] [19]

In France, two companies provide on-board vehicle weighing solutions:

- The ELTE Group provides both physical systems and a dashboard with a weighing report per collected bin (see Figure 2 below). [20]
- The Terberg Rosroca Group provides load cells combined with RFID readers for bin weighing.[21]

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[15] Steed Webzell, "Why waste companies are still fighting for the latest weighing technologies ", Recycling & Waste World, 20 April 2018, https://www.recyclingwasteworld.co.uk/in-depth-article/why-waste-companies-are-still-fighting-for-the-latest-weighing-technologies/172881 (last accessed 10 August 2021).
[16] "Pay by Weight A Success for Norse Waste Solutions", Vehicle Weighing Solutions, May 2017, https://www.vwsltd.co.uk/post/pay-by-weight-a-success-for-norse-waste-solutions (last accessed 10 August 2021).
[17] "PTB Certified; Reliable Mobile Weighing Systems", Moba Automation, https://moba-automation.uk/machine-applications/rear-loaders/mobile-weighing/ (last accessed 10 August 2021).
[18] "Load Cells and Weigh Bars", Avery Weigh-Tronix, https://www.averyweigh-tronix.com/en-GB/products-UK/load-cells-and-weigh-bars/ (last accessed 10 August 2021).
[19] "Vehicle Technology & On-board weighing", AMCS, https://www.amcsgroup.com/uk/solutions/vehicle-technology/ (last accessed 10 August 2021).
[20] "Solutions for various industries", ELTE Group, https://www.eltegps.fr/solutions/systeme-de-pesage-dynamique-des-dechets.html (last accessed 10 August 2021).
[21] "Applications: Pesage et identification de conteneurs", Terberg Rosroca, (last accessed 10 August 2021) .

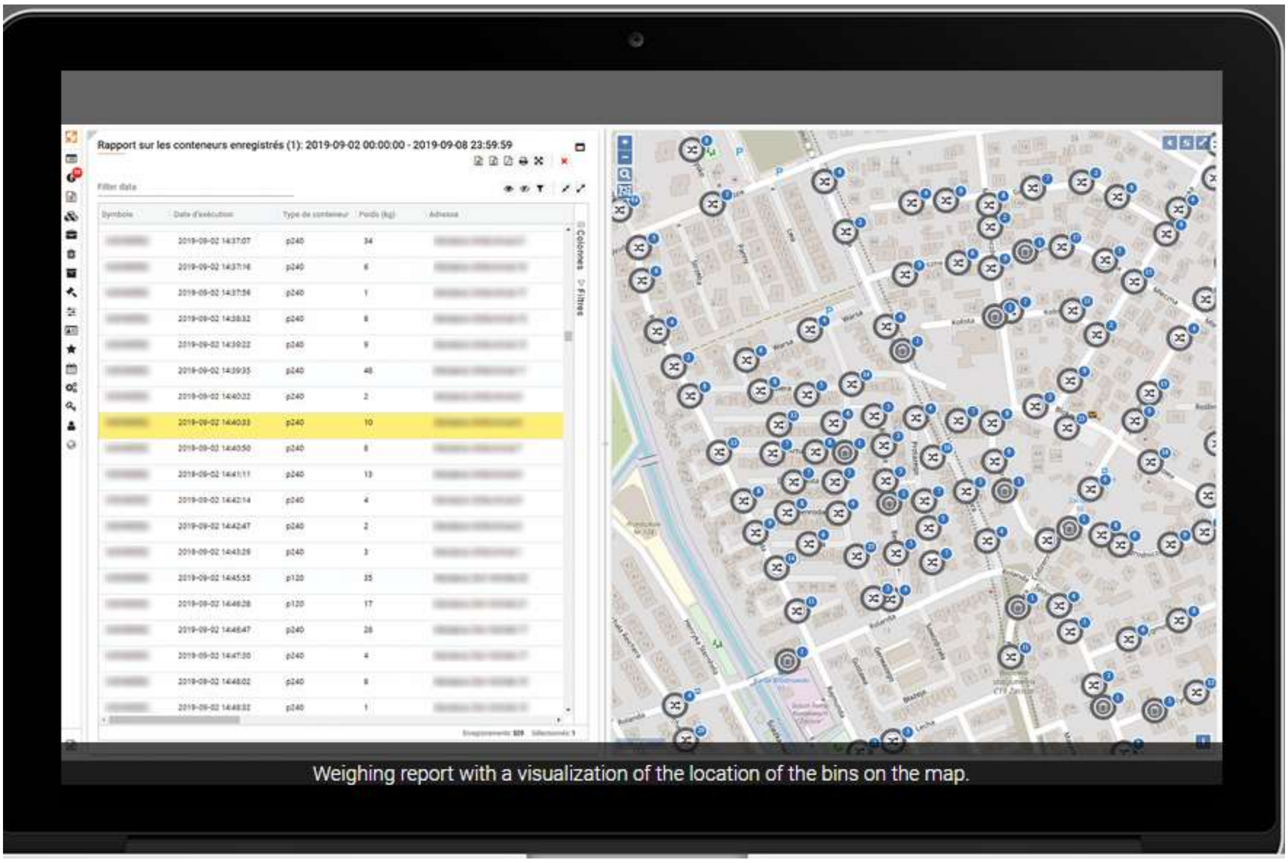

Figure 2. Spatial dashboard provided in relation to on-board weighing solution. (ELTE Group, 2021)

2.4.2. Waste composition assessment solutions: enhanced scanning technologies

The main challenge at present is the limited automated technologies for obtaining detailed composition of collected dry recyclables. There is also an absence of technologies used for residual waste composition evaluation. If these processes can be automated to a high level of accuracy using affordable scanning and weighing machinery, it will be possible to obtain a near-continuous level of data insight, allowing to obtain detailed composition of collected dry recyclables. Ideally, refuse and recycling vehicles, waste transfer stations and sorting facilities would all be equipped with these systems.

New companies in the UK and France are developing innovative solutions in this area. Some examples of these are:

FR – LIXO.tech - A start-up developing a vision and Artificial Intelligence (AI) detection system for real-time composition analysis. This can be used across the entire chain, from collection (refuse vehicles) to incoming and outgoing flows in MRFs, as well as at waste disposal facilities. The solution is still being prototyped and limited information is available. One of the main advantages is the integration of a micro-computer for on-site interpretation. This avoids image transmission in the cloud and makes integration in refuse trucks feasible.[22]

The solution is currently being tested at MRFs in Brittany and the Centre-Val de Loire. A first pilot will likely be launched at the end of 2022 to be used by local government and private customers in France.

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[22] "Future of waste recycling and sorting with Lixo", Ecole Polytechnique, https://polytechnique-entrepreneurship.fr/en/node/310 (last accessed 10 August 2021).

UK - Greyparrot.ai - A company that has developed a complete vision and AI detection system that can be retrofitted to existing MRF facilities. This makes it possible to obtain a detailed understanding of over 45 categories of waste from both the MRF input and the output perspective. This enables complete visibility of dry recycling.

One greyparrot.ai visioning unit costs around £10,000 and 10-20 units must be retrofitted for complete visual information. The product will be available from October 2021 as a service subscription (Information based on a conversation between Greyparrot and EcoWise).

In addition to composition data this detailed information allows for a better understanding of MRF configurations. It also offers the potential to utilise the greyparrot data for sorting and picking robots in the near-term future.

UK - Recycleeye.com - A company that is developing 'mini' MRFs at the scale of 5,000 tonnes of processed waste per year. The MRFs have camera vision scanning options using AI. These cost far less than infrared systems, as they do not rely on expensive hardware.[23]

In the future, a mini MRF can be deployed for automated computer recognition of the waste content in a bin bag, both for residual waste and dry recycling. The investment costs are estimated at £300,000 for facilities with 5,000-tonne capacities, with a 60% cost saving on operational costs relative to traditional MRFs.[24]

The cost of these solutions must be compared within the context of cost efficiency gains by increasing recycling rates. The cost of obtaining such data with more traditional means must also be considered; for example, the cost of conducting an in-depth manual residual waste composition study.

2.4.3. Local authority product data solution: product surveys

The aim of the product stock survey is to fill a major data gap for local authorities regarding the number of products people buy, own and dispose of within a defined area or region. The ways in which people reuse and recycle products is critical for a circular economy to emerge. A lack of data regarding reuse through second-hand, giveaways or reuse shops, makes it hard for local authorities to steer and support their residents.

A household product survey would help to fill this data gap by asking residents about how many products they own, where they acquire them and how they dispose of them. Few such surveys exist, and none are carried out on a standardised basis.

The aim of these surveys is:

- To create a product inventory, estimate by quantifying the number of products (e.g., shoes, blenders, towels) within individual categories (e.g., fashion, kitchen appliances, bathroom products) within a local authority's boundaries; and
- To quantify how many products are acquired and disposed of, and the way in which they are disposed of.

To build upon existing work, BLUEPRINT is delivering a survey to gain the following insights:

- The scope of the problem, including the tonnages of items, and carbon emissions.
- Reuse and recycling performance before products go to waste.

[23] "Automated, Digitalised and Decentralised Circular Waste Sorting", UK Research and Innovation, https://gtr.ukri.org/projects?ref=48704 (last accessed 10 August 2021).
[24] "Decentralised and Digitised Mini Material Recovery Facilities", Recycleye https://recycleye.com/mini-mrf-julien/ (last accessed 10 August 2021).

- Where and how to focus campaigns and infrastructure to support the move towards a circular economy. The benefits of gaining this understanding include:
    - Prevention - Measure the potential impact of circular economy campaigns and consumer behaviour actions.
    - Repair and reuse - Better planned textile reuse and repair shops infrastructure.
    - Collection - Be able to evaluate the costs and benefits of collection services.
    - Recycling - Planning with the sector for investment in local/regional recycling technology.

By carrying out the product survey in a statistically representative manner, the findings can be gathered across the local authority area. To do this, results will be extrapolated using relationships from key demographic characteristics and their related product acquisition, use and disposal behaviours. Different households will have different habits around purchasing and product use, which affects the lifespan of products.

The product survey method that is developed for garments serves to fill this gap. It will deliver data in a standardised manner to obtain information about four different aspects:

1. Socio-economic information about participants.
2. Information about how many types of clothing a survey participant owns.
3. How and where people acquire new clothing and how often.
4. How many items of clothing are thrown or given away and where they go to?

The socio-economic information — including income, age, gender, household type, and home size —can be evaluated to see which characteristics influence the acquisition, use and disposal of clothing at end-of-use. The analysis between socio-economic characteristics and other survey information will enable the creation of a complete picture of garment ownership and disposal across the local authority.

This information can be used for the following analyses:

1. To link to information about existing collection options (kerbside bags, clothing banks, at-home on demand collection, charity shops), and how their presence or absence influences disposal routes. This will make it possible to suggest ways to improve garment
2. collections (See Figure 3 for an example of spatial mapping between jeans ownership and reuse infrastructure).
3. To assess where to focus behaviour change campaigns relating to collection options, reuse and repair.
4. To evaluate the cost and benefits of investment in enhanced textile recycling at regional and county level.

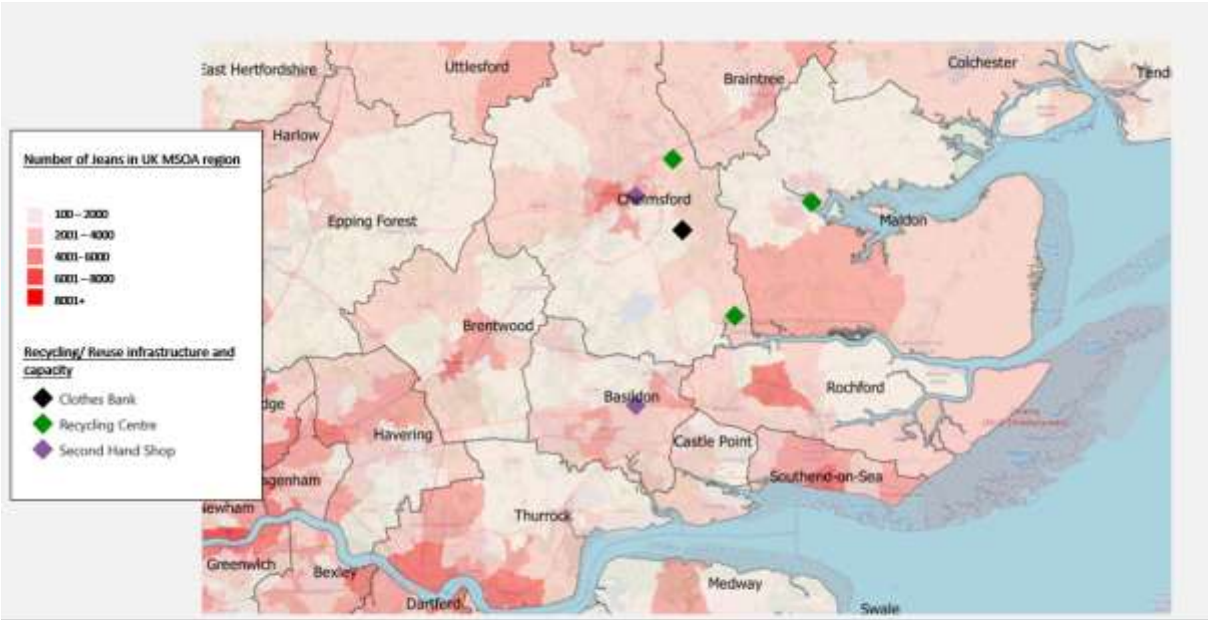

Figure 3. Example of spatial mapping between jeans ownership and clothing disposal infrastructure.

The survey will be carried out digitally, as this is a simple and low-cost method for local authorities. At a later stage, the survey could also be run in-person for groups that are not digitally connected to ensure more complete coverage of all resident types.

Other key considerations for the success of the survey include:

- The duration of the survey - A maximum of 20 questions to reduce time required to complete the survey (estimated at 30 minutes).
- User friendliness and accessibility, which will be improved by creating as many visual content and closed option questions as possible. Local authorities in BLUEPRINT do not have a standardised survey route. The survey will prioritise accessibility to enable widespread access and ease of use.
- Obtaining consent for use of socio-economic information and handling of personal data in accordance with GDPR regulations. People are provided with information about their right to withdraw from the survey and an email address to contact regarding this matter.

  The following privacy measures will be taken:

  1. All survey datasets will be anonymised.
  2. All survey datasets will be stored in a single cloud hosted SharePoint by EcoWise. Access will be restricted to only two EcoWise employees and one officer from each local authority partner.
  3. Only the first three digits of the postcode will be requested to geo-locate survey participants.
  4. Personal data on name, surname and email will be collected with consent (people can also opt not to provide them) and this will be stored separately from the survey information to ensure anonymity.

The initial product survey was developed by EcoWise, and the questions are listed below. The survey has been reviewed by two researchers from the OSLO Consumption Research Norway Group (SIFO) who have supported the quality improvement of the survey.[25] Answer options are omitted for brevity.

1. Question: What is your gender?
2. Question: Please state your age.
3. Question: How would you describe your living situation?
4. Question: How many people live in your household?
5. Question: Which best describes your total annual income?
6. Question: Which best describes the total annual income of your household?
7. Question: How would you describe your current main occupation?
8. Question: How would you describe the size of your household?
9. Question: How many items (including sportswear, costumes, shoes and accessories) do you own of the following (including in your house and stored elsewhere)?
10. Question: How many other garments do you have that did not belong to any of these categories?
11. Question: Do you use any clothing rental services (including uniforms)?
12. Question: On average, how many items do you add to your wardrobe every three months, both new and second hand?
13. Question: Out of those items, how many would be bought new, second-hand, homemade, other?
14. Question: On average, how much do you spend on adding items (all the items listed above, including shoes and bags) to your wardrobe every month?
15. Question: Which items do you acquire most frequently (select 4)?
16. Question: On average, how many items of clothing do you throw or give away every three months?
17. Question: What happens with items you get rid of?
18. Question: Would you be willing to conduct your own wardrobe study taking approximately one hour?

2.5. Conclusions and recommendations

There were three key findings from chapter three:

1. Substantial waste flow data is available for materials, but it is not easy to trace this data back to its spatial location.
2. There is a lack of information available on waste composition. This is needed to analyse circular economy solution potentials, but the available data is either outdated or not specific to the locality.
3. There is no information available on product acquisition, use, and disposal of items such as textiles, appliances and furniture.

These three challenges were evaluated, and new methodologies were designed. Based on these, three recommendations can be made for local authorities:

1. Assess the approach by which waste flow data is currently captured by the local authority in relation to an existing and/or upcoming waste collection contract of the council. For new contracts,

[25] "Consumption Research Norway (SIFO)", Oslomet, https://www.oslomet.no/en/about/sifo (last accessed 10 August 2021).

evaluate the potential to equip refuse vehicles with onboard bin-weighing systems and GPS tracking with display dashboards at street level. This will allow local authorities to visualise waste and recycling generation in the local area.

2. Evaluate investments in novel machine vision and AI infrastructure to carry out automated near-continuous waste composition analysis for both collected recyclates and residual waste. This will enable enhanced insights in both upstream impacts (e.g., household and business kerbside behavioural changes and waste stream material changes) and downstream impacts (e.g., recycling performance at MRFs and waste transfer stations).
3. Devise and deploy an annual household product survey for categories such as textiles, furniture and appliances. This will help to fill data gaps and analysis on the purchasing, reuse, repair and disposal of durable products. This will allow for a better understanding of both campaign impacts and infrastructure requirements.

2.6. Next Step

Local authority officers are unable to obtain key data on the costs of waste management or the tonnages and deposits of collected waste. This prevents the efficient implementation of sustainable and efficient strategies.

To support with those challenges, the BLUEPRINT Project will lead the creation of a **new monitoring and evaluation framework** to be utilised by local authorities supporting them in tracking their progress towards a circular economy.

3. Appendices

3.1. Appendix A – Overview of Circular Economy concepts

The circular economy strongly enhances the more common concept of the waste hierarchy, shown in Figure 4 below. This prioritises actions to minimise material and product waste. The idea of the waste hierarchy is that actions should be taken starting with the top of the inverse pyramid (prevention). This can be done by eliminating the need for specific materials, such as unnecessary packaging. This would make existing products lighter, thereby reducing their material footprint. Alternatively, the need for products can be removed entirely by incentivising individuals to consume less. A primary example of the latter is removing multi-pack offers of bottled water, where six bottles are tied together with unnecessary soft plastic wrapping. The need to buy bottled water itself has recently been challenged by refill campaigns, which have encouraged people to bring a reusable bottle out with them, to be refilled in bars/pubs and restaurants who support this initiative

The second priority is keeping products in “the loop” for as long as possible through reuse and repair efforts, while maintaining product quality. Keeping products for as long as possible and extending their lifespan reduces the need for extracting new raw materials.

The third level (remanufacturing) involves bringing parts of a product back into the manufacturing cycle and upgrading them to match the quality of new items. The most famous example of this are ink cartridges, which can be refilled many times through collection and resales.

Recycling makes up the fourth layer of the model. This can be via different routes, such as mechanically, organically, or chemically. Here, differentiation can be made between closed and open loop recycling. The former means making the same or a similar product out of a material. Open loop recycling (often also referred to as downcycling) involves making an inferior product out of the material of the original.

Mechanical plastics recycling sorting is an example of open loop recycling. The process is still not sufficiently advanced to enable high purity streams for a large portion of recovered plastics, because it is difficult to separate different types of plastics. As a result, about 20- 40% of recovered plastics from MRFs end up in mixed plastic waste streams combining different plastics (E.g.: PE, PP, PVC, PS etc.), which is only suitable for open loop recycling. This plastic waste can be turned into grey recycled plastic composites that are used in kerbside roadblocks or benches, instead of plastic bottles being turned into plastic bottles.

The penultimate option – recovery - relates primarily to incineration through Energy from Waste facilities. In these facilities, waste is burnt to obtain heat to be turned into electricity. A residual incinerator bottom ash is also created as a by-product, which is sent to landfill.

Disposal, the final option, relates to the landfilling of waste.

Note that the main underpinning of most policies at present is the waste hierarchy (see Figure 4). The waste hierarchy related to the circular economy in that it describes what should be the priority of different circular economy strategies. Despite being practised for multiple decades, the waste hierarchy is currently more of an ideal than reality, as most of the waste still ends up in recovery and disposal. We are far from a circular economy that adheres to this waste hierarchy.

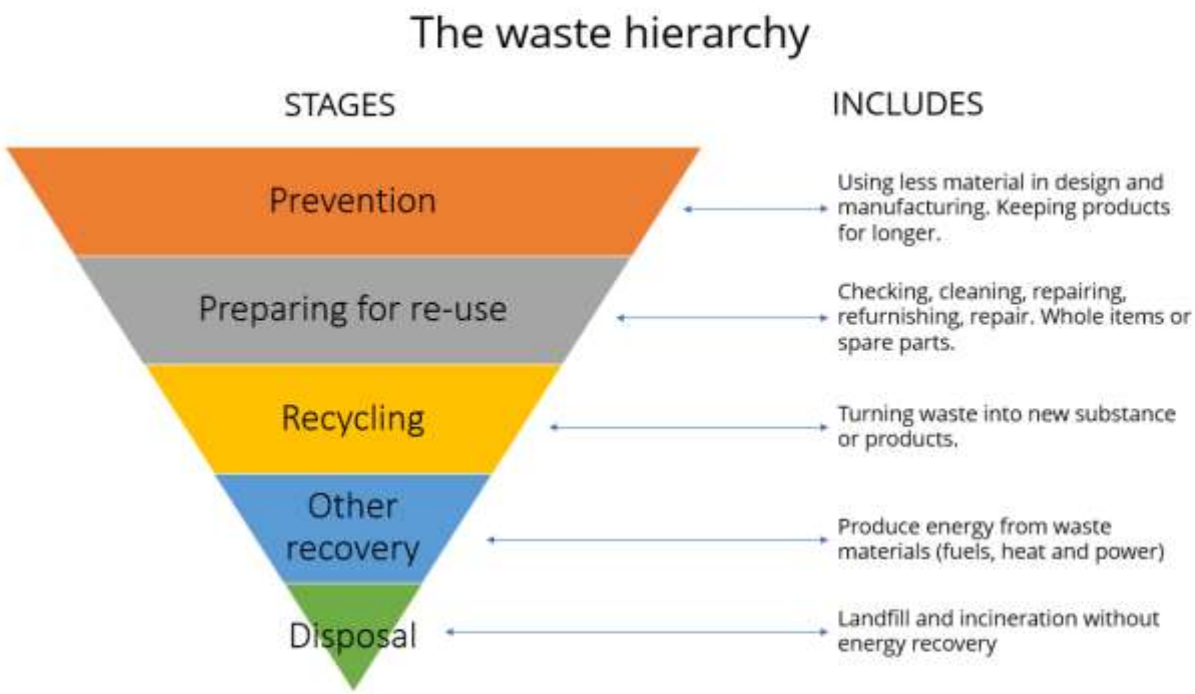

Figure 4. The waste hierarchy, EcoWise, 2021

Beyond the biosphere, Technosphere and waste hierarchy, the circular economy can also be embedded within the social and economic fabric of society. This shifts away from looking through a material or product lens and focusses on looking at the circular economy as a means towards societal ends. Significant thinking has gone into this in France where the purpose of the circular economy has been identified as part of three domains of action resulting in seven pillars.[26]

The three domains of action are:

1. How individuals use resources and where the resources come from.
2. The demand and consumption behaviours of companies and residents.
3. The generation of waste.

From these domains where action can be undertaken, seven pillars that define a circular economy emerge:

- Sustainable supply ensures that there is a sustainable exploitation of resources with as little waste as possible. This relates to non-renewable and renewable resources. Sustainable supply also ensures that procurement processes take sustainable resource use into account.
- Eco-design ensures that processes, goods and services are designed to take their entire life cycle into account and optimise their longevity while minimising their environmental impact.
- Industrial ecology ensures there is collaboration between companies to utilise waste as resources between them. Businesses can do this by enabling the uptake of waste from one industry to resource in another industry.

[26] "Économie circulaire", ADEME, 2017, https://www.ademe.fr/expertises/economie-circulaire (last accessed 10 August 2021).

- The functional economy ensures that products become services instead of being owned by people.
- Responsible consumption ensures that private and public organisations consider environmental impacts at all stages of the product cycle.
- Product longevity ensures that a product is repaired, sold, donated, refurbished or reused to the full extent.
- Recycling ensures that all waste is recycled.

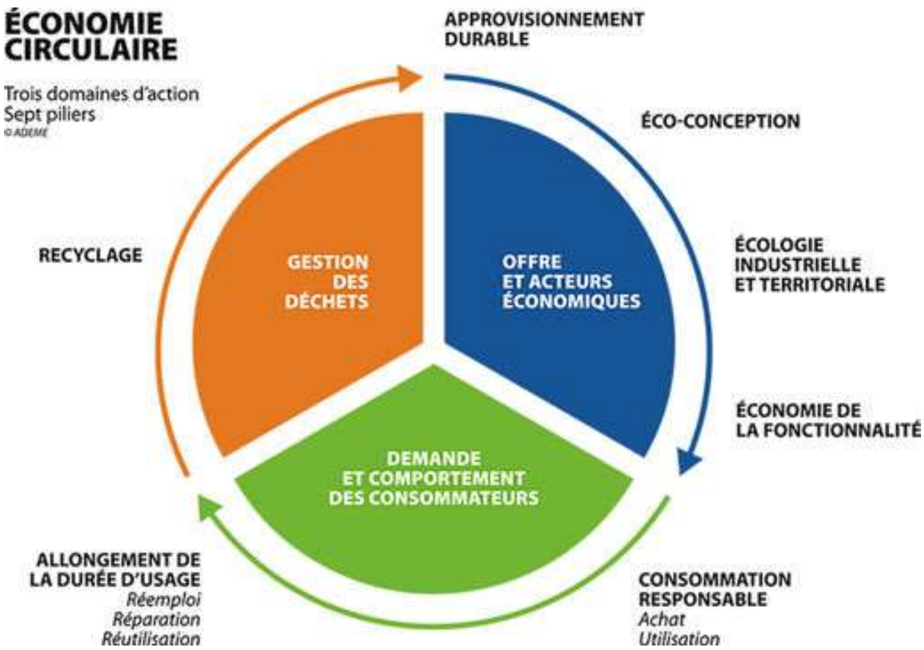

Figure 5. Circular economy concept defined by ADEME in France

The importance of both material and product evaluations

The Circular Economy Systems encompasses the circular economy as a harmonious approach. In practice, studies and initiatives have previously focussed on either material (such as elements like copper) or products (such as mobile phones). This is also reflected by the way in which waste and resource management is currently approached by national government. In France and England, the national waste prevention and product longevity strategies are carried out under waste prevention programmes, whilst the strategy for recycling falls under waste management plans. This lack of integrated planning is a consequence of the EU Waste Framework Directive 2008/98/EC under Article 28 and Article 29.[27] This separates materials and product by law. From a circular economy perspective, however, it would make sense to integrate both in a larger plan, as prevention, product longevity and recycling should be linked within the waste hierarchy.

To achieve a circular economy, a joint perspective is needed that looks at society from both materials and product perspectives. This can be explained more clearly when looking at analytical frameworks through a material flow lens. Cradle-to-Cradle and Material Flow Analysis, for example, largely emphasise the

[27] "EU Waste Framework Directive 2008/98/EC under Article 28 and Article 29", EUR-Lex, 2008, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098 (last accessed 10 August 2021).

conservation of materials, following and optimising their use to prolong their life span and value. In these frameworks, products are viewed as a temporary physical form for a collection of materials.[28]

This joint perspective is preferred to the narrow view that a circular economy is an economy in which materials are made circular through recycling. Quality and volume loss is encountered during recycling materials. This is because current technologies cannot ensure a maximum or close-to-maximum recovery or retrieval of materials, and subsequent mechanical or chemical recycling into secondary raw materials.

A strong focus on materials limits a circular economy in three ways:

- Incentivising more material consumption: Promoting recycling disincentivises waste prevention efforts, given that recycling facilities need a high tonnage of waste to be economically viable. Therefore, promoting a circular economy in this way would indirectly lead to a growth in material consumption. It would also result in higher societal costs in terms of energy and emissions and would mean a circular economy would not be reached until the distant future.[29]
- Relatively higher energy and capital costs: Recycling of materials — relative to product longevity and increased circulation efforts — comes with significant energy, capital cost and use of land. It also comes with significant carbon emissions if the energy is not produced from renewable sources. This is usually the case for chemical recycling processes and, to a lesser extent, for mechanical recycling processes.
- Product quality impact of recycling: Recycling technologies are still not perfect, as contaminations can degrade material properties. Copper contamination, for example, can occur in high quality steel recycling in electric arc furnaces. Copper contamination reduces its integrity, meaning that the steel cannot be used in car doors or as structural load bearing steel in skyscrapers.

A sole focus on maximising the use of materials thus does not provide the solution with the lowest waste output. Therefore, the waste hierarchy promotes waste prevention, product longevity and reuse perspectives over recycling. This prioritisation is key to achieving a circular economy within one to two generations.

The study of products alongside materials is thus key for BLUEPRINT and the circular economy at large. Greater efforts are needed to understand the value of a product as a collection of materials, money, energy, time and labour that is providing value to the end user. The lifespan of a product must also be prioritised and can be expanded through either renewal, remake, repair, refurbishment, remanufacture or upgrading. Studies with a product perspective have tended to focus on design, product integrity preservation, repair (e.g. the right to repair movement), as well as re-usability and lifespan extensions. [30]

Whilst keeping products in circulation for as long as possible is a key pillar of the circular economy, focussing on products alone limits a circular economy in three ways:

- Product value maintenance: In a rapidly advancing technical world, the technology in electronic products quickly becomes outdated. Whilst increasing physical durability might prolong product lifetime, it does not ensure the value of the product in maintained or increased. Solutions such as appliances with modular components have been developed, but these have been difficult to implement from a business perspective, and not yet been proven to retain or increase value.
- Energy use improvements: As technologies advance, products become more energy efficient thanks to increasingly stringent regulations. There is consequently a trade-off between higher energy usage

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[28] Fenna Blomsma and Mike Tennant, "Circular economy: Preserving materials or products? Introducing the Resource States framework", *Science Direct,* 156 (May 2020) https://www.sciencedirect.com/science/article/abs/pii/S0921344920300203.

[29] "Policies for the Sixth Carbon Budget and Net Zero", Committee on Climate Change, December 2020, https://www.theccc.org.uk/wp-content/uploads/2020/12/Policies-for-the-Sixth-Carbon-Budget-and-Net-Zero.pdf (last accessed 10 August 2021).

[30] "Right to Repair", Repair.eu, https://repair.eu/, (last accessed 10 August 2021).

from prolonging the use of an old product, or lower energy usage from using a new product. To fully understand the benefits and drawbacks of this trade-off, it is important to consider material flows and product stocks in parallel.

- Product affordability: Longer-lasting high-quality products are usually more expensive, either because of component costs and/or due to manufacturers' marketing and profit margin increases. Consequently, many consumers are either disincentivised to use such products or have an insufficient income to purchase them. From the perspective of lower income households, product circularity makes little economic sense. Materials circularity, which puts the burden on both the manufacturers through legislation, and society as a collective by distributing costs of waste collection and recycling, is much more attainable.

The reasons above demonstrate the importance of studying materials and products in parallel. This is also increasingly recognised as a paramount step towards creating and evaluating circular processes.[31]

3.2. Appendix B - England – developed material flow assessment method

Material flow assessments enable the tracing of materials across a location within a set timeframe. For example, they enable analysts to see how much residual or black bag waste is generated by households, where these were processed and in what type of facility. They also show information about the resulting materials, as visualized in Figure 6 below.

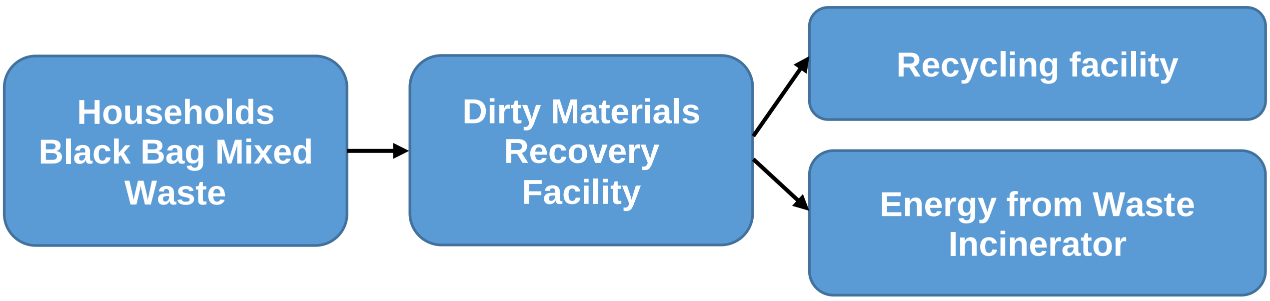

Figure 6. Example of a supply chain for black bag mixed waste that can be quantified using material flow assessment.

To carry out material flow assessments, it is necessary to have available datasets or databases that contain information about waste/materials received, processed and sent within a region and/or country. It is also helpful to have an identifier of the composition of waste/materials alongside the flows. The European Waste Classifications have been legally defined as a common framework both for England and France.[32] This contains a codification for 20 categories of materials/waste, with sub-classifications for individual types. For example:

- 20 municipal waste types including separately collected fractions:
  - 20 01 01 Paper and cardboard
  - 20 01 02 Glass
  - 20 01 08 biodegradable kitchen and canteen waste

[31] Blomsma and Tennant, "Circular Economy".
[32] "EWC Codes", Waste Support, http://www.wastesupport.co.uk/ewc-codes (last accessed 10 August 2021).

Material flow data is usually collected by local authorities for their own internal waste services. This is done by a country's Ministry of Environment or similar institution, or via national or regional environmental agencies that provide permits for waste management service facilities. However, not all of these datasets are publicly available, and many are difficult to analyse.

The material flow assessment method is based on available datasets as described in the previous section. WasteDataFlow data is often a starting point because of its comprehensiveness. It is used to obtain values for the Local Authority Collected Waste (LACW) for households and non-households (commercial and industrial). This is combined with the information on whether the waste/materials are recycled or not, split by organic and non-organic waste. It also describes the collection methods used to obtain the waste/materials. Subsequently, this information is complemented with values from the Environment Agency Waste Data Interrogator for enrichment purposes at four levels:

- The amount of non-household waste/materials.
- The processing route for disposal and recovery of waste/materials.
- The waste types using the European Waste Code (EWC) classification.
- Inflows/outflows from the local authority from/to other local authorities.

Additional datasets (the National Household Waste Composition data and the WRAP Materials Facility Reporting portal) are used for mixed waste. These break waste data down into types of materials contained in collected waste based on estimates for the composition of waste. These include the following mixed waste:

1. Residual or black bag waste.

2. Co-mingled collected waste.

3. Remaining sorting residues.

The sequence of the material flow assessment is as described in Figure 7

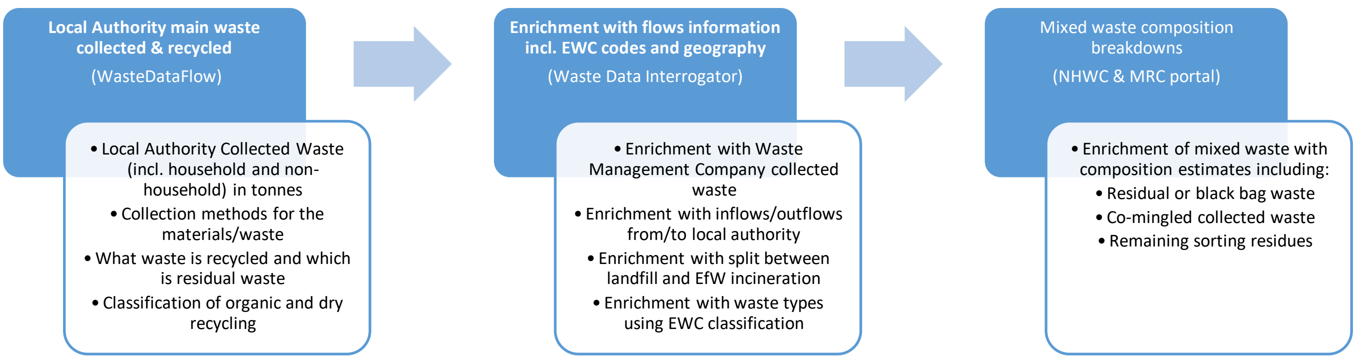

Figure 7. material flow assessment (EcoWise, 2021)

WasteDataFlow information extraction process

To implement the approach in a modular way and make it replicable for as many local authorities as possible, a series of data extraction and processing steps were carried out. In the case of WasteDataFlow**,** different datasets were extracted, integrated, and placed from the portal into a master spreadsheet dataset (see Figure 8 below). The tonnage arisings, for example, were combined with the collection methods. This makes it possible to find the following information for individual local authorities via the master spreadsheet:

- Number of households

- LACW household waste (tonnes)
- LACW non-household residual waste (tonnes)
- Total household waste collected including residual and recycling (tonnes)
- Household waste not sent for recycling, reuse or composting (tonnes)
- Household waste sent for recycling, reuse or composting (tonnes)
- Household waste sent for dry recycling (tonnes)
- Household waste sent for composting/anaerobic digestion (tonnes)
- Municipal waste sent to landfill (tonnes)
- Household waste sent for energy recovery (tonnes)
- Collection method for residual waste by number of households (bins/sacks/other)
- Collection method for dry recycling by number of households (bins/sacks/other)
- Collection method for organic waste by number of households (bins/sacks/other)
- Frequency of collection for residual waste by bin/sacks/method
- Frequency of collection for dry recycling by bin/sacks/method
- Frequency of collection for organic waste by bin/sacks/method

The sets of information can be summarised into a baseline perspective with key characteristics for the local authority, as shown in figure 8.

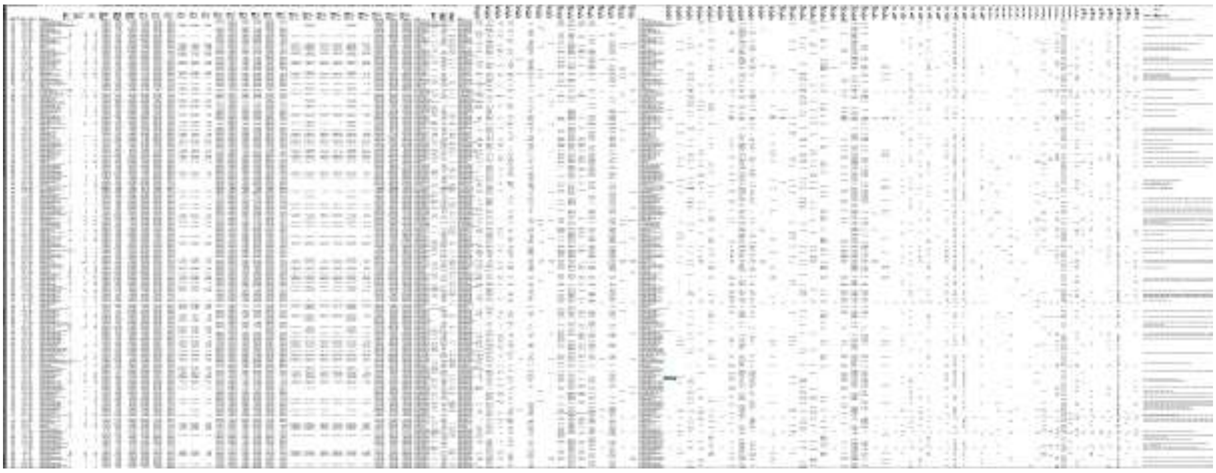

Figure 8. Zoomed-out master dataset from WasteDataFlow combining multiple datasets within the database. Each row is one local in England and each column represents an additional datapoint

Waste Data Interrogator information extraction process

In the case of the Environment Agency Waste Data Interrogator, the 2018 and 2019 databases were transferred from MS Access databases and an Excel spreadsheet into a PostGRESQL database. This allows for easy querying and extraction of specific data views by local authority and any type of data characteristics. Three queries were setup to extract perspectives on waste/material flows:

- Waste/material sent to facility in local authority A with origin local authority B-Z
- Waste/material removed from facility in local authority A with destination local authority B-Z
- Waste/material received at facility located in local authority B-Z with origin local authority A

The extracts are summary portions of the database that can be exported into a .csv or spreadsheet-based format for further data manipulation. This makes it easier to analyse the data in Microsoft Excel. These three extracts include the characteristics as defined in Table 3 below, which is split into the WDI dataset for waste received and the second WDI dataset for waste removed.

As a final step, a summary view is created in Microsoft Excel for each of the three extracts, as shown in Figure 9 below with an example for Essex. The extract summarises the data under EWC waste category 20 (household waste), 16 (packaging waste) and 19 (waste processing) into a table. The waste categories include mixed waste, refuse derived fuel for incineration, organic materials, dry materials, durable goods, and other waste, with sub-categories recovery, landfill, incineration, transfer for disposal, and treatment.

After these extracts are created and summarised, the information can be manually interpreted and further summarised to generate results formats.

Waste Received FROM

Waste originating from	Essex		
Sent to	Essex	Outside of Essex	
Mixed household and similar wastes	872,226	376,897	
Recovery	472,071	254,015	
Landfill	84,223	44,246	
Incineration	0	59,749	
Transfer for Disposal	68,573	18,312	
Treatment	247,360	575	
Refuse derived fuel	26,187	147,586	
Recovery	21,931	138,556	
Landfill	4,255	8,347	
Incineration	0	683	
Transfer for Disposal	0	0	
Treatment	0	0	
Organic Materials	190,006	113,214	
Recovery	184,644	111,771	
Landfill	435	440	
Incineration	0	874	
Transfer for Disposal	4,927	70	
Treatment	0	59	
Dry Materials (incl. Glass, Wood, Plastics, Metals, Paper and card)	147,275	286,309	
Recovery	138,543	249,409	
Landfill	1,821	40	
Incineration	0	36,580	
Transfer for Disposal	6,911	276	
Treatment	0	4	
Durable goods (incl. textiles,clothes, WEEE, bulky waste)	44,836	13,076	
Recovery	3,868	9,656	
Landfill	3,688	214	
Incineration	0	1,086	
Transfer for Disposal	19	2,121	
Treatment	37,261	0	
Other	474,224	1,141,616	
Recovery	289,515	324,420	
Landfill	182,057	783,323	
Incineration	0	1	
Transfer for Disposal	2,652	6,039	
Treatment	0	27,833	
TOTALS	1,754,754	2,078,699	3,833,452

Figure 9. Example of waste originating from Essex that is sent to facilities within Essex and facilities outside of Essex.

Table 3. data characteristics per waste flow contained in the two WDI datasets.

Waste Received Dataset	Waste Removed Dataset
Facility rpa	Facility rpa
Facility sub region	Facility sub region
Facility wpa	Facility wpa
Facility district	Facility district
Permit	Permit
Site name	Site name
Facility address	Facility address
Postcode	Postcode
Eastings	Eastings
Northings	Northings
Operator	Operator
Permit type	Permit type
Form of waste (solid/liquid/gas)	Form of waste (solid/liquid/gas)
Basic waste category	Basic waste category
Waste code (EWC)	Waste code (EWC)
EWC chapter	EWC chapter
EWC sub chapter	EWC sub chapter
EWC waste description	EWC waste description
SOC category	SOC category
SOC subcategory	SOC subcategory
Site category	Site category
Facility type	Facility type
Recorded origin	Recorded destination
Origin WPA	Destination WPA
Origin region	Destination region
Fate	Fate
Resource (R) and Disposal (D) code	Resource (R) and Disposal (D) code
Tonnes received	Tonnes removed

Waste Data Composition information

The final step is to provide a more detailed understanding of the composition of mixed waste. The approach is to use detailed estimates of waste compositions and superimpose them on the tonnages for the three types of sources above. The three types of mixed waste are:

- Residual or black bag waste, based on the National Household Composition Data, which provides for a highly detailed sampling assessment average of waste in England, Wales, Scotland, Norther Ireland, London and the entire UK between 83 different waste categories. [33]
- Co-mingled collected waste based on the WRAP Material Facilities Reporting Portal.[34] This displays the composition of mixed waste tonnage received for the majority of MRF facilities based on the split by glass, paper & card, plastics, metals, non-target, and non-recyclable material
- Remaining sorting residues based on the WRAP Material Facilities Reporting Portal. This contains samples on the composition of outputs split by glass, paper & card, plastics, metals, non-target, and non-recyclable material for some MRF facilities.

[33] “Quantifying the composition of municipal waste”, WRAP, https://www.wrap.org.uk/content/quantifying-composition-municipal-waste (last accessed 10 August 2021).
[34] “Materials Facility Reporting Portal”, WRAP, https://mfrp.wrap.org.uk/ (last accessed 10 August 2021).

The composition data for residual or black bag waste based on the National Household Composition information is shown in Table 8 for the commercial waste collected. An example of the inputs and outputs from an MRF from the WRAP portal is shown in Table 4

Table 4. Average composition across commercial waste collected by local authorities (LA) and waste management companies (WMC).

Main Categories	**Sub-categories**	**LA Collected average composition (%)**	**WMC collected average composition (%)**
Paper and Card	Recyclable paper packaging	0.95	0.71
Paper and Card	Recyclable paper non packaging	5.23	7.39
Paper and Card	Thin card packaging	1.65	2.05
Paper and Card	Thin card non packaging	0.42	0.28
Paper and Card	Corrugated card packaging	6.46	5.8
Paper and Card	Corrugated card non packaging	0	0.06
Paper and Card	Drink cartons (Tetra packs)	0.22	0.39
Paper and Card	Kitchen roll and tissues	8.29	9.21
Paper and Card	Flood contaminated P&C	1.56	1.15
Paper and Card	Waxed/laminated/wet strength P&C	1.92	2.99
Paper and Card	Other non-recyclable paper and card	0.76	0.63
Plastic film	Carrier bags	0.64	0.53
Plastic film	Black bags and sacks	1.84	3.00
Plastic film	Other plastic film packaging	4.3	7.46
Plastic film	Other plastic film non packaging	0.15	0.27
Plastic film	Plastic bottles	1.81	2.38
Dense Plastic	PTTs	1.7	2.49
Dense Plastic	Black plastic PTT	0.18	0.36
Dense Plastic	Other dense plastic	2.73	3.44
Dense Plastic	Bio plastics	0	0.07
Textiles	Clothing	1.24	0.91
Textiles	Shoes, bags, belts	0.37	0.5
Textiles	Non clothing textiles	0.77	0.81
Other combustible	Carpet and underlay	0.12	1.04
Other combustible	Furniture	0.13	0.42
Other combustible	Mattresses	0	0.11
Other combustible	Absorbent hygiene products (AHPs)	1.3	1.05
Other combustible	Wood and cork packaging	0.56	0.3
Other combustible	Wood and cork non packaging	1.5	3.07
Other combustible	Other combustible	2.28	3.38
Other non-combustible	Other non-combustible	2.53	1.66

Other non-combustible	Non combustible, non food liquid	0.24	0.07
Glass	Glass bottles and jars	3.8	1.77
Glass	Glass non-packaging	0.39	0.31
Putrescible	Garden waste	1.07	0.98
Putrescible	Soil	0.54	0.42
Putrescible	Edible food waste	20.94	14.88
Putrescible	Inedible food waste	12.46	9.71
Putrescible	Other organic	1.15	0.58
Ferrous metal	Ferrous cans and tins	1.29	1.02
Ferrous metal	Ferrous aerosols	0.08	0.08
Ferrous metal	Other ferrous items	1.12	1.9
Non-ferrous metal	Non-ferrous cans	0.51	0.47
Non-ferrous metal	Non-ferrous aerosols	0.03	0.05
Non-ferrous metal	Aluminium foil	0.33	0.38
Non-ferrous metal	Other non-ferrous	0.14	0.23
WEEE	WEEE	1.4	0.86
Potentially hazard household items	Empty Paint tins	0.03	0.03
Potentially hazard household items	Full paint tins	0.06	0.04
Potentially hazard household items	HHW	0.17	0.3
Potentially hazard household items	Batteries	0.02	0.04
Fine material	<10 MM fines	2.63	2.97

Result examples for England

Material flow assessments provide summaries on the baseline state of material/waste flow for a local authority. Three features are developed for waste data:

- What is currently collected and how is the waste collected by the local authority?
- What is the composition of collected waste?
- Where does the collected waste end up in terms of recycling and disposal?

Table templates were made for these three aspects. These can be turned into dashboards with KPI briefs that encapsulate the baseline for the local authority. This data can be fed into the BLUEPRINT Model. This section provides examples of ways to display the results based on the material flow assessment. As a result of this work, there is a readily available method to deploy during the project to obtain such information for each local authority when needed.

Brief on the state of waste collection in the local authority

The information brief is intended to answer the following questions:

- How much waste/materials are collected from households within the local authority area?

- What is the quantity of waste/materials collected from businesses and commercial entities within the local authority area?
- What is the approach to waste/materials collection at the kerbside?

The answers to these questions will be displayed in two ways:

1. An indicator overview in Table 5 for county councils that act as waste disposal authorities
2. An indicator overview in Table 6 for unitary councils that act as waste collection authorities.

Table 5. Indicators on the state of waste collection in Essex as a waste disposal authority

Indicator for local authority-collected waste	Result (2018/19)
Number of households	634,570 households
Total household waste collected in kilograms per head	462 kg/year
Total LACW household waste arisings	**680,775 tonnes**
Sent for recycling	352,690 tonnes
Of which rejected in recycling stream	8,925 tonnes
Not sent for recycling (residual waste)	326,627 tonnes
% Recycled	50.6%
Total LACW non-household waste arisings	**38,991 tonnes**
Sent for recycling	8899 tonnes
Of which rejected in recycling stream	No data
Not sent for recycling (residual waste)	30091 tonnes
% Recycled	22.8%
Total LACW arisings (household + non-household)	
Sent for recycling	363,047 tonnes
Of which rejected in recycling stream	8,925 tonnes
Not sent for recycling (residual waste)	356,719 tonnes
% Recycled	49.2%
Recycling split between organic and dry recycling	
LACW household waste sent for organic recycling	158,438 tonnes
LACW household waste sent for dry recycling	194,252 tonnes
Disposal Routes LACW household residual waste arisings	
Sent to Waste to Energy Incineration	137,568 tonnes
Household waste sent to landfill	108,205 tonnes
Total percentages for household processing	
% of household waste sent for recycling	51.8%
% of household waste sent to WtE incineration	20.2%
% of household waste sent to landfill	16.6%

Table 6. Indicators on the state of waste collection in Basildon as a Waste Collection Authority

Indicator for local authority collected Waste	Result (2018/19)
Number of households	78,310 households
Total household waste collected in kilograms per head	418 kg/year
Total LACW household waste arisings	**77,360 tonnes**
Sent for recycling	36,481 tonnes
Of which rejected in recycling stream	1,215 tonnes
Not sent for recycling (residual waste)	40,879 tonnes
% Recycled	45.6%
Total LACW non-household waste arisings	**4,212 tonnes**
Sent for recycling	114 tonnes
Of which rejected in recycling stream	No data
Not sent for recycling (residual waste)	4,098 tonnes
% Recycled	2.7%
Total LACW arisings (household + non-household)	**81,572 tonnes**
Sent for recycling	36,595 tonnes
Of which rejected in recycling stream	1,215 tonnes
Not sent for recycling (residual waste)	44,978 tonnes

% Recycled	43.4%
Recycling split between organic and dry recycling	
LACW household waste sent for organic recycling	18,589 tonnes
LACW household waste sent for dry recycling	17,831 tonnes
Residual waste collection route	
Households using a wheeled bin	0 households
Size of wheeled bin	-
Households receiving/using plastic sacks	78,310 households
Households using communal bins	0 households
Frequency of collection	Weekly
Dry recycling collection route	
Households using wheeled bins	0 households
Size of wheeled bin	-
Households using kerbside box	0 households
Size of kerbside box	-
Households using reusable sacks	0 households
Households using non-reusable sacks	78,310 households receive 2 bags
Frequency	Weekly
Organic waste collection route	
Is kitchen waste collected with garden waste?	Yes
Households using a wheeled bin	78,310
Size of wheeled bin	181-240 litres
Households using reusable sacks	0 households
Households using non-reusable sacks	0 households

Brief on the composition of collected waste

The information from WasteDataFlow can be combined with the national household waste composition data to understand the composition of waste collected by local authorities (local authority-collected waste). Given the detail in the WasteDataFlow database, the composition can be determined for 36 different waste categories, as shown in Table 7 below. The information is helpful to understand where efforts should be focussed to improve reuse and recycling. WasteDataFlow information can, for example, be used to determine what can be improved in terms of absorbent hygiene products like nappies, which are currently neither reused nor recycled.

Table 7 demonstrates that a clearer understanding of these solutions and their costs could shift several thousands of tonnes of waste towards recycling and reuse in Brighton & Hove.

Table 7. Example of waste composition estimate collected for Brighton & Hove

LACW Waste composition estimates – 2019 – tonnes					
Categories	**Total waste**	**Residual waste**	**Dry recycling (input to MRF)**	**Reuse**	**Organic recycling**
Absorbent Hygiene Products	5,251	5,251	-	-	28
Aluminium cans	811	300	511	-	-
Automotive batteries	25	-	25	-	-
Books	110	-	-	110	-
Card	5,274	2,183	3,090	-	-
Cat/Pet litter and bedding	3,063	3,063	-	-	-
Composite food and beverage	211	200	12	-	-
Food and garden waste	27,728	22,182	-	-	5,260
Gas bottles	11	-	2	9	-
Green garden waste	3,018	3,018	-	-	-
Furniture	2,049	2,049	-	-	-
LDPE (Plastic film)	4,526	4,526	-	-	55
Mattresses	791	791	-	-	-
Mixed cans	18	-	18	-	-
Mixed glass	9,442	2,309	7,134	-	-
Mixed paper & card	622	526	96	-	8
Mixed Plastic Bottles	2,053	1,007	1,046	-	-
Mixed Plastics	4,741	4,719	22	-	111
Mixed Tyres	12	-	-	12	-
Other materials including fines	6,132	6,132	-	-	55
Other Scrap metal	2,637	1,550	1,088	-	28
Paint	214	173	41	-	-
Paper	14,857	7,055	7,802	-	-
Plasterboard	380	184	196	-	-
Post-consumer, non-	79	72	7	-	-
Rubble	3,815	1,215	-	2,601	-
Soil	1,268	567	-	701	-
Steel cans	1,091	533	558	-	-
Textiles & footwear	4,637	4,271	366	-	-
Textiles only	1,913	1,686	40	187	-
Vegetable Oil	866	863	2	-	-
WEEE - Fridges & Freezers	252	-	252	-	-
WEEE - Large Domestic App	710	416	295	-	-
WEEE - Small Domestic App	1,031	541	478	13	-
WEEE - TVs & Monitors	133	-	130	3	-
Wood	1,423	1,133	290	-	-
TOTAL	**111,213**	**78,515**	**23,517**	**3,635**	**5,546**

Brief on where collected waste ends up

The information brief is intended to answer the following questions:

- Where do the waste/materials go at the end of their life?
- What share of waste is recycled, incinerated and landfilled?
- How efficient is the waste recovery infrastructure?

The answers to these questions would be displayed in an indicator overview (Table 8) for both county councils that act as waste disposal authorities and unitary council or waste collection authority. The overview includes household waste (EWC code 20), packaging waste (EWC code 15), and waste processing (EWC code 19) and excludes flows under other EWC codes (1 to 14, 16, 17 and 18), and excludes any hazardous and construction, demolition and excavation waste.

Owing to waste transfer stations, there is a potential duplication of the same waste flow within the same geography, as there are usually multiple facilities within a county council that handle the same waste. Since the Waste Data Interrogator does not directly link the origin facility and the destination facility, it requires substantial interpretation of the data flows based on the EWC codes and the amounts to understand the degree of double counting.

Table 8. Summary of waste processing information for Essex County Council

Waste category	Before and after processing	Before and after processing	Before and after processing	After processing
	Internal flow	Internal flow	Imports	Internal flow
	Sent to facility in Essex with origin Essex	Received in facility in Essex with origin Essex	Sent to facility in Essex with origin outside of Essex	Removed from facility in Essex and sent within Essex
TOTALS all categories	**1,671,679**	**1,754,754**	**331,100**	**1,009,394**
Mixed household and similar waste	**803,653**	**872,226**	**78,609**	**276,127**
Recovery	472,071	472,071	26,151	140,338
Transfer for Recovery	0	-	0	6,421
Landfill	84,223	84,223	2,302	36,699
Incineration	0	0	0	662
Transfer for Disposal	0	68,573	0	91,832
Treatment	247,360	247,360	50,156	175
Refuse derived fuel	**26,187**	**26,187**	**0**	**51,457**
Recovery	21,931	21,931	0	0
Transfer for Recovery	0	-	0	6,289
Landfill	4,255	4,255	0	4,290
Incineration	0	0	0	40,878
Transfer for Disposal	0	0	0	0
Treatment	0	0	0	0
Organic Materials	**185,079**	**190,006**	**31,346**	**61,846**
Recovery	184,644	184,644	31,312	58,522
Transfer for Recovery	0	-	0	840
Landfill	435	435	33	489
Incineration	0	0	0	207
Transfer for Disposal	0	4,927	0	168
Treatment	0	0	0	1,620
Dry Materials (incl. Glass, Wood, Plastics, Metals, Paper and card)	**140,372**	**147,275**	**62,373**	**139,233**
Recovery	138,551	138,543	44,080	125,988
Transfer for Recovery	0	-	0	10,208
Landfill	1,821	1,821	0	886
Incineration	0	0	18,292	296
Transfer for Disposal	0	6,911	0	1,856
Treatment	0	0	0	0
Durable goods (incl. textiles, clothes, WEEE, bulky waste)	**44,817**	**44,836**	**49,241**	**77,394**
Recovery	3,868	3,868	597	333

Transfer for Recovery	0	-	0	1,799
Landfill	3,688	3,688	65	75,257
Incineration	0	0	0	6
Transfer for Disposal	0	19	0	0
Treatment	37,261	37,261	48,580	0
Other waste incl. sorting residues	**471,572**	**474,224**	**109,531**	**403,337**
Recovery	289,515	289,515	58,872	45,657
Transfer for Recovery	0	-	0	2,271
Landfill	182,057	182,057	50,660	289,802
Incineration	0	0	0	4,998
Transfer for Disposal	0	2,652	0	313
Treatment	0	0	0	60,296

3.3. Appendix C – French developed material flow assessment

Information about individual regions can be found on Sinoe Dechets combined with the ADEME composition report, this information can be used to understand what is collected from the composition. Based on this approach, the flows and percentage of many categories can be estimated quantitatively. The data that emerges includes organic recovery, material recovery sent for recycling and residual waste that ends up as either landfill or incineration.

Bretagne Waste Collection Composition 2017					
Selective Collection and Household waste	Fraction (%)	TONS	Organic recovery	Material recovery	Residual waste
OMR*	65.45%	681,802.99	127,244.92	11,129.00	543,429.07
- Ferrous-metal packaging	1.0%	6,818.03	-	X	-
- Paper packaging	0.5%	3,409.01	-	X	-
- PE and PP films	4.0%	27,272.12	-	X	-
- Fine waste (not detailed)	4.0%	27,272.12	-		X
- Publicity flyers	1.0%	6,818.03	-	X	-
- Non-classifed incombustible waste (not detailed)	2.0%	13,636.06	-	-	X
- Undesirable waste	0.5%	3,409.01	-	-	X
- Fine inert waste (<20 mm)	1.0%	6,818.03	-	-	X
- JMR (Newspapers, magazines, catalogues, annuals, letters, envelopes, books, etc.)	1.0%	6,818.03	-	X	-
- Fine organic waste (<20 mm)	4.0%	27,272.12	X	-	-
- Metals (not detailed)	1.0%	6,818.03	-	-	X
- Paper (not detailed)	3.0%	20,454.09	-	-	X
- Bureaucratic paper	2.0%	13,636.06	-	X	-
- Plastics (not detailed)	4.0%	27,272.12	-	-	X
- Food waste not consumed	2.0%	13,636.06	X	-	-
- Textiles (not detailed)	1.0%	6,818.03	-	X	-
- Clean textiles	1.0%	6,818.03	-	X	-
- Sanitary textiles (not detailed)	7.0%	47,726.21	-	-	X
- Sanitary textiles (hygienic fraction)	4.0%	27,272.12	-	-	X
- Sanitary textiles (soiled paper fraction)	3.0%	20,454.09	X	-	-
- Soiled papers	0.5%	3,409.01	X	-	-
- Glass (not detailed)	2.0%	13,636.06	-	X	-
- Cardboard (others)	0.5%	3,409.01	-	X	-
- Other fuels	1.0%	6,818.03	-	-	X
- Other packaging composites	0.5%	3,409.01	-	-	X
- Other packaging plastic	3.0%	20,454.09	-	X	-
- Other metal waste	1.0%	6,818.03	-	X	-
- Other paper waste	2.0%	13,636.06	-	X	-
- Other plastic waste	3.0%	20,454.09	-	-	X
- Other putrescrible waste	1.0%	6,818.03	-	-	X
- PET bottles and flasks	1.0%	6,818.03	-	X	-
- PEHD/PET bottles and flasks	0.5%	3,409.01	-	X	-
- PEHD bottles and flasks	0.5%	3,409.01	-	X	-
- Carboard (not detailed)	2.0%	13,636.06	-	-	X
- Unclassified fuels (not detailed)	3.0%	20,454.09	-	-	X
- Composites (not detailed)	1.0%	6,818.03	-	-	X
- ELA Composites (Liquid food packaging)	0.5%	3,409.01	-	X	-
- Food waste	11.0%	74,998.33	X	-	-
- Garden waste	1.0%	6,818.03	X	-	-
- Putrescible waste (not detailed)	12.0%	81,816.36	-	-	X
- Special waste	0.5%	3,409.01	-	-	X
- Aluminum packaging waste	0.5%	3,409.01	-	X	-
- Corrugated cardboard packaging waste	1.0%	6,818.03	-	X	-
- Flat cardboard packaging waste	2.0%	13,636.06	-	X	-
- Colored glass packaging waste	2.0%	13,636.06	-	X	-
Plastic packaging/Newspapers/Magagazines	19.02%	198,168.44	-	195,968.66	2,199.78
Glass	14.49%	150,929.21	-	149,207.21	1,722.00
Food waste	1.05%	10,893.28	10,893.28	-	-
TOTAL		1,041,793.92	138,138.20	356,304.87	547,350.85

Recycling Center	Fraction (%)	TONS	Organic recovery	Material recovery	Residual waste
Recyclables (packaging plastic, paper, metal and glass)	**11.97%**	**146,865.94**	5,697.15	134,092.32	7,076.47
Bulky*	**18.91%**	**232,001.89**	385.16	36,032.29	195,584.43
- TVs without category	15.00%	34,800.28	-	-	X
- Fine waste (not detailed)	15.00%	34,800.28	-	-	X
- Wood waste	10.00%	23,200.19	-	-	X
- Hard plastic waste	9.00%	20,880.17	-	X	-
- Furniture waste	8.00%	18,560.15	-	-	X
- Ultimate waste??	6.00%	13,920.11	-	-	X
- Excavation and Rubble	6.00%	13,920.11	-	-	X
- Textiles, household linen and footwear	4.00%	9,280.08	-	X	
- Plasterboard waste	4.00%	9,280.08	-	-	X
- Flexible plastic waste	4.00%	9,280.08	-	-	X
- Other wastes	3.00%	6,960.06	-	-	X
- Plaster plates waste	2.00%	4,640.04	-	-	X
- Glass wool	2.00%	4,640.04	-	-	X
- Green waste	2.00%	4,640.04	-	-	X
- Metals (not detailed)	2.00%	4,640.04	-	-	X
- Carboard (not detailed)	2.00%	4,640.04	-	-	X
- Papers waste (not detailed)	0.90%	2,088.02	-	X	-
- Household waste in closed bags	0.90%	2,088.02	-	-	X
- Other glass (glazing, etc).	0.60%	1,392.01	-	-	X
- Windows and ushers	0.60%	1,392.01	-	-	X
- Polystyrene	0.50%	1,160.01	-	-	X
- WEEE	0.50%	1,160.01	-	X	-
- Plastic film waste	0.50%	1,160.01	-	X	-
- SDW (Specific Diffuse Waste)	0.29%	669.24	-	-	X
- Household waste	0.29%	669.24	-	-	X
- Glass	0.29%	669.24	-	X	-
- Carpet/Rugs/Floor covering	0.29%	669.24	-	-	X
- Household packaging	0.17%	401.54	-	-	X
- Tires	0.10%	240.92	-	-	X
- Pallets	0.03%	78.88	-	-	X
- Foams	0.03%	78.88	-	-	X
- Fishing nets	0.00%	2.85	-	-	X
Biowaste	**44.52%**	**546,318.53**	500,433.19	37,328.00	8,557.34
WEEE	**2.25%**	**27,566.43**	-	27,566.33	0.10
Hazardous waste	**0.68%**	**8,348.76**	-	1,320.60	7,028.15
Excavation and Rubble	**21.37%**	**262,168.36**	-	60,367.64	201,800.72
Other wastes	**0.31%**	**3,793.38**	533.62	2,862.83	396.95
TOTAL		**1,227,063.29**	**507,049.12**	**299,570.01**	**420,444.16**

Figure 10. Composition of the collected waste in Bretagne

* Bulky-Organic recovery came from the household collection (OMA) and was sent to recycling centres. Therefore, there was not any allocation (X) assigned of any subcategory from Recycling Centre.

** In France, "Communautés" (group of communities) chalked up WEEE as recycled because they hand it down to a secondary company (ECOSYSTEM) which is in charge of WEEE recycling. Therefore, WEEE that's rejected from the recycling centre is not considered by SINEO.

Brief on the available infrastructure in a region

Information from ADEME reports and regional reports on waste treatment and disposal can be aggregated and utilised to obtain a comprehensive picture of their infrastructure for recycling and their capacity to process waste. This is a useful example, as Bretagne has particularly well-developed technological infrastructure for the treatment of organic waste (compiled in Table 13 as an information brief), especially compared to England. This case study provides insight into why France (and Bretagne in particular) has invested much more in this infrastructure.

Table 13. overview of treatment facilities for organic wastes in Bretagne

Treatment facilities and incoming tons 2018

Type of Facility	Facility Waste Stream input	Project Operator	Geographic Entity	Year	Waste Category	Result	Unit	Source	Revision Date
Composting	Biowaste	Lorient Agglomeration	Caudan (Composting)	2018	Household biowaste	7,500.00	tons	OEB - Pôle déchets	09/12/2020
Mechanical Biological Treatment (MBT)	OMR	Smictom du Centre-ouest de l'Ille et Vilaine	Gaël	2018	OMR	17,200.00	tons	OEB - Pôle déchets	09/12/2020
Composting	*	Lorient Agglomeration	Groix	2018	Household biowaste	100.00	tons	OEB - Pôle déchets	09/12/2020
Composting	OMR	Suez Rv Ouest	Gueltas-2	2018	Household biowaste	2,100.00	tons	OEB - Pôle déchets	09/12/2020
Composting	OMR	Suez Rv Ouest	Gueltas-2	2018	OMR	28,400.00	tons	OEB - Pôle déchets	09/12/2020
Composting	Biowaste	Smictom des Pays de Vilaine	Guignen	2018	Household biowaste	2,400.00	tons	OEB - Pôle déchets	09/12/2020
Composting	OMR	Kerval Centre Armor	Lantic	2018	Household biowaste	300.00	tons	OEB - Pôle déchets	09/12/2020
Composting	OMR	Kerval Centre Armor	Lantic	2018	OMR	13,000.00	tons	OEB - Pôle déchets	09/12/2020
Composting	OMR	Smitred Ouest Armor	Pleumeur-Bodou (tmb)	2018	OMR	14,100.00	tons	OEB - Pôle déchets	09/12/2020
Composting	OMR	Communauté de Communes du Pays Bigouden Sud	Plomeur - Omr	2018	OMR	10,600.00	tons	OEB - Pôle déchets	09/12/2020
Composting	**	Smitred Ouest Armor	Pluzunet	2018	OMR	18,000.00	tons	OEB - Pôle déchets	09/12/2020
Composting	OMR	Communauté d'Agglomération de Saint Malo	Saint-Malo	2018	OMR	19,800.00	tons	OEB - Pôle déchets	09/12/2020
Methanization	Putrescible Waste Fraction, Multi-waste	Syndicat du Sud Est Morbihan	Vannes (Ecopôle Venezys, ZI du Prat)	2018	OMR	44,300.00	tons	OEB - Pôle déchets	09/12/2020

Table 1. Source: https://bretagne-environnement.fr/node/265841

* Groix – Their waste stream input comes from household food selective collection and their compost quality is dependent and susceptible of in-household waste sorting.
** Pluzunet – Contrary to what's stated in the table 1, the SMITRED 2019 final report shows no indication of any composting facility in Pluzunet. For more information consult Pluzunet's source in table 2.

Note: It is important to point out that there are more composting, MBT and methanization facilities in Bretagne but only the ones listed in table 1 receive and process OMR.

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