

Desktop Review of International Food Waste Collection Systems in MUDs

A submission to the NSW Environment
Protection Authority

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Executive Summary

An increasing number of local authorities are providing separate household food waste collections.

Single household dwellings are relatively easy to manage in terms of a separate collection, but the high-density nature and limited space available in apartment blocks can present a more challenging situation.

MRA conducted a desktop analysis of documented food collection systems in multi-unit dwellings (MUDs). Three main systems were observed: door-to-door collections, communal bin collections, and public place bin collections.

Door-to-door collections were the least common type of collection. Just one example of this was found. These are in council-operated housing estates in the City of London local government area. Four housing estates were involved in this collection system, where residents set out their food waste bins on their doorstep between 2-5 days a week.

Communal bin collection was by far the most common type of food waste collection found in MUDs. This involves residents separating food waste within the house/unit and transporting it down to a bin in a shared bin store, accessible to residents only. This is a common system seen in the UK, observed in Bournemouth, Edinburgh, Belfast, and in Ireland in Dublin and Galway. It is also reported in Niort (France), Barcelona (Spain), and Hong Kong. A common feature of this system is households being provided with a smaller bin “caddy” in which to collect and store food waste and allowing easier transportation to the communal bins.

There were limited instances of public-place bins used to service multiple apartment complexes. In Songpa, a district of Seoul, bins in common areas weighed input food waste and charged residents via RFID cards. Weight based billing encouraged reduction in food waste, but potentially increased illegal dumping of food waste, or hiding food waste in general waste bins (food waste is banned from landfill in South Korea). In Rijswijk, a suburb of The Hague (Netherlands), public place food bins were located on the shared footpath area to service nearby apartments. The location of these bins resulted in high contamination rates however, and data on participation rates could not be recorded.

Based on the desktop review of food collection systems in MUDs, important factors to consider in relation to effective food waste collection systems include:

- An appropriate period of education and engagement of residents;
- Sufficient bin provisions for food waste and potential reduction in general waste services;
- Effective location of collection bins;
- Monitoring of contamination levels, and appropriate community engagement (by way of doorknocking, bin stickers, and information material distribution); and
- Enforcement and policies to support the separation of food waste.

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1 Introduction

Food waste is a widespread problem across global food systems, challenging food security, the economy and environmental sustainability¹. According to a number of estimates, the value of food thrown away in Australia is up to \$20 billion dollars annually².

A growing number of local authorities are including food waste collections in their municipal waste management. However, multi-unit dwellings (MUDs) can pose a logistic challenge in food waste collection. In Australia, typical council development controls stipulate that storage space be provisioned for one to two days' worth of general waste and recycling within the house/unit. This leaves little to no room for source separation of food waste. More Australians than ever are living in apartments (over the past 25 years, the number of occupied apartments has increased by 78%³). Addressing food waste collection in MUDs is therefore an integral step to keeping food waste out of landfills.

1.1 Scope

The EPA engaged MRA Consulting Group (MRA) to undertake a desktop review of collection systems of food waste in multi-unit dwellings (MUDs). This review focuses on the collection systems involved, including bin arrangements and collection logistics, payment systems, enforcement, education and engagement, supporting activities, and the results in terms of diversion, participation and contamination data.

1.2 Methodology

A literature review was conducted by reviewing published literature, government reports, council websites, and industry databases and studies to identify and review relevant systems.

MRA relied heavily on publicly available information on the internet. Government websites were given priority as trustworthy sources of information and the recency of the source was taken into consideration. The scope of the report was limited to publicly available data. Contact was also made with some relevant authorities in the UK to obtain details of operational systems.

The research was directed towards high-density cities with culturally diverse populations. Some examples fit both of these briefs (London), but some examples focused more on densely populated areas, albeit with more homogenous populations (Hong Kong, Seoul).

The literature review sought to identify the name and location of system, date or period of introduction, implementation logistics, scope or range of system, and supporting education and activities. The effectiveness of the schemes, through diversion rates, contamination of food waste, and participation rates, were also researched however, outside of food waste collection trials this information was very difficult to source. In many cases there was little publicly available information accessible in English, particularly in relation to supporting implementation measures and the effectiveness of introduced schemes. The information below has been arranged by type of system and by location.

¹ The World Bank (2019), 'Global Food Loss and Waste', http://datatopics.worldbank.org/what-a-waste/global_food_loss_and_waste.html

² Quoted in Australian Government (2017), 'National Food Waste Strategy- Halving Australia's food waste by 2030', <https://www.environment.gov.au/system/files/resources/4683826b-5d9f-4e65-9344-a900060915b1/files/national-food-waste-strategy.pdf>

³ Australian Bureau of Statistics (2016) <https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2071.0~2016~Main%20Features~Apartment%20Living~20>

2 Collection Trials

2.1 General

The UK initiated food waste collections from apartments in the mid-2000s. Between 2007 and 2009, the Waste and Resources Action Programme (WRAP), funded the Evaluation of Food Waste Collections, which included three trial areas from multi-occupancy (apartment) properties. Additional studies on food and recycling collections have since been conducted by WRAP and individual Councils. Examples of these are discussed below.

2.2 Food Waste Collection Trials & Evaluation from Multi-Occupancy dwellings, UK

WRAP funded food waste collection trials in twenty-one local authorities across the UK. Of the 21 trials, three focused on food waste collection in MUDs. The three authorities were the London Borough of Hackney, the Royal Borough of Kingston-upon-Thames (RBKT), and the Council area of Newtownabbey, located just north of Belfast, North Ireland. Table 1 below summarises the collection trials in these three local authority areas.

Table 1 Summary of MUDs trials

Local Authority	Number of Households	Duration/Number of Phases	Bin Arrangements	Collection Type
London Borough of Hackney	4,597	70 weeks/ N/A	7L kitchen caddy and liners provided, 240L bin in shared space	Communal bin
Newtownabbey	1,552	48 weeks/ 4 phases	7L kitchen caddy and liners provided, 25L collection bin	Door-to-door
South London Waste Partnership: Royal Borough of Kingston Upon Thames (RBKT)	4,538	35 weeks/ 5 phases	25L container and compostable liners	Door-to-door

Source: WRAP, *Food Waste Collection Trials – food waste collections from multi-occupancy dwellings*

The key features of the collections in general were:

- Food waste collected separately from residual waste and garden waste
- Weekly collections
- Small dedicated food waste collection vehicles used
- Kerbside containers and kitchen caddies provided to all householders
- Liners for kitchen caddies were provided

Results

Table 2 below summarises the results of the trials for the MUDs. For the study, participation rates were determined by recording whether a household set their food waste bin at any point during the trial. Set out is the rate at which households presented their bins and is subject to vary from week to week. Neither participation rates nor set-out rates were recorded for Hackney.

Table 2 Food collection in MUDs trial results

Local Authority	Participation Rate	Set out Rate	Average kgs/household per week
London Borough of Hackney	N/A (not monitored)	N/A	0.24kg (first phase) to 0.34kg (second phase)
Newtownabbey	30.5% but dropped to 26.1% in second phase	21.02%	0.52kg (first phase) to 0.54kg (second phase)
South London Waste Partnership: Royal Borough of Kingston Upon Thames (RBKT)	28.5% in first phase (no second phase of monitoring)	17.6%	0.50kg (first phase) to 0.42kg (second phase)

Source: WRAP, *Food Waste Collection Trials – food waste collections from multi-occupancy dwellings*

The average yield per week (kilograms/household/week) from these three MUDs trials is considerably lower, approximately half, than that of the other 18 single dwelling trials (Table 3).

Table 3 Average food waste collected per household per week in the WRAP supported trials

Local authority	Average yield, kg/hh/wk	Local authority	Average yield, kg/hh/wk
Belfast	1.09	Mid Bedfordshire	1.89
Broadland	1.84	Mole Valley	1.75
Calderdale	1.28	Newcastle upon Tyne	1.14
Croydon	1.64	Newtownabbey (flats)	0.53
East Devon	1.79	Oldham	1.22
Elmbridge	1.46	Preston	1.04
Guildford	1.70	South Shropshire	2.10
Kingston-u-Thames (flats)	0.45	Sutton	1.38
Luton	1.12	Waveney	1.17
Merton	1.19	West Devon	1.48

Source: WRAP, *Evaluation of the WRAP Separate Food Waste Collection Trials (2009)*

It is noted that all of the trials with food waste collection from flats yield lower average weekly yields of food waste than kerbside food waste collections from the other trial locations. This is not unexpected as the size and number of occupants in flats is generally less than that of a single-unit dwelling.

WRAPs evaluation of the food waste collection trial in single unit dwellings found higher weekly yields of food waste in trials where general waste collections were limited to once per fortnight (on average, 1.5kg/hh/wk compared to 1.3kg/hh/wk for trials with weekly general waste collection). The same

comparison is not available for MUDs trials as the general waste collection did not change from weekly to fortnightly.

Education, data gathering & participation - Results per multi-occupancy trial:

The data recorded as part of the trials was as follows:

- Food waste tonnages per trial phase;
- Participation rates and set-out rates for the trial (RBKT and Newtownabbey only);
- In depth views of householders via focus groups (Hackney only);
- Average food waste collected per household per week;
- Socio-demographics (levels of deprivation and household size) for each local authority;
- Operational set-up and context of each trial; and
- Feedback from local authority officers on trial performance and issues.

Unfortunately, the three trials above were not assessed for compositional analysis, which could then be used to determine the diversion rates and contamination rates. Contamination was not seen to be a major issue as part of these trials. Only occasional contamination occurred and most frequently consisted of carrier bags, which many of the reprocessors reported were easy to extract prior to treatment. Reprocessors reported cutlery and metal cans as occasional contaminants.

Food waste collection from flats displayed lower participation rates than from lower density housing. Participation rates in MUDs (Kingston-upon-Thames and Newtownabbey) were lower than in single dwelling housing (Table 4). To achieve higher and continued participation, effective communication to residents is necessary.

Table 4 WRAP trial participation rates

Trial area	Participation rate	Trial area	Participation rate
Belfast	45.60%	Mid Bedfordshire	71.48%
Broadland	72.74%	Mole Valley	71.13%
Calderdale	47.39%	Newcastle upon Tyne	43.95%
Croydon	71.45%	Newtownabbey	28.30%
East Devon	70.50%	Oldham	56.40%
Elmbridge	58.60%	Preston	55.99%
Guildford	71.28%	South Shropshire	69.81%
Kingston-u-Thames	21.30%	Sutton	72.79%
Luton	53.32%	Waveney	52.63%
Merton	70.17%	West Devon	66.44%

Source: WRAP, *Evaluation of the WRAP Separate Food Waste Collection Trials (2009)*

Templates of generic communication material (for all households, not discerning between housing density) was developed by WRAP and distributed to the local authorities. Each local authority amended each template and distributed materials to residents. These materials included:

- Introduction leaflet to introduce the service to residents, inform of the start date of the trial, and the benefits of the service;
- Instruction leaflet and calendar to explain how to use the service and when the collections would take place;
- Caddy sticker to act as a reminder of what can and cannot be disposed of in the caddy;
- Contamination tag for use by crews to attach to contaminated bins; and
- Follow up leaflet to inform householders of progress of the trial.

Effective communication was found to be part of a combination of different approaches. The different approaches adopted during the food waste collection trials included:

- Door-to-door canvassing;
- Meetings with tenants' associations
- Roadshows or stands at local events
- Leaflet design and print (including narrative in minority languages);
- Posters (in communal blocks);
- Press releases; and
- Web site promotion.

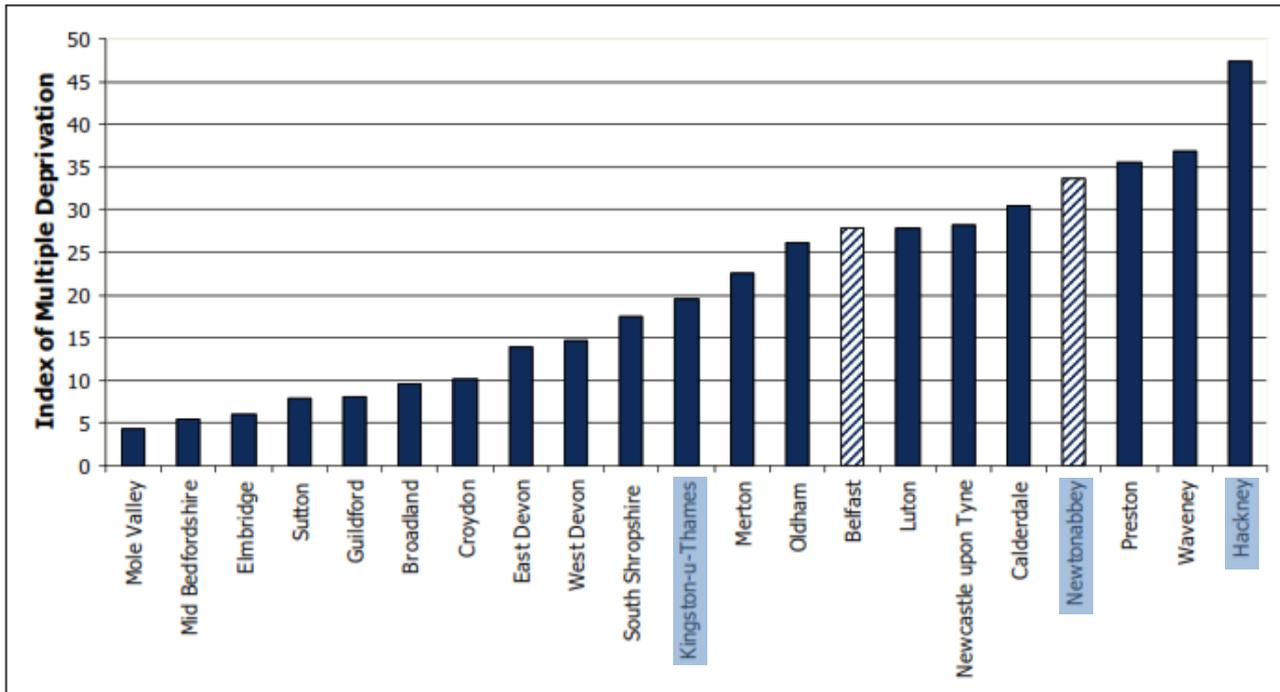
The effectiveness of the communication materials was measured through attitudinal surveys, however none of these included the three trials of MUDs. Nonetheless, 95% of residents of single-unit dwellings surveyed said that the leaflets told them everything they needed to know to participate in the trials, 88% of respondents stated that the leaflets had encouraged them to participate in the trials, and 80% of respondents claimed that they recycled more as a result of reading the leaflets. However, an authority reported that a newsletter provided to all households, had very little effect on the participation in the food waste scheme. However, this does not necessarily mean householders did not find it informative and helpful, (for example on a practical issue such as how to order more liners) but may be acting more to re-enforce capture amongst existing participants.

WRAP considered that door to door engagement was particularly effective when used in targeted areas; for examples areas where high contamination occurs. This direct interaction enabled local authority officers to clarify directly with residents what waste could be put in the food bins and prevented any further contamination.

Index of Multiple Deprivation

The three MUD trial areas achieved a range of scores on the index of multiple deprivation. These indices combine a number of indicators, chosen to cover a range of economic, social and housing issues (including income, employment, health, education, housing and access to services), into a single score for each small area to arrive at an overall measure of deprivation. The higher the number, the higher the level of deprivation. The average level of deprivation in England is around 23.

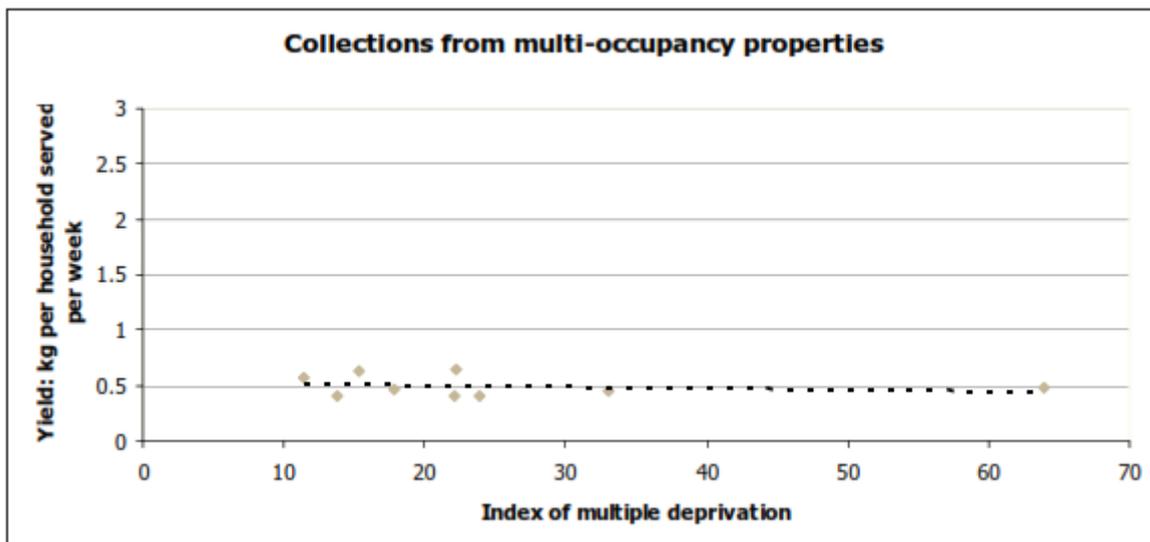
Figure 1 Average levels of deprivation in trial areas



Source: WRAP, Evaluation of the WRAP Separate Food Waste Collection Trials (2009)

Note: Indices of Multiple Deprivation in Northern Ireland are not directly comparable with Indices of Multiple Deprivation in England. Therefore, the Indices of Multiple Deprivation for Belfast and Newtownabbey (in Northern Ireland) are marked with shaded bars.

Figure 2 Average weekly food waste yields against indices of multiple deprivation in MUDs



Source: WRAP, Evaluation of the WRAP Separate Food Waste Collection Trials (2009)

Figure 2 above shows no relationship between weekly yield and indices of multiple deprivation ($R^2 = 0.04$). This suggests that socio-economic status is not a limiting factor on participation or yield of food waste.

The evaluation report for the trials also considered average weekly yield compared to household size. The two multi-unit trials at Newtownabbey and Kingston upon Thames had the lowest yields and the lowest average number of people per household. However, the considerable variation in average amounts of food waste set out per participating household and per person across the 68 trial rounds shows no clear pattern between household size and food waste yields. This suggests other factors such as lifestyle and cultural factors affecting food purchasing, preparation and consumption habits, and different approaches to communication with residents by local authorities also play a role.

Communication and the level of engagement between the local authority and residents varied. Where there was a highly engaged community and a strong education program (bin stickering, door knocking, refusal of services for contamination) recovery and participation were higher and contamination was lower.

2.3 Case Studies

Relevant food waste collection case studies:

1. Swansea recycling and food waste collections

<http://www.wrap.org.uk/content/recycling-and-food-collections-flats-swanea-case-study>

Case study, funded by WRAP, on recycling and food waste collections from flats.

2. WRAP Food waste collection trials – Communications

Details of the communication methods used in the 19 food waste trials conducted by WRAP between 2007-08. <http://www.wrap.org.uk/content/recycling-collections-flats-consulting-stakeholders>

3. WRAP – recycling collection schemes from flats – performance summary table

Summary table including dry recycling and food waste performance from flats.

<http://www.wrap.org.uk/sites/files/wrap/Updated%20performance%20summary%20table.pdf>

4. WRAP – food waste collections from multi occupancy dwellings

Summary of the three trials held in Hackney, Newtownabbey and Royal Borough of Kingston-upon-Thames.

http://www.wrap.org.uk/sites/files/wrap/Case_study_-_multi-occupancy_housing.a7a6067a.5879.pdf

5. WRAP – evaluation of food waste collection trials

Evaluation of WRAP food waste collection trials.

http://www.wrap.org.uk/sites/files/wrap/Evaluation_of_the_WRAP_FW_Collection_Trials_Update_June_2009.pdf

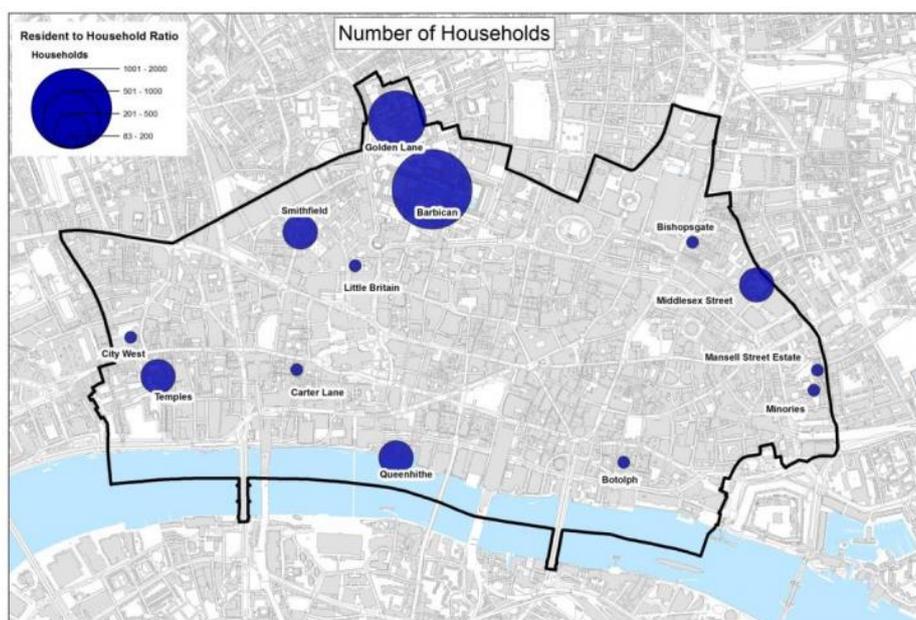
3 Door-to-Door Collection

Door-to-door collection is a system that involves residents using kitchen caddies to separate their food waste, which is then placed outside their doorstep. The food waste is then collected by crews and is transported to ground level, where it is bulked in the waste collection vehicle. A study in the UK by the Waste and Resources Action Programme (WRAP) found that local authorities have been withdrawing door-to-door collections due to expense, lower performance than expected, and health and safety concerns⁴

3.1 City of London Council, London UK

The City of London has a population of 7,400 residents, of which 4,880 (66%) live in the four council run housing estates⁵.

Figure 3 Map of resident to household ratio in the City of London Council area



Source: City of London Resident Population Census (2011)

The City of London local authority operates separate food waste collection for all of its residents in single unit dwellings. Apartment buildings with internal bin storage and council-run housing estates have a separate food waste collection as well.

The City of London owns and manages four housing estates. They are: Barbican Estate (2,141 units⁶), Mansell Street Estate (248 units), Golden Lane Estate (670 units), and Middlesex Street Estate (224 units).

Source: Ben Jonson House Blog

⁴ WRAP Household food waste collections guide, Section 8: Collecting from flats.

⁵ City of London Resident Population, Census 2011, Households

⁶ City of London Housing Stock (2018): <https://www.cityoflondon.gov.uk/services/environment-and-planning/planning/development-and-population-information/Documents/housing-stock.pdf>

Bin Arrangements and Collection Logistics

In each of these council managed estates, the council operates door-to-door food waste collection, either via refuse cupboard (a cupboard accessible from inside the flat as well as outside, see Figure 4) (Barbican) or by placing food waste caddies on the doorstep of the apartment (Mansell, Golden Lane, and Middlesex St). The Barbican estate is equipped with an internal waste disposal system known as a Garchey system.

Each household is provided with a 5-litre ventilated brown kitchen caddy, as well as compostable bin liners. Residents can collect these bins and liners from the Estate Office. With exception to the Barbican Estate, food waste is collected twice a week. The Barbican Estate has food collection occurring daily Monday to Friday.

The Garchey System

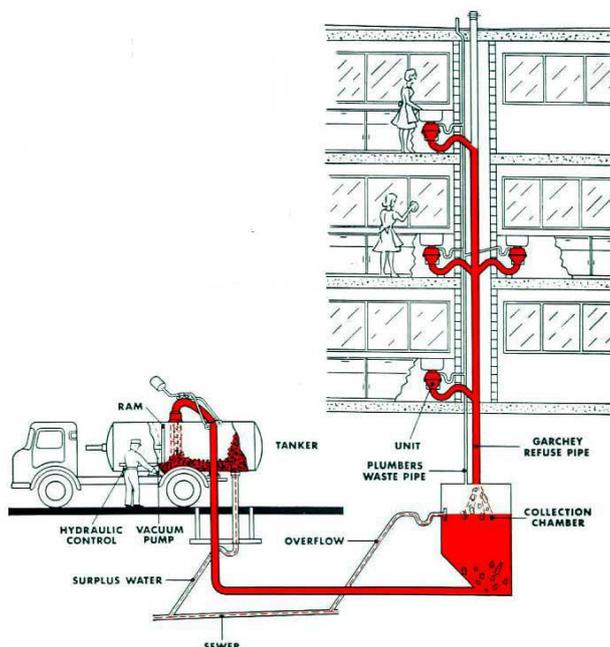
The Barbican Estate was built to include an inbuilt waste management system – the Garchey system⁷.

Figure 4 Image of the refuse cupboard as found in Barbican Estate



⁷ Garchey System <http://www.barbicanliving.co.uk/barbican-now/garchey/the-garchey-system/>

Figure 5 The Garchey system



Source: Barbican Living

The Garchey system was originally designed to fit under the kitchen sink and would receive wet rubbish (food waste) and items like cans and bottles. Garchey systems also received rainwater from rooftops. Collection of the waste from the underground tanks occurs every three weeks. The increase in plastic packaging for consumer goods tends to block the pipes and pits of the system and has resulted in abandonment of the system by 600 residents. The higher participation in the door-to-door service may be a response to the already established separation behaviour.

Table 5 Council estate food collection schedules

Location	Collection	Schedule
Barbican Estate	From refuse cupboard	Daily Monday to Friday
Mansell Street Estate	Outside apartment door	Tuesdays and Fridays
Golden Lane Estate	Outside apartment door	Mondays and Thursdays
Middlesex Street Estate	Outside apartment door	Tuesdays and Fridays

Source: City of London Council website

The City of London Waste Strategy⁸ reports that strong engagement with residents and estate managers is used as a means of ensuring good waste and recycling management practices were adopted by residents.

⁸ <https://www.cityoflondon.gov.uk/services/environment-and-planning/waste-and-recycling/Documents/city-of-london-waste-strategy.pdf>

One problem identified was the high turnover of residents in rented accommodation, principally the Barbican Estate, and how this impacts the misuse of recycling facilities.

Payment System

Residents pay a Council Tax, which covers the costs associated with municipal waste collection.

Supporting Activities and Education

Educational materials are available online through Council websites. Printed information is delivered to residents in the way of annual service leaflets (to inform residents of the services available to them, and how to use them), as well as a quarterly residential newsletter including articles and information regarding the available services. Information is also pinned to housing estate notice boards for particular campaigns (such as “Give and Take days” and Christmas Tree recycling).

The Council also runs regular Recycling Roadshows at the four main housing estates, giving council workers the chance to engage with residents and encourage them to use recycling services.

Results

Participation rates from each of the council estates are shown in Table 6 below.

Table 6 Participation rates in London council estates

Council Estate	Number of residents	Food waste collection participation
Barbican Estate	2,044	38.5%
Golden Lane Estate	564	29.3%
Middlesex Street Estate	196	17.3%
Mansell Street Estate	194	11.9%

Source: City of London Waste Strategy 2013-2020 (Published 2014)⁹

Interestingly, participation are highest where the existing Garchey system exists. Considering this is a competing system for food waste disposal participation rates are reasonably high. Information is limited for contamination of collected food waste and diversion rates.

⁹ <https://www.cityoflondon.gov.uk/services/environment-and-planning/waste-and-recycling/Documents/city-of-london-waste-strategy.pdf>

4 Communal Bins

Also known as “bring” banks or bins, this system involves residents separating food waste in the residence and self-transporting to shared bins. This is the most common type of collection seen.

This system typically uses two bins – one that sits in the kitchen of the house to capture food scraps as they are generated, and to temporarily store food waste. And a communal bin which is located in a bin store, generally within the apartment building itself.

Table 7 Summary of communal bin collections

Location	Bins	Collection	Results
Bournemouth, England	Flats with existing small bins are given a 12L food waste container. Flats with shared bins need to opt in and will receive either a 140L or 240L bin (depending on number of flats). Each flat gets a 5L kitchen caddy.	Once per week	Within two years, 4,300t of waste was collected and processed via anaerobic digestion.
Edinburgh, Scotland	5L kitchen caddies in each household Street level 1,100L communal bins	Once per week	No details
Dublin, Ireland	5L kitchen caddies in each household 240L communal bin	Once per week	No details
Galway, Ireland	Ranges between 240L bins and 1.3m ³ underground bins	Weekly to fortnightly	No details
Niort, France	5L kitchen caddies in each household 120L or 240L communal bins	Once per week	Operates as an opt-in scheme. Low contamination levels.
Barcelona, Spain	10L kitchen caddies in each household 20L communal bin	Four times per week	Contamination is at 2% and participation is at 84%
Hong Kong	3-5L sealable food storage container in each household 120L communal storage bin	Waste can be dropped off every day by residents. The guidelines recommend transporting waste to a centralised collection point every day.	No details

4.1 Bournemouth, England, UK

In Bournemouth different options are applied dependent on the way waste is collected within each block. In a 2015 review of Bournemouth's waste strategy, it was stated that 5,000 flat properties have access to food waste collections¹⁰. Bournemouth, Poole, and Christchurch (the Bournemouth Borough Council area) has a population of 346,597 and the number of flats in this area is 32,223¹¹.

Bin Arrangements and Collection Schedule

Flats which have a small bin (140L) for household rubbish collections, are automatically given a Food Waste Container (12L). Flats which have shared bins must opt-in by contacting the Council to get Food Waste Bins. Opting in requires the block's managing agent to agree to housing communal food waste bins. If the managing agent agrees, Council provides the block of flats, or shared house, with either a Little Bin (140L) or Big Bin (240L) with a brown lid to show it's only for food waste.

Each flat is offered a small kitchen caddy (5L), and a roll of compostable liners (additional free liners are available from local libraries and community centres¹²). Food waste is emptied from the kitchen caddy into the shared bin with the brown lid. The shared Food Waste Bins (with the brown lid) are emptied once a week by the council appointed waste contractor.

Supporting Activities and Education

Access to comprehensive information is provided online. Council staff also visit the residents at blocks of flats that opt in. The list of acceptable and unacceptable materials is supplied to residents at the outset as leaflets, and online. Bin stickers are used to notify residents if they've placed any non-compostable items in their bin (this is managed by recycling collection crews).

Table 8 Acceptable and unacceptable materials in Bournemouth's food waste bins

Yes Please	No Thanks
<ul style="list-style-type: none">• Meat, fish and bones• Fruit and vegetables• Dairy• Bread, cakes and pastries• Pasta and rice• Teabags and coffee grounds• Egg shells• Plate scrapings	<ul style="list-style-type: none">• Garden waste• Plastic, paper or cardboard recyclables (Big Bin please)• Plastic bags• Oil or liquid fats• Pet waste• Nappies

Source: BCP Council

¹⁰ Bournemouth Waste Strategy Review 2015, <https://www.bournemouth.gov.uk/binsrecycling/GoGreen/RecyclingWastePDF/Bournemouth-Waste-Strategy-Review-Final2015.pdf>

¹¹ Bournemouth, Poole, and Christchurch Census (2011) <https://www.bournemouth.gov.uk/councildemocratic/Statistics/Census/Censusdocuments/Bmth-Poole-Christchurch-Factsheet-2001-2011.pdf>

¹² <https://www.bournemouth.gov.uk/binsrecycling/BinCollections/HouseholdBinCollections-FoodWasteContainer/HouseholdBinCollectionsFoodWasteContainer.aspx>

Results

In the first two years of food waste collections, Bournemouth recycled over 4,300 tonnes of food waste (from single-unit dwellings as well as multi-unit dwellings), an average of 8.4 tonnes per day. No information on the diversion, contamination or participation rates in MUDs is available.

This food waste was sent to an anaerobic digester locally in Dorset. It generated enough energy to power the whole recycling process as well as 300 households for an entire year. A liquid soil improver was also made from the food waste and has been spread on nearby farming land in Dorset and Hampshire.

4.2 Edinburgh, Scotland, UK

Scotland aims to ban food waste to landfill from 1 January 2021¹³.

Bin Arrangements and Collection Schedule

For those residents that do not / cannot have a wheeled bin (e.g. those living in flats), kitchen caddies have been provided and 1100 litre communal bins are available at street level or within bin compounds in private developments for depositing the waste.

Figure 6 Image showing typical 1,100L food waste bins at street level



Source: Google Maps StreetView, 2019

The following residual and recycling bins are available at street level within Edinburgh:

¹³ The Waste (Scotland) Regulations 2012: <http://www.legislation.gov.uk/ssi/2012/148/regulation/4/made>

- Grey Top Bin: Food waste
- Blue Top Bin: Paper
- Purple Top Bin: Glass bottles and jars
- Green Top Bin: Mixed dry recyclables including cardboard, plastics, cans / drinks cartons, aerosols and foil, paper (not accepted in the blue top paper bin)
- Black Top Bin: General waste, i.e. non-recyclable items

Supporting Activities and Education

There is an interactive map online, to display bin locations for residents. There is also a reporting mechanism for overflowing bins.

Figure 7 Example of information presented to residents



Source: City of Edinburgh, Scotland

Upon the introduction of the scheme in 2013, letters were sent to households in order to explain how the system works. A full suite of online support is available, plus information leaflets / posters which can be printed and placed in blocks of flats.

The telephone number for the waste and street cleansing department is also readily provided for those who do not wish to use online services.

Results

No specific result data is available for Edinburgh's communal bin program. However, on a national scale, households on average only recycle 27% of their food waste, with best performing schemes only achieving 48%¹⁴.

A report¹⁵ aiming to enhance communal bin collection identified some key findings from focus groups with residents, including:

- Many households do not have food waste caddies;
- Residents are unaware they don't need to use bio bags;
- Food waste bins are seen as unhygienic and unpleasant to use; and
- 16-24-year olds were least likely to recycle their food waste.

These findings have created a series of recommendations for Edinburgh council, such as:

- Create food recycling communications campaigns targeting 16-24-year olds;
- Install more food recycling bins per capita;
- Provide food caddies to all residents; and
- Improve design of food bins to improve disposal experience.

4.3 Dublin, Ireland

Ireland introduced Commercial & Household Food Waste Regulations in 2015 which mandated separation of food waste from landfill. In particular, households, including apartments, must segregate food waste and have it collected separately by a waste collector¹⁶. Waste collectors are obligated to provide a segregated food waste collection service to households. This legislation however does allow for households to conduct at-home composting.

Dublin has a population of 1,173,179¹⁷ with 105,095 flats in purpose-built apartment blocks¹⁸. Dublin City Council elected to transfer all waste collection contracts to private waste companies in 2012. Fifteen licensed waste collectors operate in the Dublin region.

Bin Arrangements and Collection Schedules

Small 5-10L brown kitchen caddies are provided to residents in each apartment for initial collection of food waste. Food waste is then collated into larger shared 240L bins. These 240L bins are co-located with general waste and recycling bins. Collection is generally once per week by a suitably licensed Waste Service Provider.

Payment Systems

Municipal waste charges differ based on the waste stream. As the waste collection system is privatized, charges also depend on the operator. Some operators charge a per-lift cost - brown bins (food organics) are

¹⁴ Review of Waste and Recycling Strategy, Transport and Environment Committee (2018)

http://www.edinburgh.gov.uk/meetings/meeting/4508/transport_and_environment_committee

¹⁵ Enhancing Communal Bin Collections, Transport and Environment Committee (2018)

¹⁶ <https://www.galwaycity.ie/food-waste-information>

¹⁷ Census 2016 Summary:

<https://www.cso.ie/en/media/csoie/newsevents/documents/census2016summaryresultspart1/Census2016SummaryPart1.pdf>

¹⁸ Private Households 2011 to 2016 (Number) by Persons per Household, Regional Authority, Type of Private Accommodation and Census Year, Central Statistics Office (2016) <https://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/saveselections.asp>

charged at 2€ per collection, while black bins (general waste) are charged at between 3.60€ - 6€ (depending on bin size) per collection. Some operators charge by weight. Additionally, some operators do not charge for bio-waste collection at all, as it encourages lower contamination rates of dry mixed recycling. It is unclear how these rates are passed on to residents of apartment blocks, but it would seem likely to be through strata fees.

Enforcement Systems

In Ireland, food waste is banned from landfill. This provides a good foundation for mandated food waste collection. However, home composting is an accepted alternative to disposal. Enforcement is undertaken by the contracted waste service provider.

Results

No information is available for participation rates, diversion rates, and contamination rates of food waste collected from MUDs. In 2010, 36,000 tonnes of organic waste was collected through the brown bin system (for all of Dublin).

4.4 Galway, Ireland

From November 2013, Local Authorities in the Connacht Ulster Region ceased providing household waste collection¹⁹. Within Galway City, four main private operators manage household waste collection: Barna Recycling; The City Bin Company; Walsh Waste; and W.E.R.S. Waste. Households in Galway use a three-bin waste collection system, introducing the brown organics bin in 2001.

Bin Arrangements and Collection Schedules

In apartment buildings, collection bins are shared between units. Residents must separate their food waste from general waste and deposit it in the brown bins. Generally, collections of food waste occur every week, while residual waste collections occur every fortnight.

Table 9 below outlines some case studies of food waste collections in apartment blocks.

Table 9 Galway case studies

Location	Number of apartments	Bin Arrangements	Collection Schedule
Cappavanaveah Estate, Salthill	31 units	Seven 240L brown bins	Brown bins a third full on average, fortnightly collection
Suncroft Court Apartments, Salthill	14 units	Two 120L brown bins	Less than 25% full on average, collected fortnightly
Cuirt Seoige Apartments, Bohermore	115 units, but 50 units occupied at time of trial	1.3m ³ underground bin	Bins collected weekly regardless of fullness.

Source: *Organic Waste Management in Apartments, 2005, RPS*

¹⁹ Galway City Council Development Plan 2017-2023 Pg 140

https://www.galwaycity.ie/uploads/downloads/development_plan/2017-2023/Galway_City_Council_dev_plan_2017_2023.pdf

Supporting Activities and Education

The scheme was rolled out with the support of a team of local authority staff and environmental awareness officers. Ten trained staff conducted doorknocking to explain the new system prior to implementation and distribution of bins. Bins are inspected regularly to ensure householders are using the correct bin, and to keep contamination levels down.

Enforcement Systems

Waste truck crews tag contaminated bins with red stickers. Council staff would follow the waste trucks to talk to householders where contaminated bins were set out. There was a grace period for contamination, but following this period, contaminated bins were not collected.

Results

No information is available for participation rates, diversion rates, and contamination rates of food waste collected from MUDs.

4.5 Niort, France

Food waste collection commenced in Niort in 1994 and continues to this day. This scheme operates in housing estates and city flats (12,000 households in total). The service operates as “opt-in” rather than a result of policy change. This service is offered for free to residents.

Bin Arrangements and Collection Schedule

Bins were distributed to residents free of charge. These included a kitchen bin, and collection bins (120L and 240L). Collection bins are treated as shared and are collected from the kerbside. Collection occurs weekly.

Supporting Activities and Education

Residents are engaged through public notices, meetings, and information distributed door-to-door (face to face engagement). Additionally, a press conference and regular press communications are conducted, as well as a freephone for resident enquiries. Tours of the composting site are offered to interested residents.

Results

The contamination rates of food waste collected are extremely low. This resulted in high quality compost which the Local Authority hopes to obtain a quality label for promotion of the scheme. No information is available for participation rates or diversion rates of this scheme.

4.6 Old Quarter of Sarrià, Barcelona, Spain

Currently in Barcelona there is a separate collection of food waste for all households. This is conducted using street level bins for recyclable materials and food.

The following residual and recycling bins are available at street level within Barcelona:

- Brown Top Bin: Food waste
- Blue Top Bin: Paper and cardboard
- Yellow Top Bin: Plastic containers, beverage and food cans, metal lids, aluminium foil and cling film, polystyrene
- Green Top Bin: Glass

- Grey Top Bin: General waste, i.e. non-recyclable items

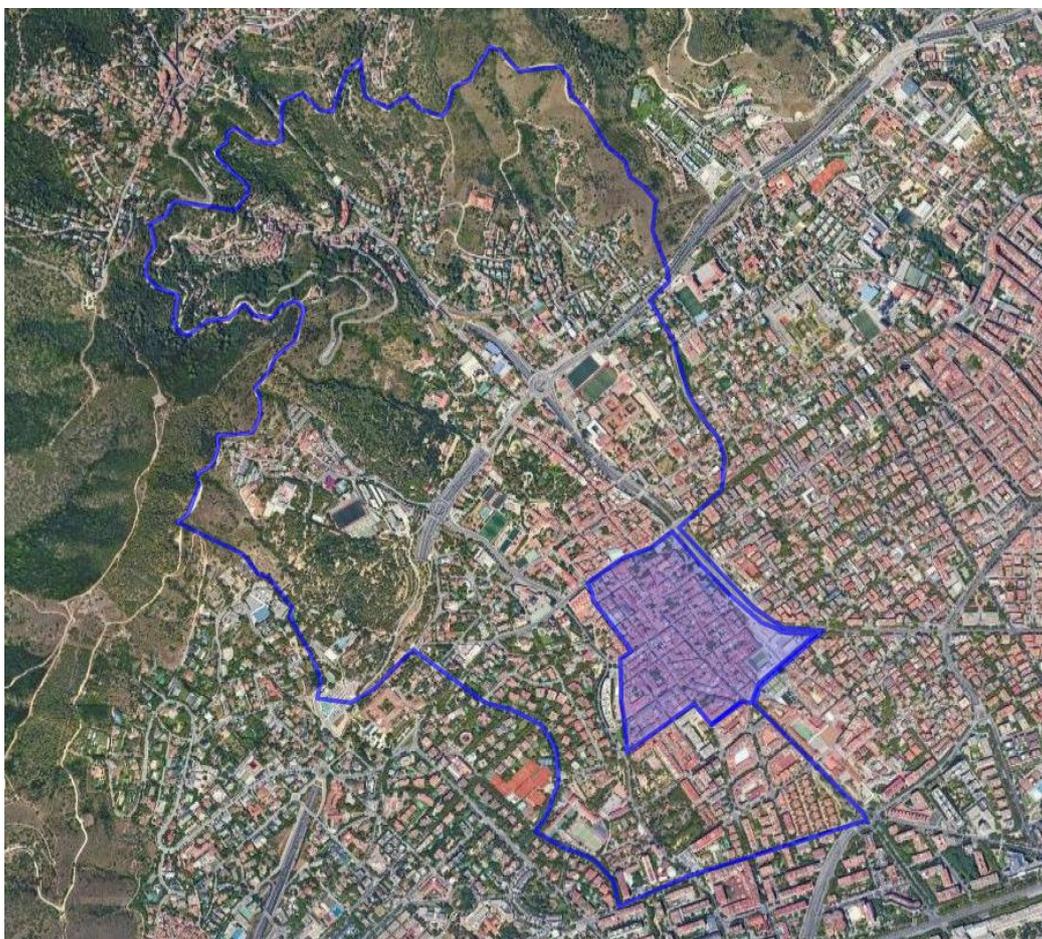
Figure 8 Street level collection bins found in most of Barcelona



Source: Google Maps StreetView, 2019

Sarrià is a neighbourhood in the Sarrià-Sant Gervasi district of Barcelona, and its Old Quarter has become the trial area for a modified food waste collection system (Figure 9). Door-to-door (in this case, door-to-door refers to the door of the building, not the door of the household itself) waste collection was trialed in conjunction with withdrawal of public-place source separation bins. It was implemented in order to create more public space on streets and was also a result of resident request. The system has shifted from a trial (October 2017 – December 2018) to a sustained separated collection. There is intention for Sarrià's door-to-door waste management system to expand into other neighbourhoods.

Figure 9 Satellite image of Sarrià (outlined in blue), and the Old Quarter (highlighted in blue)



Source: Nearmaps, 2019

This system was implemented in three stages:

1. Information and participatory sessions (beginning in mid-October 2017, continuing to December)
2. Communication campaign (starting in January 2018), including distribution of materials (bin liners, bins, and educational materials)
3. Operations began in February 2018

The roll-out of this system has benefited from weekly monitoring and reporting.

Bin Arrangements and Collection Schedule

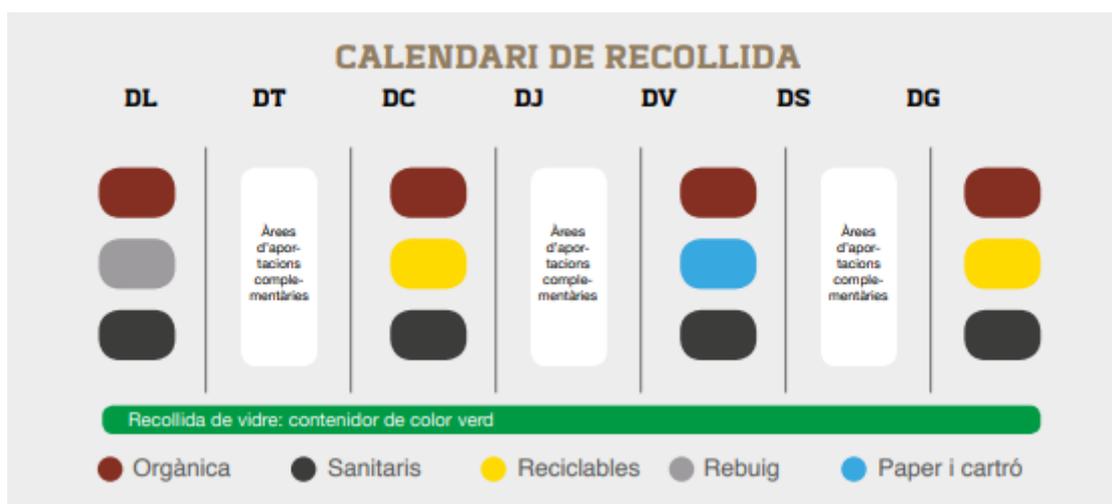
Once residents appear on the Old Quarter neighbourhood register of residents, they may collect the waste collection kit from Sarrià neighbourhood's Green Point. Materials included are:

- Compostable bags for containing and transporting food waste. Provided free to residents for the first year of implementation but must be purchased thereafter.
- A shared 20L brown airtight bin for organic waste collection;
- A 10L brown kitchen caddy for each apartment's kitchen;
- Bags for recyclable and residual waste;

- An information guide; and
- A fridge magnet calendar of pick up schedules.

Collection bins contain a chip which provides the council with statistical information on how the system is working. The Old Quarter is divided into 4 zones and the chip corresponds with these zones.

Figure 10 Collection schedule of different waste streams in Sarria



Source: Ajuntament de Barcelona

Collections occur four times per week. Residents take tied off bags of food waste from their kitchen caddy, to the shared collection bins (generally located in a shared area such as a lobby). Bins are set out after 8pm and must be collected before 10am the next morning.

Supporting Activities and Education

During non-collection days (three days a week), waste collection trucks are located as in Figure 11 below to allow “emergency” waste drop-offs.

Figure 11 Locations of emergency waste trucks in Sarrià during non-collection days



Source: Ajuntament de Barcelona

An education and engagement program preceded operations to allow residents to understand the new system first.

Results

The local authority reports a contamination level of just 2% in collected food waste. Prior to implementation of the doorstep collection, there was a contamination rate of 14% in the street-level food waste containers. Roughly 6,000kg of food waste is collected each week. Participation is at 84% of the population of Sarrià.

This program has benefited from the extensive engagement of residents and existing attitudes of residents (as seen by request of the service from residents). The multi-stage implementation of the system allowed authorities to address issues arising with operations as well as ensuring residents understood their obligations.

There is intention to roll out the door-to-door collection system to other neighbourhoods, however at time of writing there is no information regarding when this will commence and in which areas.

4.7 Hong Kong

In July 2011, the Environment and Conservation Fund (ECF) launched a funding scheme known as “Food Waste Recycling Projects in Housing Estates” to encourage the source separation, collection and recycling of food waste from households. ECF provide funds to support housing estates for setting up on-site food waste treatment facilities, i.e. composters, and implement food waste collection and recovery programs

and related engagement activities. This funding scheme encourages the collaboration of housing estates and non-governmental organizations to organize education and promotional activities, so as to raise the awareness of food waste reduction and motivate residents to actively participate in food waste recycling.

The ECF has published a technical guide to food waste collection in housing estates. Whilst it doesn't provide information regarding the effectiveness of such food waste collections, it does provide an insight into the implementation of food waste collections in apartments in Hong Kong. Currently, 34 housing estates receive equipment funding for food waste collections.

Bin Arrangements and Collection Schedule

Each household is provided with a 3-5L sealable food storage container. It is labelled as a "Food Waste Container", with a label indicating the types of recyclables and non-recyclables, and the address of the participating household (Figure 12). Only food waste can be put into the container. Residents are responsible for separating food waste, draining liquids, and delivering food waste receptacles to the housing estate staff for emptying.

Residents bring their food waste container to the designated collection point in the housing estate at a designated time. The collection point is usually at the reception area/ lobby of each building. If the container cannot be dropped off that day, residents are encouraged to temporarily store the container in the refrigerator to avoid odour generation.

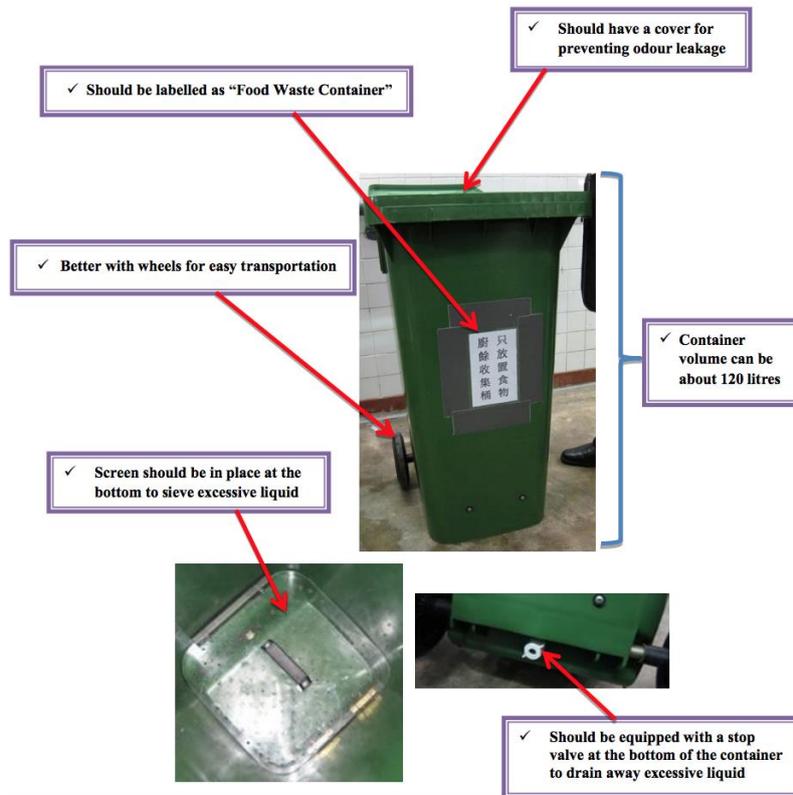
Figure 12 Example of a food waste container



Source: Hong Kong Technical Guidelines for Food Waste Recycling Projects in Housing Estates

The housing estate receives food waste from households each day, and full containers are exchanged with empty/clean ones. Operators remove non-recyclable materials out of the food waste receptacles and drain excessive liquid as much as possible. The housing estate then weighs the food waste and record its weight. All food waste containers are put into a large plastic container (around 120L, see Figure 13) for transporting to the treatment facility in order to keep the delivery route clean. The containers are washed and dried after the food waste is put into the composter for recycling.

Figure 13 Centralised food waste bins



Source: Hong Kong Technical Guidelines for Food Waste Recycling Projects in Housing Estates

Enforcement Systems

As housing estate staff are directly receiving food waste, visual inspection is easy. Contamination can be removed from the container by staff, or a container can be rejected.

Results

Authorities have experienced the following issues:

- Use of plastic bags to contain collected food waste
- Large amount of liquid
- Large fruit peels and shells
- Large bone type of food waste
- Large quantity of fruit and high-fibre food waste

Housing estates sort out the non-recyclable food waste from the recyclable food waste so as not to affect the operation of food waste composter.

5 Public Area Bins

This collection system involves bins for food waste being located in public places. This system is intended to service apartment complexes and may be located to be in proximity to several tower blocks in high-density areas.

Table 10 Public area bin implementation summary

Location	Bins	Collection	Results
Rijswijk, The Hague	5m ³ Bammens underground bins	Twice per week	Participation rate is unknown due to nature of the system.
Songpa, Seoul	RFID Bins (~240L)	Unclear	Diversion rate of 30%. However, there was an increase in illegal dumping, or household waste being disposed of in public place bins.

5.1 Rijswijk, The Hague, The Netherlands

Rijswijk is a suburb of The Hague, with a population of 50,000, 75% of whom live in apartments. Collection of source-separated organic waste has been operating since 1992, while government mandated organic collection from households commenced in 1994. However, due to high contamination levels, each city/region can decide whether to continue this segregation.

Municipal waste in The Hague is managed by Avalex, a public, government dominated company²⁰. Avalex is a joint operation between six municipalities: Delft, Leidschendam-Voorburg, Midden Delfland, Pijnacker-Nootdorp, Rijswijk, and Wassenaar.

Bin Arrangements and Collection Schedule

In Rijswijk, organic waste is collected in bins located on the street (outside the perimeter of the apartment block). They are Bammens bins which consist of a street level receptacle that feeds into a 5m³ underground chamber for storage. At collection, the entire bin lifts out of the ground to allow access to waste crews (Figure 14). The maintenance and collection of these bins is performed by Avalex, and residents must apply for an Avalex pass to use the bins.

²⁰ Looking Up: International Recycling Experience for Multiple Occupancy Households, Kelleher Environmental, <http://kelleherenvironmental.com/wp-content/uploads/2012/07/SITAUk-LookingUp-web.pdf>

Figure 14 Example of Bammens bin, raised above ground for collection



Source: Bammens Website

Figure 15 Example of a Bammens bin as located in Rijswijk (green handle)



Source: Google Maps Streetview 2019

Residents source-separate their organic waste and walk it down to the collection bins. Organics bins and residual bins are located closer to housing due to national regulations, while paper and glass recycling bins are located in more communal areas such as carparks or shopping areas. Each bin will service 60-70

households²¹. Bins are fitted with capacity sensors to indicate filling rates. Collection of waste is based on filling rates, regularly two times per week.

Supporting Activities and Education

Recent awareness and communication programs, coupled with enforcement through fines and public inspection, has improved household waste management.

Results

Participation rates cannot be determined in this type of waste collection. This scheme could benefit from more clear communications such as bin stickers to identify the bin as food waste only.

5.2 Songpa, Seoul, South Korea

In 2013, Songpa, a district in south-eastern Seoul, introduced a radio-frequency identification (RFID) based centralised system of food waste collection in multiple apartment complexes across the city. Within 4 years, 4000 RFID collection points had been installed in apartment complexes.

Bin Arrangements and Collection Schedule

Residents separate food organics within their apartments and must bring contained food waste down to the centralised RFID bins. Residents must purchase biodegradable bags in which food waste is collected. These bags can be purchased from local convenience stores or supermarkets.

Each household has a RFID card, which they must swipe on the machine to identify themselves. The input waste is weighed by the machine and an appropriate charge for the food waste is applied against the residents' account.

²¹ Looking Up: International Recycling Experience for Multiple Occupancy Households, Kelleher Environmental, <http://kelleherenvironmental.com/wp-content/uploads/2012/07/SITAUk-LookingUp-web.pdf>



Source: Global Daegu



Source: Korea JoongAng Daily

Supporting Activities and Education

In 2005, the South Korean government banned sending food to landfill.

Payment Systems

This system operates a dual payment scheme – upfront payment through purchase of special biodegradable food waste bags, and weight-based disposal charge scheme – RFID food bins weigh the input waste and charge residents accordingly. The purchase of food bags acts as an up-front payment for food waste and the money raised from these sales pays for roughly 60% of the cost of collecting and processing the food waste. Typically, the purchase of bags would cost \$6 per month for a four-person family. In addition, residents are encouraged to reduce their food waste due to the additional charges for disposal. Typical disposal charges are around \$2-3 a month.

Results

In 2017, Songpa District authorities calculated that the system had reduced food waste going to landfill by a total of 36,000 tonnes, or 25% of what was being thrown out in 2012 and achieved 7 billion won in budget savings. However, there are reports of illegal dumping of food waste in alleys²², or disposing of food waste in general waste bags (hidden in other pieces of rubbish), or dumped in public place bins²³. It appears that education and implementation of the scheme is appropriate, but community attitudes and lack of enforcement for dumping of waste requires further consideration.

²² Korea JoongAng Daily (September 2013) <http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=2977302>

²³ Ki-Yeong Yu for The Seoul Institute (2017) <https://seoulsolution.kr/en/content/6326>

6 Conclusion

The MRA desktop review identified 10 examples of food waste collection systems across three collection types in MUDs across Europe and Asia.

Data availability for participation, contamination, and diversion of food waste collection from MUDs is rarely available outside of food waste collection trials. Once the system is in place publicly available data is not readily available and limited by what the authority publishes publicly on the internet.

In general, local authority and national waste diversion data concerns total diversion and tonnages as a whole and rarely address them by dwelling type. Ongoing food waste collection organised by council authorities rarely had in-depth reporting and outside of the door-to-door collections in the City of London, no information regarding participation, contamination and diversion rates was available.

In each of the three system types, there were identified strengths and weaknesses:

Table 11 Strengths and weaknesses of collection systems

Collection System	Strengths	Weaknesses
Door-to-door	<ul style="list-style-type: none"> Greater ability to capture participation rates and observe contamination (and therefore address issues with residents). 	<ul style="list-style-type: none"> Requires more labour involved with collecting and bulking waste.
Communal bin	<ul style="list-style-type: none"> Less labour required than door-to-door collections. Generally co-located with other bin types (recycling, general waste) to allow residents to separate waste streams easily. 	<ul style="list-style-type: none"> Difficult to discern participation rates. Co-location of bins may not always mean the waste stream remains free of contamination.
Public place bin	<ul style="list-style-type: none"> Easier to access and collect waste by crews. Potential for weight-based billing with RFID technology. 	<ul style="list-style-type: none"> Contamination rates can be higher if bin lids are unlocked. May prove to be too inconvenient for residents and lead to illegal dumping.

Despite having door-to-door collection available in the council estates in London, participation rates were relatively low. This suggests that accessibility does not necessarily increase participation rates.

Contamination is easier to manage when the source of contamination can be determined – this is difficult when using communal bins or public place bins. Determining the source of contamination and the reasons why, can direct education and engagement efforts, or enforcement and fines.

Based on the examples of food collection systems in this review, important factors to consider include:

- Community attitude to recycling;
- Size and number of flats in the dwelling;
- Capacity to educate and engage residents; and
- Bin storage capacity and access requirements.