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Post-consumer plastic packaging waste in England: Assessing the yield of multiple collection-recycling schemes

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ABSTRACT

The European Commission (EC) recently introduced a 'Circular Economy Package', setting ambitious recycling targets and identifying waste plastics as a priority sector where major improvements are necessary. Here, the authors explain how different collection modalities affect the quantity and quality of recycling, using recent empirical data on household (HH) post-consumer plastic packaging waste (PCPP) collected for recycling in the devolved administration of England over the quarterly period July–September 2014. Three main collection schemes, as currently implemented in England, were taken into account: (i) kerbside collection (KS), (ii) household waste recycling centres (HWRCs) (also known as 'civic amenity sites'), and (iii) bring sites/banks (BSs). The results indicated that: (a) the contribution of KS collection scheme in recovering packaging plastics is higher than HWRCs and BBs, with respective percentages by weight (wt %) 90%, 9% and 1%; (b) alternate weekly collection (AWC) of plastic recyclables in wheeled bins, when collected commingled, demonstrated higher yield in KS collection; (c) only a small percentage (16%) of the total amount of post-consumer plastics collected in the examined period (141 kt) was finally sent to reprocessors (22 kt); (d) nearly a third of Local Authorities (LAs) reported insufficient or poor data; and (e) the most abundant fractions of plastics that finally reached the reprocessors were mixed plastic bottles and mixed plastics.

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1. Introduction

Since the Packaging and Packaging Waste (PPW) Directive came into force (Directive 94/62/EC), European Union (EU) member

Abbreviations: approx, Approximately; AWC, Alternated weekly collection; BSs, Bring sites; C&I, Commercial & industrial; ca., Circa (Latin term for "approximately" or "about"); Coll, Collected; Cx, Commingled with a separate stream of glass (g), fiber/paper (q), plastic (p) within the commingled; Cxx, Commingled with two separate streams within the commingled; DEFRA, Department for environment, food and rural affairs; EC, European Commission; EFW, Energy from waste; EPR, Extended producer responsibility; EU, European Union; FCM, Food contact materials; HDPE, High-density polyethylene; HH, Household; HWRC, Household waste recycling centres; KS, Kerbside; KSS, Kerbside sort; kt, Kilotonnes; LAs, Local authorities; MBT, Mechanical-biological treatment; MC, Multi-commingled (more than three streams within the commingled); MRFs, Material recovery facilities; NPP, Nuclear power plant; PCPP, Post-consumer plastic packaging; PET, Polyethylene terephthalate; PO, Polyolefins; PPW, Packaging and packaging waste directive; PRFs, Plastic recovery facilities; PTTs, Pots, tubs and trays; RCV, Refuse collection vehicle; RECOUP, Recycling of used plastics (Limited); UK, United Kingdom; WCAs, Waste collection authorities; WDAs, Waste disposal authorities; WDF, Waste data flow; WFD, Waste framework directive; WRAP, Waste and resources action programme; wt%, percentage by weight.

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states have made major investments in their recycling systems, e.g. collection schemes, sorting and reprocessing equipment and infrastructure. However, although the recovery and recycling targets set in the PPW Directive are similar for all member states, the operational strategies for achieving them vary considerably from country to country (da Cruz et al., 2014a, 2014b; European Commission, 2006; Marques et al., 2014). According to the extended producer responsibility (EPR) principle (an overriding principle of the PPW Directive), all economic operators placing packaging on the market are responsible for its management and recovery (OECD, 2001). Producers of packaging waste can transfer this responsibility to another entity (e.g. a Green Dot company) and by paying a financial contribution earn the right to put a "Green Dot" trademark on their packaging.

The PPW Directive and associated recycling targets updated in 2004 (European Commission, 2004), to encourage packaging re-use and recycling, do not stray from the original objectives. In particular, the Directive specifies essential requirements for the design, production, and commercialization of packaging that enable their reuse, recovery and recycling, minimizing their impact on the environment.

Furthermore, the EU Waste Framework Directive 2008/98/EC (WFD) requires member states to apply the EU Waste Hierarchy and achieve two recycling and recovery targets by 2020: (a) reuse and recycle at least 50% of household (HH) waste and (b) prepare for reuse, recycling and other recovery at least 70% of construction and demolition waste (European Commission, 2008; Ghafalkar et al., 2015; Waite et al., 2015).

The recycling of plastic packaging waste is regarded to be an important prerequisite for its diversion from landfill and the biosphere, and the generation of a recognizable high-quality secondary material (PlasticEurope, 2012). Although, there is a general agreement that the ‘clean’ fractions of plastic polymers should be recycled, there is still debate on how to properly manage the mixed and/or contaminated (“dirty”) waste plastics found in waste (Astrup et al., 2009; Lazarevic et al., 2010; Rigamonti et al., 2014). To achieve mono-material flows of secondary raw material from post-consumer plastic packaging (PCPP) waste, such fractions need to be sorted out of the HH waste (Groot et al., 2014). Matching the large variety of materials and substances that constitute PCPP (and the impurities it may contain) with the correct combination of available sorting and processing technologies to deal with them, render its effective recycling complex and challenging (Feil et al., 2017; Thoden van Velzen et al., 2013; Thoden van Velzen et al., 2016; Velis and Brunner, 2013; WRAP, 2013).

Recognising the need for high quality recycling as an effort to increase circularity and recovery of resources from waste, the present work focuses on the various collection schemes that are implemented in England, and in particular how current practices affect the recovery of PCPP waste (Feil et al., 2017; Ragossnig and Schneider, 2017; Velis, 2015).

The aims of the present study are: (a) to analyse the collection performance of the different schemes adopted by the waste collection authorities (WCAs) (mostly known as local authorities (LAs)) that operate in England, with specific focus on PCPP waste; (b) to compare the quantities of PCPP recovered from the various collection schemes and examine the proportion that reach material recovery facilities (MRFs) and reprocessors (plastic recovery facilities, PRFs) and (c) determine the final quantity and most abundant types of plastics that are, in fact, recycled, as a function of the collection scheme implemented.

2. Background on UK recycling collection schemes

Three main collection schemes, currently in use in the UK, are: (a) kerbside collection (KS), (b) household waste recycling centres or civic amenity sites (HWRCs) and (c) bring sites/banks (BSs). A detailed description of the collection schemes is presented below.

2.1. KS collection

KS collection involves LAs, paid contractors or permitted private business/charity collecting waste intended for recycling directly from HHs. Recently, there has been a degree of convergence in the detailed practical operations (e.g. how waste is sorted by the householder and the frequency with which it is collected). This can be mainly attributed to the government-funded Waste and Resources Action Programme (WRAP) creating performance benchmarks and guides for LAs (Defra, 2013). Jenkins et al. (2003) reported that LAs doubled their collection rate (by weight) with the introduction of KS collection as opposed to relying on householders to take recyclable materials to a specified collection point (Jenkins et al., 2003). It is also reported that the degree of effective source separation is a critical factor in achieving targets such as “50% recycling of HH waste by 2020” (Cole et al., 2014). It is noteworthy that the majority of English LAs operate separate

collections of recyclables and residual waste (the fraction of waste that cannot be recycled) (WRAP, 2009a, b).

There are three broad subsets of this type of collection, as follows:

- KS sort (KSS), where the collection of dry recyclables takes place in containers (mostly boxes, bags or sacks) which is then hand sorted by collection operatives into a refuse collection vehicle (RCV) that has multiple compartments for the various collected materials.
- KS single stream commingled or fully commingled (C), where the collection of all dry recyclables occurs together in one container and then transferred into a standard RCV with only one compartment. In turn, there is subsequent sorting at a MRF and in some cases there is an intermediate stop at a transfer/bulking station. After sorting, the final destination is the reprocessors, though part of the stream can be converted to energy, depending on the quality (Cimpan et al., 2015).
- KS dual or three (multi) stream commingled (Cx, Cxx, MC), where the collection of commingled materials takes place in one stream, while a separate stream is used for one or more other dry recyclates (Cimpan et al., 2015). Usually, two containers with two compartments in the RCV are used to maintain separation (split body RCV). The commingled stream is then sent to a MRF for sorting.

More details on the various collection modes (abbreviations also defined) that operate under the KS collection scheme are also shown in Table 1.

2.2. HWRCs

HWRCs serve as an alternative and/or support to KS collection. They are large facilities that usually reside within a community to which householders can take their waste. Items that are too costly for LAs to collect routinely via KS are often received at the HWRCs. These include building waste, green (garden) waste and even dry recyclables not collected via KS owing to omissions by householders or contractors.

Limited relevant literature is available regarding the collection rate performance of HWRCs. Parfitt et al. (2001) assessed the effects of container use on refuse and recycling collection in rural and urban classified areas in the UK and suggested that the contribution of HWRCs to collection was 16%, and was mostly attributed to green waste (Parfitt et al., 2001). Other studies on recycling via HWRCs focused on the collection of bulky waste, optimisation of parameters involved in this kind of collection scheme, or the

Table 1

Code description for the various collection streams that operate under the KS collection scheme.

Symbol	Terminology	Description
C	Commingled	(Single stream)
g	Separate Glass Stream	Separate Glass Stream, within the commingled dual or 3 stream collection scheme
p	Separate Plastic Stream	Separate Plastic Stream, within the commingled dual or 3 stream collection scheme
q	Separate Paper/Fiber Stream	Separate Paper/Fiber Stream, within the commingled dual or 3 stream collection scheme
MC	Multi Stream Commingled	Either 2 or more commingled collection separated according to fiber and containers or other
KSS	Kerbside Sort	Collection of dry recyclables in containers (mostly boxes, bags or sacks) with further hand sorting into a RCV with multiple compartments for the various collected materials

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