

# Benefits of introducing door-to-door separate collection in rural and low populated areas

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**ABSTRACT:** There is a pre-conception that in rural, and isolated areas, the production of recyclable waste (paper/cardboard, metal/plastic and glass packaging) is small, and thus door-to-door collection schemes are not worth setting-up. This work describes the implementation of a pilot test for door-to-door collection of dry recyclable waste at a small, rural site. It aims at improving the knowledge about the waste generated in rural areas and the impact on source segregation habits arising from the implementation of door-to-door collection. The strategy comprised the introduction of individual waste containers and bags at household level with a once-a-week door-to-door collection. The amount of residual waste and dry recyclables was monitored, and the physical composition determined. The recyclable waste more than tripled after implementation of door-to-door collection, from 23 kg/inhab/year to 73 kg/inhab/year. Concomitantly, residual waste decreased from 230 kg/inhab/year to 180 kg/inhab/year. The strategy followed at the test site represented a positive incentive for householders and services to source segregate and produce less residual waste.

## 1 INTRODUCTION

Historically, there has been a higher concern with waste management in large cities. This can be explained by various factors, namely the complexity of the waste management (e.g., size of the utility, resources consumed) and the consequences of service failures (e.g., financial, social, environmental), driven by amount and concentration of waste produced. Amongst the factors underlying the priority given to the waste management of large urban centers, there is also a generalized idea that the waste production in smaller communities is distinct both in terms of quantity and quality. It is believed that most people living in rural areas have a small yard, or land where they cultivate vegetables and grow small farm animals, which are fed with organic waste (food leftovers). This leads to the general perception that rural areas do not discard so much residual waste into bins and containers. At the same time, income levels in rural areas are lower, population is older which leads to reason that “recyclables” (paper/cardboard, metal/plastic and glass packaging) are not so prevalent as in more urban areas.

However, despite the progressive migration of population to large urban areas, there is still a large proportion of the population living in smaller communities. In Portugal, according to the last census (2011), roughly 40% of the population resided in communities of less than 2000 inhabitants (Fig. 1). Additionally, there is no clear trend regarding the amount and quality of waste amongst the 23 bulk waste utilities operating in mainland Portugal depending on their degree of urbanization (Fig. 2). In fact, the only distinctive case is ALGAR, which operates in the most touristic region of Portugal and also has a significant proportion of foreign residents. Therefore, finding adequate solutions in small communities is also relevant for the overall performance of the waste management at national scale. In this regard, this work aims at improving the knowledge about the waste generated in rural areas and the impact in the source segregation habits of implementing a door-to-door collection scheme for the dry recyclable waste fractions, comprising paper/cardboard, metal/plastic and glass packaging waste.

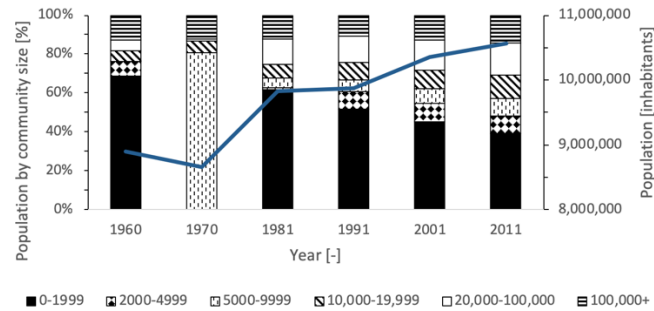


Figure 1. Evolution of the population and its distribution by community size in Portugal.

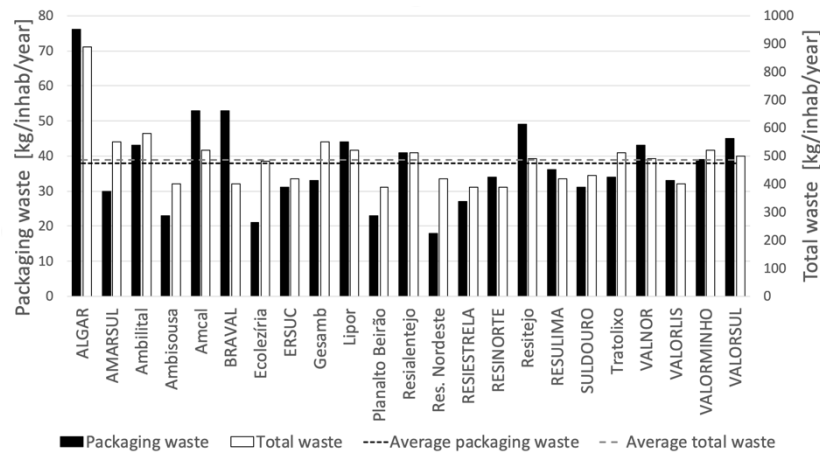


Figure 2. Packaging and total waste production in the 23 bulk waste utilities operating in Portugal mainland.

## 2 METHODOLOGY

### 2.1 Study area

ERSUC is one of the 23 bulk waste service utilities operating in mainland Portugal. It serves 36 municipalities in the center of Portugal through 7 transfer stations and 2 mechanical-biologic treatment units (TMB). Within the ERSUC area of operation, there are some differences regarding the amounts of waste produced, both mixed and separate (Table 1). The smaller municipalities produce less 16% mixed waste and less 10% separate waste, comparing to the large municipalities. The differences for the medium municipalities compared to the large ones are slightly inferior (less 12% and less 7% for mixed and separate waste, respectively).

Table 1. Mixed and separate waste capitation per municipality size (ERSUC 2017)

Municipality size	Average Population	Mixed waste (kg/inhab/year)	Separate waste (kg/inhab/year)
Small (inhab < 10,000) (n=8)	5103	319	26
Medium (10,000 < inhab < 20,000) (n=10)	14,058	336	27
Large (20,000 < inhab) (n=18)	42,086	382	29

To evaluate the performance of a door-to-door collection scheme and evaluate the waste behaviour in small communities, two rural isolated small districts of the same characteristics were selected as study areas (Fig. 3). **Site T** is the test site and **Site C** serves as the control.



Figure 3. General view of the testing site, a rural small district located in the center of Portugal (left and center); bring-banks for dry recyclables located at the study site (right).

Both sites belong to the same municipality in the area of operation of ERSUC and have similar waste collection infrastructures: 9 collective curbside waste containers (900 L or 120 L) and 3 bring-banks for packaging waste (glass, paper, metal/plastic).

## 2.2 Implementation of door-to-door collection for the dry recyclable waste fractions

The test site has 128 inhabitants who live in 49 detached houses (44 with a garden and 5 without garden) and 2 coffee/grocery shops. A set of waste containers for source segregation was distributed to every household and shop. The set comprises 3 bins of 30 L each: one for plastic/metal (yellow), one for paper/cardboard (blue) and one for glass (green). Bags of the same color were also distributed, to be used together with the bins. The color code follows the one established in Portugal. In addition to the bins, a Waste Guide and a waste collection calendar were also distributed (fig. 4). The waste calendar clearly indicated the days and hours of the new door-to-door collection scheme.



Figure 4 – Waste bins to be distributed at the testing site (left); calendar and waste guide (center); plastic bags with the dry recyclable waste fractions put out for collection (right).

Between 02.05.2017 and 27.06.2017 (2 months), a door-to-door collection scheme was implemented in which the bags with the dry recyclable waste were placed outside by the householders at designated days and were collected by the municipal team. During this period, the amount of residual waste and dry recyclables were monitored and the physical composition of the residual waste was determined.

## 3 RESULTS AND DISCUSSION

### 3.1 Dry recyclable waste collection during the door-to-door trial

The amounts of each waste fraction collected weekly are shown in figure 5. The recyclable waste collected amounted to 1610 kg, corresponding to 72.7 kg/inhab/year. Glass was the fraction collected in higher amounts, representing more than 50% of the total. The quantities of plastic and paper waste were similar.

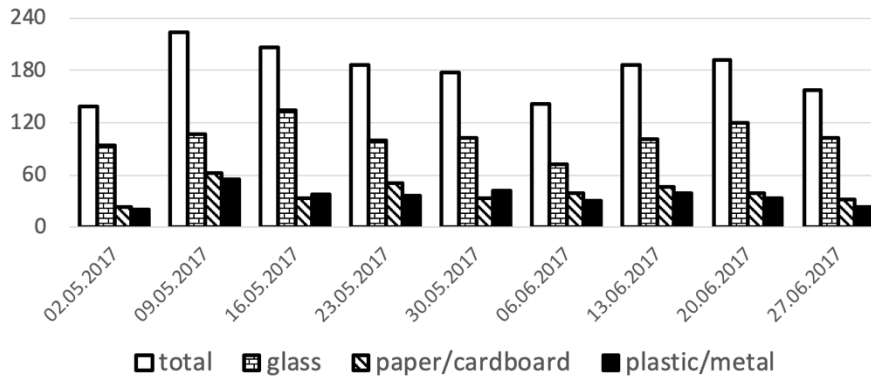


Figure 5 – Amounts of recyclable waste collected door-to-door at the testing site.

Prior to the trial, the collection of dry recyclables was based on one bring-bank (Fig. 3, right) where the 3 fractions were accordingly sorted: paper/cardboard, plastic & metal packaging and glass. Even though 88% of the people had replied in the initial survey that they already source segregated their dry-recyclable waste using the bring-bank, the annual per capita values more than tripled after the implementation of door-to-door collection, from 23 kg/inhab/year to 73 kg/inhab/year (Fig. 6). Concomitantly, residual waste decreased from 230 kg/inhab/year (average for the municipality) down to 180 kg/inhab/year (at the test site). This means that the strategy followed at the test site, comprising the distribution of individual bins and the implementation of door-to-door collection services, represented a very positive stimulus for householders and services to source segregate recyclable waste, and resulted in less residual waste being disposed of.

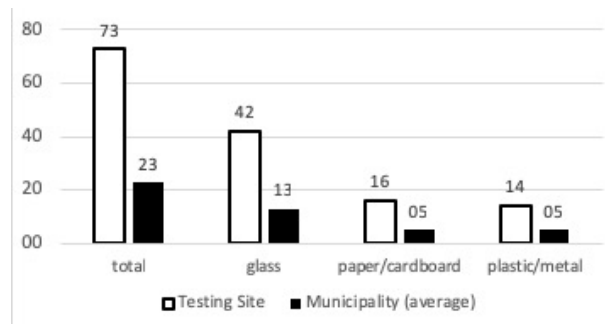


Figure 6. Annual amounts of recyclable waste (kg/inhab/year) estimated for door-to-door collection at the Site (128 inhabitants) and average values for the municipality (14,453 inhabitants)

### 3.2 Composition of the unsorted waste

Following the implementation of door-to-door collection of the dry-recyclable waste, the composition of residual waste changed, as expected (Fig. 7). The percentages of paper/cardboard in the residual waste decreased 4 times, from 20% to 5%. The other fractions (glass and plastic/metal) also reduced, although not as significantly as paper did. Overall, the pilot test resulted in a reduction to 13% of dry recyclable materials in the residual waste, compared to 34.2% at the control site. The presence of plastic, paper, glass and metal in residual waste is unwanted because its recycling potential decreases due to difficulties in the recovery from residual waste with enough quality to allow its recycling.

The presence of paper, plastic, metal and glass in residual waste is presented in table 2 for the region, and country. Values found in the literature for an urban site located in the same region as the study site are also presented, highlighting that at the rural site the amount of packaging waste is similar to the regional and national averages.

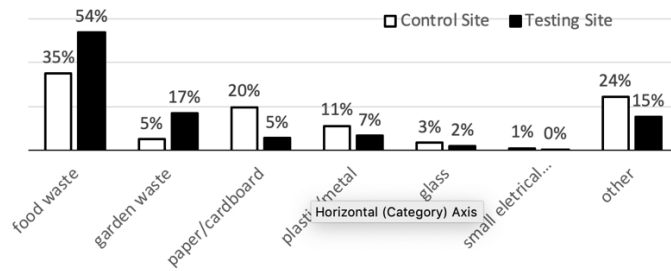


Figure 7. Physical composition of residual waste before (control site) and after (test site) the implementation of door-to-door.

Table 2. Presence of recyclable materials in residual waste

Waste	Control site (rural site)	Urban Site *	Regional Average **	National Average***
Paper	19.7%	9%	13%	10.5%
Plastic/metal	11.2%	7%	12%	12.9%
Glass	3.3%	5%	5.4%	7.3%
Total	34.2%	21%	30.4%	30.7%

\* retrieved from Dias-Ferreira (2018); \*\* from ERSUC (2013); \*\*\* from APA (2017)

As a result of the diversion of the dry recyclable waste, the percentages of biodegradable waste shifted from 40% to 70%. This effect increased the density of residual waste to  $123 \text{ kg/m}^3$ , meaning that the collection of the residual fraction is now more efficient (less volume, more mass transported by the collection vehicle).

### 3.3 Potential of collection and capture rates of dry recyclable waste

The estimated potential of recyclable waste at the testing site was  $92.4 \text{ kg/inhab/year}$ . This potential was calculated as the amount of recyclable waste present in the residual fraction ( $19.7 \text{ kg/inhab/year}$ ) plus the amount collected door-to-door ( $72.7 \text{ kg/inhab/year}$ ). The door-to-door collection strategy implemented at the study site was thus able to capture 79% of the estimated potential. Figure 6 represents the recyclable material in the residual waste in separately collected, according to the material. The capture rates achieved at the test site were 64% for paper, 66% for plastic/metal and 91% for glass.

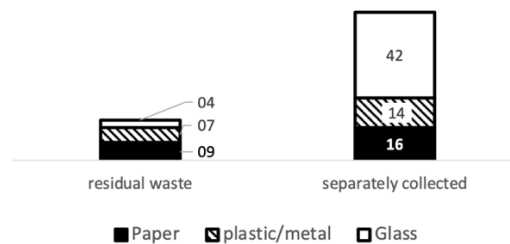


Figure 8. Annual amounts of recyclable waste (kg/inhab/year) in residual waste and in door-to-door collection at testing site.

### 3.4 Obstacles to door-to-door collection of recyclable waste at rural locations: myth or a reality?

Door to door collection is perceived by municipalities as costly and very demanding. This misconception arises from the day-to-day attitude to waste collection where the most important thing

is to service the population and commerce, without regarding efficiency and adequate management indicators. At the same time, municipalities have no direct benefit in collecting recyclables, no financial reward is available. There is also no experience in Portugal, or sufficient studies, of door-to-door collection in rural areas, thus leaving decision-makers uneasy with a risky investment in such a waste collection method. Political risk has been highlighted by Bringsken et al. (2019) as one of the constraints in the setting of innovative solutions in the waste sector. The same authors refer that to overcome this problem more communication is required, and both decision-makers and voters need to gain knowledge about the advantages of the new system.

A very strong constraint to door-to-door collection is the present high collection frequency, twice per week, for residual waste, leading to high resource use (vehicles; fuel; human resources) and lack of capacity to invest those same resources in door to door collection. Reducing residual waste collection frequency is assumed as having a negative effect on population satisfaction, hence the political risk previously referred hindering the introduction of new collection systems. The door-to-door collection was discontinued after the study mainly because there was no financial incentive for the municipality to increase collection of recyclable materials, and decision makers are not supportive of changing something that is “working well enough” meeting inhabitants expectations i.e. “waste out of sight”.

#### 4 CONCLUSION

This work describes the implementation of a 2-month pilot test of door-to-door collection of recyclable waste (dry fraction) at a small, rural site. The strategy tested comprised the introduction of small, individual containers and bags at the household level, articulated with a once a week door-to-door collection of recyclable waste. The main conclusions are:

- The annual *per capita* collection more than tripled, from 23 to 73 kg/inhab/year after door-to-door collection was implemented.
- An overall 79% capture rate for dry recyclable waste was achieved, with material specific capture rates being: 64% for paper, 66% for plastic/metal and 91% for glass.
- The percentage of dry recyclable materials in waste materials at the rural site is similar to the regional average and to the national values.
- Biodegradable waste represents 70% of the residual waste at the test site; this high value is an effect of the diversion of packaging waste materials to the door to door collection scheme.
- The specific weight of residual waste reaches 123 kg/m<sup>3</sup>, allowing improved efficiencies in the collection.

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