

# **The challenge of increasing source segregated waste collection in the Central region of Portugal**

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## **Abstract**

This study discusses the source segregation rate of packaging waste (glass, paper/cardboard and plastic/metal/composites) in the Centre region of Portugal. The amount and source segregated waste collection systems of two waste management companies were studied: ERSUC S.A. and VALORLIS S.A., involving 42 municipalities.

The source segregation rate was 7.5% (30.4 kg person<sup>-1</sup> year<sup>-1</sup>) in ERSUC S.A. and 7.6% (28.8 kg person<sup>-1</sup> year<sup>-1</sup>) in VALORLIS S.A. which are below the targets referred in the national strategic plan for municipal solid waste, 46 kg person<sup>-1</sup> year<sup>-1</sup> and 42 kg person<sup>-1</sup> year<sup>-1</sup>, respectively. Moreover, the growth of source segregation rate between 2010 and 2014 was negative, -5.1% for ERSUC S.A. and -11.3% for VALORLIS S.A. This work revealed that the current collection of recyclables in the study area, based almost exclusively on road-side containers, is not effective in reaching a higher collection rates and that modifications and improvements need to be worked out and implemented, in order to achieve national targets.

## **Keywords**

Municipal Solid Waste; Recycling; Separate collection.

## **1. Introduction**

The recycling of source segregated waste such as glass, paper/cardboard and plastic/metal/composites from household delivered more than 764 thousand tonnes of recycled waste in 2014 (INE, 2015). However, Portugal has a low recycling rate (13%), standing below the European average, 27% (Eurostat, 2015), which means that recycling still has great potential for improvement. The increase of recycling rates would lead to less energy consumption (e.g. glass and steel industry) and more economic development (Eriksson et al., 2005). In fact, recycling source segregated waste is one of the strategic objectives of the Plan for Municipal Solid Waste Management (PERSU 2020), approved in late 2014, which established a national target for

“preparing for re-use and recycling of waste materials” (paper, metal, plastic and glass) at a minimum of 50% by weight.

Currently there are 23 municipal “associations” for municipal solid waste recovery and treatment in Portugal. These associations are responsible for the collection and treatment of source segregated waste discarded by households and must comply with the recycling targets (MAOTE, 2014), as required by APA (The Portuguese national authority responsible for waste management). The main collection process is road-side containers (48.2%) followed by others (24.1%), civic amenity sites (21.7%) and door-to-door (6.0%) (INE, 2015). The region of Portugal with higher source segregated waste collection rate is “Algarve” (23.3%), followed by “Norte” (15.4%), “Lisboa” (12.9%), “Alentejo” (10.6%) and at the last position, the “Centro” (9.4%) (INE, 2015).

Although recycling of source segregated waste has been implemented in Portugal, the number of studies found in literature is scarce. These studies mainly focus the environmental, economic and social costs and benefits in the recycling system (Da Cruz et al., 2014, 2012; Ferrão et al., 2014; Ferreira et al., 2014), economies of density and size in municipal solid waste recycling (Carvalho and Marques, 2014) and economic viability of packaging recycling (Marques et al., 2014). However, none of these references targeted specifically the issue of low recycling rates in Portugal. The present paper will contribute to fill this gap by assessing and discussing the source segregation rates of packaging waste in the centre region of Portugal.

## **2. The Centre Region of Portugal**

Portugal is a country on the Iberian Peninsula located in the southwest of Europe. The Centre region of Portugal includes three regions: Aveiro, Coimbra and Leiria, comprising 42 municipalities. The study area is bordered by Oporto in the North and Lisbon in the South, has 1,245,241 inhabitants and an area of 8,848 km<sup>2</sup>, which represents 12% of the Portuguese population and 9.6% of total territory.

### **2.1 Municipal Solid Waste: generation and responsibilities**

Waste source segregation management in the study area is carried out by two EGF companies, “ERSUC – Resíduos Sólidos do Centro S. A.” and “VALORLIS – Valorização e Tratamento de Resíduos Sólidos S. A.”. Almost 500 thousand tonnes of were generated, representing about 10.5% of all MSW in Portugal and that source segregated waste was 7.5%. Unsorted waste collected in the study area is treated at three Mechanical and Biological Treatment units (located in Aveiro, Coimbra, and Leiria). When for some reasons the MTB units are not able to sort and treat all unsorted waste discarded by municipalities, then the waste is directly landfilled.

### **2.2 Source-segregation waste collection system**

From all MSW discarded by households, 7.5% was collected through the source-segregated waste collection system, specifically by road containers (95.7%) and civic amenity sites (4.3%). In 2014, ERSUC had in place 12,412 containers which allowed a coverage of 256 inhabitants per road container and the

collection of about 13,911 t of glass, 7,658 t of paper/cardboard and 6,918 t of plastic/metal/composites (ERSUC S. A., 2015a). Each “ERSUC resident” discarded at the road containers 14.83 kg/year of glass, 8.16 kg/year of paper/cardboard and 7.37 kg/year of plastic/metal/composites, totalling 30.4 kg of source segregated waste per person per year (ERSUC S. A., 2015b).

In the same period, VALORLIS achieved a coverage of 274 inhabitants per road container, with 3,542 containers for recyclables in place (VALORLIS S.A., 2015a). Amount collected was 3,787 t of glass, 2,960 t of paper/cardboard and 2,102 t of plastic/metal, using 11 vehicles and 31 employees. The amount of source segregated waste was of 28.8 kg/person year<sup>-1</sup> distributed by 12.34 kg/person year<sup>-1</sup> for glass, 6.85 kg/person year<sup>-1</sup> for plastic/metal/composites and 9.64 kg/person year<sup>-1</sup> for paper/cardboard (VALORLIS S.A., 2015b).

### 3. Methodology

The data used in this work was based on the Portuguese public reports published annually by these two companies between 2010 and 2014 (ERSUC S. A., 2015b, 2014, 2013, 2012, 2011, VALORLIS S.A., 2015b, 2014, 2013, 2012, 2011) and on demographic data by national statistics (Statistics Portugal, 2011).

The source segregation rate is defined in this work as the percentage of the amount of recyclable waste collected separately, compared to the total amount of municipal solid waste collected:

**Source segregation rate (%)** = (amount of source segregated) / (total amount of municipal waste) \*100

### 4. Results and discussion

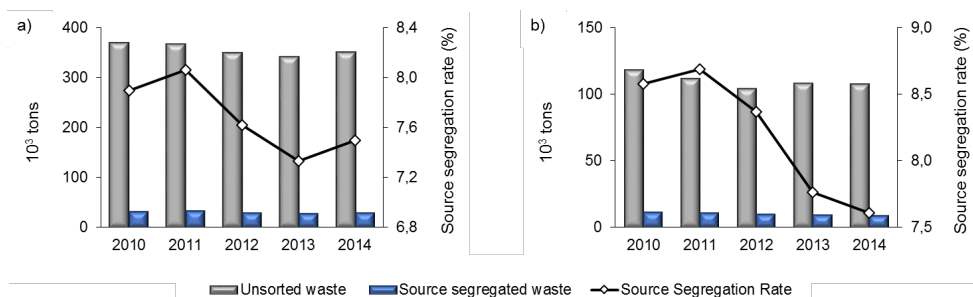
#### 4.1 Evolution of MSW collected by ERSUC and VALORLIS system

The evolution of unsorted and source-segregated waste collection from 2010 to 2014 is shown in Fig. 1. ERSUC S.A registered a decrease of the total amount of unsorted (7.7%) and source segregated waste (14.8%) between 2010 and 2013 while in 2014 this trend began to reverse and an increase on the amount of unsorted (3.0%) and source segregated waste (5.5%) was noted. The company VALORLIS S.A. also had a decrease on the collection of unsorted waste (12.1%) between 2010 and 2012. A slight increase took place in 2013 (4.0%), but the total amount of unsorted waste fell back again in 2014 (0.6%). The amount of recyclable waste collected by VALORLIS S.A registered a gradual decrease until today (20.2%).

In 2011 an increase of 2.1% in the source segregation rate was registered for ERSUC S.A and 1.3% for VALORLIS S.A. After 2011 the source segregation rates decreased until 2014, except in 2014 for ERSUC S.A which obtained an increase of 2.2% in 2014 mainly due to an increase of the collection of about 2 thousand tonnes of plastic/metal/composites. In general, the growth of source segregation rate between 2010 and 2014 was negative: -5.1% for ERSUC S.A. and -11.3% for VALORLIS S.A (Fig. 1).

In 2014 the source segregation rate was 7.5% (30.4 kg person<sup>-1</sup> year<sup>-1</sup>) in ERSUC S.A. and 7.6% (28.8 kg person<sup>-1</sup> year<sup>-1</sup>) in VALORLIS S.A. being far below the target national value of 13.6% (INE, 2015). The 2020 target (in PERSU2020) of source segregated waste is 46 kg person<sup>-1</sup> year<sup>-1</sup> for ERSUC S.A. and 42

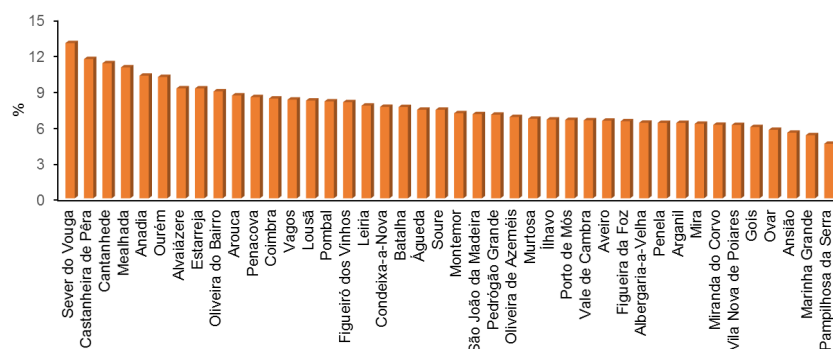
kg person<sup>-1</sup> year<sup>-1</sup> for VALORLIS S.A.



**Fig. 1** Amount of unsorted waste and source segregated waste (10<sup>3</sup> tons) collected by a) ERSUC S.A. and b) VALORLIS S. A. and source segregation rate (%) between 2010 and 2014

## 4.2 Comparison of source segregation rates across municipalities (2014)

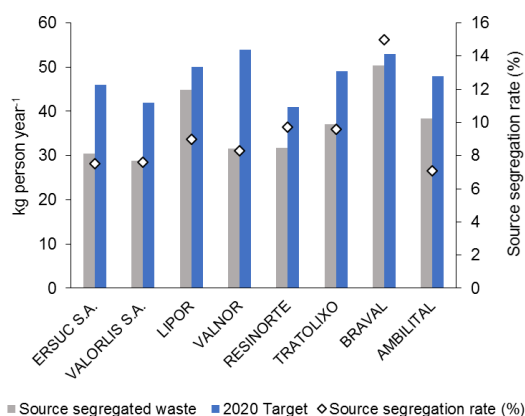
The source segregation rate obtained in each municipality of the Centre region of Portugal is shown in Fig. 2. The municipality of “Sever do Vouga” (pop. 12 000) had the highest source segregation rate: 13.0% (37.4 kg person<sup>-1</sup> year<sup>-1</sup>); followed by “Castanheira-de-Pêra” (11.6%; 31.5 kg person<sup>-1</sup> year<sup>-1</sup>), “Cantanhede” (11.3%; 38.6 kg person<sup>-1</sup> year<sup>-1</sup>) and “Mealhada” (10.9%; 39.5 kg person<sup>-1</sup> year<sup>-1</sup>). Source segregation rates were lowest in “Pampilhosa da Serra” (4.6%; 16.8 kg person<sup>-1</sup> year<sup>-1</sup>) and “Marinha Grande” (5.3%; 26.3 kg person<sup>-1</sup> year<sup>-1</sup>). It is remarkable that small, rural municipalities have higher source segregation rates than the most affluent, region capital Coimbra (8.3%; pop. 130,000) Aveiro (6.5%; pop. 77,229), and Leiria (7.7%; pop. 126,897). Although small and rural, the municipality of Sever do Vouga installed in the village Centre a total of seven ecologic isles (set of waste containers for recyclables and unsorted waste, placed in an organised manner) and added more containers for the separate collection of glass in commercial areas and restaurants. In addition, the municipality also began a weekly door-to-door collection system of paper/cardboard in commercial and strategic areas, and equipped all schools of the municipality with eco-points (set of containers for collection of recyclables). These actions were carried out together with awareness programs involving the citizens and companies. These strategies might explain the high source segregated rates achieved by municipality “Pampilhosa da Serra” within the Centre Region.



**Fig. 2** Source segregation rates (%) in each municipality of the Centre region of Portugal

### 4.3 Comparison with targets and with other source-segregated waste collection systems

The amount of source segregated waste collected by ERSUC S.A. and VALORLIS S.A. did not reach the targets established in the strategic plan for MSW management (46 kg/person year<sup>-1</sup> for ERSUC S.A. and 42 kg/person year<sup>-1</sup> for VALORLIS S.A.). The amount of source segregated waste obtained in the study area by ERSUC S.A. and VALORLIS S.A. compared to the other waste management system in Portugal is shown in Fig 6. In contrast to ERSUC S.A. and VALORLIS S.A., the LIPOR system attains 44.8 kg/person year<sup>-1</sup> of source segregated waste, which is near to the 50 kg/person year<sup>-1</sup> established as target for 2020 (LIPOR, 2015a). The source segregated waste collection system adopted in LIPOR area is also mainly by road containers (about 60%) but in addition, door-to-door collection systems are also implemented (LIPOR, 2015a). Similarly to LIPOR, the BRAVAL company also registered a high amount of source segregated waste, close to their imposed target for 2020. The collection of recyclables within BRAVAL is carried out by road containers, that quadrupled during the last 15 years. In addition, BRAVAL has strongly invested in environmental awareness in all the schools of their area. In general, the waste management systems in Portugal have difficulties in achieving their targets.



**Fig. 3** Amount of source segregated waste (kg person year<sup>-1</sup>) and source segregation rate (%) obtained by different waste management systems in Portugal, and corresponding targets defined in the waste strategic plan for 2020

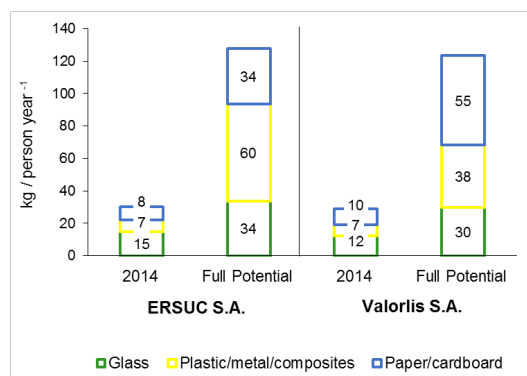
### 4.4 Source segregated waste collection and full potential

As mentioned above, the amount of source segregated waste currently collected by ERSUC S.A. and VALORLIS S.A. are very low, and recyclable waste is not discarded by households separately from unsorted waste.

The composition of the unsorted waste collected by ERSUC S.A. and VALORLIS S.A. showed relevant amounts of glass, paper/cardboard and plastic/metal/composites packaging, that would be valued in if diverted to the source-segregated waste collection system. The amount of source segregated waste per person collected in 2014 and the full potential amount of source segregated waste per person considering the percentage of recyclables in unsorted waste composition is shown in Fig. 4. In 2014, 30.4 kg per person of source segregated waste was collected by ERSUC S.A. and 28.8 kg per person by VALORLIS S.A. If all recyclable waste currently deposited by households into unsorted waste were source-segregated and diverted to separate collection, then ERSUC S.A. would achieve 128 kg person<sup>-1</sup> year<sup>-1</sup> and VALORLIS

S.A, 123 kg person<sup>-1</sup> year<sup>-1</sup>. This would represent an increase of 4 times the current rates.

ERSUC S.A. collects 44.2% of all waste glass, 12.3% of waste plastic/metal/composites and 23.7% of waste paper/cardboard. VALORLIS S.A. only collects 41.3% of glass, 17.8% of plastic/metal/composites and 17.5% of paper/cardboard. These results indicate that the current source segregated waste collection system of ERSUC S. A. and VALORLIS S.A. should be further assessed in order to increase the recycling rates.



**Fig. 4** Amount of recyclable waste collected in 2014 for ERSUC S.A and VALORLIS S.A. and the full potential considering the composition of recyclables in unsorted waste

#### 4.5 Cases of success in Portugal

The municipality of Maia located in the north of Portugal with a territorial area of 83.2 km<sup>2</sup> and about 136.000 inhabitants is a success case in Portugal for recycling rates. During the last 10 years, Maia increased its source segregation rate from 14.4 to 33.2% (68.2 kg/person year<sup>-1</sup>) representing an increase of 130%. To achieve this the municipality started a project called “Ecopoint at home” where bins and containers were distributed to households, in fact a door-to-door collection. Currently, 60% of the waste discarded is collected in this way. In addition, there are 5 civic amenity depots and awareness campaigns in schools with installation of outdoors, flashmobs and creation of games. Another strategy was the implementation of a pilot project on PAYT - *Pay as you throw* tariffs, in the second semester of 2014.

Another case of success is the town of São João da Madeira. This municipality has the smallest territorial area of Portugal (about 8 km<sup>2</sup>) and the source segregation rate registered an increase from 1% to 10% between 2002 and 2014, due to a construction of a civic amenity depot and consecutive awareness campaigns. The implementation of door-to-door collection system for the commercial waste producers with the distribution of containers or bags was one of the strategies implemented, resulting in an increase of 160% in source-segregated waste between 2007 and 2014. The current goal of the municipality is that all households are served with a door-to-door collection system.

The municipality of Lisbon has 550,000 inhabitants and covers 86 km<sup>2</sup>. Between 2003 and 2014 this municipality tripled the source segregation rate from 6% to 22%. In 2003, a door-to-door collection system was implemented. Currently about 61% of population is served by door-to-door collection system followed by road containers (23%) and ecological isles (15%).

## 5. Conclusions

This study assessed source segregated waste collection systems at the Centre region of Portugal. The discussion focused the glass, paper/cardboard and plastic/metal/composites packaging discarded by households in 42 municipalities, within two MSW management companies: ERSUC S.A. and VALORLIS S.A.

Between 2010 and 2014, source segregation waste collection decreased in the study area, both in absolute value as well as in percentage of total waste: -5% in ERSUC S.A. and -11% in VALORLIS S.A. The source segregation rates of 7.5% (30.4 kg/person year<sup>-1</sup>) for ERSUC S.A. and 7.6% (28.8 kg/person year<sup>-1</sup>) for VALORLIS S.A. are below the national average (13.6%), as well as below national targets. It is noteworthy that in all municipalities glass packaging is makes more than 50% of all recyclable waste collected by road containers. The higher source segregation rate was obtained in the municipality of “Sever do Vouga” (13.0%; 37.4 kg person<sup>-1</sup> year<sup>-1</sup>) with a population of only 12,000 inhabitants. It is remarkable that a small, rural municipality has higher source segregation rate than the most affluent areas such as Coimbra (8.3%; pop. 130,000) or Leiria (7.7%; pop. 126,897).

The assessment of source segregation rate carried out in other municipalities such as Maia suggests that the collection system is an important factor contributing to increase source segregation rates. The door-to-door collection system seems more effective than current model (road containers). This approach, complemented with awareness campaigns and implementation of a tariff system seems the best strategy to increase the source segregation rates in the Centre region of Portugal.

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## References

- Carvalho, P., Marques, R.C., 2014. Economies of size and density in municipal solid waste recycling in Portugal. *Waste Manag.* 34, 12–20. <https://doi.org/10.1016/j.wasman.2013.10.004>
- Da Cruz, N.F., Ferreira, S., Cabral, M., Simões, P., Marques, R.C., 2014. Packaging waste recycling in Europe: Is the industry paying for it? *Waste Manag.* 34, 298–308. <https://doi.org/10.1016/j.wasman.2013.10.035>
- Da Cruz, N.F., Simões, P., Marques, R.C., 2012. Economic cost recovery in the recycling of packaging waste: the case of Portugal. *J. Clean. Prod.* 37, 8–18. <https://doi.org/10.1016/j.jclepro.2012.05.043>
- Eriksson, O., Reich, M.C., Frostell, B., Björklund, a., Assefa, G., Sundqvist, J.O., Granath, J., Baky, a., Thyselius, L., 2005. Municipal solid waste management from a systems perspective. *J. Clean. Prod.* 13, 241–252. <https://doi.org/10.1016/j.jclepro.2004.02.018>
- ERSUC S. A., 2015a. Plano de Ação do PERSU 2020 - Sistema Multimunicipal de Valorização e Tratamento de Resíduos Urbanos do Litoral Centro.

- ERSUC S. A., 2015b. Relatório e Contas 2014.
- ERSUC S. A., 2014. Relatório e Contas 2013.
- ERSUC S. A., 2013. Relatório e Contas 2012.
- ERSUC S. A., 2012. Relatório e Contas 2011.
- ERSUC S. A., 2011. Relatório e Contas 2010.
- Eurostat, 2015. Municipal waste generation and treatment, by type of treatment method [WWW Document]. URL <http://ec.europa.eu/eurostat/data/database> (accessed 12.26.15).
- Ferrão, P., Ribeiro, P., Rodrigues, J., Marques, A., Preto, M., Amaral, M., Domingos, T., Lopes, A., Costa, E.I., 2014. Environmental, economic and social costs and benefits of a packaging waste management system: A Portuguese case study. *Resour. Conserv. Recycl.* 85, 67–78. <https://doi.org/10.1016/j.resconrec.2013.10.020>
- Ferreira, S., Cabral, M., da Cruz, N.F., Marques, R.C., 2014. Economic and environmental impacts of the recycling system in Portugal. *J. Clean. Prod.* 79, 219–230. <https://doi.org/10.1016/j.jclepro.2014.05.026>
- INE, 2015. Estatísticas do Ambiente 2014 [WWW Document]. URL [https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine\\_publicacoes&PUBLICACOESpub\\_boui=139543&PUBLICACOESstema=55523&PUBLICACOESmodo=2](https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_publicacoes&PUBLICACOESpub_boui=139543&PUBLICACOESstema=55523&PUBLICACOESmodo=2) (accessed 12.26.15).
- LIPOR, 2015. Relatório e Contas 2014. Baguim do Monte, Gondomar.
- MAOTE, 2014. Portaria n°187-A/2014: Plano Estratégico para os Resíduos Urbanos (PERSU 2020), para Portugal Continental. Ministério do Ambiente, Ordenamento do Território e Energia. Portugal. pp 87 (In Portuguese).
- Marques, R.C., Da Cruz, N.F., Simões, P., Faria Ferreira, S., Pereira, M.C., De Jaeger, S., 2014. Economic viability of packaging waste recycling systems: A comparison between Belgium and Portugal. *Resour. Conserv. Recycl.* 85, 22–33. <https://doi.org/10.1016/j.resconrec.2013.12.015>
- Statistics Portugal, 2011. Censos 2011 Resultados Definitivos - Portugal pp 560 (In Portuguese).
- VALORLIS S.A., 2015a. Plano de Ação do PERSU 2020 - Sistema Multimunicipal de Valorização e Tratamento de Resíduos Sólidos Urbanos da Alta Estremadura.
- VALORLIS S.A., 2015b. Relatório & contas 2014.
- VALORLIS S.A., 2014. Relatório & contas 2013.
- VALORLIS S.A., 2013. Relatório e Contas 2012.
- VALORLIS S.A., 2012. Relatório e Contas 2011.
- VALORLIS S.A., 2011. Relatório e Contas 2010.