SMALL, BUT POWERFUL – WHY WE SHOULD PUT MORE EMPHASIS ON THE COLLECTION OF SMALL WEEE

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SUMMARY: For Waste Electrical and Electronic Equipment, as for other waste streams, the recovery of the material is an initial step to enable recycling. The paper analysis two collection trails for small Waste Electrical and Electronic Equipment in Austria and compared to the results from collection trials throughut Europe. The results revial, that WEEE collection does not stand alone, but is part of a complex collection schme within a specific surrounding.

1. INTRODUCTION

With the implementation of EU regulations, the separate collection of Waste Electrical and Electronic Equipment (WEEE) has been implemented in all EU member states. The various categories of WEEE have different characteristics and significance: while cooling and freezing equipment is considered as of high environmental relevance, small WEEE (sWEEE) are most significant for their resource potential. This is mainly related to the higher content of printed circuit boards and contacts in electronic equipment for information and communication technology. In such devices, not only precious metals are found, but also materials like Neodymium, Europium or Yttrium, which are considered as "critical resources". At the same time, today sWEEE is only partly recovered for recycling.

2. METHODOLOGY

In order to find solutions for the intensified collection of sWEEE, two collection trials for sWEEE were undertaken in Austria. A first collection trail took place in Vienna and aimed at collecting sWEEE in a Multi Family Dwelling (MFD). The results (in terms of collection rates) are compared to other collection trials in MFD in Europe.

A second group of collection trials focusses on the collection of WEEE in public places, i.e. recycling banks and civic amenity sites. Here a trial was undertaken at five civic amenity sites in the province of Tyrol in order to collect high grade sWEEE separately. The results were compared to collection trails in Sweden and Germany, where the collection of sWEEE was installed at recycling

Proceedings SUM 2014, Second Symposium on Urban Mining
Bergamo, Italy; 19 – 21 May 2014

banks in the streets. Collection rates here range from 0.04 to 0.84 kg/cap/yr.

As a third group, collection of sWEEE at retails outlets is considered; two case studies from Sweden and Germany are analysed, both showing low quantities recovered.

3. COLLECTION TRIALS

3.1 Collection trail at Multi Family Dwellings in Vienna (Austria)

The MFD "*Kabelwerk*" located in Vienna has approximately 1,000 households and 2,450 residents. The compound consists of 11 blocks and was settled in 2006 and 2007. Regular collection avenues in Vienna are the Civic Amenity Sites, where citizens can bring in their bulky waste, hazardous household waste, WEEE and further waste types. The pilot collections aimed at testing the collection near the household, with higher convenience also higher collection rates were expected.

The pilot trial started in 2009 with containers for the separate collection of small WEEE in the waste collection sites (closed rooms) within the compound. 80 to 350 residents bring their waste regularly to each of the waste collection sites. The collection containers for sWEEE, where replaced in a monthly interval by empty one by the City of Vienna (Municipal Department for Waste Management, MA 48). After transport to the municipal central collection site for WEEE and hazardous household waste the composition of each container was determined in terms of weight and types of appliances, before the appliances were further processed. Before the start of the trial, the residents were informed through an information folder, posters at information spots, the compound internal newsletter and emails in the internal information system.

A first phase of the collection trial took place from June 2009 to April 2010 with 18 collection sites in the compound. From June 2010 to April 2011 the design of the trial was modified: instead of the 18 collection sites, in the second phase collection took place in only one collection point. In a third phase, from January 2012 to end of 2012 the trial was continued. Again only one collection site was used, however information of the residents was intensified and a detailed documentation of the collection results was undertaken.

Collection rate over the three phases of the trial are shown in table 1. Although only sWEEE were the targeted materials, also clearly addressed in the information campaign, alos other types of WEEE were foundin the collection container. Further a smaller ahre of unwanted material (packaging, plastics, metals etc.) were identified in the collection containers. With 18 collection sites in phase 1, a collection rate of 1.1 kg/cap/yr was achieved, while in phase 2 and 3 (when only one collection site was available) 0.4 kg/cap/yr were registered in the collection.

Table 1. Collection trial "*Kabelwerk*" (MFD in Vienna).

	sWEEE	screens	other WEEE	unwanted material	total
potential of sWEEE	3.70				
phase 1	1.13	0.43	0.08	0.11	1.75
phase 2	0.41	0.22	0.02	n.a.	0.65
phase 3	0.40	0.25	0.01	0.05	0.71

3.2 Collection trial in rural municipalities in Tyrol (Austria)

Starting point of this trial was the established collection infrastructure in Tyrol, which is typical for the situation in Austria: as in other rural regions, the municipalities have developed a collection scheme for municipal waste that builds on kerbside collection for the waste types with largest mass shares (ie. residual waste, waste paper, organic waste and partly light weight packaging), while other types of waste with lower mass share and less regular intervals for disposal (bulky waste, garden waste, hazardous household waste etc.) are collected at civic amenity sites (CAS). The separate collection of WEEE has been integrated into these collection schemes, typically residents bring in all types of WEEE at the CAS. Additionally, retailers have an obligation to take back WEEE in case of purchase of the same or a similar product.

Aim of this trial was to test the source separation high grade sWEEE at the collection site in order to enable a more specific treatment of this valuable material. The trial was undertaken with support of the regional waste management association (*Abfallverband Tirol Mitte*). As results, the mass share of high grade sWEEE in the collected material and the additional effort for this collection were observed.

The five CAS offer their service to 1 to 6 rural communities with 3,800 to 19,000 residents. Partly the economic structure of the area is dominated by tourism, bringing additional and specific waste quantities, eg. in one case a larger quantity of identical SAT receivers were registered in the collection containers, stemming from replacements in a hotel.

As a preparatory step, a list of high grade WEEE was established. For this purpose, based on available composition data, types of appliances with a higher share of printed circuit boards were selected. In table 2 the selected high grade sWEEE are listed, indicating the category where these types of appliances are assigned in the WEEE directive 2002 (“category 2002”) as well as in the new version of the WEEE directive (“category 2012”).

Table 2. List of high grade sWEEE (Grassl, 2013).

type	category (2002)	category (2012)
desk-top PCs	3	6
laptops	3	6
printer	3	6
router	3	6
mobile phones	3	6
calculator	3	6
babyphones	3	6
walkie-talkie	3	6
GPS devices	3	6
notebooks	3	6
scanner	3	6
beamer	4	6
digital camera	4	5
MP3 players	4	5
DVD player	4	5
video consoles	7	5
tablets	n.a.	6

Before starting the collection trial, in June 2012 a composition analysis of sWEEE as collected at the CAS was undertaken. By counting and weighing each appliance and classifying them as high grade / low grade the mass share of high grade sWEEE was determined. In total, 2.5 t of sWEEE were sorted at the five CAS. The results from this sorting is shown in Table 3: only small shares of non-target materials were found in the collection containers (other WEEE at CAS 4 and 5), while the majority is sWEEE as the target materials. The mass share of high grade sWEEE ranged from 8 to 27% (Grassl, 2013).

Table 3. Composition of the sWEEE material collected at five CAS in Tyrol.

	CAS 1	CAS 2	CAS 3	CAS 4	CAS 5
high grade sWEEE	25%	17%	8%	27%	8%
low grade sWEEE	75%	83%	90%	66%	92%
other WEEE	0%	0%	2%	7%	0%
total	100%	100%	100%	100%	100%

In the collection trial (4 months from August to December 2012) a separate collection of high grade sWEEE was tested at the five CAS. Users of the CAS were informed by posters at the collection site about the procedure and aim of the trail, as most important source of information the staff of the CAS were trained. Additionally through the course of the trial the citizens involved were informed though the regional newsletter of the waste management association. The documentation of the collection trial focussed on quantities (high grade and low grade sWEEE) on the one hand and on the additional effort in terms of space and labour for handling of collection containers and eventually sorting on the other hand.

In order to evaluate the results of the collection trail, a second sorting analysis was undertaken in October 2012. Both the collection containers for high grade sWEEE as well as for low grade sWEEE were analysed (one sample for each of the CAS). As in the first sorting analysis, each appliance was classified and weighted. At CAS 1 the sorting analysis was not feasible, as the operator of the CAS had decided to mix the high grade and low grade material after collection and registration. At CAS 3 a sorting analysis was not possible, as the collection containers had been emptied just before the analysis should take place.

Table 4 shows the results of the composition analysis for the low grade collection. Between 2 and 16% of the collected material was not the target material, mainly PC, printer and DVD player, while the rest was low grade sWEEE.

Table 4. Composition analysis of the low grade sWEEE material in the collection trial.

	CAS 1	CAS 2	CAS 3	CAS 4	CAS 5
low grade sWEEE	n.a.	84%	n.a.	91%	98%
high grade sWEEE	n.a.	16%	n.a.	9%	2%
total		100%		100%	100%

In table 5, the results of the sorting of the high grade collection is shown. In average 23% of the collected mass was low grade sWEEE; at CAS3 and CAS4 partly appliances such as SAT receivers and VRC recorders where collected as high grade material. Among the high grade material, printers and PC were dominat, representing 87 to 96% of the mass.

Collection rates in the trial are shown in table 6. Gross quantities (including material that was collected unintended) range from 2.0 to 4.4 for the low grade and from 0.6 to 1.1 kg/cap/yr for the high grade material. Net quantities, considering only the target material range from 0.5 to 0.6 kg/cap/yr.

Table 5. Composition analysis of the high grade sWEEE material in the collection trial.

	CAS 1	CAS 2	CAS 3	CAS 4	CAS 5
low grade sWEEE	n.a.	1%	32%	38%	11%
high grade sWEEE	n.a.	99%	68%	62%	89%
printer		*28%*	*29%*	*25%*	*33%*
PC		*59%*	*26%*	*27%*	*52%*
other		*12%*	*13%*	*10%*	*4%*

Table 6. Collection rates in the collection trial.

	CAS 1	CAS 2	CAS 3	CAS 4	CAS 5
low grade sWEEE	2.6	4.4	1.5	3.7	2.0
high grade sWEEE	1.1	0.6	0.8	0.9	0.7
total	3.7	5.1	2.3	4.6	2.7
high grade (net)	**n.a.**	**0.6**	**0.5**	**0.6**	**0.6**

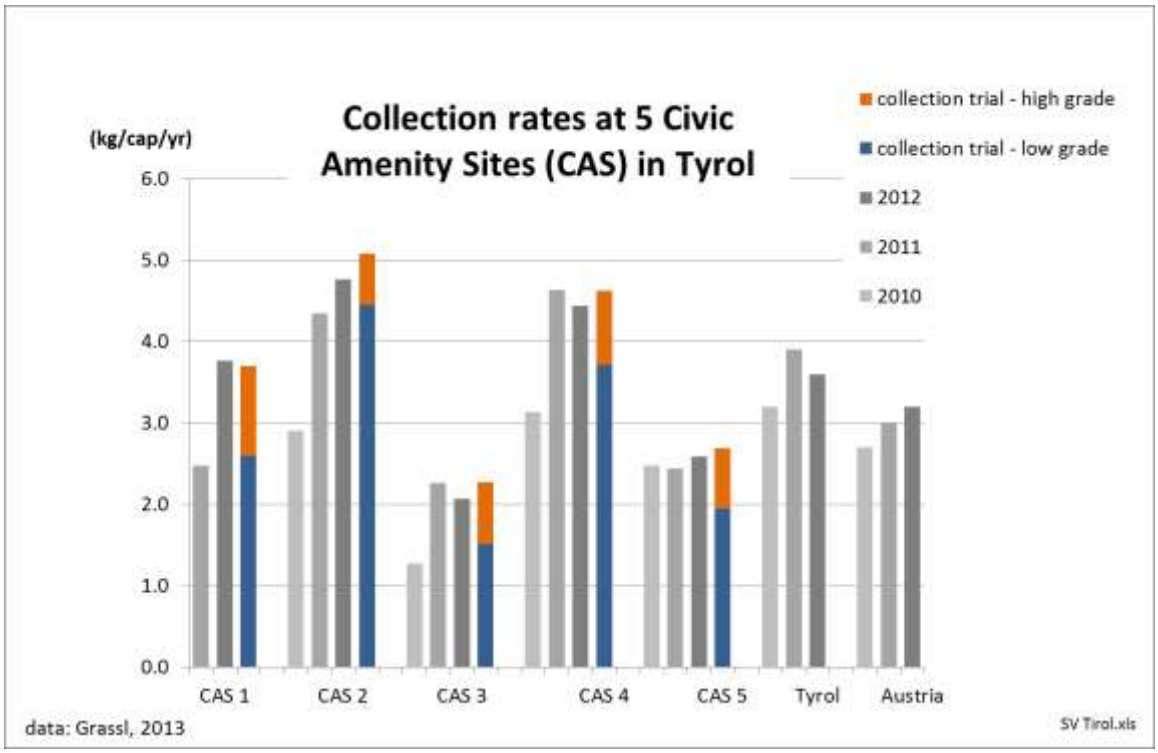

Figure 1. Collection rates in the collection trial compared to previous years and larger regios in Austria

Analysing collection rates of sWEEE at the five CAS for 2010 to 2012 (figure 1), including the test phase (four months in 2012) reveals that through these years the collection has been expanded at all sites, partly reaching high quantities as for CAS 2 and CAS 4. In the collecton trial quantities were similar as for 2012, the net share of high grade sWEEE was 0.5 to 0.6 kg/cap/yr. As comparison to the wider situation: for the province of Tyrol, collection rates for sWEEE were 3.2 kg/cap/yt (2010), 3.9 kg/cap/yr (in 2011) and 3.6 kg/cap/yr (in 2012) respectively (EAK 2012). For Austria a whole, rollection rates are in a similar range, i.e. 2.7 kg/capyr (2010), 3.0 kg/capyr (2011) and 3.2 kg/capyr (2010) (cf. EAK 2012). Concerning the additional work effort, needed to source separate high grade sWEEE at the existing CAS, the results reveiled, that the effort need is rather low (0 – 4 h per week additional labour); no additional space was needed, collection and interim storage prior to transport to the recycling facility took place in the existing facilities (Grassl, 2013).

4. RESULTS AND DISCUSSION

In this section, results from collection trials for sWEEE are compiled and compared. The collection trial inTyrol, reaching 2.3 to 5.1 kg/cap/yr of sWEEE has a specific role, as it aimed at separating high and low grade of sWEEE, while the other collection trials were conducted in order to test the collection of all types of sWEEE appliances. Table 7 summarises the result of the collection trials.

4.1 Collection at households

In Copenhagen (Denmark) WEEE collection takes place at 11 recycling centers (civic amenity sites) where in 2012 5.8 kg/cap/yr of WEEE were collected. In Frederiksberg, a part of Copenhagen additionally a collection of sWEEE at multi family dwelling has been introduced. Containers in the compounds are in use for this purpose, preliminary results show a collection rate of 1.33 kg/cap/yr. (Borregaard, 2013)

In Solna (Sweden) a collection of WEEE (all types) combined with the collection of hazardous household waste was installed at selected MFD. The collection takes places in waste collection sites (closed rooms as in the MFD in Vienna), a collection rate of 5.32 kg/cap/yr in total was acheived. No detailed data about the share of sWEEE in this mass is available (Tomasin, 2013).

Järfälla (Sweden) is a municipality near Stockholm where in 2012 8.6 kg/cap/yr of WEEE were collected. As an addition collection scheme, hazardous household waste and sWEEE are collected in a collection box (“red box”) at the households. A collection rate of 0.03 kg/cap/yr has been achieved (Tomasin, 2013).

4.2 Collection in public places

In Umea (Sweden), is a City of 117,000 inhabitants and 7 installed civic amenity sites for the collection of WEEE and other types of waste. The collection rate for WEEE in 2012 was 16.7 kg/cap/yr (El-Kretsen, 2013), near to the Swedish average of 17.2 kg/cap/yr (Eurostat, 2013). At three public places specific containers for the collections of sWEEE, batteries and lamps were installed, access was possible around the clock and the sites were accessible by car. In the test phase from December 2009 to November 2010, an additional collection rate for sWEEE of 0.04 kg/cap/yr was registered (Tomasin, 2013).

The Soest district is a rural area in Northern Germany with 304,000 inhabitants. WEEE collection takes place at 7 civic amenity sites with a collection rate of 5.9 kg/cap/yr (in 2010) (Entsorgungswirtschaft Soest GmbH), lower than the average collection rate of 9.5 kg/cap/yr in Germany for the same year (Eurostat, 2013). Collection of sWEEE and metals was tested at

recycling bank (containers at public places for waste collection). The collection was designed similar to the existing collection of waste glass. For metals and WEEE a collection rate of 0.84 kg/cap/yr in total was registered, of which 86% were WEEE. Meanwhile, the collection with containers at the recycling banks has been extended to the whole district.

In the City of Munich (Germany) citizens have beside take-back at the retail two avenues to dispose of WEEE: 12 civic amenity sites in the urban area offer aceptance, additional mobile collection takes place, delivering minior collection quantities, but perveiced as a vehicle for public relations. In total in 2011 6.1 kg/cap/yr of WEEE were collected (Abfallwirtschaftsbetrieb München, 2012). A test for the collection of sWEEE at recycling banks took place at ten recycling banks (collection sites in public places). Information took place via direct mail to all residents in the testing area as well as through advertising in newspapers and through the website of the local waste association. In 2010, a collection rate of 0.38 kg/cap/yr was achieved (Abfallwirtschaftsbetrieb München 2013).

4.2 Collection at shopping malls / retail

In Gothenburg (Sweden), a town of 522,000 inhabitants WEEE are collcted at 6 civic amenity sites, additionally at 16 collection sites for hazardous household waste (filling stations and marinas) and through mobile collection. In 2012 a collection rate of 10.3 kg/cap/yr of WEEE was achieved (El-Krestsen, 2013). At shopping malls specific containers for the collection of sWEEE, batteries and lamps was installed, actually 11 containers are in place. A collection rate (compared to all residents of the city) of 0.007 kg/cap/yr was achieved, 20% of this mass was sWEEE.

In Frankfurt, a German city with 677,000 inhabitants WEEE colection at 6 civic amenity sites reached a collection rate of 5.0 kg/cap/yr in 2012. In cooperation with *Werkstatt Frankfurt*, a socio-economic enterprise a collection scheme for sWEEE at 8 retailers was installed. A collection rate of 0.02 kg/cap/yr was reached in 2013 (Tomasin, 2013).

Table 7. Collection trials - results.

(kg/cap/yr)	**City/region**	**WEEE collection**	**trial**
at households	Vienna	6.3	1.1
	Copenhagen	5.8	1.3
	Solna	na.	5.3*
	Järfälla	8.6	0.03
in public places	Umea	16.7	0.04
	Soest	5.9	0.84
	Munich	6.1	0.38
at the retail	Gothenburg	10.3	0.007
	Frankfurt	5.0	0.02

* in Solna sWEEE, screens, batteries and lamps were col

5. CONCLUSIONS

The comprehensive recycling of WEEE requires efforts to collect these matrials to a higher extent. Results for collection trials in Europe were collected and analysed. Relying on collection rates (without considering the quality of the collected material) shows that the established collection structures (in most cases civic amenity sites, where citizens can bring in WEEE and other waste types) are a well established structure for WEEE collection. Additional collection avenues such as collection at or near the households, in public places ar at the retail may bring additional quantities, however they seem not to serve as a major collection scheme.

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