Heinz Böni/Rolf Widmer

A closer look at the recycling performance of Swico's processing partners

Between mid-2015 and mid-2016, a batch test was conducted with a predetermined input amount at six Swico recycling partners that rely on mechanical processing. In addition to determining the recycling and recovery quotas, the test was also designed to compare the performances of the companies.

For the first time in Europe, the input quantity tested in a batch test (in accordance with Cenelec 50625-1: Test batch processing) was comprised of a mixture of information and communication technology devices and consumer electronics that was virtually the same for all companies. Over a period of around three weeks, a combination of devices was defined which correspond to the average composition of the material flow in the Swico system (not including monitors).

Determining the recycling and recovery quotas in accordance with Cenelec

The Swiss standard SN EN 50625-1:2014 defines how recycling and recovery quotas have to be determined. According to this standard, the process starts with the untreated waste electrical and electronic devices and ends "... when the end-of-waste

Table 1: Categories of the end uses of the various fraction percentages (excerpt)

Final fraction	Final technology	Final use*					Basis and assumptions
		R	OMR	ER	TD	OD	
Aluminium fraction "pure"	Aluminium melt	95%	1%		4		95% Al recovery; 1% other metals as reduction agents; 4% all other organic fractions;
Aluminium fraction "not pure"	Aluminium melt	90%	1%		9%		90% Al recovery; 1% other metals as reduction agents; 9% all other organic fractions;
Batteries dry	Battery recycling	50%			50%		50% metal recovery; 50% plastics with no use in smelter
Lead batteries	Battery recycling	94%			6%		67% lead recovery; 2% other metals; 6% organic parts/hot technology; 21% sulphuric acid recovery; 4% plastics
Iron fraction "pure"	Steelwork special	97%		3%			90% Fe recovery; 5% mineral fraction; 2% other metals; 3% other organic fractions
Iron fraction "not pure"	Steelworks traditional	92%		8%			85% Fe recovery; 5% mineral fraction; 2% other metals; 8% other organic fractions
Plastic/ other organic compounds	Household waste incinerator			62%	33%	5%	62% organic percentages used for fuel substitution (R1 system); 33% organic percentages for thermal disposal; 5% inorganic percentages for disposal (landfill)
Capacitor	Special waste incinerator				100%		
Recovered plastics	Plastics recovery	51%		32%	17%		50% plastics for recycling; 1% metals; 32% plastics for use as energy; 17% plastics for thermal disposal
Copper and grey metals "pure"	Copper smelter «special»	95%		5%			75% Cu recovery; 20% other metals; 5% plastics used for fuel substitution
Copper and grey metals "not pur"	Copper smelter «special»	90%		10%			70% Cu recovery; 20% other metals; 10% plastics used for fuel substitution
Printed circuit boards/ mobile phones	Copper smelter «special»	30%		65%	5%		30% other metals; 65% plastics used for fuel substitution; 5% no use – "cold technologies"

* R = Recycling; OMR = Other Material Recovery; ER = Energy Recovery; TD = Thermal Disposal; OD = Other Disposal (e.g. landfill)

status for fractions is achieved or with the final recovery or disposal of fractions". When the quotas are determined, this includes each individual step of every operator in the treatment chain. All fraction percentages must be allocated to a final use in the last treatment step for all fractions that are recovered or disposed of. For example, during final treatment, e.g. in a smelting plant, the amounts that can be recycled (R) must be determined along with the amounts that are used for example in the process as reduction agents (OMR=Other Material Recovery) and end up in the slag.

In a joint statement of the European associations CECED, Digitaleurope, WEEE Forum and EERA from June 2016 on the proposed amendment to Article 11 of the European Waste Framework Directive to adopt new rules for calculating quotas, it was put forth that these quotas should not be calculated based on the weight of the input waste entering the final recycling process, but instead based on the weight of municipal waste recycled as provided for in the Cenelec standard. This means that the recycling quota can only include the mass fraction recycled (output of material recycling).

For the Swico batch tests, the quotas were determined in accordance with SN EN50625-1:2014, whereby standardised categories of final uses of the various fraction percentages were used for the final processes (see Table 1). These were adjusted in those cases where the company was able to provide evidence of better values to the final user and document these values accordingly.

Input composition and processed weights

Table 2 shows the specified input composition and the deviations from this formula expressed as percentages. The deviations were relatively low for all device types in five companies (see Technical Report 2016), while the sixth company was not able to satisfy the requirements for the conditioning of radios (-16.8 %) and speakers/loud speakers (+18.9 %). In addition, in individual cases there were deviations between the total weights in the companies and those recorded during conditioning. These deviations were taken into account in the interpretation of the results.

Table 2: Conditioning of the batches

Device type	Specification		Deviation from specification
	Quantity [t]	Percentage	
PC/servers	2,850	23.9%	0.1 – 2.9%
Printers	2,570	21.6%	-0.1 – 3.4%
Radios	2,000	16.8%	-0.5 – 0.2%*
Speakers/loud speakers	1,470	12.3%	-0.5 – 0.3%*
Landline telephones	750	6.3%	-5.3 – 0.1%
Keyboards	630	5.3%	0 – 0.7%
Notebooks, laptops, powerbooks	600	5.0%	-1.6 – 0.5%
Switches	450	3.8%	-3.8 – 0%
Routers/modems	300	2.5%	-0.3 – 1.5%
Amplifiers	300	2.5%	-2.5 – 2.6%
Total	**11,920**	**100.0%**	

* One company had much larger deviations

High rate of manual initial dismantling

In all companies, hazardous substances are manually removed in the initial treatment stage and the devices are partially pre-dismantled to prepare them for the subsequent mechanical stages. Manual processing produces a considerable number of fractions, which are either sent directly to an end process or disposed of in a waste incineration plant (ASR) or specialised company. Depending on the company structure and the subsequent processing technology, the total processed weight accounted for by the mass fraction of the manually generated end fractions fluctuates between around 10 % and 50 %. Even though a higher percentage of pure fractions can be sent directly to the last treatment stage as the rate of initial manual dismantling increases, the achieved recycling quotas of companies with a high rate of manual dismantling tends to be better, but not in every case. For example, the company with the lowest rate of initial manual dismantling achieved the highest recycling quotas, while the company with the highest rate of manual dismantling achieved good but not the best quotas.

Metal recycling and plastics recovery

If a high recycling quota is to be achieved, metal recycling must be maximised on the one hand, and as much plastic as possible must be recycled on the other. These must meet the requirements stipulated in TS 50625-3-1. According to these specifications, evidence must be provided that the total bromine content for these kinds of plastics is below 2,000 ppm. In addition, according to the provisions of the Federal Office for the Environment (FOEN), evidence must be provided that the brominated substances Penta and Octa BDE are each below 1,000 ppm. A limit of 100 ppm applies for cadmium, and a limit of 50 ppm for PCB. This evidence is not standardised in Switzerland but will become more important in the future. The target values for recycling can only be reached by recycling more plastic for material purposes.

The total metal weight that can be recycled reaches 47–56 % of the total weight, the greatest percentage of which is accounted for by iron (34–42 %). The other metals are primarily aluminium and copper which are recovered in a relatively pure state or mixed depending on the technology used (see Table 3).

While the differences in metal recovery are relatively small, the companies vary greatly in terms of the way they recycle plastic. This fluctuates between almost 0 % and 15 %, which directly impacts on the achieved quotas (see below). Accordingly, the weights for recovery for energy use and thermal disposal in a waste incineration plant vary between 28 % and 43 %. This may also be the result of inadequate separation in the mechanical processes, which leads to large volumes of metal in the shredder light fraction and thus also negatively affects the recycling quota (RQ).

Table 3: Ranges of the final fractions and the final uses

Final fraction	End uses	Range Min [%]	Max [%]
Metals		47	56
- Fe	R	34	42
- Cu	R	0.7	6.1
- Al	R	0.3	5.4
- Other metals	R	4	17
Plastics		14	30
- Recycling	R	0.3	15
- Use for energy	UE	17	26
- Thermal disposal	TD	0.5	6.5
Other		5	16
- Use for energy	UE	0.1	9
- Thermal disposal	TD	2	8
Total waste incinerator		**28**	**43**

Condensers from manual dismantling

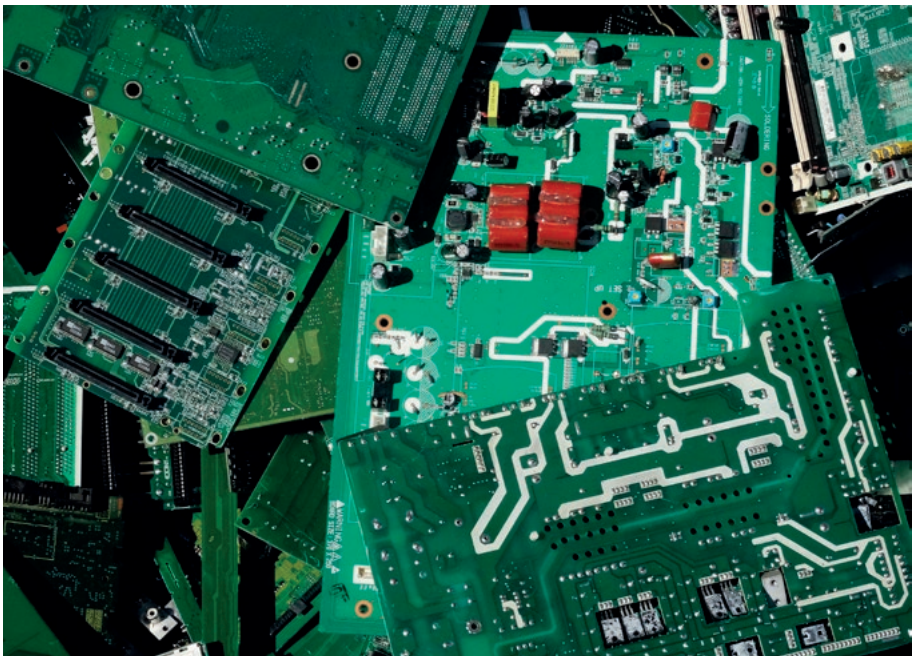
Results and outlook

The results of the tests show a high fluctuation range for the quotas achieved. Values between 53.8 % and 70.8 % were determined for the recycling quotas, and between 84.5 % and 93.3 % for the recovery quotas. While the recovery quotas are consistently above the target value of 75 %, two companies do not yet reach the target value of 65 % for recycling.

It must be noted here that European countries often report fantastically high recycling and recovery quotas. From our perspective, this is an inadmissible simplification of the (unclear) calculation models and disregard for the requirements of the regulations as laid down in EN 50625-1:2014. Pursuant to the will of the EU Commission, the standard will determine the status of technology in Europe and is to be defined as part of the next amendment to the WEEE Directive. It is therefore essential that the calculation methods are harmonised in line with the previously mentioned statement of the European associations.

The findings gained from the project allow Swico's processing partners to make a comparable estimate of their recycling performance and identify

Printed circuit board fractions from manual processing



Printed circuit boards from manual dismantling.

measures for improvement. As part of the operational inspections by Empa, regular batch tests will also be carried out in the future in accordance with the specifications of SN EN 50625-1:2014. Here the required target values must be achieved regardless of the input composition. If the target values are not achieved once more, this may result in the termination of the cooperation agreement.

Since 15 August 2015, stricter requirements have applied in accordance with the European WEEE Directive. The target values were raised by 5 % so that they are now 70 % for recycling and 80 % for recovery in the case of categories 3 und 4. SENS and Swico have not yet introduced the higher quotas, so the previous minimum quotas still apply.

The specifications for the recycling and recovery targets involve a weight-based assessment, which only takes into account the large material flows and ignores the recovery of rare technical metals. In addition, the target values do not say anything about the associated environmental performance. Under the scope of an ETH research project headed up by Empa, the scientific principles assessing the environmental performance of the treatment of electronic scrap will therefore be investigated. Results are expected in autumn 2017 and will be incorporated into the Technical Report 2018.