Rolf Widmer / Heinz Böni

Flat panel displays with mercury continue to dominate the market

In the second half of 2016, batch tests were carried out at several recycling companies to determine recycling and recovery rates and the composition of flat panel display devices.

Three of the six companies only dismantled TV sets and PC monitors. For every batch test, at least 5 t or 250 FPD units were provided in accordance with SN EN 50625-1:2014 in such a way that the combination of devices to be dismantled was as representative as possible for normal operations (size and age of the devices). The test planning was discussed with the assigned inspection experts, the tests carried out independently and the results and the photo documentation handed over to the inspection experts. To determine the recycling and recovery rates, the following treatment steps through to end use were depicted with values from RepTool for the generated dismantling fractions (Table 2).

The following tables illustrate the results of the tests in anonymised form. The respective minimum or maximum value is listed for the values determined.

Table 1: Parameters of the batch tests

Flat panel displays	TV sets		PC monitors	
	min	max	min	max
Total weight/kg	3 047	5 143	1 354	9 271
No. of devices	250	332	250	1 930
% of CCFL	74%	89%	88%	100%
% of LEDs	11%	26%	0%	12%
Average weight/kg	12.2	18.3	4.8	5.7

Either 5 t or 250 units are permitted for manual FPD dismantling. Most companies interpret the number of 250 FPDs as the minimum requirement. Particularly striking is the average weight of TV sets, which is three times as large as that of PC monitors. Recycling of LED devices still occurs at a much lower rate than recycling of CCFL devices containing mercury.

Table 2: Percentage-based mass fractions of the output fractions generated from the devices as well as their modelled percentages in the categories: Recycling (R), Other Material Recovery (OMR) plus Energy Recovery (ER).

Output fractions	Treatment/use	TV sets		PC monitors		Model	
		min	max	min	max	R	OMR+ER
Iron “pure”	for recycling	37.2	46.6	30.2	37.4	97	3
Cr-Ni steel “pure”	for recycling	0.0	0.3	0.1	0.4	97	3
Aluminium “pure”	for recycling	3.9	5.1	6.0	7.5	95	1
Copper or brass “pure”	for recycling	0.0	0.0	0.0	0.4	90	10
Plastics “PS mix”	for further processing	5.8	17.5	14.8	31.0	90	10
Plastics “PMMA”	for recycling	5.1	16.2	15.8	15.8	90	10
Plastics “PS mix toxic”	for incineration	12.9	12.9	21.5	21.5	0	62
Plastics “PS metal mix”	for further processing	5.4	22.4	0.0	0.0	60	26
Printed circuit boards	for recycling in copper foundry	7.1	9.7	6.4	7.2	30	65
Cables and plugs	for further processing	0.8	2.7	0.9	4.6	50	31
Background lighting CCFL	for disposal	0.8	1.0	0.2	0.9	0	0
Background lighting LED	for disposal	0.1	0.2	0.1	0.1	0	0
LCD panels	for incineration (possible storage	7.3	8.7	7.7	16.5	0	62
Speakers	for further processing	2.0	2.4	0.3	0.3	97	3
Power supply	for further processing	1.4	1.4	0.0	0.0	76	23
Fans	for further processing	0.0	0.0	2.7	2.7	76	23
Waste	for incineration	4.0	4.6	0.3	3.4	0	62
Condensers	for (therm.) disposal	0.3	0.3	0.3	0.3	0	0

According to the results, the two fractions with the largest weight are the ‹pure› metals (Fe, Al, Cu), of which up to 97 % can be recovered; as well as the plastics, which can be recovered on average up to 70% (TV) and 83 % (PC).

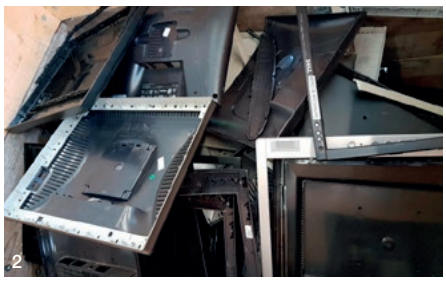
Table 3: Achieved recycling and recovery rates (Recycling Rate=MR/input and Recovery Rate=(MR + ER + OMR)/input

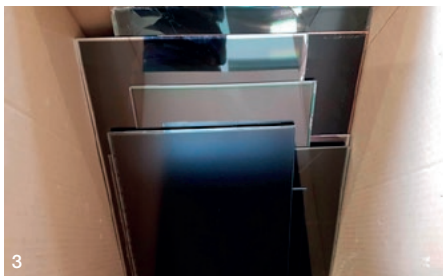
Rates	TV sets		PC monitors	
	min	max	min	max
Recycling rate	65.3%	75.4%	60.3%	80.3%
Recovery rate	88.3%	93.1%	87.1%	95.2%

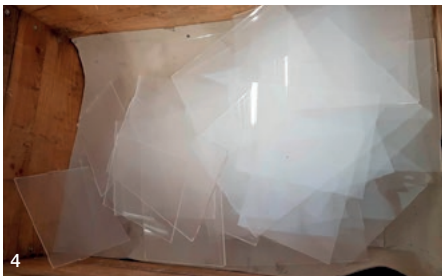
The target for the recovery rate is 75% and is clearly exceeded by all companies (Table 3). The target for the recycling rate is 65% is exceeded, but by much less, by all companies except one. The main reason why the recycling target was not or just barely met is the high amount of plastics that is disposed of by these companies in incinerators. One reason for this difference in processing may be that some companies recycle the plastics because they assume they are safe based on their own sample inspections, while others, lacking evidence that the plastics are safe, follow a careful and correct strategy and dispose of them thermally. The continued high CCFL percentage (Table 1) in the area of background

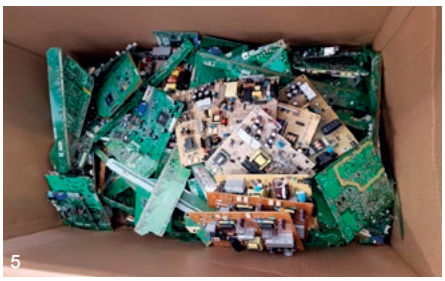
lighting shows how legitimate the regulations to prevent the release of mercury still are. In particular, FPD devices must be treated as though they contain mercury as laid down in SN EN50625-2-2:2015 “Treatment requirements for ... CRTs and FDPs ...” FDP devices are treated as though they contain mercury if nothing else can be determined. Waste electronic and electrical equipment containing mercury may not be crushed, pressed or manipulated before the hazardous substances are extracted. Appropriate and effective measures must be undertaken and documented showing that mercury is verifiably monitored and removed. Mercury must be verifiably removed from fractions that could be contaminated with mercury (e.g. circuit boards or housing) before they can be sent to be recycled. The mercury concentrations in the air of all working areas identified by the risk assessment(s) and in the affected contractors must be monitored regularly.

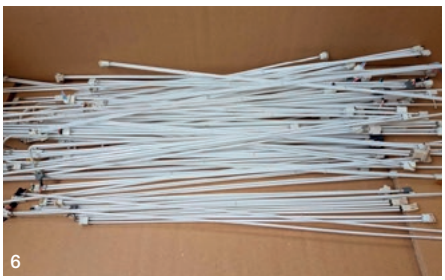
The mercury, but also the flame retardant problem, will still continue to affect FPD treatment for some time as a result of these rules.











Some of the fractions generated:
1) Fe ‹pure›, 2) Plastic housing ‹mix›, 3) FPD panels,
4) PMMA panes, 5) Circuit boards, 6) CCFL background lights.