

The activities of the technical audit departments in the last 25 years

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Even though it is still a relatively recent aspect, the technical auditing of electrical appliance recycling has seen a rapid evolution. What started as isolated activities with few stakeholders is now integrated into a Europe-wide recycling and auditing process. We take a look back at the significant events of the last 25 years of expert work in the service of environmentally friendly recycling of electrical or electronic appliances.

It is impossible in retrospect to reconstruct exactly when the auditors of Swico Recycling and SENS started their work. The 1994 activity report of Swico Recycling already mentions Empa's work as the audit department of Swico Recycling. The oldest technical report of the SENS Technical Audit Department for the attention of the Head Office dates back to 1997. This means that the auditors of SENS and Swico Recycling have been active for at least 25 years. Initially, Empa and the two SENS technical auditors worked largely independently of each other. Joint audits began in 1999. Nine years later, the cooperation was so close that the two audit departments were transferred to a joint body. Finally, in 2009, the technical and environmental requirements for recycling were also harmonised in the contracts between Swico Recycling and SENS with the recycling partners.

Focus on hazardous substances

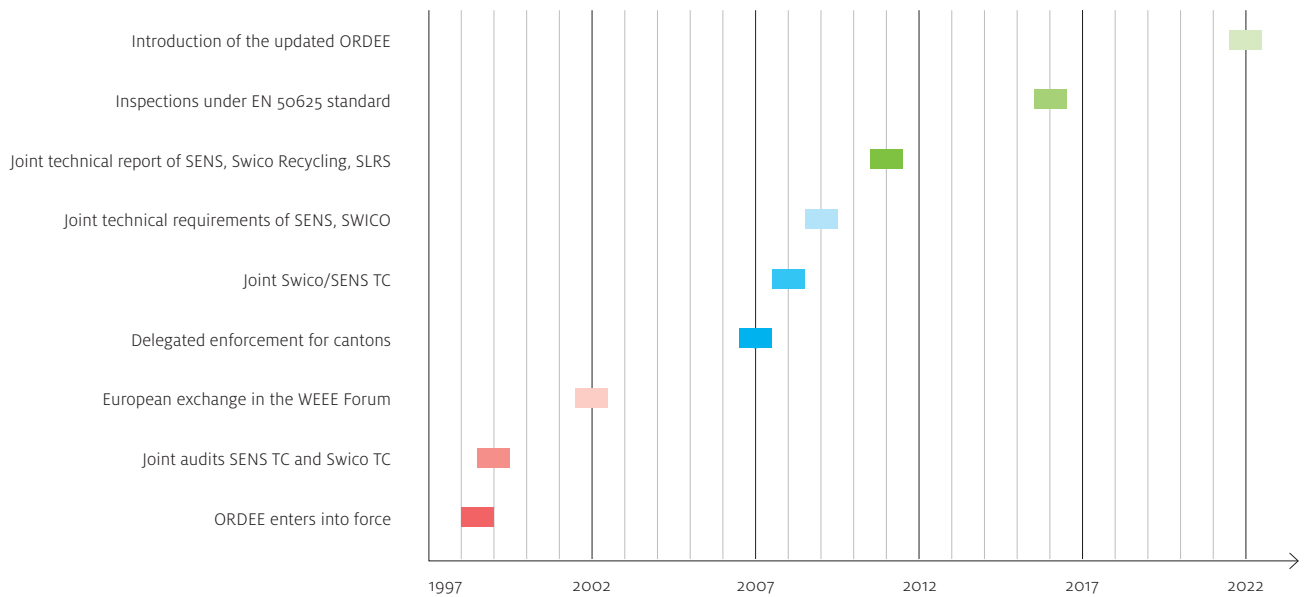
At the beginning of the audit activities, the correct separation and disposal of components containing hazardous substances from electrical or electronic appliances kept the committees very busy. The focus was on batteries containing heavy metals, getter pills containing barium from screens, CFCs from temperature exchange equipment, capacitors containing PCBs and appliance oils. Later, new problematic components appeared: on the one hand, lithium batteries cause difficulties in the recycling process, and on the other hand, new appliances with specific hazardous substances appeared, such as flat screens, lighting equipment or medical devices. Over time, the analysis of material flows at recyclers and the identification of subsequent treatment and disposal routes became more important. Procedures to demonstrate the most extensive

recycling and environmentally friendly disposal of materials from appliances were developed and implemented. Recently, there has been an increased focus on promoting the recovery of recyclable materials and on continuously improving know-how about the substances contained in appliances.

Influence on European developments

Like their clients, the technical audit departments developed dynamically. The take-back systems of SENS and Swico became operational before the Ordinance on the Return, Taking Back and Disposal of Electrical and Electronic Equipment (ORDEE) came into force in 1997. Auditing activities also started before the ordinance came into force. It was only the ORDEE that created the legal basis for a take-back and recovery obligation for old electrical appliances. The technical exchange between the SENS and Swico Recycling Technical Committees intensified with the introduction of joint audits by SENS and Swico Recycling. This helped to improve material flow analysis at recyclers and the development of key figures for assessing recycling quality. The public also became aware of the intensified cooperation after the joint technical report was published for the first time in 2011. The findings were discussed as part of a European framework in the WEEE Forum as early as 2002. Swiss experts were heavily involved in the development of a European standard for the recycling of electrical and electronic appliances from the very beginning. These activities resulted in the WEEELABEX standard and the 50625 series CENELEC standards. WEEELABEX-based audits were not introduced in Switzerland. Once the European EN 50625 series of standards was completed, it became the technical basis for Swico Recycling's audits from 2017 and SENS's audits in 2020.

Figure 1: Timeline of the development of the Technical Commission.



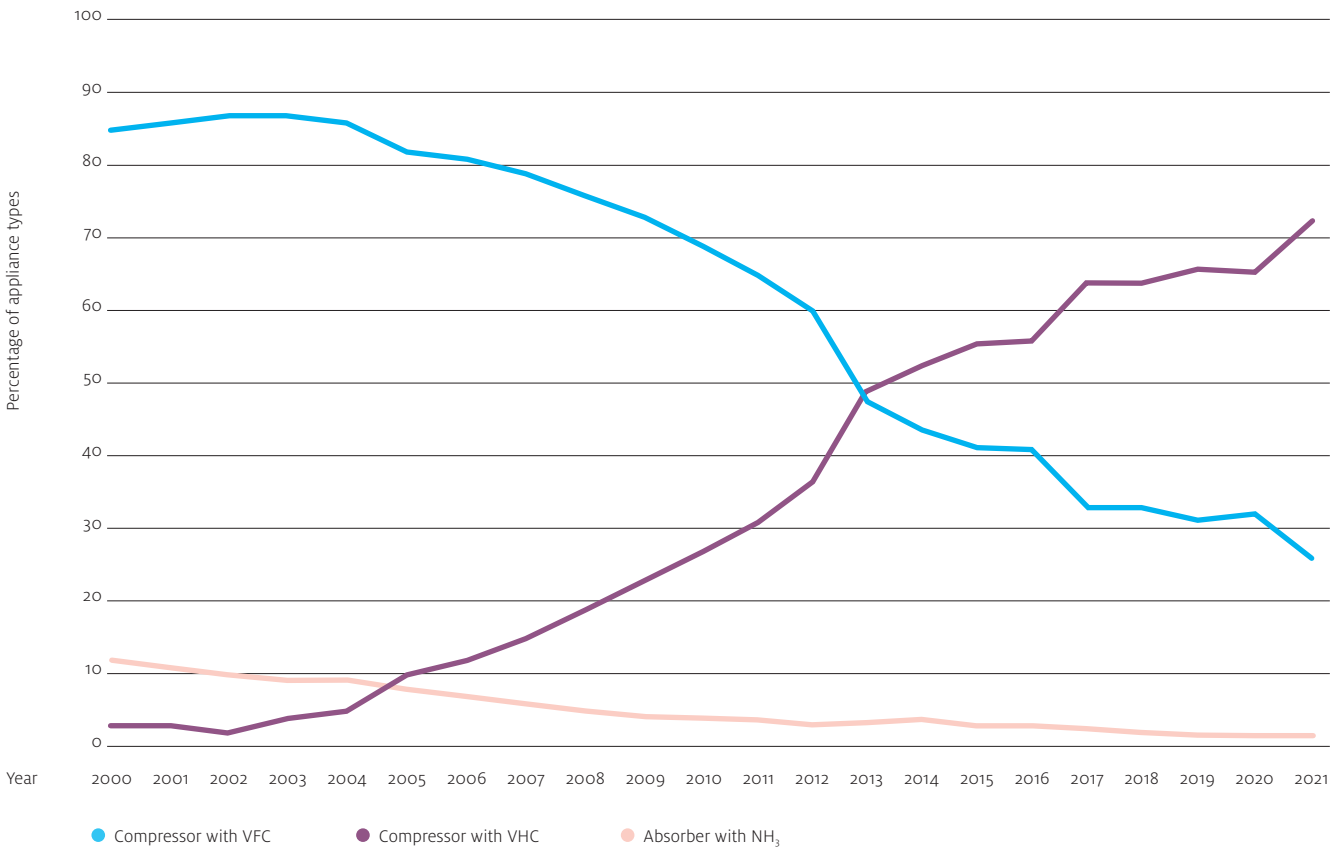
The expertise that the members of the audit departments have acquired over the years has also led to increased demand for support abroad. In 2002, for example, the State Secretariat for Economic Affairs (SECO) tasked Empa with clarifying possible projects for the sustainable handling of electronic waste in developing countries. This gave rise to projects in several countries in Africa, Latin America and Asia, for which Empa provided management and technical support.

A large number of experts have served as auditors over the years. Kurt Munger took over the chairmanship of the Swico Technical Commission at the beginning, followed by Johannes Gauglhofer, Martin Eugster and Heinz Boni. The SENS Technical Commission initially consisted of Ueli Kasser and Geri Hug. In the early years, Robert Hediger, as Managing Director of SENS, played a decisive role in the development of the SENS Technical Commission and its strategic focus. As it grew, Ueli Kasser took over as chair. The management was taken over by SENS staff members Daniel Savi, Paul Scherer and Roman Eppenberger starting in 2008. All the experts involved had a strong influence on the development of the auditing practice of SENS. In addition to those already mentioned, these were Anahide Bondolfi, Anne-Christine Chappot, Flora Conte, Emil Franov, Niklaus Renner and Silvan Ruttimann. Empa has deployed various members of staff in the audit team over the years, some of whom served as auditors only for a shorter period of time. Although they cannot all be listed here, they each made an important contribution to the development of auditing. Long-standing auditors, in addition to the chairs of the Swico Technical Commission, were Esther Thiebaud, Patrick Wager and Rolf Widmer.

From an environmental point of view, temperature exchange equipment has always held a special position. Since refrigeration and air-conditioning equipment mostly contained CFCs as a refrigerant until 1990, the safe recovery and destruction of the refrigerant has been an important auditing task since the beginning of the experts' work. Year after year, recyclers reported the shares of CFC-containing and CFC-free refrigeration equipment. Early on, the auditors made forecasts on when CFC-containing appliances would have to be disposed of. In retrospect, it is evident that the phase-out of CFCs was expected to happen much faster than it is now proving to be in practice. According to a 2000 forecast, all refrigeration equipment containing CFCs was expected to be disposed of by 2022. In reality, a quarter of the cycles in the appliance return still contain CFCs.

In the case of information technology and consumer electronics appliances, CRT screens have long occupied a prominent position in auditing activities. In the past, they made up a significant part of the weight of recovered appliances in the Swico stream, representing up to 35 per cent of the total. The focus was on the clean separation of lead-containing and residual glass, the separation of getter pills containing barium and the proper disposal of plastics containing hazardous substances. In addition, the luminescent layer contains hazardous substances on the one hand, but is also rich in rare elements on the other hand. This luminescent layer must be removed and sent to landfill. This example shows that today it is standard practice to dispose of hazardous substances in an environmentally friendly way or to isolate them from the environment. However, it has not yet been possible to return

Figure 2: Effective development of VFC and VHC appliances by 2021.



all recyclable materials from mixtures, such as the rare earths from the luminescent layer, back into the raw material cycle.

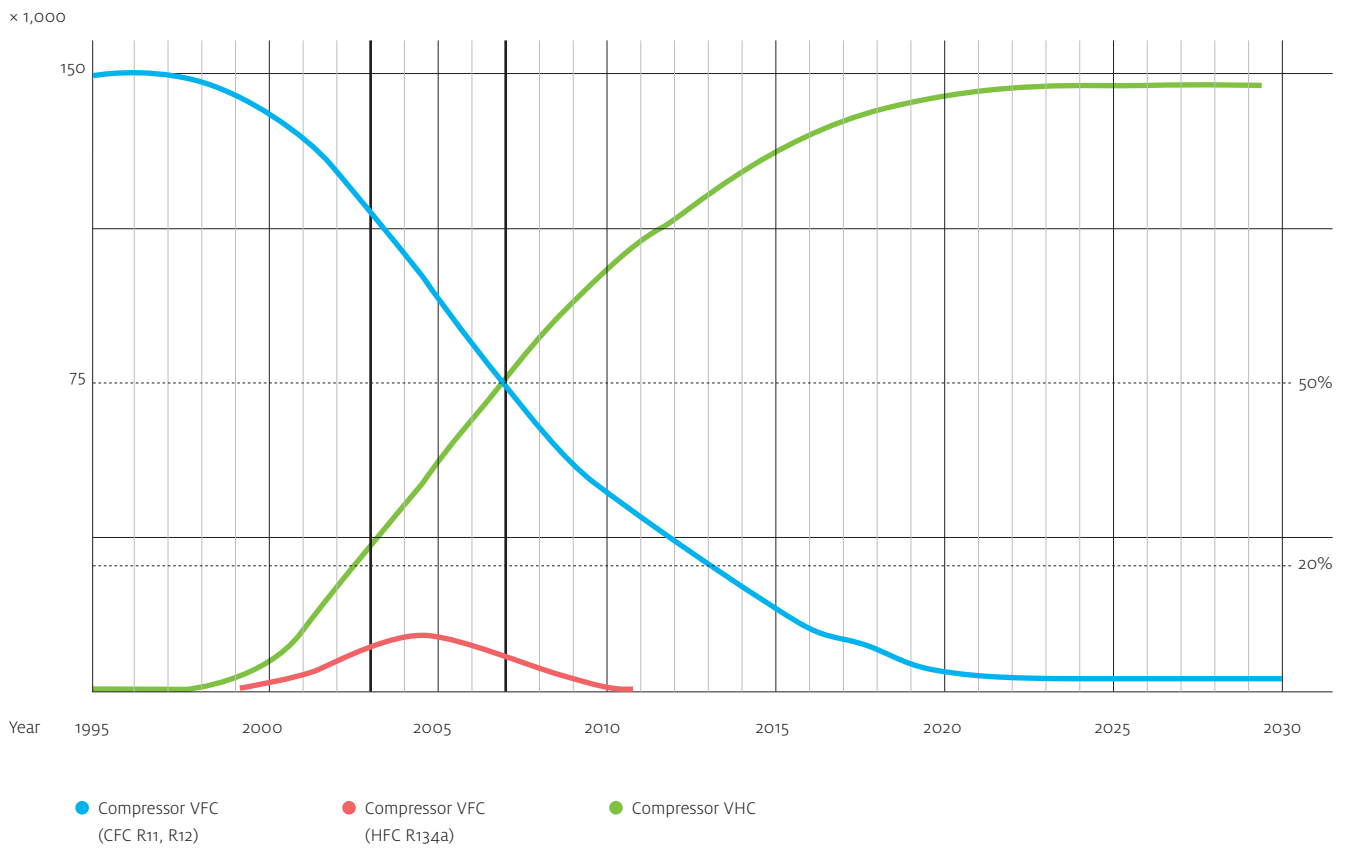
The second major issue relating to hazardous substances, especially where large household appliances are concerned, was that of PCBs-containing capacitors. Before the introduction of the SENS system, large household appliances were still mostly disassembled by hand. If the appliances were crushed in the shredder, this was done without prior removal of hazardous substances. In the 1990s, shredding became the standard for the disposal of large household appliances. This resulted in the requirement starting in 2000 that capacitors containing hazardous substances had to be removed before they could be mechanically processed. The rule of thumb was implemented back then. According to this rule, all capacitors that are the size of a thumb or larger must be removed from appliances by hand. At the time, probably no one imagined that this rule would come to be included in a European regulation and standard later on. With the decrease in capacitors containing PCBs in large household appliances, it is now a question of when this rule should be lifted again. In this context, the environmental consequences of a repeal have to be

weighed against the cost of the separate disposal of an ever smaller quantity of PCBs.

Plastics have always been an important fraction, especially in household appliances and consumer electronics. But their share in all other appliance categories has also increased steadily over the last 25 years. The large number of different types of plastic, the flame retardants that are often present and the mixed plastics that are frequently used make recycling them a complex and challenging task. The share of recycled plastics is still far from what is required for a circular economy. In addition, new plastics are cheap raw materials. As a result, the economic incentives for increased plastics recycling are low. In future, it will be a challenge for take-back systems and auditors to promote plastics recycling through smart incentives.

With the introduction of the updated ORDEE and the still outstanding implementation aid regarding state-of-the-art technology, WEEE recycling in Switzerland will have an updated legal basis in 2022. Miniaturisation in electronics, the increased use of plastics and mains-independent appliances

Figure 3: Forecast for the development of refrigerators from the 2000 Technical Report.



are constantly creating new requirements for recycling. This dynamic will continue to shape the future work of the technical audit departments of SENS and Swico.