



CEWASTE

Voluntary certification
scheme for waste treatment

PILOTING REPORTS AND MATURITY LEVEL ASSESSMENT

DELIVERABLE 4.3



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 AUTHORS: Norbert Zonneveld (EERA), Lucia Herreras & Eniko Hajosi (WEEE Forum), Yifaat Baron & Viviana Lopez (Oeko), Sonia Valdivia & Shahrzad Manoochehri (WRFA), Adeline Maijala & Harri Kaartinen (SGS)
 REVIEWED BY: All authors
 E-MAIL: Shahrzad.manoochehri@wrforum.org

Project Coordinator:	World Resources Forum Association
Work Package Leader:	Sofies
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ACRONYMS

CRM	Critical Raw Material
EEE	Electrical and Electronic Equipment
CoC	Chain of Custody
KCC	Key CRM Component
KCE	Key CRM Equipment
LAB	Lead Acid Batteries
LIB	Lithium-Ion Batteries
PRO	Producer Responsibility Organisations
SoC	State of Charge
TEE	Temperature Exchange Equipment
WEEE	Waste Electrical and Electronic Equipment
WP	Work Package

EXECUTIVE SUMMARY

This report outlines the key findings of the project's pilot audits and includes a consolidation of the feedback provided for improving and/or adjusting the CEWASTE normative requirements and the related assurance system and verification procedures, as well as recommendations related to other existing standards that were referenced in the CEWASTE document. Furthermore, the deliverable provides a comprehensive assessment of the readiness level of the audited operators against the management and technical requirements for recycling of critical raw materials (CRMs). In general, the findings show that the audited operators have an adequate level of preparedness. In cases where CRM recycling process was in place, most CEWASTE requirements were feasible and applicable in the real-life environment. Most of the cases of non-compliance were due to the fact that the CRM recycling process has not been implemented due to lack of economic or normative incentives. In some specific cases the non-compliance was due to lack of incentives for implementing the related recycling process, which was mainly associated with lack of market or acceptors for the output materials.

1 INTRODUCTION

1.1 THE CEWASTE PROJECT

The Horizon 2020 project CEWASTE aims to improve the recycling of valuable and critical raw materials (CRMs) from waste electrical and electronic equipment (WEEE) and waste batteries. As such, the project addresses the specific challenge to secure the access to valuable and CRMs for the EU economy and objectives set by the EU action plan for the Circular Economy¹ and the European Green Deal². It also aims to support the development of environmentally and socially sound recycling systems globally.

To achieve its objective and to ensure a comprehensive approach and a robust result, the project started with conducting a baseline and gap analysis to understand the existing recovery practices for recycling of CRMs from key types of waste and define the key equipment with sufficient content and concentration of CRMs, i.e. Key CRM Equipment (KCE). The KCE include different types of WEEE and batteries from electrical and electronic equipment EEE and end-of life vehicles (ELVs) with sufficiently high concentrations and processing technologies enabling the recycling of CRM. This analysis also led to the identification of the Key CRM Components (i.e. fluorescent powders, waste batteries, magnets and printed circuit boards) and the key CRMs that will be addressed in the frame of the CEWASTE certification scheme (See Deliverable 1.1 of the CEWASTE project³).

As part of the baseline analysis and by assessing more than 60 existing legislation, standards, certification schemes and guidelines, the gaps in the existing normative requirements were identified and the focus area for the CEWASTE voluntary scheme was defined. The main conclusion of this analysis was that the technical criteria need to be developed for CEWASTE, while non-technical requirements may be referenced from current legislation and standards. Moreover, it was revealed that the European Standard on Collection, Logistics and Treatment Requirements for WEEE⁴ (EN50625) approved by CENELEC on 2014-01-27, can be considered as a basis for development of the CEWASTE requirements (See Deliverable 1.1³)

Where the existing requirements were not sufficient to meet the CEWASTE objective, new set of requirements were developed. These include managerial, environmental, social, traceability and technical requirements for recycling of valuable and CRMs from the

¹ https://eur-lex.europa.eu/resource.html?uri=cellar:9903b325-6388-11ea-b735-01aa75ed71a1.0017.02/DOC_1&format=PDF

² https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

³ https://cewaste.eu/wp-content/uploads/2020/03/CEWASTE_Deliverable-D1.1_191001_FINAL-Rev.200305.pdf

⁴ https://ec.europa.eu/environment/waste/weee/standards_en.htm

identified KCE (See CEWASTE requirements⁵). To ensure a transparent stakeholder process that allows for broad acceptance and dissemination of the essentials of the scheme, external stakeholders including the project's Advisory Board members were consulted and their feedback was used to improve the certification scheme through several review and revision rounds. An assurance system and related verification procedures were developed with the aim to ensure that facilities and raw material streams are compliant with the CEWASTE requirements.

The new certification scheme was validated through 20 targeted pilot audits with selected and committed stakeholders of the value chain. Ultimately the project will develop a roadmap to ensure long-term sustainability of the scheme.

1.2 PURPOSE OF THE DELIVERABLE

This report corresponds to deliverable 4.3 of the CEWASTE project and includes consolidated feedback and key learnings from the piloting process. More specifically, the comments that can lead to improvements or adjustments in the normative requirements and the assurance system and verification procedures developed by CEWASTE, as well as recommendations for the already existing standards that were referenced in the CEWASTE requirements, are consolidated and presented in this document. Moreover, an assessment of the readiness level of the operators that participated in the pilot audits is introduced in this deliverable report. The deliverable starts with a chapter on methodology in which more information about performing the pilot audits and evaluation of their outcomes is provided.

⁵ <https://cewaste.eu/wp-content/uploads/2019/12/CEWASTE-normative-requirements-for-public-consultation.pdf>

2 METHODOLOGY

2.1 PILOT AUDITS

Between March and the end of November 2020, the project conducted 20 pilot audits (led by Sofies). The organisations and companies targeted for audits were mainly selected from members of EERA (European Electronics Recyclers Association) and WEEE Forum (International Association of Electronic Waste Producer Responsibility Organisations), ensuring full coverage of the collection, logistics, pre-treatment and final treatment stages, diversity in size and geography of facilities, and other criteria defined in order to ensure that the applicability of the scheme is as wide as possible (See Deliverable 4.1 for more details about the planning process for pilots⁶).

To complete the team of internal auditors from the project consortium, external auditors interested in piloting the voluntary CEWASTE scheme were invited to submit an express of interest. The internal auditors and the selected external auditors were introduced to the CEWASTE requirements as well as the EN 50625 standard series during a series of online training webinars. The trainings were divided into four online webinars of 2 to 4 hours (See Deliverable 4.2 for more details about the training sessions⁷).

The initial planning was to perform physical (on-site) audits, however, due to the COVID-19 outbreak in Spring 2020 and the regulations for restricted movement of the citizens in Europe (and other countries) some of the physical pilot audits were carried out remotely in a virtual format. A total of seven physical and five virtual audits took place. Additionally, one audit was partly physical and partly virtual: management requirements were verified in an online session, while technical requirements were checked on site.

As illustrated in Figure 1, audits were performed at ten European companies (in Belgium, Italy, Portugal, Spain and Switzerland) and three outside Europe (Colombia, Rwanda and Turkey). There were ten audits performed testing the CEWASTE pre-treatment requirements and three operators were audited against the final treatment requirements. Logistics requirements were tested at four facilities, while collection requirements were audited at three collection facilities. Due to the temporary closure of collection facilities caused by the pandemic, some audits had to be cancelled. In order to get feedback on the applicability and feasibility of the CEWASTE requirements related to collection, an additional questionnaire

⁶ D4.1 – Validation Methodology for the Pilots

⁷ D4.2 – Training Materials for the Piloting Team

was prepared and sent out to relevant Producer Responsibility Organisations (PROs) to verify the collection related requirements.

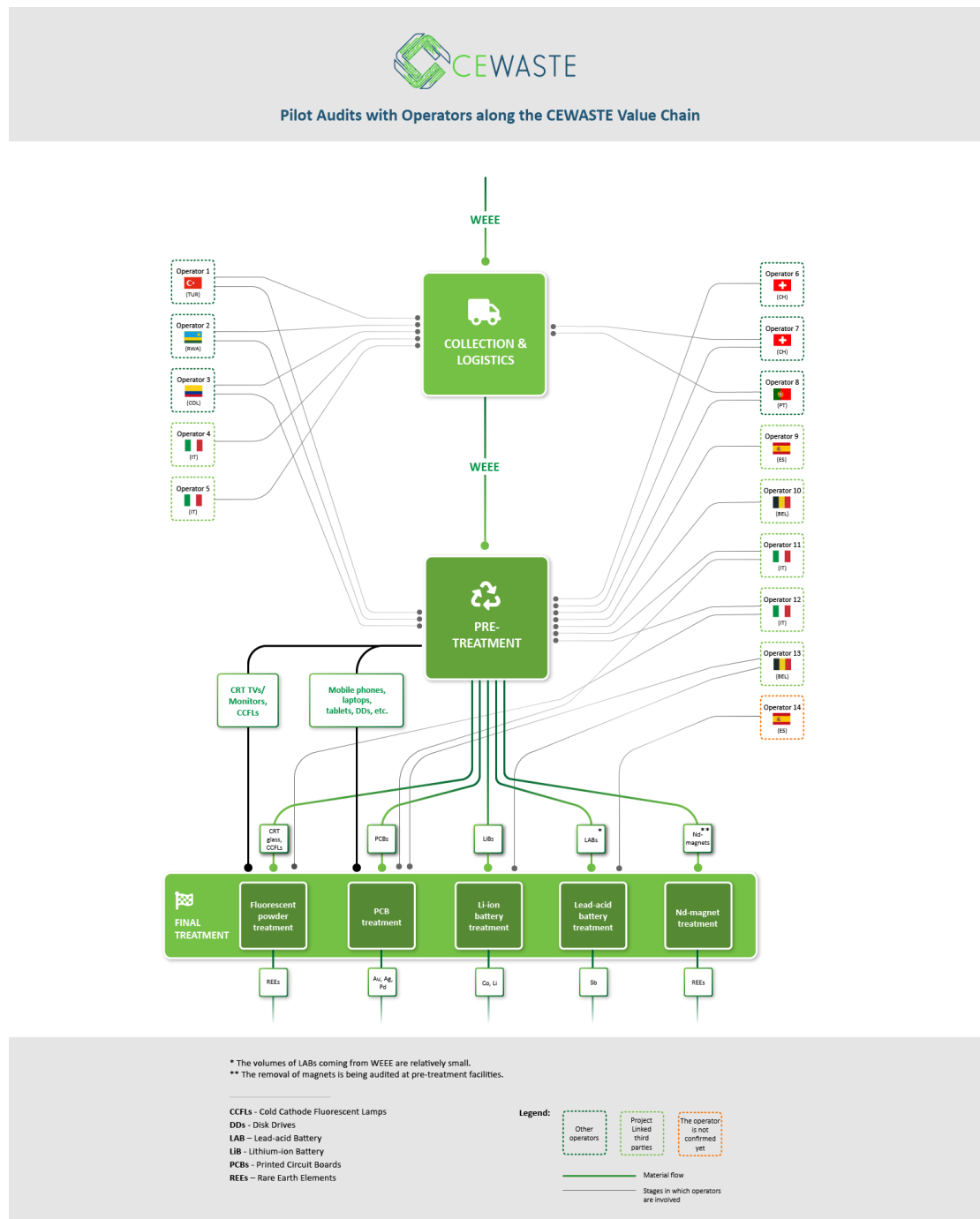


Figure 1. CEWASTE pilot audits with geographical distribution of operators along the value chains

Performing virtual audits proved to be a useful option in the verification process in times of the pandemic. Experiences show that virtual audits work best when verifying compliance against the management requirements. However, testing the technical requirements in a virtual format can be implemented with some limitations and in these cases physical audits proved to be more efficient. The overall finding is that virtual audits need much more

planning ahead, in addition unforeseen technical issues (e.g. internet connection) might need to be tackled and explanation of the complex auditing requirements in a virtual audit can be a challenge specially when language differences exist.

2.2 ASSESSMENT OF PILOTS FEEDBACK

As part of the CEWASTE verification procedures developed in work package 3 (WP3), a checklist tool was developed to support the auditors in the audit process and provide them with a template for gathering their feedback as well as comments of the audited facilities. This checklist tool, which is designed as an excel worksheet, includes questions for each of the CEWASTE normative requirements and explanatory texts for the auditor and the operator. By using filtering options in the applicability columns, the excel format allows flexible navigation to specific parts and content of the requirements. The CEWASTE requirements have been based to some degree on existing requirements of the CENELEC EN 50625 series. The provision of filtering options would also allow “hiding” questions for such requirements in the case of a CENELEC certified facility. A screenshot of the this excel file and its applicability columns is illustrated in Figure 2.

During the pilot process, all comments and feedback from the auditor and the operators was documented in this checklist tool. This led to collection of more than 600 comment lines in the excel file. Following the finalization of the audits, several online working sessions were organized, where all project partners participated and reviewed the comments in the order of their importance (i.e. major, moderate, minor and editorial). After thorough evaluation of these comments, the partners decided on how to adopt the normative requirements, the assurance system and the verification procedures to address these comments. The resolutions were recorded in the same excel file (Figure 2). The current deliverable includes a consolidation of these comments and the way these were addressed in the revised version of the documents.

As previously mentioned, development of the normative requirements and the related assurance system and verification procedures is an iterative process with several rounds of the review and revisions. In the piloting process, version 7.0 of the CEWASTE normative requirements (developed in WP2) and version 6.0 of the checklist tool (developed in WP3) were validated. The pilot feedback will be integrated in V8.0 of the requirements and V7.0 of the checklist tool.

Type of operator	Type of WEEE	Certification scope	V7 clause	V7 requirement	Type of requirement	Question ID	Audit question	Explanatory information for auditors	Explanatory information for operators	NC	Comment from auditor	Feedback priority (major/moderate/minor/editorial)	Feedback to WP2	Feedback to WP3	Resolution
Collection points	All (WEEE and waste batteries)	CEWASTE + CENELEC	4	Refer to clause 4.2 of TS 50625-4	Other	Q4.0.3.3	[skip this questions for countries where WEEE and Battery producer responsibility regulation imposes handling of the WEEE and waste batteries by approved takeback schemes (this	Check records showing the destination of the waste in the scope of the audit leaving the collection point. Verify that the destination of the waste is compliant or is working towards	Collection point operators shall track destination of waste covered by this audit. They must collect information on each destination's conformity with the applicable EN	Non-conformity	WEEE and batteries are managed by takeback schemes, collection operator does not have tools to choose the destination.	Major			WP2: Text proposed "If takeback schemes are in place, collection operators shall channel through them" This could be included in a Note or within the requirement text.
All	All (WEEE and waste batteries)	CEWASTE only	4.1	Main management principles of the management system that shall be in place include 'legal requirements and identification and	High relevance	Q4.1.0.0	Does the management system of the operator include a mechanism for risk assessment and mitigation related to environment, health and safety risks (i.e. are procedures documented in the management plan	The auditor shall check that operators have identified risks, defined how they should be assessed and defined measures for their control and mitigation as well as the frequency at which	The operator shall develop rules and procedures on risk assessment in its management plan. These shall detail how risks are to be identified and assessed and how measures should be defined for the control and mitigation of	Compliant	DVR (Documento Valutazione Rischio=Document for Risk Evaluation) + risk assessment table (risks for health, safety and environment).	Moderate		Suggestion: possibly to include a specific session for CRM in the risk assessment: both for environment and Health and	No need to change anything
All	All (WEEE and waste batteries)	CEWASTE only	4.1	To support continuous improvement, a documented 6 to 12-month Management, Monitoring and Evaluation Plan (MM&E. See example in Annex	Other	Q4.3.0.3	Is there a documented 6-12 month plan established to support continuous improvement Does the plan include short-term and mid-term actions and key performance indicators	The auditor should check that the operator has a documented 6-12 month plan for monitoring and achieving continuous improvement in place including short- and mid-term objectives	The operator should show a documented 6-12 month plan is in place including short- and mid-term objectives, actions and KPIs. During the audit the operator shall explain how continuous improvement is addressed in this plan and how its achievements	Compliant	They have a risk matrix and objectives, every year they discuss about the conclusion and the implementation. But there is not an evaluation at CRM level	Moderate		Suggestion: add targets on CRM, not quantitative, but qualitative: there's possibility to recover Yttrium, or fluctuation of composition of	WP3: Elaborate further details in manual texts based on the example of Annex II.

Figure 2. Screenshot of the checklist tool developed for the auditing process. The recommendations for improving or adjusting the normative requirements (feedback to WP2), the assurance system and verification procedures (feedback to WP3) are consolidated in the current deliverable. Moreover, the readiness level of the operators for implementing the CEWASTE certification scheme was assessed based on these comments.

3 CONSOLIDATED FEEDBACK FOR THE CEWASTE

NORMATIVE REQUIREMENTS

Based on the feedback received from the pilot audits the following modification and adjustments were incorporated in a revised version of the normative requirements (Version 8.0). These changes were mainly implemented to improve the consistency, user-friendliness, relevance with respect to the CEWASTE purpose and completeness with regards to the CEWASTE scope. The main changes are summarized below:

- **Definitions:** Most definitions were adapted and revised to fit the CEWASTE scope and purpose. More specifically, new, commented and full definitions were added including the ones for 'waste batteries', 'due diligence' and 'removal'.
- **The Key CRM Equipment (KCE) list was revised:** Large and small appliances as well as temperature exchange equipment (TEE) were removed from the CEWASTE scope as they do not contain CRM components or fractions thereof in significant amounts for making their recovery economically feasible.
- The **international application of the CEWASTE requirements** was clarified and in cases where no national regulations nor equivalent to the European regulations exists, it was required to follow the later.
- For **transboundary movements (beyond Europe)** the Basel Convention requirements and wastes codes were referred to.
- **Requirements for substances impacting the environment or human health** particularly for States lacking regulations were adopted based on the Internationally Peer Reviewed Chemical Safety Information System – INCHEM (also accessible per CAS Number) (www.inchem.org).
- The **traceability requirements** were based on the due diligence approach and applicable to lead-acid batteries and printed circuit boards whenever they are sourced from Non-OECD countries (in accordance with the OECD Due Diligence Guidelines for Multinational Enterprises). The due diligence approach will allow for "second- or third-party verification" and aim to prevent shipments of WEEE and waste batteries from operators whose operations fail to comply with the purpose of this normative document.
- The **mass balance approach** was decided as convenient for specifying the sizes of the outputs compliant with CEWASTE.

- **Most recent developments concerning the revision of the EU Batteries Directive (2006)** were taken into account such as the yields of lead-acid batteries. Moreover, the requirements on batteries storage and sorting practices were expanded as well as yields of Li-ion batteries added.
- **The requirements for ‘collection points’ were revised** as in most cases they do not need to fulfil the same requirements as ‘collection facilities’.
- The **diagram flows** for navigating through the CEWASTE and CENELEC clauses were revised for improving their readability and consistency.

4 CONSOLIDATED FEEDBACK FOR THE ASSURANCE SYSTEM AND VERIFICATION PROCEDURES

Though the pilot audits performed give insight as to the applicability of both the assurance system and the verification procedures, the audits were performed using the tools developed as part of the latter (Figure 2) and in this sense most feedback received applies to the tools and their applicability.

Feedback during the pilot audits was collected both in relation to how specific requirements are addressed in the auditing tools as well as in general regarding the usability of these tools. Most feedback can be distinguished to one of the following main categories. How feedback was considered is shortly described.

- **Feedback on the requirements:** Where feedback led to changes in the requirement document, these were later considered in the subsequent updating of the auditing excel tool.
- **Feedback on the suitability of questions and/or explanatory information provided in the auditing excel tool for specific requirements:** Content related feedback was given in some cases as to the lacking suitability of certain texts to a specific requirement, which could hamper the efficiency of its auditing or its implementation. In such cases, adjustments were made to ensure suitability, for example by adding examples of compliant or non-compliant performance in the manuals (explanatory information) or by ensuring that the question and explanatory information given in the tool was compatible with the requirement it had been developed for.

- **Feedback as to the feasibility of complying with specific requirements:** Seeing as feedback was often collected from a number of operators for a specific requirement, it allowed comparing the feasibility of compliance and concluding whether incompliance only reflected a lesser performance of a specific operator or a level of ambition too high for certain facilities. Though such feedback was usually more relevant for deciding on the requirements themselves, in some cases it also indicated a need to consider how non-compliance was to be considered in the decision on certification of a facility. In this respect, the scheme rules differentiate between requirements with “high relevance” that need to be complied with for a facility to be certified and “other” requirements, of which compliance with most requirements (70%) is sufficient for certification. In this sense such feedback was considered when setting the total share of “other” requirements that needs to be complied with in the scheme rules. Furthermore, where such feedback led to changes in requirements, this also subsequently led to an update of the auditing excel tool.
- **Reference made as to requirements similar to requirements under certain ISO standards:** The pilots showed that there was an overlap between some requirements and between some ISO standards of relevance to waste operators (e.g. ISO 9001, ISO 140001 and ISO 450001). It was thus decided to review the auditing excel tool and to add a filtering option for certain ISO standards to allow the “hiding” of relevant questions when auditing an ISO certified facility. This concerns mainly requirements in the management chapter.
- **Reference made to repetition of certain aspects within the excel auditing tool:** In some cases, this meant that a requirement appeared multiple times and was thus asked about multiple times within an audit. This could be a result of actual unnecessary repetition in the requirement document or of some requirements first being addressed generally and later being addressed in larger detail. In both cases, such feedback allowed considering where certain questions could be merged to simplify the audit and add to its efficiency.

5 RECOMMENDATIONS FOR THE EXISTING NORMATIVE REQUIREMENTS

As indicated in the introduction part of this report, the CEWASTE standard is based on the CENELEC EN 50625 series and often refers to this standard series. During the pilot audits numerous questions, which can be found in the audit manual, were posed with respect to the compliance with EN 50625. Most of the pre- and final treatment operators met the requirements. For collection facilities this was not the case. The reason is that the specific EN 50625-4 standard on collection and logistics of WEEE has not been widely implemented by collection facilities in Europe. Since the CEWASTE standard requires separation of KCE to concentrate CRM containing stream for efficient recycling of CRM, as well as some requirements of the collection and logistics standard, logistic facilities mostly failed to be compliant.

For pre-treatment there was one comment of a pre-treatment operator with respect to section 4.5 shipment of the EN 50625-1: *“No treatment operator shall initiate or contribute to shipments of WEEE, or fractions thereof, which would result in treatment that is not in compliance with this standard.”*

The CEWASTE requirements require this for CRM containing equipment, components, and fractions thereof. The recommendation was that in the starting phase of the implementation of the CEWASTE standard this requirement is too strict and cannot be met because the number of downstream operators will be limited. However, the long-term vision of the operator is that once the standard is broadly implemented the requirement is justified.

6 READINESS⁸ LEVEL ASSESSMENT OF THE EXISTING RECYCLING OPERATION

In this section of the document an assessment has been made of the readiness level of the operators that participated in the pilot audits. The audits included operators with activities in collection, pre-treatment and final treatment. While the audits included the whole chain of activities regarding collection, pre-treatment and final treatment, it has to be pointed out

⁸ In the project's Grant Agreement, this is defined as 'maturity level assessment', however, in the implementation phase, it was preferred to replace it with 'readiness level assessment'.

that audits of final treatment facilities of lead-acid batteries and magnets have not been conducted. Therefore, requirements regarding these activities have not been tested within the frameworks of the pilot audits.

The aim of assessing the maturity of the operators with regards to applying the CEWASTE requirements was to analyse the feasibility and applicability of the normative requirements developed by the project. Those key requirements or parts of the requirements were identified where the audited operators failed to comply or faced a challenge to fully meet the requirements. Assessment was made of both the management and the technical requirements, however only new requirements developed by the CEWASTE project were taken into account, existing CENELEC normative requirements were not considered in the assessment. Since there have been no new requirements developed for collection points apart from the requirement to comply with the EN 50625-4 standard, the analysis does not take these actors into account.

The results of the pilot audits were consulted at each stage of the assessment to explain the readiness of the operators to apply the CEWASTE requirements. Feedback provided by the operators during the pilot audits was also considered.

6.1 MANAGEMENT REQUIREMENTS

Main management principles of the management system include 'legal requirements and identification and review of compliance', 'risk assessment and mitigation' and 'competency development' and 'continuous improvement'. In the continuation the main areas of the management requirements will be reviewed – following the structure of the CEWASTE requirement document - with emphasis on the ones that require further attention for full compliance from the audited operators.

6.1.1 MANAGEMENT SYSTEM

The identification and compliance with legal requirements do not seem to pose a great implementation challenge for the pre-treatment and final treatment operators. Most of the pre-treatment and final treatment facilities taking part in the pilot audits have an ISO management system (ISO 9001, 14001, 45001) in place and/or are WEEELABEX certified (CENELEC EN 50625). The CEWASTE requirements that describe requisites regarding the obligation to identify and ensure compliance with legal requirements are mostly met by the operators as they are covered by the management system prepared for the ISO certification and/or WEEELABEX. The scope of the management plan in most cases does not include the activities related to CRM removal and treatment. Including these activities can be done at

the periodical update of the management system, and since it does not require substantial extra work it can be considered feasible.

The CEWASTE requirements describes the need to support continuous improvement and thus have a documented 6 to 12-month plan including the scope of the activities, which includes short-term and mid-term actions and key performance indicators and targets. Key performance indicators and targets specifically related to CRM recovery were generally found missing in the risk assessment and mitigation plan, because in many cases the operators did not separate KCE or treat KCCs at the time of the audit. The reason for this is that the current economic conditions for several CRMs are insufficient to carry out the activities.

6.1.2 RISK ASSESSMENT

Risk assessment and mitigation was found to be part of the already existing management system of the operators. However, both in the case of quality risks to prevent CRM losses and health, safety and environmental risks the scope of the activities need to be extended to include CRM collection, logistics and treatment activities. When detailed quality goals for analysis of loss of CRMs are not currently included in the CEWASTE requirements. If this will be added, it might imply costs for the operator.

Health, safety and fire prevention plans are in place at all the pre-treatment and final treatment operators. To comply with the CEWASTE requirements corrections will need to be made to them to include CRM related activities, however these do not pose significant financial or other kind of additional challenges.

6.1.3 MONITORING

Upstream and downstream monitoring is already part of the usual practices of the pre-treatment and final treatment operators. Once separation of KCE and KCCs as well as final treatment of CRM is performed, the concerned streams and fractions have to be included in the monitoring process. The sampling and analyses of these streams require effort and time from the side of the staff responsible for these operations and therefore costs will increase. The cost can be recovered if there is a business driver for the whole chain of collection and treatment activities.

6.1.4 TRACEABILITY

According to the CEWASTE requirements traceability requirements shall be complied with by upstream operators concerning lead-acid batteries and printed circuit boards waste streams and fractions.

Pre-treatment facilities

Traceability requirements are partly met by most lead-acid batteries and printed circuit board pre-treatment facilities. Due diligence is to be used for lead-acid batteries and printed circuit boards waste streams and fractions if received from a non-OECD country. Operators keep track of the direct supplier of the materials and keep records of such materials entering and leaving the facility, but due diligence is not fully performed. Operators many times do not have their processes verified by a second party auditor as described by the CEWASTE requirements. Similarly, they might not have in place a third-party verification process such as chain-of-custody (CoC). The requirements also state that a manager should be appointed as a responsible for the CoC. The performance of these audits and establishing the policies and procedures, the possible need for the recruitment of an additional manager might mean that additional financial resources, time and effort needs to be invested to comply with this CEWASTE requirement.

Final treatment operators

The audited printed circuit board treatment operator was found to conduct a thorough and extensive upstream due diligence to ensure supplied materials were sourced from conflict-free and legal practices. Supply chain reporting is considered by this operator as key element to ensure quality and credibility that materials are recovered according to state-of-the-art. However, the auditee stated that the market still lacks maturity, and there's little explicit demand for traceable supply chains of secondary raw materials.

In case of the lead-acid batteries due to the lack of audit at a final treatment operator assessment of traceability aspects could not be made.

6.1.5 DOCUMENTATION

In general, CEWASTE documentation requirements are not completely new to the pre- and final treatment operators. All the audited facilities have a fire and explosion plan, emergency plans and related testing and records. Environment, health and safety procedures and reports are also part of their system.

Collection facilities and logistics operators might have to assume higher costs to comply with the CEWASTE requirement on the obligation of yearly reporting. Compliance with this requirement would probably bring about new activities that have to be performed by the staff. Introduction of a procedure to report annual quantities, weighing and the record keeping itself require extra effort, time and thus cost to the facilities. Training and recruitment of additional personnel might require extra funds too.

The CEWASTE requirements that would bring about a change in the processes of pre-and final treatment operators would be the documentation of the mass input for each CRM containing waste stream and recording the CRM components and outputs containing CRM removed from the input waste. Since most operators keep records of the input and output streams, including additional details to these records might require more time but is not an altogether new procedure, so probably can be relatively easily assumed by the operators.

6.1.6 COMMUNICATION & PERSONNEL

Having a Communication matrix or plan in place is a requirement that was met by all the pre-treatment and final treatment facilities. Most of these audited facilities are ISO 9001 and ISO 14001 certified, and the preparation of a communication plan and a stakeholder's matrix constitutes part of the verification process to achieve these certifications. CRM related communication however have to be included in the plan once such processes are performed. This can be done at the revision of the ISO documents so there is no excessive financial or time-wise effort needed to comply with the given requirement.

Training is provided by all the pre- and final treatment operators on activities, risks that are related to the processes of the facilities, this is required by the ISO 9001 management system. Training on CEWASTE requirements and CRM related issues however were not included in any of the cases since they are not performing such activities at the moment. Should they wish to comply with the CEWASTE requirements these elements need to be included in the training plan. Subsequent extra cost and work-related efforts can be justified if the output CRMs are marketable.

Based on the audit results Occupational health and monitoring requirements are mostly met. The maturity level of the operators on these issues can be explained by the fact that some are ISO 45001 and/or WEEELABEX certified, thus they have implemented a wide range of occupational and health measures.

Some areas where improvement is needed were e.g.: the frequency of the health checks, details of pollution monitoring and health checks, and measures related to women's health. To justify the incompliance with this latter requirement one operators stated that they had no women workers at the treatment processes.

In case the CEWASTE normative requirements are demanded, the focus of the medical checks and the pollution monitoring should include the hazardous substances described by the requirements especially for pre- and final treatment operators dealing with CRTs, lamps, Lithium-ion waste batteries, magnets and lead-acid batteries. The addition or adjustment of the monitoring procedures and of the medical checks can result in higher costs and more

effort from the part of the employees however it is considered essential and of high importance.

Audited operators comply with the requirement on employees however in countries where there are gaps in labour-related legislations, these requirements shall pose a possible challenge. The regulation of labour related issues based on the Principle 1, Objective 1.2 of the ISO IWA 19 is a fundamental part of the requirements and should be met despite the possible additional costs involved.

6.1.7 SUSTAINABILITY REQUIREMENTS

Sustainability CEWASTE requirements focus on ‘environmental impacts control’, emission monitoring and control and recommendations on ‘local communities well-being’ and contribution to ‘society’. At the assessment it was concluded that all the audited operators comply with the requirements on environmental impacts controls. Operators with final treatment activities of printed circuit boards, and lithium-ion batteries comply with the emission monitoring and control aspects of the requirements as well. During the audits no specific observations were made with respect to other sustainability recommendations.

In general, it can be stated that the certified ISO and WEEELABEX operators contribute strongly and positively to societal concerns like legal employment, environment and the concept of ‘circular economy’. Many of the operators have a proactive approach and go beyond existing regulations by investing in innovation. Some have taken part in innovation projects or projects for developing standards (such as the CEWASTE project) and promote legally binding standards to create a level playing field for operators.

6.2 TECHNICAL REQUIREMENTS

The technical requirements describe the activities that WEEE, key CRM equipment and key CRM components should comply with when going through the waste management process. Reviewing the readiness of the operators to apply these requirements was done through the analysis of the key focus areas the CEWASTE requirements concentrates on:

- Collection/sorting;
- Technical and infrastructural pre-conditions;
- Handling, receiving and storage;
- Documentation/monitoring;
- Removal and separation of CRM components;
- Final treatment

6.2.1 COLLECTION/SORTING

One of the key technical requirements is that WEEE received at collection facilities and logistics facilities shall be collected and sorted as per key CRM equipment. At this moment collection facilities and pre-treatment facilities receiving WEEE only partially comply with this requirement.

Lamps with fluorescent powder and lead-acid batteries are separated in most cases, temperature exchange equipment and CRTs are usually also collected separately. IT devices described in the CEWASTE requirements and external CDDs, ODDs, devices with internal CDDs/ODDs however are hardly separated from other IT or small appliances. The same applies to lithium-ion batteries, which are being collected with other batteries or with small equipment.

The collection facilities would certainly need extra resources to train their personnel to recognise the CRM containing appliances. The sorting of WEEE and batteries into these new streams would require extra space due to the increased number of containers/boxes. Placing additional containers might not always be feasible due to limited surface area of the collection and logistics facilities. In case of the pre-treatment facilities training would also be needed but the staff are professionally more prepared, and space is not such a limiting factor. Space, training time and extra tasks at the work however entail higher costs for both types of operators. Entities representing collection facilities raised their concerns regarding these points when they were consulted on this requirement. Some recyclers also suggested that they preferred to sort the WEEE themselves into the pre-defined categories to avoid having to re-do the sorting, due to wrong sorting by the public or staff at collection facilities who might not be adequately trained to do proper sorting.

Further efforts, thus costs will be involved regarding the smooth reception and acceptance of key CRM equipment by the collection and logistics operators. The requirements specify that the staff shall inform the public with visuals and instructions to help identify the types of WEEE containing CRM and the location to dispose of them.

The requirement on battery removal at collection facilities when there is no tool needed has been considered a challenge by the auditees. Some operators indicated that this is considered as treatment according to their legislation and cannot be performed. Other facilities replied that the staff was contractually not allowed to touch the WEEE. There were other comments on the financial and time related efforts this process would require, e.g., if the picking up is close the destination/pre-treatment plant, going back to logistics facility for sorting would not be an efficient process.

6.2.2 TECHNICAL AND INFRASTRUCTURAL PRE-CONDITIONS

The treatment operators related to the recycling of printed circuit board, fluorescent powders and waste batteries, were compliant with the requirements for pre-treatment and treatment facilities and the general technical and infrastructural pre-conditions of clause 4.2 of EN 50625-1. For final treatment of copper and precious metals contained in WEEE and fractions of WEEE, the relevant requirements of TS 50625-5:2017 were met in addition to the ones mentioned above.

Since final treatment of magnets is not working in practice, it was not possible to verify the compliance with the technical and infrastructural pre-conditions.

6.2.3 HANDLING RECEIVING AND STORAGE

In general terms the operators are up to meet the requirements regarding handling, receiving and storage processes. Areas where updates in the processes might be needed are the storage processes, in which case special containers described in the requirements should be obtained. Although these measures, such as e.g., the sorting of lithium-ion batteries according to their state upon reception and the use of acid-proof containers for leaking lead-acid batteries might have additional cost implications, avoiding possible risks and incidents should be considered a prior concern by the operators.

6.2.4 DOCUMENTATION

Written agreement exists between the sender and the acceptor of both CRM containing equipment and fractions. The content of the contract and the verification procedures might have to be adjusted to comply with the CEWASTE requirements. Since more elements are already included and procedures are followed the operators seem ready to comply with this requirement.

6.2.5 REMOVAL, SEPARATION OF CRM COMPONENTS

Removal⁹ of KCCs is typically already implemented by audited operators, as such components need anyway to be removed to comply with existing regulations and standards. For those KCCs that are not currently removed (e.g. Nd-containing magnets), a removal process is generally seen as easily implementable provided that economic incentives allow it and/or normative requirements demand it.

⁹ Definition of removal: manual, mechanical, chemical or metallurgic handling with the result that targeted substances, fractions, mixtures and components are contained in an identifiable stream or are an identifiable part of a stream within the treatment process.

The CEWASTE requirement on the removal of the targeted batteries (lithium-ion batteries and lead-acid batteries) does not allow the collection and/or pre-treatment operator to shred the devices and consequently remove batteries. Some pre-treatment operators using this process will have to change their process to comply with the CEWASTE requirement. This might bring about financial implications and might also mean extra effort and time from the part of the workers.

The separation of magnets is not performed by any of the operators, except one. Various treatment facilities indicated that they had previously removed magnets in the framework of a project or part of a pilot process but stopped the separation as the process did not make sense from an economical point of view.

Some operators indicated that after their shredding process magnets ended up in different output fractions. This practice does not meet the CEWASTE requirement that states: “removal practices should not damage components in a way that this will hinder subsequent CRM recovery”. Changes would have to be made to comply with the requirement that might imply an increased cost and effort.

Due to the fact that separation of magnets is usually not part of the pre-treatment process, the removal of non-NdFeB magnets from other types of magnets is not implemented either. The requirement of the removal of magnets though feasible from a process point of view can be a challenge since financially it does not seem viable due to lack of acceptors.

6.2.6 FINAL TREATMENT OF CRM

The final treatment concerns the priority CRM or alloys selected for recovery and the final processing technology identified.

The requirement of the delivering the CRM components or fractions to final treatment operators compliant with the CEWASTE requirements will only be feasible once the CEWASTE verification system is up and running and has yielded a number of CEWASTE compliant final processors.

The final treatment processes assessed during the pilot audits were regarding smelting of printed circuit boards in an integrated copper smelter and recycling of lithium-ion batteries in a dedicated smelter operated by the same operator, and the recovery of fluorescent powders by a different operator.

Printed Circuit Boards

Regarding the printed circuit boards, the audited facility met all the CEWASTE requirements for the final treatment. In general, the auditee was found to comply with the requirements

related to energy/water consumption, emission control, metal recovery yields however they suggested that more consistency should be brought on these topics for the final treatment of other KCCs.

Li-on batteries - LIB

During the audit of the final treatment of waste batteries it was found that with respect to LIBs the operation focusses on the recycling of cobalt and not on lithium. This is due to the fact that at present there is no market for downstream treatment of streams containing lithium. This being said, the auditee was found to comply with all the requirements covered in the audit, with the exception of the discharging of the batteries:

The auditee requires suppliers to discharge LIBs prior to shipment. In practice this is however not always done. In some cases, the auditee decides whether discharge is needed or not prior to dismantling based on a risk assessment. Discharge is therefore not systematically done, only when there's a significant risk of fire (e.g., if the battery is damaged and the SOC is above 30%).

Fluorescent powders

The facility predominantly deals with WEEE pre-treatment but has installed a plant that can recover rare earths in the form of an oxalate from fluorescent powders. The facility has developed a process to produce concentrates from fluorescent powders coming from waste CRTs and fluorescent lamps. The process has proved to be working but at the time of the audit it was not operational. The process has been stopped as the acceptor previously receiving the output material is no longer on the market, which makes the operation economically not feasible.

During the audit the process has been assessed to verify whether it complied with the requirements for final treatment operators. Although they fulfilled most requirements - e.g., the mass of the output fraction, the name of the first acceptor-, they failed to meet the requirement regarding keeping records of the composition of the output material, information on the downstream acceptor(s) of the fractions, and the final treatment technologies. These later ones are considered as commercially sensitive information and were not provided by the acceptor; in fact, the only information available in the commercial agreement with the acceptor record only general information on the recovered materials and not the achieved amount for single CRM, neither the final treatment technologies applied.

7 CONCLUSION

Feedback from the pilots revealed that the main areas where the CEWASTE requirements need to be improved and/or adjusted are related to the international application of the CEWASTE requirements, transboundary movement of waste, and substances with environmental or human health impacts. Furthermore, it was concluded that the traceability requirements shall be based on the due diligence approach and applicable to lead-acid batteries and printed circuit boards whenever they are sourced from Non-OECD countries. The feedback revealed that there is a need to revise the requirements for collection facilities and to adjust the diagram flows for navigating through the CEWASTE. The CEWASTE requirements were revised based on the feedback and the decisions made within the project consortium.

With regards to the CEWASTE assurance system and verification procedure, feedback showed that the suitability of questions and/or explanatory information provided in the auditing excel tool for specific requirements can be improved and the feasibility of complying with specific requirements should be revised. Moreover, the pilots showed that there was an overlap between some requirements and ISO standards of relevance to waste operators and that in some cases there is unnecessary repetition of audit questions.

Having reviewed the readiness level of the audited operators to apply the CEWASTE requirements it can be concluded that they were found to have an adequate level of preparedness. Those requirements that posed a challenge to them can be divided into three categories:

1. The fulfilment of the requirement was not met as the overall process of CRM recycling has not been implemented because it is not economical. When economically feasible changes can be made requiring minor financial, organisational, work and time investment.
2. The fulfilment of the requirement was not met as the overall process of CRM recycling has not been implemented. The changes can be made with medium financial, organisational, work and time investment.
3. The accomplishment of the requirement was not fulfilled, and the process of CRM recycling has not been implemented due to lack of incentives and/or technology. In this case the requirement was not fulfilled because it required extra investments. But because the output material of the process was not marketable, due to lack of acceptors and/or lack of final treatment processes, these investments are not made.

In the majority of the times not meeting a requirement was due to case no. 1., i.e., incompliance was simply due to the fact that the overall recycling process is not feasible and therefore has not been implemented. With minor resources and changes the process of CRM recycling could be feasible. There were some examples of case no. 2. where resources required were estimated to be higher to achieve compliance. These were mainly related to traceability requirements, in some cases the separate sorting of CRM equipment and for some requirements for collection facilities. Case no. 3 was noted for final treatment operators processing fluorescent powders and pre-and final treatment operators for magnets.