



LIFE Project Number
LIFE14 ENV/UK/000344

Final Report
Covering the project activities from 01/09/2015 to 31/03/2019

Reporting Date
26th June 2019

Critical Raw Material Closed Loop Recovery Project

Data Project

Project location:	United Kingdom, Germany, Italy & Czech Republic
Project start date:	01/09/2015
Project end date:	31/03/2019 Extension date: n/a
Total budget:	€ 2,104,439
EU contribution:	€ 1,262,662
(%) of eligible costs:	60%

Data Beneficiary

Name Beneficiary:	Waste and Resource Action Programme (WRAP)
Contact person:	Mrs Bettina Gilbert
Postal address:	Second Floor, Blenheim Court, 19 George Street, Banbury, Oxon OX16 5BH
Telephone:	01295 819900
E-mail:	bettina.gilbert@wrap.org.uk
Project Website:	www.criticalrawmaterialrecovery.au

1. Table of contents

1. Table of contents.....	2
2. List of key-words and abbreviations	3
3. Executive Summary	5
4. Introduction	9
5. Administrative part.....	11
5.1 Description of the management system.....	11
5.2 Problems encountered	13
6. Technical part.....	14
6.1.1 A1 Project Set-up	14
6.1.2 A2 Bringing Together Flows Work Across Europe.....	16
6.1.3 B1 Selecting Collection Mechanisms Trials and delivery	17
6.1.4 B2 Delivery of Reprocessing and Recycling Trials	27
6.1.5 B3 Policy Input.....	33
6.1.6 B4 Pan European Infrastructure Development Recommendations.....	37
6.1.7 C1 Monitoring & Evaluation of the Collection and Recovery Trials	41
6.1.8 C2 Monitoring of the Socio-economic impact of the project actions	44
6.1.9 D1 Communication & Dissemination Activity	48
6.1.10 E1 Project Management, Monitoring and Reporting	64
6.1.11 E2 Delivery of AfterLIFE Plan	66
6.1.12 E3 Indicators	68
6.1.13 E4 Networking with other LIFE and non-LIFE EU Projects.....	70
6.2 Main deviations, problems and corrective actions implemented	72
6.3 Evaluation of Project Implementation	77
6.4 Analysis of benefits	95
7. Project Specific Indicators.....	104

List of Figures and Tables

Figure 1 Recovery of gold from PCs in Scotland	5
Table 1 Increase in collection rates of gadgets	6
Figure 2 Recycling chain efficiency for tantalum.....	7
Table 2 CRM Recovery project partners.....	11
Table 3 A1 Deliverables, Milestones and Indicators	15
Table 4 A2 Deliverables, Milestones and Indicators	17
Table 5 Response rate on ITT	18
Table 6 Priority products collected by trial hosts.....	19
Table 7 Collection methodology and activity	20
Table 8 Tonnages collected in the trials.....	22

Table 9 Re-usable percentage of collected products	24
Table 10 B1 Deliverables, Milestones and Indicators.....	26
Table 11 Priority materials targeted in recovery trials	27
Table 12 Recovery methodology and activity.....	28
Table 13 Costs and revenues of trials.....	29
Table 14 Limits to current WEEE processing.....	30
Table 15 B2 Deliverables, Milestones and Indicators.....	32
Table 16 B3 Deliverables, Milestones and Indicators.....	36
Table 17 B4 Deliverables, Milestones and Indicators.....	40
Table 18 Re-use assessment results	42
Table 19 C1 Deliverables, Milestones and Indicators.....	44
Table 20 Quantity of items collected and sent for re-use.....	46
Table 21 C2 Deliverables, Milestones and Indicators.....	47
Figure 3 web data	49
Table 22 Published case studies	49
Figure 4 Photographs from the project's Interim Conference.....	51
Figure 5 Photographs from Final Conference (showing general room shot and Panel Session 1).....	51
Figure 6 Example of promotional tweets for DIF201 Policy webinar on the projects' Vimeo' site	53
Table 23 Summary of media coverage.....	54
Figure 7 Examples of templates, documents and promotional activities	58
Figure 8 Noticeboard displays.....	60
Table 23 D1 Deliverables, Milestones and Indicators	61
Figure 9 Project team	Error! Bookmark not defined.
Table 24 E1 Deliverables, Milestones and Indicators.....	66
Table 25 E2 Deliverables and Indicators	68
Table 26 Waste management collection of WEEE in trial areas	69
Table 27 E3 Deliverables, Milestones and Indicators.....	70
Table 28 E4 Deliverables and Indicators	72
Table 29 Evaluation of each activity/methodology.....	77
Table 30 Quantity of items collected and re-used.....	96
Table 31 Environmental benefits of collections trials.....	96
Table 33 Project indicators.....	104

2. List of key-words and abbreviations

DMC	Domestic Material Consumption
EARN	EARN Elektroaltgeräte Service Gmb (Associated Beneficiary)
EEE	Electrical and Electronic Equipment
EIP	European Innovation Platform
ERP	European Recycling Platform (Associated Beneficiary)
ICT	Information and Communication Technology
KTN	Knowledge Transfer Network (Associated Beneficiary)
LDA	Large Domestic Appliances
PC	Personal Computer
PCB	Printed Circuit Board
PFR	Preparation for Re-use
PMB	Project Management Board

SG	Stakeholder Group
SOPs	Standard Operating Procedures
WEEE	Waste Electrical and Electronic Equipment
WI	Wuppertal Institut für Klima, Umwelt, Energie GmbH (Associated Beneficiary)
WRAP	Waste and Resources Action Programme (Co-ordinating Beneficiary)
CRM	Critical Raw Material

3. Executive Summary

The CRM Recovery project was initiated on the 1st September 2015 and closed on the 29th March 2019. This report documents the project's delivery and findings.

Project Objectives (5% and 20%)

The overall objective of the “CRM Closed Loop Recovery Project” was to demonstrate viable approaches to increase the recovery of target CRMs from WEEE by 5% by 2020 and by 20% by 2030. These ambitious objectives were founded on a baseline assessment of the efficiency of the current recycling chain that currently results in insufficient recovery of many Critical Raw Materials. Figure 1 includes an illustration of the status quo, taking the example of gold recovery from printed circuit boards installed in PCs. Despite a very high recovery rate in the final step of smelting the material, the overall efficiency is only 28% due to the losses during the collection (48% yield) and pre-treatment phases (90%/ 50% yield). The figures are considerably lower for other Critical Raw Materials like tantalum, for which a large percentage of the material is also lost during the final recovery.

The findings of the main aims of the project are explained in detail throughout this report and supporting documentation. In summary the project achieved its objectives, and explained below in relation to the 5% and 20% increase in CRM capture.

In order to demonstrate viable approaches for a short term increase of **5%** during the project duration, various innovative collection approaches have been initiated and analysed (the methodology for which is discussed in detail in the C1 – Monitoring and Evaluation report) which would increase the amount of CRM-rich products recovered. Considering Figure 1, the example of recovering gold from PC's in Scotland illustrates that one way to achieve the short-term target for the overall recycling chain efficiency would be to increase the collection rate from 48% to 50.5%, an increase of 5% over the projected collection rate for ICT in the UK for 2017.

Figure 1 Recovery of gold from PCs in Scotland

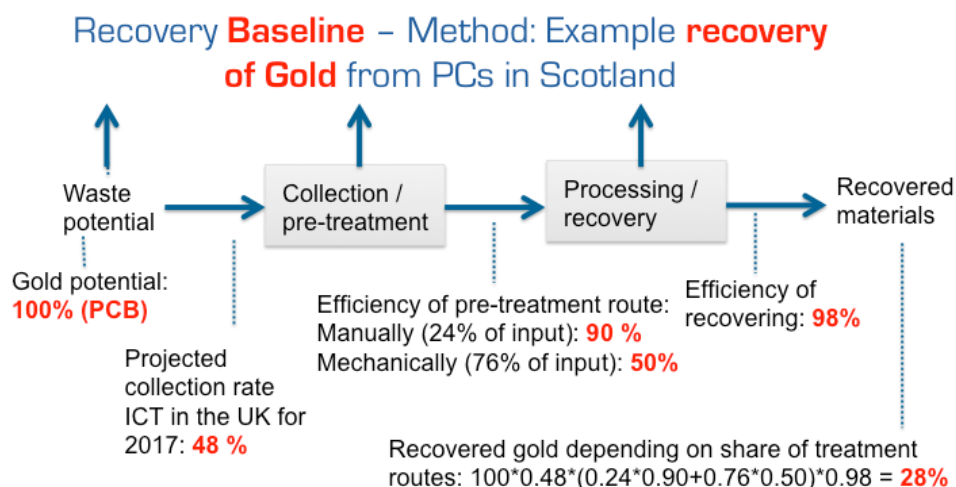


Table 1 below shows (taking the example of gadgets) that this target of +5% could have been achieved by at least seven of the trials (although the +126% for the Axion British Heart Foundation trial should be considered as an exceptional outlier). The economic viability will depend on further economies of scale and learning curve effects as efficiency improves over time following successful adoption and wider take-up of improved ways of doing things, as well as a harmonized regulatory framework.

Table 1 Increase in collection rates of gadgets

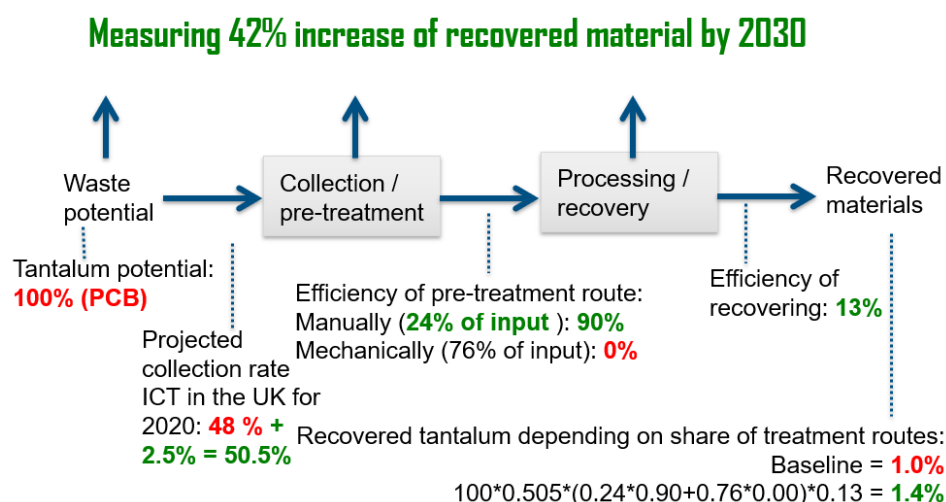
Represent the share of products, which otherwise (without the activity) would have been re-used or recycled		Old WEEE + the share of products, which could be re-directed with the activity (and would otherwise have been put in the rubbish bin)	
Target group: people participated at the activity...	Old WEEE collection rate (pcs-%)	Potential WEEE collection rate (pcs-%)	Increase (%)
Asekol: general	53.38	61.86	15.89
Axion: Dixons	65.71	77.14	17.39
Axion: BHF	37.25	84.31	126.34
Axion. John Lewis	45.83	55.55	21.21
Ecodom: general	54.75	61.16	11.71
Recycling Boerse: ReBox	32.53	32.53	0.00
Retek: Halls	54.48	66.58	22.21
Re-Tek: B2B	55.92	67.77	21.19

There is a good chance of increasing the CRM recovery by **20%** by 2030 due to improved collections across Europe through spreading and implementing the project findings and methods of WEEE collection. There is also some additional potential for increasing the CRM recovery by implementing early-stage recovery innovations.

To demonstrate viable approaches for such a systemic improvement, various early-stage recovery innovations have been tested and analysed. Taking the example of tantalum, the end-of-life recycling rate so far has been estimated to be below 1% (see e.g. UNEP 2011). A combined implementation of the trial results for the collection phase (50.5% collection, 24% disassembly and 13% recovery rate from bio-leaching) would lead to an overall recovery rate of 1.4%; an increase of 42% compared to the current recycling efficiency of 1% (see Figure 2, below, for this example). Tantalum may be an extreme, although probably not unique, example in terms of the potential to increase recovery. For gold, silver or copper, the current recovery rates are of course already substantially higher, thus the increase would be lower but nevertheless significant.

Increased recovery over time implies that activities are scaled up, but it may also mean that materials that are difficult to recover are more effectively targeted. Increased recovery can also be achieved through improvements in the technologies utilised.

Figure 2 Recycling chain efficiency for tantalum



Project overview

The CRM partners brought a range of skills and expertise to the project which has assisted in securing trial hosts, Stakeholder Group members, and dissemination of EU-wide marketing communications, together with a vast range of technical expertise contributing to the monitoring and evaluation of the project, Policy Development (B3) and the Pan-EU Infrastructure Plans (B4). The partnership has worked well and has resulted in the successful completion of the required deliverables.

The project had a number of actions which are summarised as follows:

Status – All Completed

A1 Project set up	B4 Pan-EU Infrastructure	E1 Project Management,
A2 Bringing together flows work across Europe	Development Recommendations	Monitoring and Reporting
B1 Selecting Collection Mechanisms, Trials and Delivery	C1 Monitoring and Evaluation of the Collection and Recovery Trials	E2 Delivery of the After-LIFE Plan
B2 Delivery of Reprocessing and Recycling Trials	C2 Monitoring the Socio-economic Impact of the Project Actions	E3 Indicators
B3 Policy Input	D1 Communication and Dissemination Activity	E4 Networking with other LIFE and non-LIFE EU Projects

The project set up (A1) was completed in 2016 when all reporting and management systems were put in place along with detailed Governance, RACI and project manual documents. A European WEEE flows model and guidance document (A2) was completed in 2016. This was used to support the CRM Recovery project in identifying suitable locations for infrastructure development opportunities and developing the policy recommendations. The original timescale set to commence this piece of work was February 2016. This date was changed to September to incorporate key data published by organisations external to the project which were released later than initially planned.

The CRM Stakeholder Group (E1) was comprised of 38 members from across the electrics and electronics sector. The group met on 7 occasions (once as part of the final event) and provided invaluable advice and insight to the PMB and project delivery as it progressed.

A communications plan was developed to meet the project's Communication and Dissemination (D1) requirements, which encompassed specified actions over the lifetime of the project. Noticeboards were produced along with the project overview brochure and project website. Over its lifetime the project published 8 press releases, 14 e-newsletters and various social media activities with the project having both a dedicated LinkedIn group with 681 followers and Twitter account 405. The project held its final event in February 2019, when over 120 delegates were in attendance.

Work progressed well across all project deliverables with only small changes required to a limited number of deliverable dates. Further detail of these changes are provided in Schedule 6 of this report. There were some challenging areas of work that were identified through the project's management process, these were as follows:

B1 & B2 - Combining of Collection and Recovery Activity: A key element of the project was to establish the link between collection and recovery. To allow for the collection method to be designed with recovery methods in mind and to facilitate the movement and effective handling and processing of materials, it was agreed that end-to-end processes, from the point of WEEE collection through to CRM recovery, should be procured and trialled. The benefits of the end-to-end approach resulted in reduced risks associated with the coordination, timing, storage and shipment of electricals. This approach was communicated to the Commission in the first progress report (May 2016) and in emails to/from the project monitor. Reporting and budgets for B1 and B2 remained separate.

B1 - Selecting Collection Mechanisms Trials and Delivery - Tonnage Collection Target: The collection trials carried out under B1 targeted household WEEE and these tonnages were fed directly into the recovery trials run by the trial hosts. Each individual trial had determined the volume and type of WEEE required to successfully test the recovery methods proposed. The tonnage of WEEE collection was estimated at 20-30 tonnes overall. The trials were selected via competitive procurement and reflect the requirements and limitations set by the market and technologies used by the trial hosts. The estimated tonnage was less than the 100-tonne figure projected in the bid. This figure was based on a previous collection trial undertaken in a school, which included a significant proportion of historic WEEE that had been stockpiled for the event and included large items such as CRT monitors and printers. The decrease in tonnages collected by the CRM Recovery project trial hosts did not impact on the achievement of the primary project objective (a 5% increase in the recovery of target CRMs compared to existing recovery methods), and the project gathered sufficient data to test and evaluate relationships between collections methods and recovery levels. NEEMO was informed of this outcome in the January 2017 monthly report.

4. Introduction

Each year around 9.9 million tonnes of WEEE is generated in the EU. Only 30% of WEEE generated is reported as properly collected and recycled. Many modern electrical and electronic products contain metals which have been classified as Critical Raw Materials (CRMs) by the EC. Most CRMs are virtually unrecovered from WEEE. The high losses of CRMs are attributed to the current collection and recycling arrangements, as evident in the waste stream ([WRAP, 2014](#)). In the UK, WRAP has undertaken work to explore the viability of Critical Raw Materials and precious metals recovery from the EEE waste stream, to map product and material flows, investigate relevant technologies, and identify hotspots which block progress. The work highlighted the need to find a solution which spreads much further than the UK. The CRM Recovery project was developed to take forward this work in partnership with European experts and practitioners e.g. WEEE collectors and recyclers.

Using the knowledge and experience of the project consortium, the CRM Recovery project identified a range of collection, disassembly and reprocessing trials to be undertaken in EC Member States in order to expand our understanding of the relationship between collection and recovery methods and quantify the potential to increase the recovery of target CRMs through system changes.

Through the **project activity** described we sought to:

- Demonstrate the environmental, economic & social benefits that an innovative circular economy for CRMs could deliver for the EU.
- Trial innovative collection, re-use, recycling and other forms of recovery of WEEE.
- Produce European infrastructure plans for collection and recovery of products, parts, components & CRMs from WEEE.
- Demonstrate innovative methods to support the 7th Action Programme, Priority Objective 5: To improve the evidence base for environmental policy & Citizen support to improve transparency of fate of end-of-life products, parts, components and materials.
- Illustrate how, through positive price mechanisms, WEEE shipped to non-OECD countries could be reduced.

Detailed information on the project's success on these can be found in the supporting document (*Annex 4.1 - Supporting objectives project end position*).

The knowledge gained from these trials has informed the development of policy and infrastructure recommendations for the EU, including:

- Potential actions that could be undertaken;
- How each of the actions could be enabled;
- The potential impact of each action both nationally, European and, where appropriate, globally.

The CRM Recovery project has tested what must be done by public and private sector interests to achieve the supporting objectives of meeting the revised Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU and implementing the EU “Roadmap to a resource efficient Europe” – Section 3.2, and key deliverables from the EU Raw Materials Initiative – (pillar 3). The projects results hope to drive a new way of doing business and contribute towards

the delivery of reductions in domestic material consumption (DMC) of 30% by 2020 and 70% by 2050.

The outcomes from the 14 WEEE collection and 7 CRM recovery methods tested (against a target of 10 and 5 respectively) in four EU countries (Germany, Italy, UK and Czech Republic) formed a key element in the achievement of the **overall project objectives of:**

- A 20% increase in collection tonnage of the target WEEE products - around 0.2 million tonnes per annum.
- Increasing the recovery of target CRMs by weight by 5% by 2020 and an increase of 20% by 2030.
- Contributing towards the delivery of reductions in domestic material consumption (DMC) of 30% by 2020 and 70% by 2050.
- Increasing the recovery of Critical Raw Materials in the EU and delivering over €300 million of value to the EU economy by 2020.

Indeed, the project has demonstrated that replication of the learnings from this project across the EU will result in a 20% increase in the weight of (target) WEEE collected, equating to circa 0.2 million tonnes per annum. Currently WEEE categories targeted by this project account for 30% of the total WEEE collected across the EU.

The EU 7th Action programme to 2020 identifies the need for the EU to “*step up the contribution of environmental policy to the transition towards a resource-efficient, low carbon economy*”. It recognizes that “*resource use is still largely unsustainable and inefficient and waste is not yet properly managed. As a result, EU businesses are foregoing the significant opportunities that resource efficiency offers in terms of competitiveness, cost reductions, improved productivity and security of supply.*” This project has made a significant contribution to delivering key parts of the 7th Action Programme and in particular:

- Priority Objective 2: To turn the EU into a resource-efficient, green and competitive low-carbon economy;
- Priority Objective 5: To improve the evidence base for environment policy;
- Priority Objective 6: To secure investment for environment and climate policy and get the prices right;
- Priority Objective 8: To enhance the sustainability of EU cities;
- Priority Objective 9: To increase the EU’s effectiveness in addressing regional and Global environmental and climate challenges.

Detailed information on the project’s success on these can be found in the supporting document (*Annex 4.1 - Supporting objectives project end position*).

The project has aligned its results as far as possible with a number of EU policy instruments including the Roadmap to a Resource Efficient Europe, Circular Economy Package, WEEE Directive and the EU Resource Efficiency Transition Platform.

Expected Environmental benefits

Electrical and electronic products are one of the fastest growing waste streams and a significant user of CRMs. The CRM Recovery project has made a positive contribution to developing a circular economy for these materials in Europe and will make it possible for the EU to recover

substantial tonnages of CRMs, identify the right economic drivers to support full implementation of the revised WEEE Directive & accrue environmental benefits from the efficient use of resources. The outputs from the project have provided a series of learnings and actions to enable their replication across Europe which are detailed in the technical section of this report. Further details on Environmental benefits can be found in section 6.4 Analysis of benefits.

5. Administrative part

5.1 Description of the management system

Working method

The project deliverables and schedule were structured around the objectives, supporting actions, milestones and deliverables detailed in the grant agreement and outlined in the project plan. See A1.5 Final Project Gantt chart.

Governance was provided by the project management board (PMB), which was made up of representatives from the beneficiary partners involved in the project (see Table 2 below). Other groups were set up to help advise the project and provide insight from across the supply chain. These included several specific themed working groups to progress specific deliverables.

Table 2 below provides detail on the CRM Recovery project partners and their project roles (a staff Organogram is attached in *Annex A1.4*).

Table 2 CRM Recovery project partners

Beneficiary Name	Description	Role
WRAP	WRAP is the lead UK organisation for resource efficiency.	Co-ordinating beneficiary <ul style="list-style-type: none"> •Lead for preparatory actions (A1, A2) •Lead technical delivery of (B1, B2, B3, B4) •Lead monitoring of pilots and survey (C2) •Lead on all (E) activities
EARN	A subsidiary of three leading enterprises in the field of environmental services with significant recycling capacities throughout Europe	Beneficiary partner <ul style="list-style-type: none"> •Supporting trials work and trials management in Germany (B1-B2)
KTN	Funded by Innovate UK, KTN connects people to accelerate innovation. Its unique network includes large and small companies, government agencies and research organisations, tech hubs, start-ups, public funding bodies, VCs and private investors.	Beneficiary partner <ul style="list-style-type: none"> •Lead communication and dissemination (D1)
WI	WI is a research institute based in Germany that undertakes research and develops models, strategies and instruments for transitions for sustainable development	Beneficiary partner <ul style="list-style-type: none"> Lead on Monitoring and Evaluation activities (C1)
ERP UK Ltd	ERP is an Environment Agency approved WEEE producer Compliance scheme	Beneficiary partner <ul style="list-style-type: none"> Supporting trials work and trials management in Italy and Czech Republic

The WRAP Programme Manager, supported by the Project Manager and project team, actively managed and tracked individual milestones and outputs. This included setting up and using a variety of tools to scope actions, record progress and identify and manage risks effectively. These have been described in further detail below.

Project organisation

A project management and governance structure was set up to ensure roles, responsibilities and accountabilities were clear. All beneficiaries to the project received a formal partnership agreement from the lead beneficiary, WRAP. These partnership agreements were signed in October 2015.

The CRM Recovery project intranet site, called SoonR (Autotask) provided secure file sharing and collaborative project software. The site was used to communicate project updates and store all relevant project materials (project manual, timesheets, strategies, meeting reports, etc.). All project evidence including partner/beneficiary's timesheets are saved electronically on SoonR (Autotask). Signed paper copies were sent quarterly to the WRAP Project Support Officer.

WRAP's initial Project Manager oversaw the project until Dec 2015, PM2 took over until May 2016. Since this date PM3 has seen the project through to completion. The PM held regular progress meetings with each partner organisation to discuss key issues.

Governance for the project was established in late 2015, as detailed in the Project Manual V10 (*Annex A1.1*). This document was produced to establish Standard Operating Procedures (SOPs) and ensure appropriate/consistent project management (E1) was conducted throughout the project. The manual proved particularly important during staff changes – see further detail in section 6.1.1. Project communications and updates were conducted through a variety of channels and included stakeholders, partners, funders and lead beneficiary staff. Communications included:

Project communications

Project Management Board meetings (PMB) - project partners met quarterly to review finances, progress and activity plans, highlight issues and project risks and to agree the sign off of project deliverables. See further updates and supporting documents in section 6.1.10 E1 Project Management, Monitoring and Reporting.

One-to-one meetings - with lead staff from all partners were undertaken by WRAP project managers. These meetings were used to provide updates on progress against actions, discuss upcoming deliverables and to raise any issues or questions specific to each individual partner.

Communications meetings – were used to go through the communications and dissemination plans in detail. The WRAP project & communications managers along with the KTN communications managers were in attendance.

Task and finish groups - were established to enable collaboration across the project partnership on specific activities. The T&F groups held have focused on trials (B1/B2) and Communications (D1/E4) activities.

Finance reporting - to facilitate the management of the project, partners submitted quarterly progress and budget reports to WRAP (E1). These reports included evidence of all activity, including timesheets, invoicing and evidence of delivery. Paper copies of timesheets and expenditure reports along with invoices and receipts were sent quarterly to the WRAP project support officer.

The **Stakeholder Group** - (E1) met twice a year and provided advice to the Project Management Board on the project and its progress through the delivery phases. The members have provided advice and guidance on trials procurement and policy and infrastructure activities which has proved invaluable in supporting the project activity.

Partner support has been extremely valuable in delivering the project activity, particularly in our procurement/evaluation activities and encouraging new stakeholders to sign up.

5.2 Problems encountered

During the period since the last official progress report 2 (February 2018) our main difficulties have been in relation to the following:

Please note that a full list of all problems and challenges encountered throughout the project can be found in section 6.2 Main deviations, problems and corrective actions.

5.3 Communication with EASME and NEEMO monitoring team

The WRAP Project Manager has sent monthly progress reports (from September 2015) and quarterly updates (from July 2016) to the project monitor, NEEMO; from September 2016 we also sent these directly to our EASME project representative. These have included requests to move milestones dates, changes to the delivery of the trials, changes to trial countries, budget movements (under 20%) and updates on changes in staff. We have also conducted ad-hoc telephone calls to discuss project activities.

5.4 Grant amendments

Three amendments were made to the grant agreement, which are summarised below:

Amendment 1: Modification of obligation to information, threshold for submission of audit certificate and submission of reports.

Amendment 2: Request for amendment to the Grant Agreement for the project's legal address and notification of changes to the legal authorised representative and main project contact on behalf of the coordinating beneficiary for project LIFE14 ENV/UK/000344 – LIFE CRM Critical Raw Material Closed Loop Recovery project.

Amendment 3: Modification of the definition of conditions for natural persons, submission of VAT certificate and threshold for submission of the certificate on the financial statements.

6. Technical part

6.1 Technical progress

A final deliverables and milestones table can be found in (*Annex 6.1.1*). In addition to the CRM Recovery project, WRAP has been working on complementary actions outside LIFE. Between 2015 and 2016 WRAP worked with a number of electricals stakeholders to reduce product returns and support the development of sustainable business models, published the UK WEEE Material Flows Model and Report¹, and published a series of case studies on WEEE collections and monitoring². WRAP's work in the area of sustainable electricals between 2015 – 2017 is summarised in the publication of the Switched onto Value report (see http://www.wrap.org.uk/sites/files/wrap/Switched%20on%20to%20value%20-%20Powering%20business%20change_0.pdf),

6.1.1 A1 Project Set-up

- Action Completed December 2015

Lead Partner: WRAP

Supporting Partners: all partners

The original end date shown in the bid was agreed as incorrect and was therefore changed. All activities were completed by December 2015.

Foreseen start date	September 2015
Actual start date	September 2015
Foreseen end date	September 2015
Actual end date	December 2015

Introduction

To set up a robust and appropriate project management system to help report and manage the projects milestone and deliverables and implement an appropriate reporting structure.

Description

Using programme and project governance frameworks to develop specific project governance for CRM. To ensure that appropriate methods were in place for oversight and control of the project throughout its lifetime and that appropriate reporting structures were put in place.

Action undertaken & outputs achieved

Set-up actions and processes were fully adopted by December 2015 with a governance system and complete reporting system in place, as evidenced by the project manual version 10 (*Annex A1.1*), this document was produced by the WRAP project manager in conjunction with the finance team and project partners and was updated several times throughout the duration of the project.

The project kick off meeting, which was also the first Project Management Board (PMB) meeting, was held on the 24 September 2015 in London. This was managed by WRAP. The project's Senior Manager also attended the Commission's kick-off meeting in Brussels on the 4th November 2015. The final PMB took place on Thursday March 21st, 2019 in Manchester, UK.

¹ <http://www.wrap.org.uk/sustainable-electricals/esap/re-use-and-recycling/report/weee-market-flow-model-and-report>

² <http://www.wrap.org.uk/content/case-studies-weee-collection-trials-and-monitoring-0>

The CRM Stakeholder Group (referred to in the bid as Steering Group) by the end of the project had 38 registered members from across the EEE sector who received updates, meeting information and acted as the project's champions. The group has met on 7 occasions (once as part of the final event) and was facilitated by WRAP and managed by the Project Manager. The group has provided invaluable guidance and insight to the PMB as the project progressed through the delivery phases. The group adopted a terms of reference (TOR's) document at the beginning of the project which outlines their roles and responsibilities in the project. The TOR's were drafted by the Project Manager, agreed during the first Stakeholder Group meeting (26th January 2016), and were incorporated into the Governance section of the project manual.

Over the course of the project the PMB (E1) met on 14 separate occasions. This group worked well together and all meetings held were attended by each project partner (i.e. 100% attendance rate). WRAP co-ordinated and Chaired the PMB which was comprised of senior representatives from each of the partner organisations. The PMB was accountable for the delivery of the project and met quarterly to discuss general management and address specific milestones or areas of work including project finances, delivery and key outputs, operational systems and risk management (*Annex A1.2*).

Comparison with planned outputs

All work was carried out as per the original bid. An outline of the budgets against spend can be found in section 6.3 and 8 of this report.

Problems encountered and solutions

Throughout the duration of the project there were a number of staff changes within the lead and (some of the) partner organisations. The project manual and the meeting schedules were of great use in the change process and represent an element of best practice project management. Several detailed handover documents were also produced to facilitate staff changes, which, together with regular communications and excellent standards of project management, ensured that potential negative impacts of staff changes on project delivery were mitigated.

Deliverables, Milestones and Indicators

Table 3 A1 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/Status
Milestone	Project Set up	Original 09/2015 – Complete 12/2015	Complete

Indicator of Progress	Evidence
Governance system in place by Sep 2015	Original project manual submitted May 2016 Current project manual V10 at Project close – (<i>Annex A1.1</i>) RACI Document – (<i>Annex A1.3</i>)
Detailed project plan in place by Sep 15	Detailed operations plan including a risk register, finalised Dec 2015 (<i>Annex.A1.2</i>) final version and communications plan (<i>Annex D1.12</i>)
Additional evidence	Risk Register (<i>Annex 1.2</i>) as at project close Staff Structure V10 (<i>Annex A1.4</i>) as at project close

6.1.2 A2 Bringing Together Flows Work Across Europe

- Action completed September 2016

Lead Partner: WRAP

Supporting partners: WI, ERP & EARN

The start date of this work package was postponed allowing for the release of the revised Eurostat data to be incorporated in the work package. The work was completed as set out in the original bid, and there were no variations to the actual work package.

Foreseen start date	September 2015
Actual start date	March 2016
Foreseen end date	February 2016
Actual (anticipated) end date	September 2016

Introduction

The aim of this work package was to develop a high level European-wide WEEE and EEE flows model which describes the volumes of products placed on markets through to disposal, to be used in work-packages B3 and B4 to identify opportunities and locations for intervention and infrastructure development required. This model pulled together current European Country (W)EEE flows models to allow for a picture to be presented on the movement of WEEE across Europe. The work was completed in September 2016 and some update work was carried out in early 2018 to ensure the datasets used were the most recent.

Actions undertaken, and outputs achieved

In 2011 WRAP developed the UK WEEE flows model which looked to map how electricals flow through the UK treatment system. This model was used as a starting point for developing a Europe wide model. During the initial data gathering stages of the project by the project team, delays were incurred due to the current limited access of data from key sources (such as CWIT). This is because the most up-to-date data was not yet available. Rather than duplicate CWIT research, or progress without the relevant data, it was agreed with NEEMO that it was in the best interest of the project to wait for the CWIT data and delay this output. Once the data was available and collated, a framework procurement process was carried out and Valpak Consulting were awarded the work to gather data and build the model.

The model included all 28 EU countries, splitting them into three groups based on purchasing power (the number of goods or services that can be purchased with a unit of currency). These groups were used to fill data gaps (see *Annex A2.1 - User Guide*). The model utilised two key datasets; EC 'Study on Collection Rates of Waste Electrical and Electronic Equipment (WEEE); and Eurostat. The completed model (A2.2) allows users to interrogate the data by country and product type, and more generally by flow point. This work package was completed in September 2016 by WRAP with input from all partners. The model was presented to the Stakeholder Group during the 22nd September meeting 2016. Information about the model was included in the October 2016 press release and e-newsletter. During feedback from Progress Report 2 we were asked to submit a summary and literature review. This has been completed and can be found in *Annex A2.3*.

In the summer of 2018 the WRAP project team updated the WEEE flows model by checking and using the most up-to-date Eurostat data to ensure that the most up-to-date data was used in the development of the project's Policy and Infrastructure reports. This work was completed by a member of WRAP's Market Economics team.

Comparison with planned activity

All activity was carried out as per the original bid.

Problems encountered and solutions

As noted above, the original timescales suggested for the completion of the model didn't fit with the publication of the new sets of Eurostat data, but this was alleviated by moving the deliverable end date back to September 2016. EASME was notified as part of Progress Report 1 submitted in May 2016 and it was agreed as acceptable within the response received from EASME on the 24/10/2016.

Deliverables, Milestones and Indicators

Table 4 A2 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/Status
Deliverable	EU Materials and CRM flows Model produced	Original 02/2016 Complete 09/2016	Complete
Milestone	Completion of EU materials and flows work	Original 01/2016 Complete 09/2016	Complete

Indicator of Progress	Evidence
Estimation of EU materials and CRM flows	Output of model was used to develop work under B3 and B4
Other evidence of progress	Contract awarded to Valpak May 2016 (TID Info Annex A2.4)
	Completed WEEE Flows model – (Annex A2.2)
	Completed WEEE flows guidance – (Annex A2.1)
Other	Methodology as requested from PR2 (Annex A2.3)

6.1.3 B1 Selecting Collection Mechanisms Trials and delivery

- Action completed June 2018

Lead Partner: WRAP

Supporting Partners: EARN & ERP

Changes have been made to the original deliverables with the collection and recovery activities being combined. This was completed to reduce project risks, increase the demonstrable link between collection and recovery and reduce the risk of material movement and storage.

Foreseen start date	May 2016
Actual start date	May 2016
Foreseen end date	Jan 2017
Actual (anticipated) end date	June 2018

Introduction

The aim of this action area was to set up 10 collection trials across four countries to test various mechanisms that could maximise the collection of target EEE (Display, Consumer electronics,

ICT and small household appliances). The trials provided data and insight to the varying impact that the different approaches have on re-use, and linked to B2 to provide evidence as to how collection methods impact component recovery, material recovery and the recovery of CRMs.

Actions undertaken, expected results and outputs achieved

To determine which collection methodology options to trial, a literature review and desktop study of current collection mechanisms was carried out. This was completed by EARN. WRAP produced a matrix of collection trial options which enabled the collection options to be prioritised (*Annex B1.1-B1.3*), and these were submitted as part of PR1.

Comprehensive trials summary and assessment reports have been completed, as part of the monitoring and evaluation work under C1/C2, which highlight the methodology and approach used, provide a cost benefit analysis and include key trials data such as products collected, proportion of products suited for re-use, repair and/or recycling, value of products re-used etc.

Procurement Activities that took place to identify and secure trials partners were as follows:

An internal Trials Working Group comprised of representatives from WRAP, EARN and Wuppertal Institute was convened and tasked with defining and agreeing the tender scope and assessment criteria, responding to tender enquiries, and evaluating tenders received. In addition, during the first Stakeholders Group meeting (on the 26th January 2016) consultation was undertaken regarding the proposed methodology for the collection and recovery trials. As a result of feedback gained from stakeholders, which identified issues that would affect delivery of the trials and increase costs of the trials relating to the shipment of waste potentially across borders and regulatory requirements, the decision was made to combine the collection and recovery trials. This methodology required potential trial hosts to propose a supply chain approach integral to the proposed trials, rather than the CRM Recovery project partners facilitating supply chain development, and resulted in a much more efficient means to deliver the trials.

Trials selection

Collection and recovery trials were competitively tendered across 4 countries (Lots), between 11/02/16 and 07/04/16. Copies of each of the Invitation to Tenders (ITTs) received can be found in the relevant project folders. Forty-eight organisations downloaded the ITTs (see Table 5 below), representing industry and consultancies across all four target host countries.

Table 5 Response rate on ITT

	Number of Downloads			
Organisation Type	UK	Italy	Germany	Czech Republic (changed from Turkey)
Asset management	4			
Consultancy	14			4
Waste management	11	4	1	2
R and D	3	1	1	
Other	1	1		1
Totals	33	6	2	7

Five organisations submitted tenders to participate in Lot 1 (UK) and Lot 3 (Italy). Contracts were awarded to Axion and Re-Tek for Lot 1 and to Ecodom for Lot 3.

However, no tenders were received for Lots 2 and 4 (Germany and Turkey). Following review by the trials working group, it was agreed that additional supplier engagement was necessary for Lot 2 (Germany). Six organisations were identified and invited to participate in a selected tender procedure. This call opened in September and closed on 26/10/2016. Following independent assessment and panel assessment during a meeting held on 14/12/2016 and attended by ERP, KTN, WRAP, QSA Partners and EARN, the Recycling-Börse proposal was identified as the successful tender.

During development of the procurement strategy for the trial in Turkey, a coup was attempted, and a 3-month state of emergency was announced (21/07/16) for Turkey. As the personal safety of the project team was paramount, and the on-going political uncertainty created uncontrollable risks to the successful completion of the trials, a request was made to the EC to change the location of this trial to another country. Data on volumes of electronics manufacturing and WEEE arisings in other EU countries was analysed and the strengths of EARN, ERP and KTN's networks reviewed (*Annex B1.5*), to identify a suitable alternative for the Turkish trial. The Czech Republic and Slovakia were identified as countries which scored favourably on each criterion. The proposal to change the trial site was submitted to the Commission (*Annex B1.19*) on 10/10/16 and agreed (11/10/16).

The subsequent call for tenders was open between 21/11/16 and 16/01/17. WRAP, EARN, ERP and KTN communicated extensively with their networks to promote the call and engaged with 24 organisations and networks. Following assessment by panel, the decision was taken to award to tenderer ASEKOL a.s. on 07/03/17.

Trials activities began in May 2016 and were completed by March 2018. As the procurement took place over a series of time, and each trial had a different methodology, requiring differing time frames, the start and end dates of the trials were staggered. This benefited the project team, as a steady flow of activity took place which made the allocation of resources and task delivery easier to manage than if all the trials had started and completed simultaneously.

Summary of Collection Trial activity undertaken




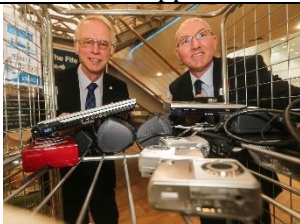

Each of the priority products was collected by at least one trial host as illustrated in Table 6 below.






Table 6 Priority products collected by trial hosts



Priority Products for Collection	Axion	Re-Tek	Ecodom	Recycling-Börse	Asekol
Display		✓	✓	✓	
Consumer Electronics	✓	✓	✓	✓	✓
Information Communications Technology (ICT)	✓	✓	✓	✓	✓
Small Household Appliances			✓	✓	✓

A summary of the collection methodology and activity for each trial host are provided in Table 7 below. Detailed information for each is contained in the both the Trials Summary Report (*Annex B1.4*) and also the individual trial reports (*Annex B1.5 - 9*)

Table 7 Collection methodology and activity

	Collection Activity Summary	Trial Host and location Trial Dates
1	 <p>Retail take back in charity retailer (British Heart Foundation)</p> <ul style="list-style-type: none"> Collections commenced in four BHF stores 11/2016 and continued until the end 04/2017. Reusable electrical items collected via BHF were sold on BHF's eBay site which then directly raised money for the charity. Non-reusable items were sent to E3 Recycling for dismantling. Axion supported the communications, surveying and staff training. 	Axion Consulting - Greater Manchester (UK) 11/2016-04/2017
2	 <p>Retail take back with major electrical retailer (Dixons)</p> <ul style="list-style-type: none"> Collections commenced in five Dixons stores at the end 02/2017 and continued until 05/2017. All items were sent to E3 Recycling for re-use assessment and dismantling. Axion supported the communications, surveying and staff training. 	Axion Consulting - Greater Manchester (UK) 01/2017-05/2017
3	 <p>Retail incentivised returns (John Lewis)</p> <ul style="list-style-type: none"> Collections commenced in the two John Lewis stores on 04/2017 for five months. The incentive offered was a free data wiping service. Any reusable items were passed to BHF for selling on for charity. Non-reusable items were sent to E3 Recycling for dismantling. Axion supported the communications, surveying and staff training. 	Axion Consulting - York and Leeds (UK) 04/2017-07/2017
4	 <p>Employee amnesty events in Business to Business WEEE collections</p> <ul style="list-style-type: none"> Collections took place across 5 businesses and two social enterprises between 09/2016-01/2017. <i>Photo - Councillor Wincott (left), Spokesperson – Environment & Transport at Fife Council supporting the employee amnesty WEEE collection at Fife Council offices, October 2016.</i> 	Re-Tek - Various locations across Scotland and Northern England (UK) 09/2016-01/2017
5	 <p>Primary school collection hubs</p> <ul style="list-style-type: none"> Following workshops run by Re-Tek and Enscape (trial partner), Strathdon School and Albyn School agreed to host collection containers for WEEE. 	Re-Tek – Aberdeenshire (UK) 09/2016-01/2017

6	University Halls of Residence collection hubs <ul style="list-style-type: none"> The Unite Group run halls of residence in 26 cities. Re-Tek engaged with them in Glasgow, Edinburgh, Newcastle and Durham to install collection containers. Leaflets about the scheme were distributed to students. 	Re-Tek – Glasgow, Edinburgh, Newcastle, Durham (UK) 11/2016-01/2017
7	 WEEE bins at recycling centres specifically for re-use <ul style="list-style-type: none"> Re-use specific containers were installed next to the WEEE recycling bins. Greeters were trained to educate users and divert reusable products to the separate container. <i>Photo - Collection container at Cumnock HWRC, November 2016.</i> 	Re-Tek - Kilmarnock and Cumnock (UK) 09/2016-01/2017
8	 Collection events in city public squares <ul style="list-style-type: none"> Large collection containers with greeters were located in public squares for 4 consecutive Sundays. Collections from 09/2016-12/2016, then 05/2017-06/2017. Ecodom have supported with communications and media. <i>Photo - Container on location in Via Maria Pagano, Milan, October 2016.</i> 	Ecodom - Milan (Italy) 09/2016-07/2017
9	 Primary school collection hubs <ul style="list-style-type: none"> Engaging with staff and students and the local community at Comano School, Milan, to host the collection container for 2 days during 02/2017. The second day was open to the local community. 	Ecodom - Milan (Italy) 01/2017-03/2017
10	 Collections in Stores <ul style="list-style-type: none"> Static WEEE Collection bins in Co-operative stores in Milan 	Ecodom- Milan Italy
11	Primary school collection hubs <ul style="list-style-type: none"> Setting up a competition (Re-use Olympics) between schools in the Herford area of Germany. Schools acted as collection hubs and ran special days to raise awareness. 	Recycling-Börse - Herford (Germany) 04/2017-10/2017
12	 Kerbside household collections <ul style="list-style-type: none"> Collection sacks issued to all households in the Herford municipality with communications focussing on re-use and priority products. Monthly collections. 	Recycling-Börse - Herford (Germany) 04/2017-10/2017

13		Household and Business collection box <ul style="list-style-type: none"> Householders and businesses were offered a collection box for collecting small household appliances and mobile phones for re-use. Once full, these boxes were returned to Recycling-Börse. 	Recycling-Börse - Herford (Germany) 04/2017-10/2017
14		Mobile collection units in areas unable to have permanent collections <ul style="list-style-type: none"> Asekol have permanent collection bins in most areas of Prague, however areas of high aesthetic value do not have them. A mobile collection was proposed to service these areas. A sampling methodology was followed on WEEE collected via the permanent street bins and from the containers located in collection yards. <p>Any devices categorised under IT and Telecoms Equipment were assessed for re-use.</p>	ASEKOL a.s. - Prague (Czech Republic) 04/2017-07/2017

The similar nature of some of the collection trials (e.g. 1 & 2; 5, 9 & 11) enabled the testing and comparison of collection methods across different demographics and countries. In some countries we exceeded our original target of a maximum of 3 collection activities. This is as a result of the activities proposed by bidders during procurement and therefore we did not wish to impose a limit. The issue of activity numbers was raised with NEEMO in the January 2017 monthly report.

Tonnages collected during CRM recovery trials

During bid development an estimated 100 tonnes of product was to be collected by the 10 collection trials activities. The project requested a change to the total in January 2017 (see issues section below). Table 8 below summarises the actual total tonnage collected by the trials during the project period.

Table 8 Tonnages collected in the trials

	Axion	Re-Tek	Ecodom	Recycling-Börse	Asekol	Total
Instore Takeback	672.56					672.56
Schools/University Halls		102	943	2629		3674
Mobile Containers/Bring Banks			2615		1659	4274
Stationary Containers/HWRCs		4226			9058*	4226
Public Events			2008			2008
Collection Yards					17664*	0
B2B		1246				1246
Social Enterprise		621				621
Household Collections				285		285
Total	672.56	6195	5566	2914	28381	43056.7

Together the trials collected over 43 tonnes of WEEE of which 9.9 tonnes would not have been collected had the trials not been conducted. For the C1 evaluation work, the 9.9 tonnes of product was used to develop the monitoring and evaluation findings. The overall amount of WEEE collected across all the trials was higher than that included in this evaluation, as not all data was reported in the template provided to the trial partners. Asekol's collections via stationary containers and collection yards, as well as Ecodom's collections in grocery stores and

one of the two school collections were not assessed, as it was not possible to gather data from these trials on a product-specific basis.

However, the collections carried out by Asekol with stationary containers and collections yards are not "innovative collection activities" and have long been part of the actor's collection practices. The innovative collection system, which was also tested by Asekol, was the "mobile collection container". The "mobile collection containers" were also evaluated by the Wuppertal Institute.

With regard to the Ecodom collections, it can be said that at least one of Ecodom's school collections was included in our evaluation. This means that data on this collection system was collected and evaluated under the specific context conditions. Unfortunately, we could not conduct an environmental assessment of the "grocery store collections" for the reasons mentioned above. However, the collection activity was part of our (qualitative) economic evaluation (e.g. data gathered from the interview with Luca from Ecodom).

Linking collection to recovery

The overall aim of the trials was to ascertain whether there was a demonstrable link between the collection phase and the recovery phase of the trials and the lessons this may give for a wider rollout across Europe.

There is an argument that collecting greater amounts of WEEE increases the chances that the CRM's will be captured, rather than WEEE being hoarded by households or ending up in landfill. However, the corollary of this is that if you don't collect WEEE in an appropriate manner for the end process then many of the products that could have been re-used will be too damaged and CRMs that could have been extracted if they had been sorted and disassembled at an early stage are more likely to be lost due to the practice of WEEE shredding. Therefore, the quality of the collection is as important as the quantity that is collected.

Based on the recovery systems trialled, it appears to be economically and environmentally sound that collection systems enable as many items as possible to be processed for re-use markets, prior to recovery/ recycling. If re-use is the final form of CRM recovery then the evidence from the trials is that collections need to target newer, high specification items with a relatively high resale value.

However, depending on the CRM recovery process it may be optimal to target older WEEE that have a high concentration of components used, e.g. PCB's. Development of a product database including knowledge of embedded CRM content will produce sorting criteria that could be used much earlier in the collection stage, for example in the marketing of the collections, encouraging citizens to bring CRM-rich WEEE for collection and reminding them of the need to handle their products with care.

Problems encountered and solutions

A key element of the CRM Recovery project was to establish the link between collection and recovery. To allow for the collection method to be designed with the recovery method in mind, it was determined that the trials should be procured as complete end-to-end processes from WEEE collection to CRM recovery. This methodology, which minimised risk around project timings, storage of electricals and shipment of materials, was communicated to the Commission

and NEEMO in the Progress Report (May 2016). To ensure all project deliverables were met despite these changes, an internal review of project outputs was undertaken.

Overall summary of outputs

Although we noted that the cost and revenues from the individual trials are not directly comparable, they do suggest that collecting high value products (that can be resold with little or no repair) as economically as possible (via a retailer) could offer the most effective means of increasing CRM recovery. Further work should investigate the potential additional costs that could be included (i.e. revenue lost to a retailer from the loss of floor space) and whether economies of scale in both collection and recovery could increase the effectiveness of this method of collection.

A key insight from the trials was that retailers and charity shops have a great opportunity to increase collections of WEEE. Retailers that are part of consumer's everyday habits (e.g. small convenience stores) offer an economical way to collect small WEEE from consumers. Trusted retailers may also give consumers confidence to hand over appliances where data security issues are greatest (e.g. smartphones). This also increases the potential economic returns on collections since items returned are likely to be of relatively high value.

Please note that a summary report for the trials can be found on the [projects website](http://www.criticalrawmaterialrecovery.eu/projects_website). <http://www.criticalrawmaterialrecovery.eu/>

Data from the collection trials was utilised to inform work under WP C1 – Monitoring and Evaluation. In addition, and as part of WP C1, structured interviews were undertaken with trials hosts to facilitate evaluation of the economic costs and benefits of the specific collection, re-use and recovery trials. A synthesis of collection/re-use trial data was undertaken to enable comparison of all results in a transparent and consistent way. This comparison was based on data from all trials and included information regarding 4,890 items or 9,854kg of collected products. As noted above, the overall volume of materials collection through the trial was much higher, however only data from the trials that were directly comparable were included in the C1 evaluation.

Findings from WP C1 reported that, based on assessments undertaken by treatment operators, the re-use potential from the trials was as follows:

Re-use Amount in relation to collection amount across the trials

Table 9 Re-usable percentage of collected products

Product Category	% Re-usable
Televisions and Monitors	43 %
Consumer Electronics	15 %
Information and Communication Technologies (ICT)	17 %
Small Household Appliances	8 %

There was only a small observable difference in the age of products across all category groups. Over two-thirds of re-usable products were 0-3 and 3-6 years old (37% and 37% of products respectively) and 27% of re-usable products were more than 6 years old.

Further analysis was reported through WP C1 and included:

- Comparison and interpretation of results under consideration of the specific trial conditions;
- Environmental assessment: e.g. how the collection/re-use potential of the trials change if focus is placed on resource/CO2e equivalent savings compared to weight based environmental assessment; and
- Economic assessment.

Comparison with planned output

The most significant alteration from the bid was movement of the fourth collection trial from Turkey to the Czech Republic. This movement, undertaken to reduce risks to the health and safety of staff and trial delivery, resulted in a subsequent delay to procurement. Nonetheless, trials in Germany and the Czech Republic were completed on time. This change was notified to our EASME project officer on 10/10/2016 and a response by email was received on 11/10/2016 to accept the proposal.

Combining collection (B1) and recovery (B2) trials into a single procurement has meant that B1 milestone dates were amended to match those of (B2). Reporting and deliverables remained separate for B1 and B2 (the final reports will have clear sections for B1 and B2). The milestone dates for contracting the collection trials changed to 31/03/17 to accommodate the delays from the additional procurement processes required for the trials in Germany and the Czech Republic.

Problems encountered and solutions

Low number of bids received

Attracting tenders was challenging. WRAP and the project partners engaged with key organisations in Germany and the Czech Republic which would be suitable for the project, however only one bid was received from each country. The brief for the trial was intentionally open to encourage innovative approaches. However, some organisations fed back that a more defined scope was preferred. Other organisations suggested they did not have enough capacity to take on additional work.

Tonnages

The collection trials being carried out under (B1) target household WEEE and tonnages are being fed directly into the recovery trials run by the collection trial hosts. Each individual trial determined the volume of WEEE required to successfully test the recovery methods proposed. In Italy, the target was 10 tonnes of WEEE, whilst in Scotland; the requirement for the recovery activity was for approximately 60 PCBs. The focus of the collection trials was therefore on the tonnage and product-type requirements for each individual recovery trial, which was estimated at 20-30 tonnes overall. The trials were selected as a result of the competitive procurement process undertaken and reflect the requirements and limitations set by the market and technologies selected for trial. Throughout the collection trial activities that took place during

the course of the CRM Recovery project activity the trial partners collectively gathered around 43 tons of product.

The estimated 30 tonnes noted by trial partners to be collected was proportionally less than the target of 100 tonnes stated in the bid. This notional target was calculated at 10 tonnes per trial based on the success of a schools-based collection in Wales in 2010. This collection included a significant proportion of historic large WEEE that had been stockpiled for the event and was not directly comparable to the targeted products included in this project (e.g. laptops and mobile phones). Because of this the project requested a change. This issue was reported to NEEMO in the January 2017 monthly report and as part of the midterm report submitted to EASME in May 2017. This change was deemed as acceptable as part of feedback letter received on 27/09/2017.

Please note: Detailed individual trials and summary reports are provided as supporting information for action areas B1 and B2 (*Annex B1.5 - 9*).

Deliverables, Milestones and Indicators

Table 10 B1 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/Status
Deliverables	Completed matrix of collection trials	Original 05/2016 – completed 05/2016	Completed
Milestones	Secure Collection Trial hosts	Original 06/2016 – completed 04/2017	Completed
Milestones	Start Collection Trials	Original 06/2016 – completed 04/2016	Completed
Milestones	Complete Collection Trials	Original 01/2017 – completed 06/2018	Completed

Indicator of Progress	Evidence
Finalised report on current collection activity	PowerPoint presentation on existing collection operations in Germany sent to NEEMO with August 2016 monthly report – Annex B1.1.
Finalised report on the specification of collection trials in the four host countries	Excel matrix and prioritisation sent to the Commission with Progress Report (May 2016) – Annex B1.2 and B1.3.
Commitment of 10 collection sites secured (written agreement)	In total 5 hosts across 4 countries (UK, Germany, Czech Republic and Italy) covering 14 collection activities were contracted.
Detailed trial delivery plan completed (document)	Detailed delivery plans received for each of the contracted trials – Annex B1.10-B1.14.
Collection trials commenced on 10 sites	14 different collection trials have been completed
Collection trials completed on 10 sites	Completed Summer 2018
Analysis of collection site completed	
Report completed on collection trials	
Technical report on finished trials	
Report for the results of the different trials and CRM concentration in collection groups/categories	Completed Summer 2018
Other evidence of progress	
	Summary Trials Report (Annex B1.4)

6.1.4 B2 Delivery of Reprocessing and Recycling Trials

– Action completed June 2018

Lead Partner: WRAP

Supporting Partners: EARN & ERP

Introduction

Five CRM recovery methods were trialled across four countries to test different methods of recovering CRMs from waste electricals. The outputs from each recovery trial (proportions of CRMs extracted) were matched to the product type and age profile of WEEE received from each of the associated collection trials.

Foreseen start date	February 2017
Actual start date	March 2017
Foreseen end date	June 2018
Actual (anticipated) end date	June 2018

Action undertaken, expected results and outputs achieved

The initial stages of this work package were to understand the recovery methodologies currently in use for each of the CRMs. This took the form of a literature review and desktop study, completed by EARN with input from all project partners. This review allowed for a greater understanding of methods for testing and was sent to NEEMO with the August 2016 monthly report.

Individual trial reports (*Annex B1.5 - 9*) and a collective summary/assessment report (B1.4) have been produced that outline the processes, recovery achieved, costs and value of CRM's recovered.

Procurement process

Given the combined procurement of B1 and B2 to establish stronger links between collection and recovery, the procurement process for B2 was the same as that detailed under B1 above and therefore is not repeated here.

Recovery trials overview

Seven recovery trials were carried out across four countries to test different methods of recovering CRMs from waste electricals. Eight priority materials were identified in the bid, and were collected by at least one of the trials, as indicated in Table 11 below:

Table 11 Priority materials targeted in recovery trials

Priority Materials for Recovery	Axion	Re-Tek	Ecodom	Recycling-Börse	Asekol
Graphite	✓		✓		
Cobalt	✓	✓	✓		
Antimony	✓				
Tantalum	✓			✓	
Rare Earths	✓			✓	✓
Platinum group metals	✓		✓		✓

Gold	✓	✓	✓		✓
Silver	✓	✓	✓		✓
Other	Tin Copper				Aluminium Copper

During the initial stages of this work a literature review and desktop study was completed by EARN (*Annex B2.1*), with input from all project partners, to understand recovery methodologies currently in use for each of the target CRMs. This review allowed for a greater understanding of methods for testing and was sent to NEEMO with the August 2016 monthly report.

A summary of the recovery methodology and the recovery activity for each trial host is provided in Table 12 below.

Table 12 Recovery methodology and activity

	Recovery Activity Summary	Trial Host and location Recovery Trial Dates
1	De-soldering of printed circuit boards (PCBs) and concentration of components <ul style="list-style-type: none"> 200 non-reusable collected items were dismantled at E3 Recycling. PCBs were de-soldered using ITRI's innovative method. Separated components were sorted and chemically analysed at the TOMRA test facility. 	Axion Consulting - Greater Manchester (UK) 05/2017-06/2018
2	Electrochemical Deposition <ul style="list-style-type: none"> 60 PCBs were crushed. Preliminary testing completed to get optimum conditions of bio-leaching and acid leaching to liberate CRMs from the PCBs. Once the methodology was optimised, the solutions were passed through an electrochemical cell for extraction of pure metal ions at the cathode. Carried out by the University of the West of Scotland. 	Re-Tek – Glasgow (UK) 12/2016-06/2017
3	Extracting cobalt from Li-ion batteries <ul style="list-style-type: none"> Took place at SEVAL in Colico. Disassembly, thermal treatment, acid leaching and then a combination of precipitation, crystallisation, calcination and solvent separation. 	Ecodom – Colico (Italy) 09/2017-04/2018
4	Comparison of CRM-rich and non-CRM-rich fractions <ul style="list-style-type: none"> A sample of CRM-rich WEEE and non-CRM-rich WEEE were passed through STENA's established precious metal recycling reprocessing plant. This allowed us to understand the benefits of collecting a CRM-rich stream compared to other WEEE collections (and therefore establish a link between collection and recovery). 	Ecodom - Angiari (Italy) 09/2017-04/2018
5	Extraction of Neodymium from magnets <ul style="list-style-type: none"> Magnets from hard disk drives were isolated. Neodymium was extracted via melt-spinning with the production of Nd-Fe-B flakes that were used in production of new sintered magnets. Carried out by Technical University of Hamburg & Fraunhofer IWKS 	Recycling-Boerse – Hamburg (Germany) 04/2017-12/2017
6	Extraction of Tantalum from capacitors <ul style="list-style-type: none"> The capacitors were extracted from PCBs and isolated by electrohydraulic fragmentation. Tantalum was extracted via bio-leaching and bio-sorption. Carried out by TUHH. 	Recycling-Boerse – Hamburg (Germany) 04/2017-12/2017
7	Increasing CRM concentration from WEEE reprocessing	Asekol a.s. - Jihlava (Czech Republic)

	<ul style="list-style-type: none"> Looked at how to increase the concentrations of individual CRMs to produce an output material that is richer in CRM content and therefore a more commercially viable product for smelting. Concentration methods included wet separation and electrostatic separation. 	
--	---	--

Comparison with planned outputs

As per the variation for B1, the most significant variations are from changing the fourth country from Turkey to the Czech Republic, and the combination of B1 and B2 for procuring the trials.

Summary

In order to assess the up-scaling potential of the different trials, costs and benefits related to the collection scheme innovations were analysed. Costs, revenues and wherever possible necessary investments were estimated based on: i) data by the trial hosts as part of their reporting obligations; ii) interviews with responsible managers for the different steps of the trials; and iii) additional sources from the literature (especially on general framework conditions etc.).

Based on these data the following were compared:

- The economic viability of the different approaches in their specific national/ regional contexts; and
- Potential cost saving by increased economics of scale and learning curve effects.

Table 13 below shows the costs and revenues for the different trials, in total, as well as relative figures per collected kg of CRM rich products. For the trials in Italy, the income figures have been estimated using the data from Germany. For the trials in UK by Re-Tek average costs for the different trials have been indicated by the trial host.

Table 13 Costs and revenues of trials

		Axion		Re-Tek	Ecodom		Recycling-Börse			Asekol
		John Lewis	BHF		Market Squares	Grocery Shops	Re-use Olympics	Re-Box	ReBag	
Costs (€)	Investment s/ permits		200		410			5400	5000	7000
	Media	300	4000		2000	7236	800	930	300	3000
	Labour costs	200	200	4660	2590	4963	4600	1600	6000	32000
Revenues (€)	Re-use	1633	1240	1338	78	258	417.5	55	270	304.78
	Recycling				38	125	201.35	5	15	146.99
Collection in kg		66	349	3477	399	1321	2134	95	163	1570
Costs per kg, in Euro		7.58	12.61	1.34	12.53	9.23	2.53	83.47	69.33	26.75
Revenues per kg, in Euro		24.74	3.55	0.38	0.29	0.29	0.29	0.63	1.75	0.29

Please note: that detailed individual trials and summary reports are provided as supporting information for action areas B1 and B2.

Initially, a number of dismantling tests were scheduled to be carried out to remove certain CRM-containing components. During June 2018 a decision was made to map appropriate process flows for the maximum recovery of CRMs by using the trials LOT 1-4 experiences as well as specific results from previous activities and expert knowledge (see comparisons with planned outputs section below for further information on changes). The trials results were analysed on focused CRMs, how these could be separated and up-concentrated and finally how the CRM recovery could be increased by applying these methods. Additionally, experts at smelters (e.g. Umicore, Aurubis H.C. Starck) and WEEE recycling companies (e.g. Electrocycling) were interviewed on the current recovery of CRMs, the limitations and, how the recovery of CRMs from WEEE could be improved from a technical as well as a policy point of view. The limits to current processing are listed in Table 14 below.

Table 14 Limits to current WEEE processing

Element	Available recovery route	Limits in current WEEE processing
Au	Cu-fractions for smelter route	During shredding and separation process, amounts of Au end-up in fractions such as steel, aluminum, plastics, dust: Au is not recovered.
Co	Specialized Li-ion battery treatment	No significant Co recovery from material fractions in WEEE processing except battery recycling.
Nd	Magnet recycling route	Once mixed with other material, even with other types of magnets, Nd recovery is not feasible
Pd	Cu-fractions for smelter route	During shredding and separation process, amounts of Pb end up in fractions such as steel, aluminum, plastics, dust: Pd is not recovered.
Ag	Cu-fractions for smelter route	During shredding and separation process, amounts of Ag end up in fractions such as steel, aluminum, plastics, dust: Ag is not recovered.
Ta	Specific recovery process for Ta wastes	No Ta recovery from any current WEEE fraction.
Y	Recycling of energy saving bulbs/ fluorescent tubes	No Y recovery from any current WEEE fraction.
Graphite	Graphite recycling (mostly on high level an knowledge about composition and origin)	No Graphite recovery from any current WEEE fraction.
Sb	SbO ₃ e.g. recovered in Umicore process Creasolv © process can recover SbO ₃ from plastics	No Sb recovery from current WEEE fractions installed
Pt	Recovered in Cu smelting process	Not very common in WEEE

An optimized flow for WEEE treatment was set-up and recommendations for the further processing of certain CRM relevant products and components (High-grade PCBs, other high-

grade components (CPUs, plugs, ...), Li-Ion batteries, HDDs, plastics with SbO₃, LCD panel glass, lamps) was described.

It was concluded that the main reason for reluctance in investment into new technologies is the lack of economic drivers (CRM prices, availability of CRMs) and the resulting uncertainty regarding commercial viability of strategic investments at recyclers as well as at smelters. However, the trials lead to a better understanding of the opportunities and obstacles to increasing CRM recovery by processes. The best opportunity to increase CRM recovery is by getting the material into the right existing channels, so that increased collection and focused treatment of CRM-containing WEEE are the essential actions for the future. Therefore, specific policy recommendations including certain CRM-specific requirements for treatment standards are the most valuable and promising result of this survey.

Please note that a summary report for the trials can be found on the [projects website](http://www.criticalrawmaterialrecovery.eu/projects_website). <http://www.criticalrawmaterialrecovery.eu/>

Comparison with planned outputs

Initially, a number of dismantling tests were scheduled to be carried out to remove certain CRM-containing components. The bid recommended that these tests be supervised and analysed under scientific conditions, and that recovery tests on different product groups should be done in a newly developed crushing and sorting model factory. The objectives of the tests were to investigate, evaluate and define appropriate process flows for a maximum recovery of CRMs. Finally, the sampling tests were to determine the CRM content of key fractions/components to enable assessment of the degree of recovery of CRMs from the trials.

At the time the bid was written the method stated above was a valid approach, however over recent years data has become available from other (EU funded) projects, which enabled the project to produce more reliable results and which represent a much wider data set/product range than would have been possible or feasible if the initial (manual) methodology set out in the bid had been utilised. Ultimately, the approach undertaken represented best value and quality for the project. This was reported to Neemo in August 2018 as part of our monthly and quarterly updates process (*Annex B2.2 Revised Approach*). The revised methodology is summarised below.

Revised methodology

There are three substantial sources for mapping appropriate process flows for a maximum recovery of CRMs: the trials LOT 1-4 experiences, results from previous activities, and expert knowledge.

In order to achieve the project results on the above mentioned initial idea and aims, the following approach was utilised:

- Collation of all results from the individual trials LOT 1-4 on quantitative recovery potentials, commercial viability and future development potentials. This was structured in relation to the CRMs in focus and on the specific types of equipment.
- Missing information on CRM contents was collected by analysing previous projects (e.g. REPRO in Germany, PROSUM).

- Expert interviews were done with the trial's partners and with external recycling companies involved in processing the related types of equipment. From this, recommendations for the most efficient procedures were deduced, and procedures were proposed with a higher focus on certain CRMs.
- Finally, all data, information and knowledge was analysed and information on best CRM recovery practice was displayed and utilised to inform the policy recommendations and estimate the increase of CRM recovery potential in future.

The changes to delivery did not compromise the results required and added value to the overall conclusions made. Results of these activities can be found (B2.3 Policy input and B2.4 Recovery Potentials). These activities were led by EARN with support of the partners.

Problems encountered and solutions

As with B1, the main problems encountered in the general management were around the low responses to tenders received. Each trials report gives details of any problems encountered for each of the individual recovery activities.

Due to the variety and innovation levels of the recovery activities it was challenging to model the economic case at commercial scale. We recommended that further investment in R&D is necessary to further develop recovery activities.

Deliverables, Milestones and Indicators

Table 15 B2 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/Status
Milestones	Secure Recovery Trial hosts	Original 02/2017 Completed 04/2017	Complete
Milestones	Start Recovery Trials	Original 02/2017 Completed 04/2017	Complete
Milestones	Complete Recovery Trials	Original 06/2018	Complete

Indicator of Progress	Evidence
Identification of recovery types	A review of current recovery mechanisms through a literature review and desktop study was carried out. Slides summarising this information was shared with NEEMO – August 2016 monthly report. (Annex B2.1)
Clear prioritisation of recovery techniques	The slides produced for the previous indicator and a subsequent database of processing capacity allowed for an informed review of the recovery activities submitted in the bids for the trials (Annex B2.1)
5 recovery trial hosts indented and secured (written agreement)	In total 5 hosts across 4 countries (UK, Germany, Czech Republic and Italy) covering 7 recovery activities were contracted, contracts agreed and signed.
Recovery trial plans completed (completed)	Detailed delivery plans received for each of the contracted trials – Annex B1.10-B1.14 (combined with collection).
Recovery Trials commenced	Completed
Recovery trials completed	Completed
Analysis of recovery trials completed	Completed

Completion of trial report	Completed
Other evidence of progress	Sampling tests of CRM in products to ensure robust results – (Annex B2.3-4) Disassembly trials to allow for extraction of CRM for sampling tests - (Annex B2.3-4) Summary Trials Report (B1.4) Methodology statements – Annex B1.7-B1.9. Individual trials reports – Annex B1.5 – B1.9a Cost Benefits C1 and C2
Expected Results	Trial report for each technology outlining the process, recovery achieved, costs and value of resultant CRMs recovered: (<i>Data contained in the individual trial reports - B1.5 – B1.9a</i>) Assessment of the use of combined technologies to recover the target CRMs; (This is covered in C1 and B4 documents) Review of the benefits of pre-sorting or intermediary processing on levels of CRM recovery; (<i>Contained in the Infrastructure and policy reports - where separate collections are a key policy recommendation</i>). Cost benefit analysis of the processes used – <i>This information is contained in a selection of the trial's reports B1.5 – B1.9a and also in the C2 report. The overall cost benefit analysis of the recovery trials proved to be inconclusive largely due to the size being lab scale and also the limitation in the technology readiness levels of the sector.</i>

6.1.5 B3 Policy Input

– All worked completed September 2018

Foreseen start date	December 2017
Actual start date	December 2017
Foreseen end date	June 2018
Actual end date	September 2018

Lead Partner: WRAP

Supporting Partners: All partners

Feedback obtained during the mid-term report highlighted concerns around the changes in the end date for B3 requesting that the action be initiated as early as possible and that sufficient time and commitment be provided to ensure suitable evaluation and dissemination post completion of action B3 and B4. The date was subsequently changed to September 2018 to allow more time for dissemination activities.

Introduction

This work package produced a set of policy recommendations, at both a country level and a cross-EU level, that aimed to increase the collection of CRM-rich products and the recovery of CRMs from within them. The work package was closely linked to the outputs of B1, B2, C1 and C2.

Actions undertaken, expected results and outputs achieved

We have fulfilled this action by developing a suite of policy recommendations relevant to specific nations as well as the EU as a whole (see *Annex B3.5 – B3 Final Report*). There were some changes to how we did this, addressed below, but the overall output was still achieved. The result has been high quality recommendations, created with the input of policy experts and key stakeholders (from the CRM stakeholder group – see *Annex B3.3 – Working Group Meetings*), which have already been well received at the final conference and through our initial

dissemination activities. The outputs of a suite of nation-specific recommendations and EU policy options document is covered by the final B3 report (*Annex B3.5* as above) and describes how and where the outcomes of the trials can be rapidly implemented across Europe.

Explain procurement journey

Towards the end of 2017 the project team discussed with the Commission contracting some support for the literature review and drafting of the initial suite of policy and infrastructure recommendations from an experienced contractor. This was necessary due to gaps in the skill-set of the team that arose after staff-turnover since the commencement of the project. To facilitate a swift procurement, WRAP utilised their internal technical specialists' framework for tendering the work. This framework consists of previously approved specialists with a wide-range of skills – in particular electricals and policy expertise. From this framework, we initially selected the most qualified contractors (Sofies Consulting), who were able to take on this supportive role to the project. Sofies were procured in April 2018 to specifically support with the literature review and recommendations drafting between May and August 2018. The relevant documents for this process are contained within the Supporting Evidence folders (*Annex B3.6 – Contractor for B3 and B4*).

Summary

The European Union (EU) is largely dependent on imports of Critical Raw Materials (CRMs) from non-EU countries. For this reason, it is important to ensure CRMs are recovered from waste electrical and electronic equipment (WEEE) so as to continue their continued circulation within the European market and increase the security of CRMs.

The Critical Raw Material Closed Loop Recovery project aimed to test the link between a targeted collection of WEEE and the subsequent economic viability and effectiveness of CRM recovery. This report presents a suite of accompanying pan-European policy recommendations and enabling actions that have been made in-line with the findings from the trials in addition to a comprehensive literature review of current relevant legislation (*see Annex B3.1 – Supporting Files*).

The five innovative WEEE collection and CRM-recovery trials were undertaken in four European nations (Czech Republic, Germany, Italy and the UK) in order to establish how best to capture CRM-rich WEEE and recover targeted CRMs. The most successful collection trials partnered up with known and trusted organisations including retailers and charities and introduced secure collection points at conveniently located positions such as in shops, schools and universities. The innovative lab-based recovery trials included obtaining CRMs from batteries hard drives, printed circuit boards (PCBs) and magnets.

The availability and efficiency of recovery infrastructure is influenced by many factors and complex interactions between policies and priorities. While some policies directly target CRMs, others indirectly influence CRM recovery through enabling or hindering implications. They often can be categorised by their pulling or pushing character. The former are policies that aim to pull the market in a certain direction for example by informing consumers about a product (i.e. creating demand) while the latter aims to push the market in a direction through for example enforcing bans on certain products (European Commission, 2018).

A number of themes emerged during the trial analysis culminating in the need for dedicated policy actions along two complementary areas:

1. To engage consumers and waste handlers with targeted actions and campaigns highlighting the importance of proper disposal of CRM-rich WEEE. Ensuring traceability and increasing citizen's trust in the disposal process, especially for personal data-bearing products, such as mobile phones and cameras (where data protection is a concern), might help to overcome lack of trust that was also evident from interviews conducted during the trials.
2. Authorities and policy makers must play an active role in the redesign and implementation of infrastructure that supports the collection and preparation of WEEE for re-use (PFR).

The five key themes identified from the trials include cross-cutting barriers and opportunities for policy recommendations, which would affect multiple stakeholders involved in WEEE collection and preparation for re-use or recycling activities:

1. Awareness needs to be raised of the importance of WEEE collections and CRM-recovery amongst citizens and businesses;
2. Eco-Design considerations with recycling considerations need to be included at the early stages of product design ;
3. Trust and transparency levels need to increase to encourage citizens to recycle their unwanted electrical items;
4. CRM-recovery needs to be introduced within Standards and;
5. Collection infrastructure needs to be redesigned with particular attention to the role of consumer behaviour.

To investigate how the lessons learned from each of the trials could be transferred to other Member States, a comparison exercise has also been conducted to complement this report. The criteria for the Compliance Promotion Exercise (see B3.1 Policy Report) was used in addition to an analysis of the individual situations of the four Member States where the five collection and treatment trials took place.

A continuation of CRM recovery research and knowledge sharing is required to scale-up the recovery activities from lab-based to commercial operations. It is also clear that there is no dedicated platform available for actors in the CRM recovery industry to exchange knowledge or seek out collaboration activities. An online platform to foster continued research efforts, alongside a continuation of available funding from the Commission is recommended to ensure experts in the field can progress CRM recovery within the EU.

Problems encountered and solutions

During the project the technical specialist at WRAP who had been assigned to this project left. They were replaced with a new TS, who possessed significant technical experience on electricals, but, at the time, required additional support from individuals with specialist policy expertise. As such we contracted Sofies (as above) to assist with research (literature review and data gathering) necessary to support development of the policy recommendations, which enabled WRAP to deliver well-considered recommendations which take into consideration the wider policy work in this field. A request for this was included in Progress Report 2 submitted in February 2018, and EASME acknowledged the request during the letter received on 6/7/2018.

Reliable data analysis and economic modelling was not possible, due to inconsistencies in the data collected from Member States within Eurostat statistics. However, the trials demonstrated that issues underlying the lack of CRM recovery are prevalent across all trial regions. As such, it was not possible to develop a suite of policy options tailored to each of the trial host nations individually. Even so, the research and consultation undertaken to develop the policy recommendations to increase the recovery of CRMs did identify a set of actions relevant and applicable to all of the trial regions (Italy, Germany, Czech Republic and the UK) and across Europe, which include:

1. **Redesign and harmonise WEEE collection infrastructure;**
2. **Increase awareness amongst citizens and businesses;**
3. **Create incentives for collection and recycling organisations;**
4. **Continue innovation and research on CRM recovery and foster international collaboration**
5. **Introduce CRM-specific requirements into standards.**

The difficulties in developing a suite of policy recommendations were discussed at the project mission visits in 2019.

Comparison with planned outputs

The outputs were delivered as planned with the exception noted above (re. why it wasn't possible to develop individual policy options for each trial country).

Deliverables, Milestones and Indicators

Table 16 B3 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/Status
Deliverable	Suite of policy ideas for the beneficiary countries	Original 05/2018 Completed 09/2018	Complete
Deliverable	EU Policy options	Original 06/2018 Completed 09/2018	Complete
Milestones	Finalise county and EU specific options following feedback from key stakeholders	Original 05/2018 Completed 09/2018	Complete

Indicator of Progress	Evidence
Evidence base created from collection and recovery trials	Annex B3.1 - Supporting Files
Draft of country and EU policy recommendations	Annex B3.2 – Sofies Work
Finalising recommendations after stakeholder engagement	Annex B3.3 - Working Group Meetings & Annex B3.4 – Policy Recs Feedback
Final report of Policy options for the Beneficiary Countries	Annex B3.5- B3 final report

Sustainability and continuation

This report gives several policy and infrastructure recommendations for individual EU governments on how they could move forward to increase the amount of CRMs captured. These recommendations are mutually beneficial and should not be treated in isolation. In order for national and regional governments, organisations and companies to increase their investment in collection and recovery infrastructure they will need a clear signal of policy intent. This in turn will give them the confidence to invest and reconfigure their business processes. Only then will the economies of scale and impacts noted in this report have a chance of being captured in both the short and long term.

In terms of sustainability – beyond this project future efforts will be needed to monitor the wider policy and infrastructure landscape and adapt the recommendations where appropriate to ensure their continued relevance; in particular we have highlighted the expected forthcoming review of the WEEE Directive / current WEEE Regulations in the UK, and the need to monitor any potential changes in the EU list of CRMs.

6.1.6 B4 Pan European Infrastructure Development Recommendations

– Completed September 2018

Lead Partner: WRAP

Supporting Partners: All Partners

Foreseen start date	Sep 2018
Actual start date	Jan 2018
Foreseen end date	Nov/Dec 2018
Actual (anticipated) end date	September 2018

Within the original bid agreement, no work was scheduled to commence on this action until quarter 3 of 2018. After comments fed back on the mid-term report and after consideration of the deadline requirements, we felt that work needed to start sooner with the aim of delivering in September 2018.

Introduction

The outputs of the trials (B1, B2 and C1) and the flows model (A2) were analysed to identify the potential to increase collection and re-use of WEEE, and the recovery of CRMs. We also considered any additional infrastructure that would be required to meet the increased demand for re-use, disassembly for components and recovery within the infrastructure development plan (see *Annex B4.2 – Final B4 Report*).

Actions undertaken, expected results and outputs achieved

As per the bid, we have developed EU infrastructure development recommendations that outline the required collection and recovery infrastructure to secure resources and value in the EU. This infrastructure includes a consideration of collection, re-use, repair and recovery requirements. The document (and subsequent dissemination work, e.g. the webinar which took place on 19th March 2019) sits alongside and links to the policy recommendations.

We have endeavoured to deliver recommendations that can be implemented by the EU nations either individually or collectively (see note below re. issues encountered).

Although these recommendations sit alongside the policy recommendations, the principles and practical actions clearly described within the report could be adopted by industry or by governments with or without the influence of the policy options identified in B3 (see *Annex B3.4 – B3 Final Report*).

Procurement journey

Towards the end of 2017 the project team discussed with the Commission the possibility of contracting some support from an experienced contractor for the literature review and the drafting of the initial suite of policy and infrastructure recommendations. This was necessary due to gaps in the skill-set of the team that arose after staff-turnover since the commencement of the project. To facilitate a swift procurement, WRAP utilised their internal technical specialists' framework for tendering the work. This framework consists of previously approved specialists with a wide-range of skills – in particular electricals and policy expertise. From this framework, we initially selected the most qualified contractors (Sofies Consulting), who were able to take on this supportive role to the project. Sofies were procured in April 2018 to specifically support with the literature review and recommendations drafting between May and August 2018. The relevant documents for this process are contained within the Supporting Evidence folders (see *Annex B3.6 – Contractor for B3 and B4*).

Summary

The objective of this report is to provide recommendations for the development of infrastructure that will result in better collection, increased re-use and improved dismantling of WEEE and increased recovery of CRMs across Europe.

This report analyses data available on WEEE collection and recovery at an EU and a country level for CRM-rich WEEE. Using findings from a desk-based research exercise together with feedback from stakeholders, we have compiled the known infrastructure to recycle WEEE and recover CRMs in Europe. We then discuss some of the commercial considerations that influence the incentives of recycling and recovery businesses.

The report then analyses the results of the collection and recovery trials undertaken as part of the CRM Recovery project. Firstly, to understand the costs and benefits of the different Trials' methods, and secondly to understand the link between collection and recovery and to identify lessons that should be taken forward if the trials are to be rolled out across Europe.

Results

The total WEEE (waste electrical and electronic equipment) generated within the EU-28 is expected to rise from around 10Mt in 2018 to 11.1Mt by 2030. In contrast small IT WEEE generation (i.e. rich in CRMs) is projected to decline slightly to around 700Kt in 2030. The expected fall in CRM-rich WEEE is due to a decline in waste generation from heavier items such as desktop computers and telecommunications equipment. The majority of EU-28 particularly large economies collect between 45% and 65% of the IT placed on the market. At the other end of the performance scale there are other large economies that only collect around 25% to 40%.

According to Eurostat figures (see *Annex B4.6 – Background work/Eurostat*) around 3Mt of WEEE are recycled or re-used in the EU each year (including 500Kt of ITE). Germany, France and the UK account for 50% of total accredited WEEE recycling in the EU. However, taking into account recycling not carried out by accredited facilities and re-use of parts not accounted for in the official statistics, this may increase to around 4Mt.

Despite there being encouraging performance levels in collecting CRM-rich WEEE, this does not necessarily mean that the CRMs embedded in them are recovered for further use from either a technical or an economic perspective. Depending on how the products are presented and reprocessed many, or all, of the CRMs may be dissipated, making recovery very difficult.

There are only four known plants in Europe (located in Belgium, Sweden and Germany) that recover CRMs on a commercial scale. Despite this, the ability to process CRMs is thought to be limited to post-production scrap and end-of-life equipment derived from industrial sources. Although there is limited capacity (at least in terms of number of operators, see *Annex B4.3 – Sofies Work/Supporting Work/Capacity information*) to recycle the CRMs within Europe (and even these primarily source from industrial sources) there are operators who aggregate different CRMs for export for reprocessing. Depending on how contracts are set up, it can be the case that the recovered CRMs are returned to Europe for re-use.

The recycling of CRMs is not always economically feasible. High investment and operating costs for sorting and recycling technologies deter the private sector from investing in recovery infrastructure. Additionally, regional disincentives may exist in relation to the complexity of processes for the acquisition of requisite licenses and permits. Rapid product and material developments and innovations result in changes to the composition of WEEE and recovery processes, which creates uncertainty and increases risk to companies seeking to invest in technology that may quickly become unsuitable for future waste streams. A lack of demand for secondary material, due to high costs, low or inconsistent quality, and volatile market prices, provide further disincentives for investment in recovery of CRMs.

The recovery of CRMs from WEEE largely depends on the type of application and on the value of the raw materials contained within products. For example, precious metals in electronics (e.g. platinum group metals in printed circuit boards) are generally separated and recycled because this is economically viable. However, the recovery of materials such as gallium, germanium, indium, silicon metal and rare earths, is more challenging because of their dispersed use in products.

The recovery systems trialed during the project demonstrated that collection systems should be designed and marketed with the end recovery process in mind – whether that is re-use, component recovery, or reprocessing for the extraction of CRMs. If re-use is the final form of CRM recovery then the trials suggest that collections need to target newer, high specification items with a relatively high resale value. However, depending on the CRM recovery process it may be optimal to target older WEEE that have a high concentration of components used, e.g. Printed Circuit Boards (PCBs).

The trials suggest that collecting high value products (that can be resold with little or no repair), as economically as possible (via a retailer) could offer the most effective means of increasing CRM recovery. Further work should investigate the potential additional costs that could be included (e.g., revenue lost to a retailer from the loss of floor space) and whether economies of scale in both collection and recovery could increase the effectiveness of this method of collection.

Based on this analysis our report (*Annex B4.2 – Final B4 Report*) makes three key recommendations to policymakers and industry:

- Increased awareness through improved information and data provision;

- Harmonised collections that are smarter at targeting CRM-rich WEEE;
- Financial incentives to collect and re-use CRM-rich products or otherwise recover CRMs.

Problems encountered and solutions

Whilst we have access to good quantities of data relating to this area, there are areas where it is out of date or incomplete. Our approach was therefore as follows:

Based on previous research and modelling undertaken by the United Nations University (UNU) on behalf of the European Commission, we were able to estimate the amount of WEEE generated for each country in the EU-28 by broad category. The model developed by UNU projects likely volumes of WEEE generated by category from 2014 to 2024. In the absence of the underlying model created by UNU we then extrapolated the trend in WEEE generation.

Eurostat data was utilised to understand current levels of collection and recycling in different member countries (the latest data that was available at the time of preparing the report). We recognise that this may not reflect all of the collection and recycling activity in each member country, only that reported to government by obligated businesses. The report makes up for this gap by taking evidence from other studies that have sought to estimate the amount of WEEE recycled and exported outside of the EU (see *Annex 4.6 – Background Work*).

Across WEEE generation, collection and recycling, we were limited in our analysis of CRMs. Not all WEEE has a high content of CRMs. Therefore we focused our analysis on those WEEE streams that we know are high in CRM content, e.g. small IT.

Comparison with planned outputs

The report provides detailed infrastructure recommendations on an EU level. Although applicable to each and every country in the EU the report notes where countries have specific challenges (e.g. poor waste management infrastructure) that require additional resources.

Deliverables, Milestones and Indicators

Table 17 B4 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/Status
Deliverable	Nation-specific infrastructure recommendations	1/2018 - Completed 09/2018	Complete
Deliverable	EU Infrastructure recommendations	12/2018 completed - 09/2018	Complete
Milestone	Finalise country and EU specific infrastructure recommendations following feedback from key stakeholders	11/2018 Completed - 09/2018	Complete

Indicator of Progress	Evidence
Research & review of existing EU infrastructure for WEEE reprocessing	Annex B4.6 Peter's work\Background work

	& Annex B4.3 – Sofies Work/Capacity information
Analysis of required infrastructure capacity including type, size and location	Annex B4.4 – WEEE Flow data
Draft recommendations on additional beneficial infrastructure	Annex B4.3 – Sofies Work
Finalise recommendations on additional beneficial infrastructure with stakeholder engagement	Annex B4.5 – Stakeholder Group Meeting
Final report on nation specific Infrastructure recommendations	Annex B4.2 – Final B4 Report
Final report on EU infrastructure recommendations	Annex B4.2 – Final B4 Report

Sustainability and continuation

This report gives several policy and infrastructure recommendations for individual EU governments on how they could move forward to increase the amount of CRMs captured. These recommendations are mutually beneficial and should not be treated in isolation. In order for national and regional governments, organisations and companies to increase their investment in collection and recovery infrastructure they will need a clear signal of policy intent. This in turn will give them the confidence to invest and reconfigure their business processes. Only then will the economies of scale and impacts noted in this report have a chance of being captured in both the short and long term.

In terms of sustainability – beyond this project future efforts will be needed to monitor the wider policy and infrastructure landscape and adapt the recommendations where appropriate to ensure their continued relevance. In particular, we have highlighted the expected forthcoming review of the WEEE Directive / current WEEE Regulations in the UK, and the need to monitor any potential changes in the EU list of CRMs.

6.1.7 C1 Monitoring & Evaluation of the Collection and Recovery Trials

– Completed October 2018

Lead Partner: WI

Supporting partners: All Partners

Introduction

Foreseen start date	June 2016
Actual start date	June 2016
Foreseen end date	Sep 2018
Actual (anticipated) end date	Sep 2018

This work package evaluated the collection and recovery trials. The monitoring and evaluation was based on a quantitative assessment of collected and reusable WEEE as well as the share of recovered CRM and the related environmental benefits. In order to assess the upscaling potential of the trials, the economic costs and benefits of the specific collection and recovery trials were analysed based on qualitative assessments.

Actions undertaken, expected results and outputs achieved

Broadly, Wuppertal Institute (WI) undertook the following actions, for the output of the delivery of C1 Monitoring and Evaluation report (see *Annex C1.4 – C1 Final Report*) pertaining to the collection and recovery trials: gathering of trial results; conducting of interviews with Trial partners; establishing of baseline and evaluation methodology (see *Annex C1.1 – Baseline*); synthesis of the trial results and participant survey responses; and detailed assessment and analysis of the environmental and economic factors (additionally covered under C2, see *Annex C2.1 – C2 Final Report*). The key results of the draft report were presented at the 6th Stakeholder Meeting at December 6th 2018 to gain stakeholders input. The feedback

was very positive, and WI received valuable comments which were incorporated into the final version.

One of the key actions undertaken as described above, was the collection and aggregation of data from the collection and re-use trials. The Wuppertal Institute established the synthesis of the collection/re-use trial data, which allows a comparison of all results in a transparent and consistent way. Overall, 4890 items collected (or 9854 kg collected) were part of the evaluation. Table 18 below shows the results of the re-use trials. The re-use assessment methods differed enormously between the trials (i.e. whether items were tested by the treatment operator, assessed by the consumer or actually sold). Therefore the interpretation of the re-use amounts and re-use rates is only possible under consideration of the specific trial conditions. Furthermore, some trial partners conducted more than one re-use trial (e.g. within the Ecodom trial, disposed products were judged by consumers and in addition screens were tested by a professional treatment operator). Table 18 below shows the results of these activities (e.g. in case of Ecodom the consumer judged suitability for re-use).

Table 18 Re-use assessment results

	Asekol: Mobile containers	Axion: BHF			Axion: Dixons			Axion: John Lewis			Ecodom: Market squares			Ecodom: Schools		
Age class		0-3	3-6	>6	0-3	3-6	>6	0-3	3-6	>6	0-3	3-6	>6	0-3	3-6	>6
Collection, pieces	1311	2	34	157	4	17	55	7	10	16	40	448	657	17	41	196
Collection, kg	1570	3	20	326	11	48	223	19	17	30	40	293	988	14	50	335
Reuse trial (1), pieces	5	2	13	41	3	13	25	4	3	6	13	78	236	7	9	28
Reuse trial (1), kg	9	3	16	123	8	38	123	13	3	18	13	92	391	1	10	64
Reuse rate (1), mass-based, %	4	100	78	38	76	80	55	70	16	61	32	31	40	7	20	19

	ReTek: B2B			ReTek: Halls			ReTek: HWRC			ReTek: Schools			ReTek: Social Enterprise			Recycling Boerse: Re-Bag	Recycling Boerse: Re-Box	Recycling Boerse: Schools
Age class	0-3	3-6	>6	0-3	3-6	>6	0-3	3-6	>6	0-3	3-6	>6	0-3	3-6	>6			
Collection, pieces	27	171	88	0	0	4	40	240	129	1	43	22	3	40	21	262	67	720
Collection, kg	49	478	250	0	0	1	227	1251	708	3	124	42	17	207	120	163	95	2134
Reuse trial (1), pieces	14	56	6	0	0	0	10	83	18	0	12	8	3	16	4	29	6	45
Reuse trial (1), kg	35	192	28	0	0	0	43	406	84	0	48	15	17	89	25	16	13	82
Reuse rate (1), mass-based, %	72	40	11			0	19	32	12	0	39	35	100	43	21	10	14	4

The overall collection amount across all the trials is higher compared to what is considered in the evaluation, as only a part of the data was reported in the template provided to the trial partners. Asekol's collections via stationary containers and collection yards, as well as Ecodom's collections in grocery stores and one of the two school collections were not part of the environmental assessment, since it was not possible to gather these data on a product-specific basis.

Summary

Compared to the collection trials, the technological approaches of the recovery trials selected for this project show significantly lower TRLs (Technology Readiness Level) which made them on the one hand very innovative, but on the other hand challenging to estimate their environmental and economic impacts. Against this background the analysis was based on the recovery trials outcomes and focused primarily on qualitative assessments of strengths and weaknesses of the specific trials.

The results showed that very different product types were collected within the collection activities. At the same time the baselines showed the potential to capture WEEE which otherwise would have been lost (e.g. put in the rubbish bin), is very different for the specific devices and can be very large in one region and very small in the other. This indicates that the potential to save resources or to reduce the climate impact is context-dependent. Hence, a high resource consumption (TMR: Total Material Requirement) of the product mix collected using a given collection model does not necessarily equate to high resource saving potential when replicated in another region, due to (regional) variations in the volumes and types of WEEE generated. This principle also applies when the collection model generates the same product mix or specific TMR. The results may still produce very different efficiencies regarding not only resources savings, but also economic impacts. Analysis from the collections trials also showed that product type has a greater influence on re-use rates than product ages, regardless of the collection mechanism.

Linking collection and recovery processes illustrated the overall economic impact of the specific end of life chains with a focus on CRM re-use/recovery. The costs and revenues per kg collected of CRM relevant products differed significantly between the different trials. Overall, the research confirmed that the sale of second-hand products creates an extension to the use phase of products, and thereby reduces demand for CRMs.

The analysis showed that the economic viability of collections clearly depends on successful coordination with other/existing collection activities, to reduce the cost per unit collected (e.g. the combined collection of WEEE and textiles). Cooperation with existing infrastructures (e.g. household recycling centres), or the retail sector is critical to success. Therefore, cost effective collection infrastructures focussed only on CRM-rich products would be difficult to establish.

The analysis also highlighted the current challenges of CRM recovery technologies due to the low cost of virgin materials (compared to the peak 2012 - see <http://hwwi-rohindex.de/>). Some of the proof of concept laboratory experiments demonstrated high recovery rates of the materials of interest. However, further laboratory work is required before these separation techniques would be suitable for use within a commercial environment. The work has for instance shown that bioleaching resulted in high potential recovery rates, but lacks commercial viability at this stage. However, considering the significantly reduced environmental impact of bioleaching compared to conventional pyrometallurgical processes, both the real costs and operational risks are lower than those associated with chemical leaching.

As a result, we concluded that it is important for national and local governments (as well as non-governmental organisations) to partner with R&D projects, to encourage the adoption of sustainable methods of CRM recovery such as bioleaching. Furthermore, it is important that the private sector is made aware of the feasibility and benefits of adopting this approach to CRM recovery, versus traditional metal recovery techniques.

Problems encountered and solutions

The deadline for this deliverable was pushed back a month from September to October 2018 due to the knock-on effect of delays to the trials completion, and thus the corresponding results being available for analysis. This change was communicated in the monthly report for August and discussed with our monitoring officer. It was also the case that some of the survey responses (specifically those from Recycling-Börse) had to be gathered retrospectively using insights from

staff rather than directly from the citizen participants, due to a poor response from the householders linked to the nature of the collection activity (not as face to face as in other cases). Additionally, due to availability of staff, interviews to assess the economic outcomes of the Axion trials were completed a few months after the interviews with the other trial partners (although we do not deem either of these problems encountered to have had any effect on the accuracy of the data collected, because of the solutions implemented above).

Compare progress with planned outputs

Whilst there were some limitations in terms of how saleable and comparable the findings of the trials were due to the different natures of the trials and what they were testing, as well as the lab-scale approach, we were nonetheless able to deliver a comprehensive monitoring and evaluation report of both the collection and recovery activities.

Deliverables, Milestones and Indicators

Table 19 C1 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/
Deliverable	Evaluation Report from Collection Trials	Original 09/2017 - Completed 10/2018	Complete
Deliverable	Evaluation Report from Recovery Trials	Original 09/2018 – Completed	Complete
Milestone	Completion of Collection Trial Monitoring & Evaluation	Original 08/2017 Completed 10/2018	Complete
Milestone	Completion of Recovery Trial Monitoring and Evaluation	Original 08/2018 – Completed 10/2018	Complete

Indicator of Progress	Evidence
Baselines established/agreed - to be finalised after the final decision on all trial partners	Baseline methodology as agreed by all trial partners: Annex C1.2 – Partners’ methodology agreement Background work on baseline development:
Operationalized evaluation concept developed - consulted with all trial partners and finalised	Annex C1.6 - Evaluation report for Collection and Reprocessing trials
Data collection completed	Annex C1.3 - Compiled survey data
Specific evaluation reports for the different trials completed	Annex C1.4 - C1 Final report
Completion of final evaluation report	Annex C1.4 - C1 Final report

6.1.8 C2 Monitoring of the Socio-economic impact of the project actions

- Completed January 2019

Lead Partner: WRAP

Supporting Partners: WI

Introduction

To fully understand the economic and social benefits of the trial activities, the users of the trials (generally members of the public) need to be surveyed to understand the current (pre-trial) methods of

Foreseen start date	June 2016
Actual start date	June 2016
Foreseen end date	January 2019
Actual end date	January 2019

WEEE disposal, attitudes towards different disposal methods and attitudes to the hoarding of electricals. The information gathered will also enhance the evaluation in C1 and will feed into the final report.

Actions undertaken, expected results and outputs achieved: (in quantifiable terms)

The impacts across the project have been assessed using both the C1 report directly and the raw data from the trials. Information about the trials was collected by means of qualitative discussions with those involved and who have an interest in the work, as well as through surveys of users. Two quantitative surveys were conducted as well as separate qualitative interviews with those involved. These provided relevant information on the social and economic benefits. Net economic and social costs resulting from the C1 report were analysed as for this deliverable, as were the five innovative technologies which were undertaken as part of the trials – with particular focus on their ecological and economic impacts.

A detailed delivery plan for C2 was defined and executed at the beginning of January (see *Annex C2.3 – Delivery Plan*), and the write-up of the C2 deliverable progressed according to this plan. The report was internally reviewed by several members of the project team at WRAP – including the senior project team members, and the project partners have fed into the analysis through project meetings (Wuppertal and Ecodom in particular). Through this process we interrogated the underlying data to arrive at a strong evaluation conclusion for the project. An update on this deliverable was provided to those that attended the final Mission Visit and PMB meetings.

Summary

The trials were designed with the main aim to demonstrate the potential to increase the recovery of target Critical Raw Materials from CRM-rich products including ICT, display equipment, mobile devices and other small household electrical items. The trials took place in five locations in EU Member States and included collection trials with at least two recovery technologies in each case. Data has been gathered across all trials for evaluation to assess their potential.

- Survey data from the trial areas was utilised to assess the potential for WEEE collection and CRMs recovery and to provide baselines for each trial, and establish what would have otherwise happened to the targeted items.
- Monitoring data was collected by trials partners regarding the quantities of WEEE collected, and the results of the recovery technologies.
- A stakeholder group and expert interviews were used to provide additional insight, particularly for assessment of the recovery trials where the quantitative data collected was not directly comparable.

The trials evaluation developed data collection instruments, carried out surveys and qualitative interviews. They also coordinated collection of monitoring data from trial partners using a standard methodology. These data and findings have been included in the report from the Wuppertal Institute, *'Monitoring and Evaluation of the Collection and Reprocessing Trials, Critical Raw Material Closed Loop Recovery Project'*. One of the core tasks for evaluation was to understand the ability of the trials to deliver outcomes that would not otherwise have been able to be achieved. Survey data was used to assess what would have happened to WEEE products collected without the trials. Questions were designed to find out whether the trials

captured additional material by asking what participants in the trials would have done with the items otherwise.

Re-Tek were particularly successful in collecting large quantities of both ICT and display equipment. Axion were successful in diverting a greater proportion of items to re-use across all categories than other trials. Overall display equipment was the most likely to go to re-use.

The revenues from re-use achieved by Axion appear to have singularly achieved a positive cost / revenue ratio. Only Re-Tek came close to matching this and in their case the volume of re-use appears to have been beneficial to overall revenue. Re-Tek 's collections service also reported no investment costs and no media costs which helped the overall balance of cost to revenue.

Table 20 below provides a summary of the quantity of items collected during the collection trials, and the quantities of these that were sent for re-use.

Table 20 Quantity of items collected and sent for re-use

	Collection pieces	Collection kg	Re-use pieces	Re-use kg
Asekol: Mobile Containers	1311	1570	5	9
Axion: BHF	193	349	56	142
Axion: Dixons	76	282	41	169
Axion: John Lewis	33	66	13	34
Ecodom: Market Squares	1145	1321	327	496
Ecodom: Schools	254	399	44	75
Recycling-Börse Rebag	262	163	29	16
Recycling-Börse Rebox	67	95	6	13
Recycling-Börse Schools	720	2134	45	82
Re-Tek Workplace	286	777	76	255
Re-Tek Halls	4	1	0	0
Re-Tek HWRC	409	2186	111	533
Re-Tek Schools	66	169	20	63
Re-Tek Social Enterprise	64	344	23	131
TOTAL	4890	9856	796	2018

Recovery trials set out to separate CRMs from those items collected that had not gone to re-use. New technologies were trialled and demonstrated on a small scale and there were notable successes in achieving high enough concentrations of CRMs for recovery in some cases. It is important to note that the recovery trials were each designed differently and, as such, did not produce comparable results. The total quantity of CRMs separated was not recorded in most cases. Specific examples of CRMs that were separated and recovered included gold,

neodymium, tantalum, and cobalt, which were recovered from printed circuit boards and from batteries.

There is potential to scale-up some of the recovery technologies that achieved positive outcomes during the trials, where it was demonstrated that the technology worked successfully at a very small scale. As above, the laboratory nature of the trials for this project means that conclusions cannot currently be drawn about operationalising the technology on a larger scale. Further trials would look to demonstrate viability on a larger scale.

To be effective the trials needed either to pilot new technology, or to operationalise effective (already tested) technologies. Due to difficulties recruiting trial partners, the project sought to work at a level of market-readiness that the participating trial partners had not yet achieved. Future research could build on the early findings of the new technologies.

Problems encountered and solutions

Delivery of C2 was relatively straightforward. There was a need to discuss the German and Axion data further, with Wuppertal and Ecodom respectively, due to the low consumer response to the surveys and a query on how best to interpret the data from the graphite and cobalt battery recovery trials. These were all resolved through discussion and the appropriate approach and values detailed in the final report.

Compare progress with planned outputs

This deliverable was completed as per the planned outputs. One small change we made was to keep the C2 report as a separate document rather than combine it with C1 as it was written after C1 and by a different author. Nonetheless the final C2 report references and clearly links to the C1 report. They could be combined by dove-tailing them together if desired.

Deliverables, Milestones and Indicators

Table 21 C2 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/status
Milestones	Analysis of economic and social impacts incorporated into the final evaluation report	01/2019	Complete

Indicator of Progress	Evidence
Qualitative interviews completed	Interview templates produced – attached Mid term report Interview matrix produced – attached to Mid term report
Socio economic surveys (1100 households)	In total 2,542 surveys were completed – see compiled survey data C2.2
Review report produced to feed into final report	Annex C2.1 - Final Report
Analysis of economic and social impacts incorporated into the final evaluation report	For ease as these documents were authored by two separate organisations, we have kept the documents separate – although the C2 report references and clearly links to the C1 report: Annex C2.1 - Final Report

6.1.9 D1 Communication & Dissemination Activity

– Activities completed by March 2019

Lead Partner: KTN

Supporting partners; WI, WRAP, ERP and EARN

Foreseen start date	September 2015
Actual start date	September 2015
Foreseen end date	March 2019
Actual end date	March 2019

Introduction

This supporting action was integral to the main implementation actions, and activity continued throughout the project, from initiation to final press release.

Actions undertaken, expected results and outputs achieved: (in quantifiable terms)

Communications Plan

An initial communications plan was established to provide a framework for communication and dissemination activity. D1 targets and deadlines were embedded within the plan, which was initiated in November 2015 and reviewed and refreshed in December 2017.

The plan worked as a framework to capture the activities necessary to promote the project to its intended audience. It included:

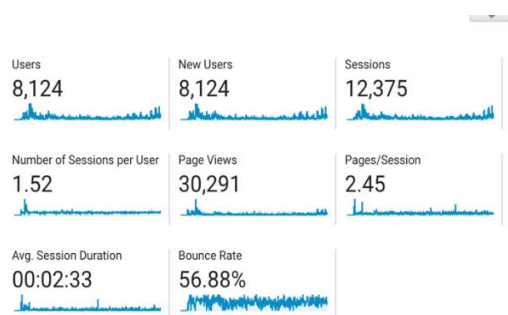
- Social media - initial plan and summary of tweets;
- Newsletter schedule and contents;
- Case study schedule and contents;
- Event headline plans;
- Identification of intended audience and (where possible) how best to reach them. The identified audience groups for the project included:
 - Shareholders (e.g. Electrocycling, Coolrex, Indumetal)
 - Waste Collection stakeholders (e.g. Local Authorities/ civic amenities / compliance schemes / waste handling/management companies / manufactures/suppliers that collect end of use waste)
 - Material recovery and processing organisations (e.g. smelters / processors / reuse specialists)
 - Research based organisations (e.g. universities / RTOs / project coordinators)
 - Policy Makers (e.g. national Governments / European Commission)
 - ‘Associated organisations’ (e.g. producers/manufacturers / retailers & suppliers of EEE / WEEE recyclers / logistics companies / commercial & social enterprise reuse organisations)
 - Other potential stakeholders (e.g. trade bodies / NGOs / charities / business leaders).

Project website

The project website was set up and went live in November 2015. Throughout the duration of the project it has been used for communication activities (project details, brochures, introductory videos) and dissemination activities (sharing case studies, newsletters, project news, Layman’s Report). The website’s URL is: <http://www.criticalrawmaterialrecovery.eu>.

During the project lifetime, there were 12,375 page impressions. A summary of web data is as set out below:

Figure 3 web data



Case studies

In accordance with project targets, 10 case studies were published on the project website, all of which had the objective to disseminate activity, outcomes, learning and opportunities. The full list of published case studies is set out in Table 22 below.

Table 22 Published case studies

Title	Type	Summary	Link
Schools and parents join forces	WEEE Collection Trial	Discussion of the Re-Tek WEEE collection trial and the benefits accrued from collaboration with a primary school in Scotland.	http://www.criticalrawmaterialrecovery.eu/schools-and-parents-join-forces
Take Back and Incentivised Return Trials in Northern England	WEEE Collection Trial	Review of Axion WEEE collection trial and the outcomes of their collaborative projects with John Lewis, the British Heart Foundation and Dixons Carphone in the UK.	http://www.criticalrawmaterialrecovery.eu/home/casestudies/retail-and-charity-trials
Three ways to get great WEEE recycling results	WEEE Collection Trial	Summary of Recycling-Börse's activity with a range of education establishments in Germany.	http://www.criticalrawmaterialrecovery.eu/three-ways-to-get-great-weee-recycling-results
Recovering value from circuit boards	CRM Recovery Trial	A summarised review of Axion's recovery trial, delivered in partnership with E3 Recycling and ITRI.	http://www.criticalrawmaterialrecovery.eu/home/casestudies/recovering-value-circuit-boards
Collect more, collect better	WEEE Collection Trial	Outline of Ecodom's experience in involving Milanese citizens in a range of collection activities, using publicly located WEEE collection receptacles.	http://www.criticalrawmaterialrecovery.eu/home/casestudies/collect-more-collect-better
Working towards a second life for Critical Raw Materials in Italy – Precious metals,	CRM Recovery Trial	A summarised review of Ecodom's recovery trial, delivered in partnership ENEA.	http://www.criticalrawmaterialrecovery.eu/home/casestudies/working-towards-second-life-

batteries and flat panel displays			critical-raw-materials-germany
Working towards a second life for Critical Raw Materials in Germany	CRM Recovery Trial	A summarised review of Recycling-Börse's CRM recovery trial.	
Testing separation techniques to recover value from circuit boards	CRM Recovery Trial	A summarised review of Re-Tek's CRM recovery trial, delivered in partnership with the University of the West of Scotland.	http://www.criticalrawmaterialrecovery.eu/home/casestudies/testing-separation-techniques-to-recover-value-from-circuit-boards
CRM Recovery Trial in the Czech Republic	CRM Recovery Trial	A summarised review of Asekol's CRM recovery trial, delivered in partnership with E3 Recycling and ITRI.	http://www.criticalrawmaterialrecovery.eu/home/casestudies/crm-recovery-trial-in-the-czech-republic
WEEE Collection and CRM Recovery Trials Across Europe	WEEE Collection & CRM Recovery Trials	An overview of all project WEEE collection and CRM recovery trials, demonstrate the links between both collection and recovery, identify common outcomes and opportunities and summarise common learnings from the trial.	http://www.criticalrawmaterialrecovery.eu/home/casestudies/weee-collection-and-crm-recovery-trials-across-europe

The complete range of 10 project case studies are available on the project website. <http://www.criticalrawmaterialrecovery.eu/home/casestudies>.

Events

Three significant events (targeted to communicate project aims and to disseminate outputs and achievements) were developed and delivered, in line with project targets:

Dedicated Event 1: Launch Event - The project's initial launch event was delivered 'virtually' in early 2016, with the publication of two videos and the infographic on the website. A link to the videos can be found on the project website, and also via the Vimeo page <https://vimeo.com/crmrecovery>. An infographic was developed for use on multiple media outlets, including the project's brochure, which was published in the first quarter of 2016.

Dedicated Event 2: Interim Conference - "Integrating the Supply Chain for the Recovery of Critical Raw Materials from WEEE" was held on the 15th June 2017, at the Radisson Edwardian Hotel, Manchester, UK. This event was aimed at assessing the barriers to improved recovery and recycling of CRMs throughout the whole supply chain from the logistics of collection to advanced recovery techniques, the event featured a range of speakers and relevant topics, see *Annex D1 - Agenda & List - CRM Recovery Event - 15 June 2017 (D)* event agenda & attendee list. We also used this event as an opportunity to celebrate 25 years of the LIFE programme.

Feedback was (anecdotally) very positive on the day. Post-event, we gathered feedback from attendees that was overwhelmingly positive, it was stated that they had made a

collective total of 29 new contacts at the event. As an added value aspect of the event, and to further promote the project's activity, immediately following the conference delegates had the opportunity to visit the recycling facilities at trial partner Axion's local site.

Figure 4 Photographs from the project's Interim Conference



Dedicated Event 3: Final Conference - Held on the 19th February 2019 at The Royal Society, London, UK. The final event was targeted to:

- Disseminate the project's main activities and achievements;
- Further disseminate the policy and infrastructure recommendations;
- Launch the Layman's Report.

The full agenda, speakers, presentations and a set of video interviews have been made available on the project website: <http://www.criticalrawmaterialrecovery.eu/wp-content/uploads/2019/01/Second-LIFE-for-CRM-Event-Booklet-Website.pdf>.

The headline outputs are that we had over 150 people registered, with a further 45 or so on a waiting list. On the day 121 delegates attended.

Feedback was very positive, with delegates appreciative of the opportunity to network, be part of stimulating discussions and hear about the EU collection and recovery trials. Feedback was gathered via hard copy form and an online question set.

The collated feedback is available on SoonR (*Annex D1.2 - Events 3 Final Event February, Collated Feedback*).

Figure 5 Photographs from Final Conference (showing general room shot and Panel Session 1).



N.B. For all physical conferences (venue hire and conference brochures) a formal procurement exercise was undertaken in accordance with company procurement policies - in these cases a minimum of 3 quotes from suppliers, with a decision made and justified in each case.

Layman's Report

At the Final Conference we also launched the project's Layman's Report. A copy was provided to each delegate and was further disseminated via social media and a project specific webinar. A copy of the report can be found here:

<http://www.criticalrawmaterialrecovery.eu/wp-content/uploads/2019/02/KTN-Laymans-Report-Final.pdf>.

N.B. for design and printing of the Layman's Report, a formal procurement exercise was undertaken in accordance with company procurement policies - in this case a minimum of 3 quotes from suppliers, with a decision made and justified.

Policy dissemination activity

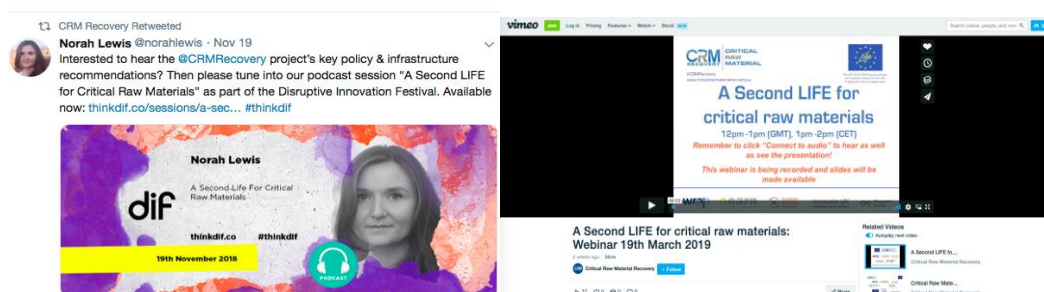
To support the dissemination of the project activities and the policy and infrastructure recommendations, we organised, hosted and introduced two webinars.

- DIF 2018. The project participated in the Ellen Macarthur Foundation's Disruptive Innovation Festival (DIF) which ran from 6-23rd November 2018. This is run through the Ellen Macarthur Foundation and is an annual (global) online festival based around the theme of 'what if we could redesign everything'. DIF 2018 was a mix of live web streams, live filmed events, and pre-recorded activities, including podcasts, which is the format used by the project. We launched our podcast on the 19th November and based it around the theme of public involvement in WEEE collection trials. Content included a project overview, a summary of UK trials, an overview of the Italian and Czech Republic trials and EARN covering the RecyclingBörse trials. Some really useful promotion for the project was achieved by participation, for example DIF branded speaker banners used on social media and a 'listener' audience of ca. 77 (who are people that have listened all the way through the podcast – for perspective, this figure is on the top 10 of the 20 or so podcasts). The podcast was available to listen to until the end of January 2019 - <https://www.thinkdif.co/sessions/a-second-life-for-critical-raw-materials> .
- Policy dissemination webinar: held on the 19th March 2019. The webinar was promoted via eventbrite (<https://www.eventbrite.co.uk/e/webinar-a-second-life-for-critical-raw->

[materials-tickets-58355584123](https://www.criticalrawmaterialrecovery.eu/news-events)) and partner social media channels. We were delighted to have 185 people registered and 94 listen in on the day. Attendees from 18 different countries dialled in, with 47% of these representing businesses (with 8% policy-makers). The webinar was recorded and has been made available on the project website: <http://www.criticalrawmaterialrecovery.eu/news-events>.

- Initial dissemination of Policy & Infrastructure Recommendations at the International E-waste Day, 3th October 2018. The project used this day to promote its range of case studies and to do a soft launch of policy recommendations via a summary infographic: <http://www.criticalrawmaterialrecovery.eu/wp-content/uploads/2018/10/5-policy-recommendations-infographic.pdf> . Partners and stakeholders worked hard to promote and support the project's input via social media.

Figure 6 Example of promotional tweets for DIF201 Policy webinar on the projects' Vimeo' site



Newsletters

In line with project targets, 14 quarterly newsletters were issued. As an example of content, the final project newsletter was published in March 2019, where the contents included:

- Summary of final case studies -Asekol and an amalgamated summary of collection & recovery trials;
- Summary of the Final Conference and policy webinar;
- Short pieces on the project closure meeting and a Stakeholder 'thank-you';
- A summary of the object outputs that will be available for future download;
- Regular section on topic-relevant news and events.

At project conclusion, there were 542 people signed up to receive the newsletters. Of these subscribers the following analysis can be made:

Audience

- The top 5 categories of newsletter recipient can be classed as
 1. Industry – 47% (255 in total)
 2. Project partners – 7% (37)
 3. Trade bodies / associations – 5% (29)
 4. Research & Technology Associations - 55 (29)
 5. Project stakeholders – 2% (13)
- 35 of these were policy influencers (namely representatives of government departments and / or public authorities.

Location

- The top 5 recipient countries were:
 1. UK – 64% (345)
 2. Germany – 5% (25)
 3. Italy – 3.5% (19)
 4. Belgium – 3% (16)
 5. France – 2% (12)
- Other EU countries also had a range of recipient numbers (Ireland, Portugal, Spain, Holland and Greece for example).
- There was a very wide geographical spread, including recipients based in New Zealand, Japan, India, Chile, Brazil, Peru, Canada, Columbia, Turkey, Sweden and Israel.

Press Releases

Eight project-related press releases were published during the project’s duration, in line with targets:

- “New €2.1 million project to map out effective recovery of raw materials from electrical products”. 14.10.15;
- “European project launches tender to improve collection and recovery of Critical Raw Materials from electrical waste.” 11.02.16;
- “Trials begin for collection and recovery of Critical Raw Materials from electrical waste”. 26.07.16;
- “Collection Trials Finish in Critical Raw Material Closed Loop Recovery Project.” 18.12.17;
- “Take Back and Incentivised Return Trials in Northern England Result in Great Returns on WEEE Collection”. 30.05.18;
- “A Second LIFE for Critical Raw Materials - Free conference for businesses, funding bodies and research organisations with an interest in the recovery of Critical Raw Materials.” 07.11.18;
- “FIVE POINT PLAN TO KEEP ELECTRICAL EQUIPMENT OUT OF LANDFILL.” 20.02.19;
- “Critical Raw Material Closed Loop Recovery Project Closes with Release of Trial Learnings.” 29.03.19.

Summary of media coverage

Table 23 Summary of media coverage

Publication / Outlet	Date	Link
CIWM Journal Online	21/02/2019	https://ciwm-journal.co.uk/five-point-plan-to-keep-electrical-equipment-out-of-landfill/
Lets Recycle	21/02/2019	https://www.letsrecycle.com/news/latest-news/study-targets-critical-materials-from-weee/
Waste Management World	20/02/2019	https://waste-management-world.com/a/london-event-sees-report-on-critical-raw-material-recycling
Envirotec Magazine	31/05/2018	https://envirotecmagazine.com/2018/05/31/collaborative-approach-to-collection-increases-weee-recovery-in-northern-england-trial/#provider_moreover
Electronics World	22/12/2017	https://www.electronicsworld.co.uk/news/5577-collection-trials-

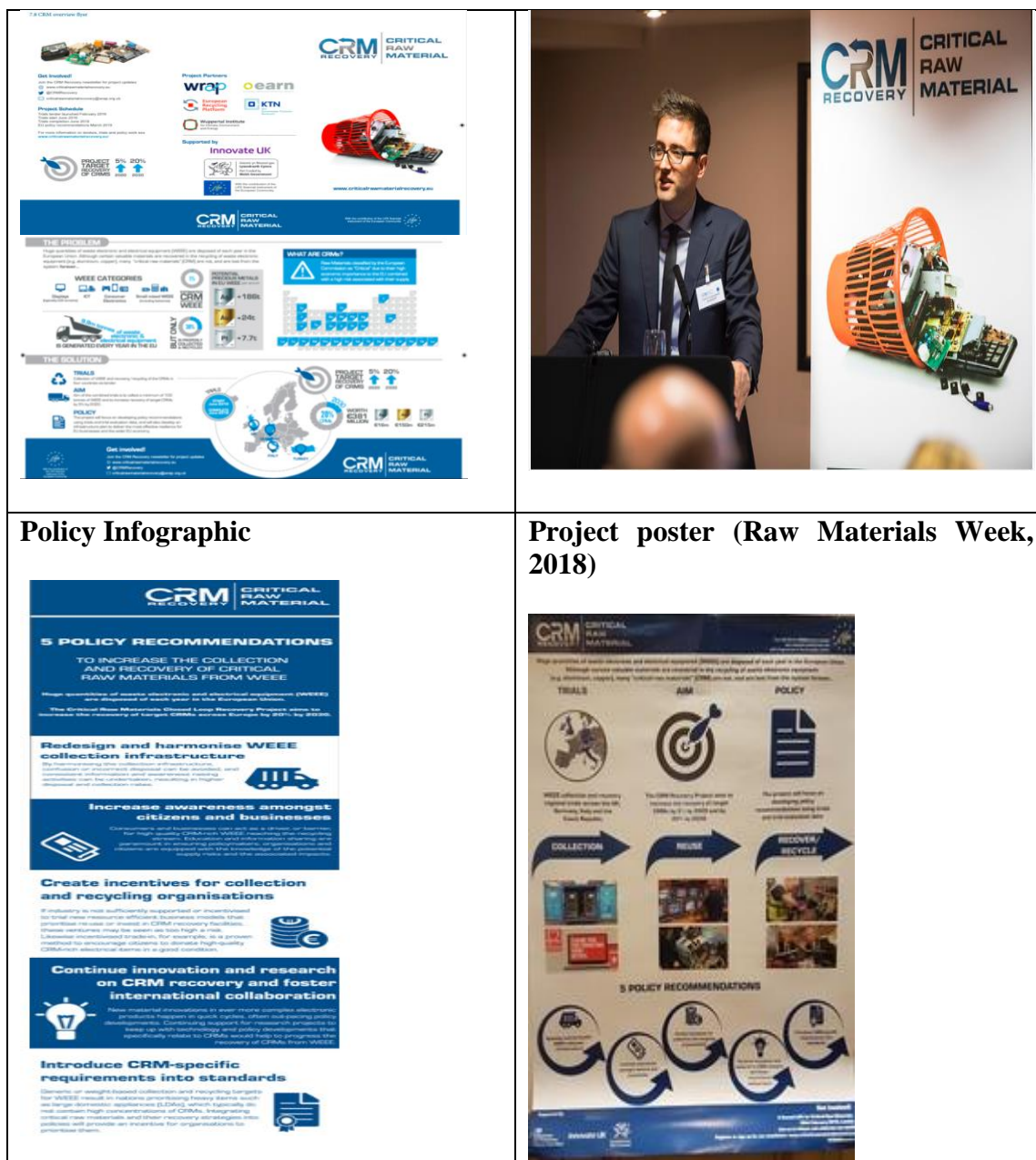
		finish-in-critical-raw-material-closed-loop-recovery-project?tmpl=component&print=1&layout=default&page=
Resource efficient business	19/12/2017	http://www.rebnews.com/news/recycling/critical_raw_material_closed_loop_recovery_project_finishes_first_stage_collection_trials.html
Watergas	08/11/2017	http://www.watergas.it/it/news/a_ecomondo_presentati_i_dati_d
Recycling International	02/08/2017	https://www.recyclinginternational.com/recycling-news/10720/e-scrap-and-batteries/united-kingdom/axion-starts-new-phase-crm-recovery-project
il fatto alimentare	14/07/2017	http://www.ilfattoalimentare.it/raee-supermercato-olio-di-frittura.html
Alternativa Sostenibile	20/06/2017	http://www.alternativasostenibile.it/articolo/presso-2-punti-vendita-coop-di-milano-parte-la-raccolta-sperimentale-di-piccoli
Partecipa COOP	16/06/2017	https://www.partecipacoop.org/progetto-crm-recovery-butto-rifiuti-elettronici/
Recycling International	09/06/2017	http://www.recyclinginternational.com/recycling-news/10594/e-scrap-and-batteries/united-kingdom/axion-takes-next-step-critical-raw-materials-recovery-project
Neue Westfälische	06/05/2017	https://www.nw.de/lokal/kreis_herford/buende/21772025_Achtung-jetzt-kommt-ein-Karton.html
Neue Westfälische	05/05/2017	https://www.nw.de/lokal/kreis_herford/loehne/21770826_Recyclingboerse-stellt-Sammelboxen-fuer-Elektroschrott.html
Resource Magazine	Spring 2017	http://resource.co/article/rare-earth-recycling-how-can-we-keep-our-gadgets-sustainable-11904
Covenant Circular Economy Newsflash // 01-15 November Edition	01-Nov-16	Email newsletter (no link available)
La Casa In Ordine	20/10/2016	http://www.lacasainordine.it/2016/10/crm-recovery-riciclo-green-dellelettronica/
Covenant Circular Economy Newsflash // 15-31 October Edition	15/10/2016	Email newsletter (no link available)
Best Start blog	25/09/2016	http://bestarblog.blogspot.com/2016/09/ambiente-ecodom-al-via-il-progetto-crm.html
Adnkronos	20/09/2016	https://www.adnkronos.com/sostenibilita/risorse/2016/09/20/oro-platino-nei-piccoli-elettrodomestici-milano-progetto-recupero_08li8dxdtCYnCfOv2oD2SJ.html
Focus	20/09/2016	https://www.focus.it/ambiente/ecologia/oro-e-platino-nei-piccoli-elettrodomestici-a-milano-un-progetto-di-recupero
Axion Polymers Newsletter	01/09/2016	http://axionrecycling.cmail19.com/t/ViewEmail/y/FDB913295EF34FA/E6E75258DE0029126A4D3D471B02C3D7
Axion Polymers	01/09/2016	http://www.axionpolymers.com/news-item/trials-begin-for-collection-and-recovery-of-critical-raw-materials-from-electrical-waste/
Sustainable Brands	18/08/2016	http://www.sustainablebrands.com/news_and_views/products_design/hannah_furlong/trending_consumers_want_fewer_phones_more_e-waste_recy
Resource Recycling	04/08/2016	http://www.resource-recycling.com/node/7767
GM Business Growth Hub online article	29/07/2016	https://www.businessgrowthhub.com/green-technologies-and-services/green-intelligence/resource-library/firm-awarded-funding-for-innovative-e-waste-recovery
Edie Net	27/07/2016	http://www.edie.net/news/5/UK-company-awarded-EU-funding-for-waste-electrical-product-recovery-trials-/
adnkronos Online	26/07/2016	http://www.adnkronos.com/sostenibilita/best-practices/2016/07/26/recupero-materie-nobili-dai-raee-progetto-italiano-finanziamento-internazionale_r9wuhKKfVBjLzTYSfbBcTJ.html

CIWM Journal Online	26/07/2016	http://www.ciwm-journal.co.uk/trials-begin-boost-recovery-critical-raw-materials-e-waste/
Recycling & Waste World	26/07/2016	http://www.recyclingwasteworld.co.uk/news/trials-begin-for-recovery-of-critical-raw-materials-from-electrical-waste/143863/
ERP Newsletter	01/07/2016	http://www.erp-recycling.co.uk/wp-content/uploads/sites/35/2016/07/ERP_July16Newsletter_FINAL.pdf
Green Growth online article	29/06/2016	https://www.green-growth.org.uk/article/firm-awarded-funding-innovative-e-waste-recovery
Non solo ambiente	20/04/2016	http://nonsoloambiente.it/economia-circolare/rifiuti/second-hand-economy-niente-si-butta-tutto-si-trasforma/
elettricomagazine	03/03/2016	https://www.elettricomagazine.it/2016/03/03/recupero-dei-metalli-nobili-dai-rifiuti-elettronici-raee/
ERP Online	15/02/2016	http://www.erp-recycling.co.uk/news/tender-launched-to-improve-collection-and-recovery-of-critical-raw-materials-from-electrical-waste/
Green Planner Magazine	12/02/2016	http://www.greenplanner.it/2016/02/12/riciclo-via-al-critical-raw-material-closed-loop-recovery-project/
Rinnovabili	12/02/2016	http://www.rinnovabili.it/ambiente/recupero-metalli-preziosi-idee-innovative-666/
Recycling International	12/02/2016	http://www.recyclinginternational.com/recycling-news/9466/e-scrap-and-batteries/europe/euro-2-million-enhance-europe-039-s-e-cycling
CIWM Journal Online	11/02/2016	http://www.ciwm-journal.co.uk/e660000-invested-in-improving-weee-collection-recovery/
Edie Net	05/11/2015	http://www.edie.net/blog/Raw-materials-Not-the-next-gold-rush-but/6097918
Sustainable Brands	26/10/2015	https://sustainablebrands.com/read/waste-not/3-6m-wrap-project-targets-european-clothing-waste
Environmental Leader	19/10/2015	http://www.environmentalleader.com/2015/10/19/2-3m-recycling-partnership-focuses-on-critical-raw-materials-recovery/
Recycling International	16/10/2015	http://www.recyclinginternational.com/recycling-news/9096/e-scrap-and-batteries/united-kingdom/eu-funds-euro-2-million-e-scrap-materials-project
Sustainable Brands	15/10/2015	https://sustainablebrands.com/read/defining-the-next-economy/wrap-to-lead-2m-raw-materials-recovery-project-for-electronics
Resource Efficient Business	15/10/2015	http://www.rebnews.com/news/resource_efficiency/project_map_effective_recovery_raw_materials_electrical_products.html
Business Green	14/10/2015	http://www.businessgreen.com/bg/news/2430402/wrap-launches-eur21m-project-to-explore-commercial-opportunities-of-electronic-waste-recovery
Resource Magazine	14/10/2015	http://resource.co/article/wrap-launches-weee-material-recovery-project-1--0556
Lets Recycle	14/10/2015	http://www.letsrecycle.com/news/latest-news/wrap-led-european-project-to-look-at-weee-material-recovery/
Edie Net	14/10/2015	http://www.edie.net/registration/regwall.asp?origin=http%3A%2F%2Fwww%2Eedie%2Enet%2Fnews%2F5%2FNew%2DEUR2%2D1%2Dmillion%2Dproject%2Dto%2Dboost%2Drecovery%2Dof%2Draw%2Dmaterials%2Dfrom%2De%2Dwaste%2F&title=%26euro%3B2m+project+to+boost+recovery+of+raw+materials+from+e%2Dwaste
CIWM Journal Online	14/10/2015	http://www.ciwm-journal.co.uk/new-e2-1m-project-to-map-out-materials-recovery-from-electrical-products/

Examples of templates, documents and promotional activities produced under the D1 work package:

Figure 7 Examples of templates, documents and promotional activities

<h2>Presentation Template</h2> 	<h2>Case Studies</h2> 
<h2>Newsletters</h2> 	<h2>Layman's Report</h2> 
<h2>Project brochure</h2>	<h2>Project banner</h2>



Noticeboards

Through the project activity over 63 noticeboards were display across the project partners and trial hosts locations in the following Countries.

- Germany;
- Czech Republic;
- Italy;
- United Kingdom;
- Northern Ireland.

The noticeboards have been displayed in the foyers of each of the partners and trial partners offices and also in various locations as part of the collection trial activities. A small sample of the images can be seen below.

Figure 8 Noticeboard displays



WRAP



EARN



Green Solutions



Fraunhofer IWKS, Germany.



Ecodom, Milan, Italy.



Re-Tek, Fife, UK.

The noticeboards have allowed for marketing and notification to the public and potential user of the project's key information, funders and partners. Noticeboards were developed in late 2015 and have been a stipulation for any partners involved in the project.

Problems encountered and solutions

In the main, delivery of D1 activity was fairly straightforward, thanks to the valuable output coming from the trials, having a communications plan in place with regular timings for D1 output (newsletters, press releases etc), and thanks to partner support and inputs.

Internally, there were a number of changes to the assigned Project Manager. Risks were mitigated by ensuring that replacements were experienced in managing these types of multi-partner, EU-funded projects and that a robust hand-over was provided. The rest of the KTN

D1 team remained largely unchanged throughout the project duration, which was invaluable in terms of building project knowledge and relationships.

Within these types of project, there is always a risk that some partner activity can be missed / not shared, which could reduce the volume and impact of project materials to be communicated and / or disseminated. Through the robust project management processes that were enacted (monthly reports, PMBs etc), these risks were minimised as far as possible.

Compare progress with planned outputs

All deliverables and milestones were achieved. Some submission / delivery dates were changed, for example the project Layman's report was aligned with the Final Conference delivered in February 2019 (rather than December 2018) to ensure that the policy recommendations could be fully disseminated, and some case studies were delayed to align with the marketing and promotion of the Conference.

Deliverables, Milestones and Indicators

Table 23 D1 Deliverables, Milestones and Indicators

Deliverable	Date	Status
Case Studies (10)	Dec-18	Completed by end of March 2019, in alignment with extension to Final Conference.
Project Communications plan	Nov-15	Completed and refreshed in Dec 2017.
Quarterly newsletter after first 9 months of project	May-16	Completed – 14 newsletters published.
2 press releases per year	Dec-18	Extended to March 2019.
Project overview Brochure	Nov-15	Completed
Notice Boards produced	Nov-15	Completed
Laymen's report published	Dec-18	Completed in February 2019, in alignment with extension to Final Conference.

	Name	Deadline	Progress/status
Milestones	Case Studies (10)	Original 12/2018 - Completed 03/2019	Complete
Milestones	Project communications plan	Original 11/2015 - Completed	Complete
Milestones	Quarterly Newsletter after first 9 months	Original 05/2016 – Completed 05/2106	Complete
Milestones	2 press releases per year	12/2018	Complete
Milestones	Project Brochure overview	11/2015	Complete
Milestones	Notice Boards produced	11/2015	Complete
Milestones	Laymen's Report published	Original 12/2018 Completed 02/2019	Complete
Deliverables	CRM Recovery dedicated event 2	Original 12/2016 Actual 06/2017	Complete
Deliverables	Launch Event	Original 01/2016 Actual 02/2016	Complete
Deliverables	Communications Plan	11/2015	Complete
Deliverables	CRM Recovery dedicated event 3	Original 12/2018 Actual 02/2019	Complete
Deliverables	Project Website set up	11/2015	Complete

Indicator of Progress	Evidence
Extranet site on-line - 3 months from start of project	SoonR workplace live and used by all project partners.
Public web-site on-line - 3 months from start of project	The project website was completed in December 2015 and refreshed around the project mid-term period. The project website URL is http://www.criticalrawmaterialrecovery.eu/ .
Newsletter circulated through mailing lists and through website – Quarterly, after the first 9 months of operation	The first newsletter was issued 3 months ahead of schedule to promote the project. 14 newsletters were published during the project lifespan - Annex D1.10- D1.14.
Social networking feeds - 2 networking sites to be set up within 3 months from start of project	Both a LinkedIn group page:) and a Twitter account (@CRMRecovery) were set up for project activity.
Agreements with other networks to disseminate activity - 4 collaboration agreements	We worked with a number of partners to maximise dissemination output, for example, the WEEE Forum, the H2020 SCREEN project, the CREAM Network and the H2020 COLLECTORS project.
Dissemination via presentations and literature	<p>During the duration of the project, the partners attended over 40 events across Europe – See Annex E4.2 external events log. We estimate (using sign-in sheets where available etc) that the total size of the audience at these events was 6,423. Not all will have attended a project presentation, but it is likely that a high percentage will have received copies of slides from the events.</p> <p>The first project brochure and roll up banner were produced in the first quarter of 2016. This was delayed due to the restructuring of the trials into single activities, rather than separate collection trials followed by recovery trials.</p>
Presentations at events and workshops - 25 presentations at external events	<p>As noted above, the project partners attended and delivered at least 40 external presentations that helped to disseminate the project. Of these, the project team presented at around 30, with evidence.</p> <p>The project had 2 related targets:</p> <ul style="list-style-type: none"> - To deliver presentations to 600 business delegates – 755 businesses were estimated to have attended project-related presentations (a conservative estimate), with 686 at the events with full evidence. - To reach policy influencers during these presentations - we estimate that 307 policy influencers attended these external events (meaning government bodies / local authorities).
CRM Recovery dedicated dissemination events – 3 events	<p>Launch event took place January 2016.</p> <p>Interim event delivered on 15th June 2017.</p> <p>Final Conference delivered on 20th February 2019.</p>
Preparation of project overview brochure - Within 3 months of project start	The first brochure was produced in the first quarter of 2016 (copy sent with first Progress report May 2016). The brochure was subsequently refreshed to include the new trial country.
Preparation of external, best practice case studies - 10 case studies by the end of the Project	10 project trial related case studies were published by the end of the project (5 related to the WEEE collection trials, 4 to the CRM recovery trials and 1 ‘amalgamated’ summary of the trial process and outcomes). All case studies have been made available on the project website and are also available on SoonR.
Presentation template and standard format - 3 months from start of project	<p>Standard Slide deck produced - Annex D1.16.</p> <p>Additional project information slide decks were developed and utilised by partners during dissemination activities, especially in the period following release of the policy and infrastructure recommendations.</p>

Press releases issued - 2 press releases per year	8 press releases were issued during the project duration. All press releases, distribution lists and examples of resulting publicity are available on SoonR (Annex D1.6)
Page impressions - Peak at 2,000 / month	From an initial starting point of 259 website visits in the first quarter of the project activity to the first peak that exceeded target (2,543 during the launch event and first round of procurement activity), the project website has had 7,678 page impressions during its duration. (Annex D1.11)
Registered users - 300	To the end of March 2019, 542 users were signed up to receive the project newsletter, a 183% achievement against the target. (Annex D1.4)
Project material includes reference to European programme - 100% of all internal material includes agreed statements	<p>All project material references the EU programme, including the following documents:</p> <ul style="list-style-type: none"> - e-newsletters - project summary slide decks - project and conference brochures. - Layman's Report - project banner stand, - CRM website - social media platforms (twitter and LinkedIn page). <p>100% of circulated and issued dissemination activity has included the appropriate references to funding sources.</p> <p>N.B. the funding attribution text was updated to reflect action necessary from Mid-Term report comments – i.e. marketing materials now contain the sentence, <i>'The LIFE 2014 CRM Recovery project has received funding from the LIFE Programme of the European Union.'</i></p>
Followers on social networking sites - 200 followers	As at the end of March 2019, the project has 681 followers on social media (405 on twitter and 276 members on LinkedIn), 340% of the targeted figure. During the project duration, we followed 190 other organisations / individuals and tweeted 547 times.
Communication Plan	The original project communications plan was plan submitted with Progress Report One in May 2016. The plan as further developed and updated in December 2017 (Annex D1.12).
Engagement with business community	755 businesses were estimated to have attended project related presentations (a conservative estimate). Businesses were also engaged via the previously reported Conferences and webinars.
Business attending presentations	755 businesses were estimated to have attended project related presentations (a conservative estimate).
Engagement with policy stakeholders	As previously reported, we estimate that 307 policy influencers (meaning government bodies / local authorities) attended external events where the project presented. Influencers also attended project conferences and were engaged via webinars, newsletters and social media.
Policy influencers attending presentations and workshops	As previously reported, we estimate that 307 policy influencers (meaning government bodies / local authorities) attended external events where the project presented.

Inputs to written policy	<p>Policy influencers were updated throughout the B3 process and offered the opportunity to feedback during the stakeholder group meetings. Written feedback was obtained following the final conference in addition to a feedback survey sent to a number of policy influencers which sought to understand their opinion on:</p> <ul style="list-style-type: none"> - the achievability of the recommendations, - barriers preventing the success of the recommendations, - whether the recommendations could have a lasting impact if implemented, - which recommendation would be the priority, and, - if the policy recommendations represented the overall findings of the CRM Recovery project. <p>Discussions with key influencers regarding the recommendations have continued post-project end date.</p>
--------------------------	--

6.1.10 E1 Project Management, Monitoring and Reporting

- Action completed by March 2019 and final report to be completed by June 2019. no changes/deviations to start – end dates

Lead Partner WRAP

Supporting Partners: EARN/ERP/WI/KTN

Foreseen start date	September 2015
Actual start date	September 2015
Foreseen end date	March 2019
Actual (anticipated) end date	March 2019

Introduction

The project management process used was a well embedded process which has tracked the deliverables and milestones in detail throughout the duration of the project. Risk registers have been kept up to date and reviewed regularly; any changes and additions were flagged to all partners with the risks being discussed collectively at every PMB meeting (*Annex E1.1*).

Actions undertaken, expected results and outputs achieved

The project set up 3 key groups to oversee the project management activities, these were the Stakeholder group (referenced as the steering group in the bid), CRM Recovery Project Management Board and the project team.

The **Stakeholder Group** - met on 7 occasions, with the final meeting incorporated as part of the final conference in February 2019 (*Annex E1 - Stakeholder info folder*). Meetings were chaired by the project's Senior Project Manager (BF) with the Project Manager (WRAP) acting in a secretariat role. The final list of registered stakeholder members stood at 38 individuals representing 28 organisations (*Annex E1.2*). The group of representatives were made up of organisations covering academia, R&D, regulators, compliance, funders, business, collectors, trade bodies and business. The group's remit was to provide advice to the Project Management Board and delivery teams on the project as it progressed through the delivery phases. The full stakeholder remit can be found as (*Annex E1.3*). Note that although the original bid references steering group, it was decided early in the project that the group remit was more suited to a stakeholder group than a steering group.

The **Project Management Board** met 14 times since project inception in September 2015; during each meeting, partners reviewed finances, progress against deliverables and milestones,

discussed future activity plans, highlighted issues, reviewed/updated the project risk register and signed off on various project deliverables. The meetings gave an opportunity to update the PMB on feedback received from the stakeholder meetings and was delivered as part of the WRAP update to partners. Partners participation has been 100% with most meetings being held virtually to cut down on spend and travel time. The project conducted two face to face meetings, one in June 2018 and another in March 2019. All meeting information including presentations, agendas, actions and notes can be found in *Annex E1 - PMB Meetings* folder.

Project Teams - The project has 4 main teams, these covered the overall delivery and UK trials management, German trials activity, research, monitoring and evaluation and communication, dissemination and networking. These were all overseen by the Senior Project Manager (WRAP).

Finance Reporting - to facilitate the management of the project, partners submitted quarterly progress and budget reports to WRAP from January 2016. These reports included evidence of all activity, including timesheets, invoicing and evidence of delivery. Paper copies of timesheets and expenditure reports along with invoices and receipts were sent quarterly to the WRAP project support officer for checking by the project manager.

Progress reporting – the lead WRAP Project manager is also responsible for the delivery and submission of the required reporting, in total 11 quarterly reports and 14 monthly progress reports have been submitted. The WRAP Project Manager has also been responsible for submitting 2 progress reports, the Mid Term and the final reporting documentation.

The **Replication Report** was completed with input from all partner and trial hosts organisations. This report sets out the actions taken by the project to achieve its main aims and objectives. Specifically, the report covers the outcomes of the project's trials and their potential for replication, as well as services that are currently being undertaken which have replicated trial activities and/or have been set up as a direct result of the project. In addition, the report provides recommendations for additional replication activities required to increase the recovery of CRMs from WEEE and demonstrates how the scaling up of activities undertaken during the project trials would achieve the project targets to increase CRM recovery. The full report can be viewed (*Annex - E1.4 Replication Activity report – final (D1)*).

Problems encountered and solutions throughout the project activity

The main problems were largely around the delays in some of the project information required for reporting purposes which led to a delay in the submission of the midterm report in February 2017. We also had several changes to staff. These have been across both the lead and several the partner organisations, but this did not have any negative impact on delivery. This was largely down to the strong governance systems and project management processes that allow for effective handover of tasks and knowledge sharing between existing and new project staff.

Comparison with planned outputs

As noted above several changes to staff personnel have taken place throughout the duration of project and this has been documented in the monthly update reports sent to the project's monitoring officer.

Deliverables, Milestones and Indicators

Table 24 E1 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/status
Deliverable	Quarterly Project Reports after first 9 months	09/2016	Complete
Deliverable	Replication Activity Report	02/2019	Complete
Milestone	Project Team Set up	09/2015	Complete
Milestone	Draft of Final Project Report	01/2019	Complete
Milestone	Project Steering group set up	Original 01/2016 Actual 02/2016	Complete

Indicator of Progress/expected results	Evidence
Project starts on time and attracts a high calibre of staff	Project team in place – see updated final staff chart (Annex A1.4)
Project progresses to schedule	All progress reporting completed (Monthly, quarterly, PR1/2, Mid-term) (Annex E1 LIFE Progress and Midterm reports folder)
Project meetings are held and well attended	Stakeholder Group set up and 7 meetings have taken place – Member list attached (Annex E1.2) 13 PMB meetings held to date – 100% partner attendance at each. Actions and Agenda attached (Annex E1 PMB Meetings folder)
Project milestones met to time, quality and budget	Updated project plan detailing issues, changes, milestones updates and risk log.
We will produce quarterly reports on progress of the trials/project	Quarterly progress reports 11 attached from April 2017 until March 2019. (Annex Quarterly reports (D) folder)
Other evidence of progress	Project manual detailing project and reporting processes required (Annex A1.1 CRM Manual V10) Project risk log completed and maintained – (Annex E1.1)
The project has a sound business reputation with our industrial and commercial partners	Slide Pack detailing feedback to date (Annex E1.5)

6.1.11 E2 Delivery of AfterLIFE Plan

- Action completed by March 2019, no changes/deviations to start – end dates

Lead Partner: WRAP

Supporting Partners: ERP, WI, KTN and EARN

Introduction

Foreseen start date	Jan 2018
Actual start date	Jan 2018
Foreseen end date	March 2019
Actual (anticipated) end date	March 2019

The AfterLIFE plan stands as a separate chapter of the final report and demonstrates how the project partners plan to continue disseminating and communicating the results of CRM Recovery after the project has completed.

Actions undertaken, and outputs achieved

On 10th December, , the Programme Manager from WRAP, attended the AfterLIFE event held at the Living Planet Centre in Woking, which acted as the first development stage for the completion of the AfterLIFE plan. Tangible development of the AfterLIFE communications plan commenced in the Autumn of 2018, the Lead PM (AT) was responsible for the initial data gathering of information from the partners and project stakeholders to complete the first draft

document, this was then presented to the project team for further input and finally signed off at the PMB group meeting on the 21st March 2019 (*Annex E2.1 - completed AfterLIFE Plan*).

The AfterLIFE plan outlines how the project partners can/will continue to disseminate and communicate the results of the Critical Raw Materials Closed Loop Recovery Project (CRM Recovery) after the project ends on March 29th, 2019. The outputs and results from the project have been built into various forms of media and marketing collateral such as the project website, case studies, presentation slides and media packs, all of which will be used by project partners and made available to stakeholder partners after project close.

The plan is necessary to ensure that the project continues to have an impact after its completion. The plan presents a strategy to continue communications with the project's target audiences for the coming years. The AfterLife Plan sets out activities scheduled over a five-year period (2019 – 2023).

AfterLife plan objectives

The objectives of the AfterLife communications are to raise awareness of the project, and promote its outcomes, to contribute to the overarching project aims:

- To increase CRM recovery by 20% by 2030;
- Reduce CO2e emissions;
- Increase the economic viability of CRMs recovery;
- Reduce material loss;
- Secure more effective and efficient CRM recovery across Europe through re-use and recovery operations.

Key messages from both the project findings and insight gained from partners and stakeholders, were utilised to create strong and compelling messages and to raise awareness of the project outcomes, policy, and infrastructure recommendations.

These messages will continue to be disseminated via relevant communications channels, including the project website, social media, networking opportunities, and through project partners and trial hosts and their networks.

Collections and recovery activities implemented as a result of the project will continue as 'business as usual' for several of the project partners and trial hosts.

Wherever practical and feasible, project partners and stakeholders will seek to implement the policy and infrastructure recommendations developed by the CRM recovery project.

Comparison with planned outputs

No changes made to planned output.

Problems encountered and solutions throughout the project activity

None to report.

Deliverables, Milestones and Indicators

Table 25 E2 Deliverables and Indicators

	Name	Deadline	Progress/Status
Deliverable	AfterLIFE Communication Plan in place	03/2019	Complete

Indicator of Progress/Expected results	Evidence
Draft Plan will be completed by Dec 2018	Completed plan attached (Annex E2.1)
Completed AfterLife Plan March 2019	As above

6.1.12 E3 Indicators

– Initial work action completed June 2016, continual monitoring and evaluation up until April 2019 for final reporting and in to the AfterLIFE period.

Foreseen start date	n/a
Actual start date	n/a
Foreseen end date	n/a
Actual (anticipated) end date	n/a

Lead Partner: WRAP

Introduction

As part of one of the obligatory requirements of the project WRAP was responsible for completion of the indicators table which includes both quantitative and qualitative data. The indicators were designed to contribute to evaluation of the impacts of the LIFE project in view of the overall objectives of the LIFE programme.

Actions undertaken, and outputs achieved

All indicators were completed by the WRAP evaluation team and entered on the LIFE online system by the time the PR1 report was submitted back in May 2016. The indicators and their progress have been updated and reported on in both the Progress 2 and mid-term reports. The indicators and most recent progress to date has been included in Section 7 Summary of Key project indicators further on in this report.

Compare with planned output

During January 2018 the Commission conducted a review and revamp of their online indicator database and as a result we were asked to revise and add some additional mandatory indicators to our original data. These are illustrated in the attached indicators table and have been added to the online portal in time for final reporting requirements.

During the first submission of indicator data we identified a baseline of 3.10 million tonnes across the EU and set a target to increase this to 3.15 million tonnes of waste from electrical and electronic data. We have subsequently provided project level data for the quantity of target WEEE collected at the start of the project, with the most recent reported quantity of target

WEEE collected indicating the level of progress. The revised figures are specific to the areas where the trials were conducted. See detail in Table 26 below:

Waste management – WEEE collected

Table 26 Waste management collection of WEEE in trial areas

NUTS 2 region	NUT2 code	Per capita kg target WEEE 2015	Total tonnes collected target WEEE 2015
Czech Republic		3.2	
Střední Čechy	CZ02		4209
Severovýchod	CZ05		4822
Jihovýchod	CZ06		5385
Moravskoslezsko	CZ08		3897
Germany		4.61	
Detmold	DEA4		9357
Italy		2.53	
Lombardia	ITC4		25307
Veneto	ITH3		12467
UK		3.98	
Tees Valley and Durham	UKC1		4721
Northumberland and Tyne and Wear	UKC2		5714
Greater Manchester	UKD3		10913
North Yorkshire	UKE2		3224
West Yorkshire	UKE4		9034
Eastern Scotland	UKM2		8195
South Western Scotland	UKM3		9310
North Eastern Scotland	UKM5		1954
TOTAL collected target WEEE (tonnes) in trial regions			118507

Analysis of WEEE collected in the NUTS2 regions where the trials operated, found 118,507 tonnes for the quantity of target WEEE collected as the state of the art before the trials. The trials themselves collected 43 tonnes, of which 9.9 tonnes were evaluated as waste disposal reduction.

Target WEEE included:

- Small household appliances;
- IT and telecommunications equipment; and
- Consumer equipment and photovoltaic panels.

Various categories of reported WEEE were excluded therefore, in particular large appliances, (which were included in the collection trials) which were outside the scope of the CRM recovery trials and were not targeted for this project due to lower incidence of CRMs and higher value for re-use within this product category.

From 2015, photovoltaic panels were included as consumer equipment. However, of the countries included in the trials, only the Czech Republic and the UK were able to separately report the quantity of photovoltaic panels.

Germany reported a reduction in the quantity of WEEE prepared for re-use per capita in 2015, but the volume increased again in 2016. They reported this was due to changes in reporting

requirements. The data for Italy for 2016 used here were actually reported data for 2015 as a report for 2016 had not yet been provided at the time the data was accessed (25/03/2019).

The quantity of WEEE collected in kg per capita was based on Eurostat reported data from table env_waselee. What we have included refers to target WEEE only, from households (the vast majority) and non-household sources. In terms of waste reporting the relevant collection codes are 20 01 35, 20 01 36 and 16 02. Total WEEE collected for target categories was reported in kg per capita and has been scaled up to NUTS2 regions to establish the CRMs trial background data from before the trials, using population data are based on NUTS2 regions using table demo_r_d2jan. For both waste collected and population data the reference period is a calendar year. The background data has not been updated for the end of the trials at the current time as 2016 is the most recent year for which WEEE collected is available.

Issues: As the result of the requirement imposed during the third quartile of the project, to incorporate several additional project indicators, it was necessary to allocate additional time to develop and agree targets and methodologies to measure and monitor these new indicators. In addition, we experienced issues with accessing the new KPI's database which led to minor delays in uploading indicator data.

Deliverables, Milestones and Indicators

Table 27 E3 Deliverables, Milestones and Indicators

	Name	Deadline	Progress/Status
Deliverables	n/a	n/a	n/a
Milestones	n/a	n/a	n/a

Indicator of Progress	Evidence
Draft indicator table produced before first progress report	Indicator table submitted May 2016 with 1 st progress report and uploaded on to LIFE online systems.) New KPI database completed by the time of final reporting

6.1.13 E4 Networking with other LIFE and non-LIFE EU Projects

– all actions on track to be completed by March 2019. Activities to continue into AfterLIFE period

Lead Partner: WRAP

Supporting Partners: WI, EARN, ERP and KTN.

Introduction

All partners from the CRM Recovery consortium to carry out networking activities with other relevant projects throughout the duration of the project.

Foreseen start date	Jan 2016
Actual start date	Jan 2016
Foreseen end date	March 2019
Actual (anticipated) end date	March 2019 (activities will continue into AfterLIFE period)

Actions undertaken and outputs achieved

WRAP and all project partners have participated in various networking activities with other LIFE and non-LIFE funded projects. For example, these have included various networking opportunities with:

- ProSUM – WEEE Forum led bid H2020;
- ReBus – Resource Efficient business models;
- esap – Electrical and Electronic Equipment Sustainability Action Plan;
- COLLECTOR’s Horizon 2020;
- Wales Environmental Services Association;
- CLEVER;
- SCRREEN.

As part of the requirements of the CRM stakeholder membership we requested that all members act as champions for the project and promote its work across the broader electrical and electronic products industry. To give an example of these activities, on the 26th of March 2019 one of our stakeholder group members delivered a project presentation to Northampton University. The 1-hour presentation on the CRM Recovery project and its key outcomes provided delegates an insight to the challenges faced in developing a commercially viable CRM system in the UK and Europe and suggested approaches to overcome these challenges.

We have also acted upon opportunities to network with and through other organisations. These activities resulted in various meetings/teleconferences/visits/workshops/events with educational institutions, industry members, trade bodies and other organisations. These opportunities enabled both relevant feedback and exchanges between CRM Recovery project and other EU/non-EU related activities and organisations (*Annex E4.1- Networking list*).

Expected results of this action

We used the relevant feedback and knowledge gathered from each of the networking activities to inform the development of the project and its outcomes.

Compare with planned output

No changes were made.

Problems encountered

We encountered 2 notable problems with this activity area. Firstly, being able to track and evidence all the activity that takes place across the project has been challenging. As networking activities for the project are conducted by various individuals including the lead, partners, beneficiaries and trial host organisations it was difficult to identify and evidence all the activities that took place, particularly where this was informal engagement/discussion. To record and evidence as many activities as possible the project developed a networking guidance document and also included, as a standard agenda item, networking and communications updates in all 1-2-1 meetings, regular social media alerts from KTN, and a presentation slide on these activities which was covered by each partner during the PMB meetings. The project has logged over 60 networking activities, but we believe we have completed several more which were not logged or evidenced.

Secondly, we had difficulty differentiating between activities undertaken under D1 dissemination and networking activities under E4. To address this we defined each activity as follows and provided this definition to all partners:

D1 Dissemination: Focus on pushing out information about the project. Likely to be a 1:many activity. Project websites, logos and promotional materials, webinars, social media, newsletters, notice boards, speaking at conferences, stands at exhibitions.

E4 Networking with other LIFE/non-LIFE EU projects: Focus is on exchange of information and building relationships for mutual benefit. Likely to be a 1:1 activity. Meetings or direct engagement (virtual or face to face) with other European projects or key stakeholders. Attending a meeting held by another European project to learn about the project and make connections as a precursor to future more in-depth networking.

Deliverables, Milestones and Indicators

Table 28 E4 Deliverables and Indicators

	Name	Deadline	Progress/Status
Deliverable	n/a	n/a	Complete

Indicator of Progress	Evidence
Number of engagements with relevant project partners per quarter	<p>The project has reported on 63 networking activities completed over the lifetime of the project.</p> <p>Networking spreadsheet that captures visits and contact with projects – (Annex E4.1)</p> <p>Update reporting on a monthly basis which details networking activities for current period sent as part of the monthly update reporting to NEEMO.</p>

6.2 Main deviations, problems and corrective actions implemented

The project encountered a few challenges and deviations throughout its duration; however none of these posed a risk to the overall project timeline or the completion of any of the project milestones and deliverables. All changes were reported to NEEMO in relevant monthly reports and official LIFE reports and documentation; a summary of these are shown below starting from PR1 through to deviations encountered during the final reporting period March 2018 – March 2019:

Trials Methodology (B1 – B2)

The CRM Recovery project plan suggested that the procurement and delivery of the collection trials would be a distinct activity from that of the recovery trials. However, feedback gathered during supplier engagement and market testing, prior to the trials procurement, identified that by undertaking two distinct activities it would prove very challenging to engage supply chain cooperation between the two activities, which could result in the risk of significant delays to the recovery activities, storage and transfer of waste, and potentially the need to apply for additional permits and planning to meet associated regulatory requirements. These issues would potentially escalate the costs of the trials for no additional value to the project. In addition, industry suggested that the budget for the trials was limited, and there was a need for flexibility for the allocation of the costs between collections and recovery activities. If this flexibility was not possible, the risk was that in some regions there would be an underspend in some activities

and potentially not enough funding available to sufficiently deliver other activities. Furthermore, there was potential for materials collected to be unsuitable for the recovery activities proposed during tendering, which would have jeopardised the success of the project. As a result of this consultation, industry suggested that the *trials be combined* and procured on a regional basis, in order to facilitate a supply chain approach, reduce risk and increase value for money.

Reported during Mid Term Report

Tonnages (B1 – B2)

Procurement of Trials across 4 countries (B1 and B2) – The first open procurement for the trials yielded bids for only 2 of the 4 countries (UK and Italy). For Germany, it was felt that potential bidders needed much more prior engagement to encourage interest. Therefore, following market review, six organisations were identified and a select tender procedure was carried out resulting in one (ultimately successful) bid. When planning was under way for the procurement in Turkey, an attempted coup took place in that country and a 3-month state of emergency was announced (21/07/16). The personal safety of the project team was paramount and this, combined with the potential ramifications of managing the successful completion of the trials due to on-going political uncertainty, resulted in a request to change the location from Turkey to another country. Possible locations were reviewed by analysing data on yields and electronics manufacturing and also understanding the strengths of EARN, ERP and KTN's networks. The Czech Republic and Slovakia were identified as countries which scored positively in all the criteria. An open procurement process was carried out which yielded one (ultimately successful) bid.

All trials contracted confirmed they would complete within the required project timescales (for the completion of the recovery trials by June 2018). Therefore, there was no knock-on impact from these changes.

Combining of Collection and Recovery activity (B1 and B2) - A key element of the project was to establish the link between collection and recovery. To allow for the collection method to be designed with the recovery method in mind and to facilitate the movement and effective handling and processing of materials, it was agreed that end-to-end processes should be procured and trialled, from the point of WEEE collection to CRM recovery. The benefits of the end-to-end approach resulted in reduced risks associated with the coordination, timings, storage and shipment of electricals. Furthermore, trials hosts were responsible for gathering the required tonnage and product profile that was most suitable for the recovery project. Reporting and budgets for B1 and B2 however remained separate. As above, all the contracted trials completed within the required project timescales (for the completion of the recovery trials by June 2018). Therefore, there was no knock-on impact from this change.

Monitoring the Socio-economic impact of the project actions (C2) – The deliverable required review of the net economic and social benefits of the project, to inform both the C2 deliverables and the policy recommendations. In particular, this action sought to determine what impact the project achieved, compared to a baseline which was determined by surveys, to represent what would have happened without the trials as interventions. The surveys also provided insights about users' preferred options for WEEE collection, and attitudes about the importance of environmental initiatives and potential contribution of WEEE recycling to the environment.

It was not possible to gather data from all trial sites, located in 4 different countries with the original budget of €2,000, which presented a risk to the achievement of this deliverable. €24,000 of underspend was identified from the consumables budget, as a result of cost savings from combining the collection and recovery activities, which was allocated for completion of C2 surveys, to enable the collection of robust and reliable data for analysis.

Due to the nature of many of the collection activities, where users dropped-off items at un-manned collection points, it was extremely difficult to identify individual users of the trials and was therefore impossible to survey those users. Where this was the case, we broadened the approach to surveying by combining the pre-and post-trial questionnaires. The post-trial questions asked for attitudes on a hypothetical collection system which exactly matched the relevant collection activity. For example, with collection hubs at recycling centres as the trial activity, because the actual users could not be identified, participants in an online survey were asked their views on how they would use a collection hub at a recycling centre if it was available. This approach fulfilled both pre-and post-trial survey requirements and allowed us to reach a larger cross section of the local demographic profile. The only drawback with this approach was that the captured attitude towards the disposal option available from the trial pertained to a hypothetical situation rather than an actual trial user.

Reported during Progress Report Two

During this reporting period the main deviation was around the ***final submission date for the mid-term report E1***, this changed from February 2017 to July 2017; this was due to several factors which were discussed with both Neemo and the Commission.

We also encountered minor issues with the ***split of B1/B2 budgets***. The original external spend was split between B1 and B2 as 33%:66% respectively. Once all the trials had been contracted, the actual split was nearer 55:45. The revised split was a result combining the trials following market engagement (via the procurement process), and maximised value for money. The changes to the budget allocation across WPs did not affect delivery of the trial's outputs. This was reported in the July 2017 monthly report and also the July-September 2017 Quarterly report.

Technical Specialist Support B3/B4 - As part of the original staff structure developed for the bid, WRAP had identified the project's Technical Specialist Officer (TSO) to deliver on the B3 Policy and B4 Infrastructure development work. WRAP had also identified backup resource but unfortunately both these individuals left the organisation. WRAP appointed a new TSO whose role included responsibilities under the B3/B4 action areas. However, WRAP required further resource to provide support and supplement expertise in relation to the development of the policy recommendations. External consultancy support was engaged, to provide independent expertise and quality control for the policy and infrastructure recommendations and ensured that we met the (revised) deadlines for B3/B4. Discussions regarding this change were held with our monitoring officer at Neemo and a briefing paper was sent on the 13th December 2017.

Reporting for final period

Cost Categories E1 - Throughout the project we varied some of the cost categories lines in order to complete the specific project activities. For example, WRAP personnel didn't have a specific cost category/budget for travel to the final event, however we still had sufficient budget

in the overall travel and subsistence budget category which meant we had sufficient funds to cover this necessary activity. Each cost category variation has been detailed in separate spreadsheets for each of the partner organisations and WRAP. Any variations to the original cost categories were made to ensure that the project's activities were completed as required. Cost variations from what was detailed in the original bid have all been justified and deemed necessary in order to deliver the project successful and are all deemed eligible costs as per the financial guidelines (see *Annex E1 - Partners spending justification*).

Direct Personnel Costs E1 - Throughout the project minor changes have variations were made in relation to staff days forecast for specific activities and actual days required to complete project activities as required. Cost variations have all been justified and deemed necessary, eligible costs (see *Annex E1 - Partners spending justification*).

Initially the bid noted that EARN would carry out several ***Sampling and Dismantling Tests B2***. The tests were to be supervised and analysed under scientific conditions, to include target product groups and to be undertaken in a newly developed crushing and sorting model factory. It was proposed that alternative process flows would be investigated and evaluated to define appropriate process flows for maximum recovery of CRM's. Finally sampling tests were also planned to determine the CRM content of key fractions/components for the assessment of the degree of recovery of CRM's from the trials.

At the time the bid was written the original method (stated above) was a valid approach. However, over recent years new data became available from (other) EU funded projects, which provided a much more costs effective, approach to this deliverable. The data utilised also facilitated development of more reliable results and represented a much wider data set than initially proposed or which could have been feasible had we utilised the methodology proposed in the bid and resulted in a very positive outcome for the project (see *Annex B2.2 - Sampling and Test Trials revised approach*). This revised methodology was discussed with the project's Neemo Monitoring Officer during July 2018 and was noted as part of our monthly update submitted during July 2018.

This methodology utilised the budget allocated for the Sampling and Dismantling Trials, however the costs were associated with personnel costs, rather than consumables. The change did not constitute a budget virement between costs types in excess of 20% and therefore did not require a formal change.

Reporting format B3 & B4 – The bid originally stated that we would provide a suite of nation-specific recommendations. As reliable data analysis and economic modelling was not possible due to inconsistencies in the data collected from Member States within Eurostat statistics, this proved not possible to do meaningfully. However, as the trials demonstrated that issues underlying the lack of CRM recovery are prevalent across all trial regions, the research and consultation undertaken to develop the policy recommendations to increase the recovery of CRMs did identify a set of actions relevant and applicable to all of: Italy, Germany, Czech Republic and the UK, which are additionally relevant across Europe. This is detailed in the B3 and B4 final reports (*Annex B3.5- B3 final report, Annex B4.2 – Final B4 Report*). The B4 report additionally is tailored on a nation-specific level as it details where some countries will have specific challenges (e.g. poor waste management infrastructure) that require additional resources.

The deliverables for the *Layman's report* changed from December 2018 until February 2019 to coordinate with the project's final event. This was communicated to Neemo during October and reported as part of November's monthly update report. This change didn't impact on the project's overall activities.

6.3 Evaluation of Project Implementation

Table 29 below sets out successes and failures of the methodology applied for each of the actions.

Table 29 Evaluation of each activity/methodology

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
Project Management (A1, E1)	<p>The project delivery methodology applied for CRM has been successful in ensuring that project partners are aware of the activities they need to deliver, the timescales for actions and the budget commitment.</p> <p>Via the stakeholder working group the project was able to have regular, direct engagement with the key organisations and individuals from across the sector.</p>	<p>Tried and tested project management processes were used to successfully managed the project from start to finish. This has resulted in a clear understanding of the tasks to hand with the majority of milestone and deadline dates being achieved as per the agreed timescales.</p> <p>Routes to understand the sectors needs and current state of play were established.</p> <p>The stakeholder groups helped to share information regarding the CRM Recovery. In addition, a key purpose of this group was to guide and advise the project, on the delivery methodology, and shaping of the resulting infrastructure and policy recommendations.</p>	<p>The Project Management Board and partner meetings were invaluable to ensure the successful running and time management of the project. These meetings provided team members with opportunities to discuss issues, request support and highlight any areas that needed attention. Due to the geographical location of partners, many of these meetings were held by video conference to reduce time and costs associated with travel. Based on this experience, WRAP advises that remote and face to face meetings are alternately scheduled (e.g. Q1, face to face, Q2 remote, Q3 face to face, etc).</p> <p>It was challenging to attract stakeholders from other EU countries, with many of the participants based in the UK. The project sought to address this by undertaking calls for membership through social media, promotion via partners, and our</p>	<p>In order to effectively track, manage, liaise with partners and adhere to the requirements of funders, effective Project Management and resource allocation was vital, therefore the days spent were slightly more than originally anticipated/ budgeted, but was necessary based on the level and detail required for reporting and the achievement of successful outcomes. However as the actual day rate used was lower than the day rate within the project bid the costs saving meant that the E1 area came in just under budget.</p> <p>Within the initial project budget, costs were not allocated for venue hire for PMB meetings, therefore it was necessary for the project to utilise budget allocated for venue hire costs for other project activities. Future projects should give consideration to the full costs and</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
			existing stakeholder channels, with limited success.	<p>resources required for running of the project Board.</p> <p>A successful outcome of the project was that the costs of stakeholder engagement were reduced, and effectively delivered through the use of existing stakeholder channels.</p> <p>Also due to the majority of our stakeholders being based in the UK we were able to reduce the costs regards the travel and venue hire for project staff.</p> <p>Total costs breakdown: A1 Budget 63,982 – total spend 30,057. Cost savings were made as once the initial set up had taken place and the governance of the project agreed, the updating and monitoring work fell under E1. This was also the case with the running and facilitation of the stakeholder group, with the costs being attributed to E1 activity. Also as WRAP has a tried and tested project management systems and processes already in place for a number of other projects it meant that we could use these as a starting basis and that less time was required to develop such systems. We also saved money</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
				on external, travel and subsistence costs by seeking the best possible prices for travel and venue hire.
EU WEEE Flows (A2)	To develop a European wide model of the flow of WEEE through the recovery system with a set of assumptions and a level of confidence of data.	The model development was based on the previously developed UK wide flows report and used data sets from Eurostats.	The original timeframe for this piece of work needed to be changed to coordinate with deadlines for the release of revised EU stats data. External factors and deadlines need to be taken into consideration and timescales worked around these.	<p>The actual costs to produce the report, which was sourced externally and competitively procured, came in at 6,300 euro which was 5,000 Euro below the estimated budget. We also made some cost savings by allowing the Technical specialist to lead on this work package which resulted in cost savings under the PM role.</p> <p>A2 External Budget 25,000 – Actual spent 18,611.57.</p>
Collection Trials (B1)	<p>To deliver 10 Collections activities across 4 countries and collect a minimum of 100 tonnes of project.</p> <p>The collection trials aimed to test mechanisms to maximise the collection of target WEEE (Display, Consumer electronics, ICT and small household appliances), i.e. those products with the</p>	<p>The trials delivered 14 collections trials across 4 countries (Italy, UK, Czech Republic and Germany) and collected a total of 43 tonnes of product.</p> <p>The project exceeded both the anticipated number of collection trial activities (14 actual compared to 10 anticipated) and the revised targets for tonnes of WEEE collected (43 tonnes actual compared to up to 30 tonnes anticipated). The project also exceeded targets to deliver</p>	The original estimate of 100 tonnes of materials collected was revised to reflect responses received during the procurement process. Each individual trial procured determined the volume and type of WEEE required to successfully test the recovery methods proposed, this was estimated at 20-30 tonnes overall. The trials were selected via competitive procurement and were indicative of the requirements and limitations set by the market and technologies selected for the trials. The project team then reviewed the tonnage targets in detail to understand the difference between what the market	<p>The actual trials activities came within the allocated procured budget.</p> <p>Only one of the trials realised a positive net economic benefit; all other trials indicated significantly higher costs than revenues. The figures for the one economically viable trial (the incentivised retailer take-back service at two John Lewis stores located in England), show that extremely valuable products were collected which could be resold, and that labour costs were low due to cooperation with the external partner (whose costs were not included in the analysis).</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
	<p>highest concentrations of CRMs, and to collect data to facilitate evaluation of how the different approaches to collection effected the re-use and recovery of CRMs, and the socio-economic impact analysis of the trials (project action C2). This section summarises the collection trials and details the 10 collection activities undertaken by the (5) trial hosts.</p>	<p>up to three collection activities in each country and therefore successfully tested a wide range of collections mechanisms.</p> <p>The trials were also successful in collecting priority products (deemed as such due to their high CRM content). All the trials collected consumer electronics and ICT, and three of the trials collected display equipment. This enabled sufficient testing of each of product types in the subsequent recovery trials.</p> <p>Although we noted that the cost and revenues from the individual trials were not directly comparable, they did suggest that collecting high value products (that can be resold with little or no repair) as economically as possible (via a retailer) could offer the most effective means of increasing CRM recovery. Further work should investigate the potential additional costs that could be included (i.e. revenue lost to a retailer from the loss of floor</p>	<p>suggested was achievable and the targets in the bid. It was clear that based on the average weights of the target products collected the target of 100 tonnes was not achievable. However, it was clear that we would still be able to achieve the overall requirements of the project with the smaller tonnage figure so the project continued with a revised target which was exceeded by 13 tonnes.</p> <p>Changes needed to be made to one of the selected trial countries (Turkey), due to safety concerns caused by political unrest.</p> <p>Throughout each of the collection trials lessons were recorded which can be found in the trials and project reports, some of which are highlighted below:</p> <p>UK: Ensuring all collection staff were engaged proved difficult, staff attendance at training sessions was limited due to shift patterns. - Having a “recycling champion” at each trial partner store to take responsibility for the day-to-day implementation of the scheme, who encouraged members of staff to follow the trial procedures, proved invaluable to the trial. This also helped to maintain continuity between</p>	<p>Collection costs differed significantly between the different trials - ranging from €1.34 per kg to €83.47 per kg.</p> <p>In terms of the actual split of the costs between B1 and B2, they are different to what was originally stated in the bid document. This was largely to do with the decision to combine the collection and recovery activity and the market response which meant that the budget across both would be more evenly split.</p> <p>The bid showed the external spend was split between B1 and B2 as 33%:66%. Now that all the trials have been contracted, the actual split is nearer 55:45. The revised split is as a result of testing the market (via the procurement process) to maximise value for money. It hasn't affected the delivery of the trials or the results we set out to achieve through the project.</p> <p>In total across both B1 and B2 activities we were around 14k overspent against our original</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
		<p>space) and whether economies of scale in both collection and recovery could increase the effectiveness of this method of collection.</p> <p>A key insight from the trials is that retailers and charity shops have a great opportunity to increase collections of WEEE. Retailers that are part of consumers' everyday habits (e.g. small convenience stores) offer a cost effective way to collect small WEEE from consumers. Trusted retailers may also give consumers confidence to handover appliances where data security issues are greatest (e.g. smartphones). This also increases potential economic returns on collections because items returned are likely to be of relatively high value. Data from the collection trials has been utilized to inform work under WP C1 – Monitoring and Evaluation. In addition, and as part of WP C1, structured interviews were also undertaken with trials hosts to facilitate</p>	<p>different shifts. Anecdotal evidence from consumer surveys indicated that there was a general lack of awareness of the correct WEEE disposal routes for older devices. Respondents were more inclined to hoard items, saving them as backups in case their newer devices stopped working. High street retailers and charities offer highly convenient and trusted locations for the general public to deposit WEEE.</p> <p>UK: ICT collected from Schools had the highest re-use level, at 25.4%, followed by Social Enterprise collections (23.4%), B2B (15.7%) and finally Household Waste Recycling Centres (HWRCs) (11.5%). Although school collections had the highest levels of re-use, the largest numbers of units collected were from HWRCs. The type of collection system appeared to influence the types of equipment deposited e.g. high percentages of printers were deposited at HWRCs and higher levels of data-bearing equipment at schools e.g. laptops. This indicated that it may be of benefit to set up collection schemes in a range of locations to give individuals a choice.</p>	<p>budget. This was largely driven by the market through the procurement process.</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
		evaluation of the economic costs and benefits of the specific collection, re-use and recovery trials. A synthesis of collection/re-use trial data was undertaken to enable comparison of all results in a transparent and consistent way. This comparison is based on data from all trials, and includes information regarding 4,890 items or 9,854kg of collected products. As noted above, the overall volume of materials collection through the trial is much higher. However, only data from the trials that are directly comparable have been included in the C1 evaluation.	Italy: The Ecodom trials found that by facilitating a convenient and trusted route for the disposal of WEEE to members of the public, it is possible to increase the quantity and the quality of the WEEE collected. The communication effort was extremely important to reach the achieved result. Dissemination and educational activities in schools is an important starting point to increase social awareness about CRM issues. However, the cost of having one-off collections was prohibitive, despite the amount of materials collected. Collection events would need to be conducted regularly, a higher volume of materials needs to be collected, and transport payloads should be maximised to make collections cost effective.	
Recovery Trials (B2)	Test a minimum of 5 reprocessing and recovery techniques	Separate recovery trials have been completed these included: De-soldering of PCBs and concentration of components; Extraction from disassembled Lithium Ion batteries; Comparing batches of collected WEEE through an established precious metal recovery system; Tantalum extraction from capacitors by bioleaching;	<p>A full list of lessons learnt can be found in the supporting trials reports, a summary of some of these are shown below:</p> <p>Italy: Although it was not easy to evaluate the recovery results, especially regarding the PMR process and the treatment of batteries, some general considerations can be proposed linking the success of the collection and</p>	<p>In terms of the actual split of the costs between B1 and B2 they are different to what was originally stated in the bid document. This was largely to do with the decision to combine the collection and recovery activity and the market response, which meant that the budget across both would be more evenly split.</p> <p>The bid showed the external spend was split between B1 and B2 as</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
		Neodymium extraction from magnets in hard disk drives; Increasing concentrations of CRM for smelting via wet separation and electrostatic separation; Electrochemical deposition from PCB solutions	<p>recovery trials. Almost 20% of the collected screens were reusable. It confirms that attention has to be given to the WEEE collection and transport phase, promoting clustering of disposed appliances and avoiding damage. The quality of the collected WEEE (high CRM content) was a crucial aspect of the treatment performance. Both of these results suggest the need to further invest in the promotion of effective and rational collections that target high CRM-rich WEEE, but that is also collected and handled correctly.</p> <p>Germany: Although undertaken on a lab-scale basis, the successful results show potential for future innovation projects. Though the operational costs of bioleaching are considered a little higher than the cost of traditional recovery processes and conventional mining, more metal can be extracted using bioleaching, especially from low-grade material. For example, conventional copper mining can extract 60%-65% from an ore/material whereas 90%-95% can be extracted using bioleaching. The cost of recycled material was equal to the assumed costs of scrap magnets in Germany of about 4 €/kg. The costs of producing 1 kg</p>	<p>33%:66%. Now that all the trials have been contracted, the actual split is nearer 55:45. The revised split is as a result of testing the market (via the procurement process) to maximise value for money, it hasn't affected the delivery of the trials or the results we set out to achieve through the project.</p> <p>In total across both B1 and B2 activities we were around 14k overspent against our original budget. This was largely driven by the market through the procurement process.</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
			<p>magnet material from used magnets from HDDs was circa 15€.</p> <p>Czech Republic: Three fractions for each of the collection trials were chosen. Each of the output fraction material was evaluated focusing on amount, particle size and contents of elements of interest. Plastic fractions < 0.5 mm and plastic fractions 0.71-1.5 mm from both of the collected material streams were chosen for those recovery trials focused on increasing the concentration of precious metals. The highest concentrations of rare-elements (mainly Nd) were contained in fine ferrous fractions, and these were chosen for the laboratory trials focused on rare-earth elements.</p>	
Policy Input (B3)	For each EU nation with a participating beneficiary a detailed set of policy ideas will be developed outlining policy actions that could be taken, how each of the actions could be enabled, and the potential impact of each action at a national, European and,	We have fulfilled this action by developing a suite of policy recommendations relevant to specific nations as well as the EU as a whole (see <i>Annex B3.5 – B3 Final Report</i>). The result has been high quality recommendations, created with the input of policy experts and key stakeholders (from the CRM stakeholder group – see <i>Annex B3.3 – Working Group Meetings</i>), which have already	Input from the stakeholder group was particularly valuable for this deliverable, and we went to great lengths to ensure we addressed all responses and views and incorporated them where appropriate. If we were to run this exercise again, it would have been beneficial to have a longer stakeholder consultation process, although whether this could have actually been achieved in reality with the busy and conflicting schedules of the stakeholder group is debateable.	Total spend came in on budget, the project did outsource around €10,000 of technical specialist time which benefited the project and enabled us to add value and support the internal technical specialist.

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
	where appropriate, global level.	been well received at the final conference and through our initial dissemination activities. The outputs of a suite of nation-specific recommendations and EU policy options document is covered by the final B3 report (<i>Annex B3.5</i> as above) and describes how and where the outcomes of the trials can be rapidly implemented across Europe.	<p>The support of the external contractor (<i>Sofies</i>) proved invaluable for bringing support and breadth to the literature review and examining specific in-country opportunities.</p> <p>Overall, we are pleased with our approach and the outcomes of this work.</p> <p>One key lesson learnt, that links to our ability to evaluate this work in the longer term, is that not enough time has passed since the publication of the recommendations (March 2019) to be able to assess the impact of these on EU and country policy.</p>	
PAN-European Infrastructure Development Recommendations (B4)	To develop European infrastructure development recommendations that will result in better collection of WEEE, increased re-use of product, improved dismantling and increased recovery of CRM across the EU.	<p>Recommendations have been developed that outline the required collection and recovery infrastructure to secure resources and value in the EU. This infrastructure includes a consideration of collection, re-use, repair and recovery requirements.</p> <p>We have endeavoured to deliver recommendations that can be implemented by the EU nations either individually or collectively.</p>	<p>Throughout the process we gained a better understanding of the available data and successfully altered our planned approach to accommodate the updates required to the figures.</p> <p>The support of the external contractor (<i>Sofies</i>) proved invaluable for bringing support and breadth to the literature review and examining specific in-country barriers.</p> <p>Overall, we are pleased with our approach and the outcomes of this piece of work.</p>	We made cost savings under the original budget heading, this was largely due to the way the action area was managed in conjunction with the B3 Policy action area, which meant that the Technical specialist time for work under B4 was coded to B3 as the work was completed simultaneously.

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
		<p>Although these recommendations sit alongside the policy recommendations, the principles and practical actions clearly described within the report could be adopted by industry or governments can adopt with or without the influence of the policy options identified in B3 (see <i>Annex B3.4 – B3 Final Report</i>).</p>	<p>As above, one key lesson learnt that links to our ability to evaluate this work in the longer term is that not enough time has passed since the publication of the recommendations (March 2019) to be able to assess the impact of these on EU and country policy – or more simply, whether this has resulted in ‘better’ collection and re-use as foreseen in the proposal.</p> <p>In order to achieve the objectives of the bid, to investigate how the lessons learned from each of the trials could be transferred to other Member States, a comparison exercise was conducted using criteria from the Compliance Promotion Exercise. An analysis of the individual situations of the four Member States where the collection and treatment trials took place was also conducted.</p> <p>Following this analysis, considering the variety of factors detailed in Section 5 of the B3 report, it was not possible to identify clear patterns or cluster of countries in a unique way. Therefore, reliable data analysis and economic modelling to determine replication in other member States was not possible.</p>	

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
			This was largely due to inconsistencies within the available data collected from Member States by Eurostat. Nor was it possible to determine the ease of set up or impact of introduction. However, the trials demonstrated that issues underlying the lack of CRM recovery are prevalent across all trial regions and so pan-European recommendations were developed.	
Monitoring and Evaluation of the Collection and Recovery Trials (C1)	Evaluation of the collection and recovery trials carried out by the project.	<p>In the work package C1 an environmental and economic assessment of the collection, re-use and recovery activities was successfully undertaken.</p> <p>Overall 9854 kg of WEEE collected (4890 items) were part of the evaluation.</p>	The overall collection amount across all the trials is higher compared to what is considered in the evaluation because only a portion of the data was reported in the template provided to the trial partners. Asekol's collections via stationary containers and collection yards, as well as Ecodom's collections in grocery stores and one of the two school collections were not assessed, as it was not possible to gather data from these trials on a product-specific basis. However, the collections carried out by Asekol with stationary containers and on collections yards are not classified as "innovative collection activities" and have long been part of the actor's collection practices. The innovative collection system, which was also tested by Asekol, was the "mobile collection container". The results of the "mobile	The overall budget for C1 activity came in below budget by around €10,000. Cost savings were made as less time was spent by the WRAP researcher on this element of the work in relation to the day to day contact with WI. This was covered by the project manager and the technical requirements covered by the researcher.

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
			<p>collection containers“ were evaluated by the Wuppertal Institute. With regard to the Ecodom collections, it can be said that at least one of Ecodom's school collections was included in WI's evaluation. This means that data on this collection system were gathered and evaluated under the specific context conditions. We unfortunately could not conduct an environmental assessment of the "grocery store collections" for the reasons mentioned above. However, the collection activity was part of our (qualitative) economic evaluation.</p> <p>The technological approaches of the recovery trials selected for this project were of low TRLs (Technology Readiness Levels) which made them innovative, yet challenging to estimate their environmental and economic outcomes at a commercial scale. Against this background, analysis was based on the recovery trials outcomes and focused primarily on qualitative assessments of strengths and weaknesses of the specific trials.</p>	
Monitoring the Socio-Economic	Review of the net economic and social benefits of the project,	Referring to C1 and using survey data, the socio-economic impacts of the project were	C2 was cost effective in using data collected for C1 and combining information from the project evaluation	Final spend for this area was €33,000 more than was originally identified within the bid.

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
impact of the project actions (C2)	which were an important project output.	<p>included in a separate report for C2.</p> <p>The evaluation under C1 and C2 concluded that re-use was the most cost-effective method of recovering CRMs. Trials that successfully collected large quantities of items were also more cost-effective if they co-located with existing infrastructure, making them more convenient and reducing the resource requirements to run the collections.</p>	<p>which was already part of the planned project, with survey results to better understand how the trials impacted on the local areas where they were carried out.</p> <p>Larger sample sizes and data from before the activities took place across all trials would have provided more robust results.</p> <p>Use of control groups for the surveys around the collection trials would have improved the standard of evidence provided but was not possible within the budget and scope of the trial.</p> <p>The innovative nature of the recovery trials meant that it was not possible to compare across the trials and meaningful control groups would not have been achievable.</p>	<p>The reason for this was as follows: The requirement to gather data from all trial sites which were located in 4 different countries was proving extremely difficult to complete with the original budget of 2,580 euros and presented a major risk to the achievement of this deliverable. We therefore identified 24,000 euros of underspend from the consumables budget to allocate to C2 and some additional underspend from the C1 personnel budget which could increase internal personal costs to €13,000. Underspend from the consumables budgets were as a result of cost savings made from combining the collection and recovery activities. Budget changes had been discussed with NEEMO and highlighted in the monthly update for February 2017. The overall budget changes were well within the 20% allowance.</p> <p>We felt that a total spend of €36,000 to gather data and evaluate results from 4 trial countries proved to be cost effective.</p>
Communication and	To facilitate a range of effective Dissemination	D1 activity successfully communicated and disseminated	A key message to take forward to other projects is to ensure that all project	In the main, promotional activities and materials were produced in-

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
Dissemination (D1)	activities to promote the project and its findings.	<p>project-related activity, objectives and outcomes.</p> <p>Communication tools (website, social media, newsletters) were used from the outset of the project to initially raise awareness of the need for the project and its intent.</p> <p>A wider range of organisations and individuals have been made aware of project activities and outcomes, through:</p> <p>Delivering 3 events (Launch, Interim and Final). Producing 14 newsletters, with 542 recipients. Publishing 8 press releases and 10 case studies. Presentation on the project at 30+ events, to 755 business attendees and 304 policy influencers.</p>	<p>partners feed into and support the project communications plan. It is essential that the leaders of a D1 type work package have sight of all instances of project promotion. With cross-EU partnership and partners focussed on their own work packages and deliverables, it can be easy to miss out on activity and hence under-report to some extent. Regular project management board meetings and monthly reporting did help to mitigate this risk within this project, although there did need to be an amount of follow-up work undertaken to contact partners and ensure that as much D1 type activity as possible is captured, recorded and evidenced.</p>	<p>house, in line with allocated resources.</p> <p>Where activity could not be undertaken in-house (design, printing, venue hire etc), these were procured utilising the appropriate processes to ensure value for money (again, in line with allocated resources).</p>
Delivery of AfterLIFE Plan (E2)	Identify how the partners plan to continue disseminating and communicating the results of the CRM Recovery project.	<p>As the actions set out in the AfterLIFE plan are to take place from the end of the project it is too early to report on its achievement and successes. However the project has already been invited to various events,</p>	<p>One of the main takeaways from this action is the difficulty to plan for unanticipated changes to partners' business operations throughout the duration of the project. During the bid-writing process it was identified that</p>	<p>The draft document was completed by WRAP with input from partners. The partners' time has been coded to E2 activities. The bid suggested that time should be coded elsewhere, however in order to understand the time taken to develop this document</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
	This plan outlines how the project partners can/will continue to disseminate and communicate the results of the Critical Raw Materials Closed Loop Recovery Project (CRM Recovery) after the project ends on March 28th, 2019. The outputs and results from the project have been built into various forms of media and marketing collateral such as the project website, case studies, presentation slides and media packs, all of which will be used by project partners and made available to stakeholder partners.	most recently the project team has been invited to take part in the RSC 'Future Wastes Round Table' Discussion on the 20th May 2019. We envisage that this level of engagement will continue well into the period of the AfterLIFE plan.	dissemination of the project's results would coincide with the implementation of the WRAP Sustainable Electricals Action Plan (eSAP) and would be incorporated to the ESAP stakeholder engagement plan. Up until 2018 the project worked closely with the ESAP programme and its stakeholder. In 2018 WRAP took the decision to absorb the work of ESAP into other areas of the business and close the main activity of ESAP. The CRM Recovery project quickly responded to the changes in direction and took a good look at the likely implications of this change and concluded that, due to the cross-over with the CRM Recovery project stakeholders and some of those associated with ESAP and our continued contacts with the likes of Prosum, Umicore and the WEEE Forum, this was not going to cause any delivery issues for the project or impact on any future dissemination activities.	we felt it was necessary to code to the actual activity code as stated within the bid. Development of the plan came in around €2,500 below budget.
Indicators (E3)	Draft Indicator table produced well ahead of first progress report	The project has overachieved on a number of its key indicators, especially in relation to humans influenced, project reach,	The project has revised the baseline and target for waste collected at project level. The baseline for target items of (CRM-rich) WEEE collected in 2015 has been adjusted to 118,507 tonnes.	The personnel costs have come in below budget.

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
		dissemination and project area length.	<p>This background data provides the baseline against which the project's outcomes have been judged and the project itself effectively diverted 43 tonnes of CRM-rich WEEE from the general stream into either higher value reuse or into the recovery trials.</p> <p>In 2018 a small number of new mandatory indicators were included as part of the project activities. Some of these have proved more difficult to achieve as they weren't factor in during the early planning stages.</p>	
Networking with LIFE and Non-Life EU projects (E4)	Networking with other groups and organisations in order to get best value for the project.	The project has carried out a number of successful networking activities, these have been varied and have included face to face meetings, presentations, international video conferencing calls, email exchanges and contact through the project's dedicated email account. 62 activities have been logged with many more non-evidenced activities taking place. The networking was successful in building project relationships with the likes of the WEEE Forum, Prosum and various academic organisations. One example was the	<p>During the first quarter of the project it became clear that the project needed some clarity concerning the difference between networking activities under E1 and dissemination activities under D1. This resulted in a paper being drafted to outline some additional guidance to work alongside that is provided by the Commission on dissemination and networking to ensure the project took a consistent approach to coding time spend on different activities. The following definition was stated:</p> <p>Dissemination: Focus is on pushing out information about project. Likely to be a 1: many activity. Project websites,</p>	<p>The networking costs actually incurred for personnel have come in below the original budget. This is largely to do with the project completing both networking and dissemination activities at the same time, which resulted in some of the networking time E4 being coded against dissemination D1 activities. This has meant some cost savings under this area for personnel time.</p> <p>We have also incurred some T&S costs to the networking activities which weren't originally stated within the bid document. These were necessary in order to complete some</p>

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
		networking activities that took place with Swansea University which resulted in a number of opportunities (both pre and post project close) to present at Royal Society of Chemistry events to disseminate and discuss the policy findings.	<p>logos and promotional materials, webinars, social media, newsletters, notice boards, speaking at conferences, stands at exhibitions.</p> <p>Networking: Focus is on exchange of information and building relationships for mutual benefit. Likely to be a 1:1 activity. Meetings or direct engagement (virtual or face to face) with other European projects or key stakeholders. Attending a meeting held by another European project to learn about the project and make connections as a precursor to future more in-depth networking.</p> <p>Even after this piece of work was completed it was clear that there was still cross-over and some confusion with activities undertaken as part of the D1 work and vice versa. It would make sense to combine these 2 activities for future projects.</p> <p>Problems were also encountered with being able to track and capture all activities that were taking place across not only the project partners but also the activities that were being undertaken by the trial hosts and stakeholders. A dedicated networking log was produced</p>	of the face-to-face networking activities undertaken.

Action	Activity/Methodology	Achievement	Evaluation/Lessons Learnt	Cost Efficiency
			and shared and also, during each 1-2-1 catch up, discussions were had about networking activities that had taken place and ones that were planned. The project has captured evidence for over 60 networking activities but in actual fact this figure could likely be double.	

6.4 Analysis of benefits

Environmental and economic benefits:

The following list summarises the project specific indicators and the actual results achieved:

- Waste management: 9.9 tonnes of the 43 tonnes collected WEEE were evaluated.
- In the NUTS 2 regions of the trials, based on Eurostat reported quantities of target (CRM-rich) WEEE collected, the quantity of target WEEE collected increased from 119,000 tonnes of WEEE in 2015 (used as the baseline for the trials in terms of overall quantity of WEEE available in the trial areas) to 122,000 tonnes in 2016. This background data can be compared to the outcomes of the trials which effectively diverted 43 tonnes into higher value reuse or into the recovery trials.
- Greenhouse gas emissions: The production of 8 selected CRMs contained in 9.9 tonnes of collected WEEE have an avoided impact of 182 kg CO_{2e}.
- In the NUTS 2 regions of the trials, based on the average GHG emissions for the product types handled by the trials in each area, and the total WEEE collected in those areas, the GHG emissions for those products rose from 2,152,793 kg CO_{2e} in 2015. GHG emissions associated with the products collected for the trials amounted to 182kg CO_{2e}”
- Critical raw material captured: The CRM quantity in the evaluated collection amount (9.9 tonnes) is 1.76 kg.
- Critical raw material capture value: The value of CRMs in the evaluated collection amount is around 3.531 Euros, which equates to 2008 Euro per kg CRM collected.

Overall, the results of the environmental assessment of the collection trials have shown that the increase in collection consistently contributes to the environmental protection, since resources and CO_{2e} emissions are saved. However, targeted action in the sense of maximising the potential for environmental benefits is not possible without prioritising impact categories. Furthermore, there are considerable uncertainties in the calculation of both the quantities of CRM and the environmental indicators.

Regarding the analysis of the economic assessment of the collection trials the results have shown that the economic viability clearly depends on successful coordination with other collection activities or the cooperation with existing infrastructures or the retail sector. Additional collection infrastructures just for CRM-rich products will be difficult to establish due to insufficient economic viability.

The trial activities were largely focused on innovative, proof-of-concept methods for the recovery of CRMs. Therefore, extrapolating data to determine the costs and benefits at an industrial scale is extremely complex and could be highly unreliable. Indeed, the costs of many of the CRM recovery methods trialled were high in comparison to industrial recovery costs precisely due to their low TRL but illustrated that commercial feasibility would require a concentration of CRMs to achieve economically viable economies of scale.

The recovery trials within the CRM Recovery project were small in scale, but, for example, bio-leaching has shown high potential recovery rates although it still lacks commercial viability. However, considering the significantly reduced environmental impact of bio-leaching compared to conventional pyrometallurgical processes, the real costs are lower, and the operational risk level is lower than chemical leaching. Consequently, the prospect of bio-leaching especially in developing countries is encouraging.

Environmental benefits: Each trial was assessed on tonnages of WEEE collected, carbon/greenhouse gas emissions, water and energy use. Regular monitoring of the trials was undertaken, along with monthly reporting to ensure trials progressed to plan and that the systems put in place to measure project results were successfully implemented. The scale of the environmental impacts were developed following development of policy recommendations (work package B3), which highlighted opportunities to support and promote NGOs.

Table 30 Quantity of items collected and re-used

	Collection pieces	Collection kg	Re-use pieces	Re-use kg
Asekol: Mobile Containers	1311	1570	5	9
Axion: BHF	193	349	56	142
Axion: Dixons	76	282	41	169
Axion: John Lewis	33	66	13	34
Ecodom: Market Squares	1145	1321	327	496
Ecodom: Schools	254	399	44	75
RecyclingBörse ReBag	262	163	29	16
RecyclingBörse ReBox	67	95	6	13
RecyclingBörse Schools	720	2134	45	82
Re-Tek Workplace	286	777	76	255
Re-Tek Halls	4	1	0	0
Re-Tek HWRC	409	2186	111	533
Re-Tek Schools	66	169	20	63
Re-Tek Social Enterprise	64	344	23	131
TOTAL	4890	9856	796	2018

Table 30 above provides a summary of the quantity of items collected during the collection trials, and the quantities of these that were sent for re-use.

Table 31 Environmental benefits of collections trials

	Collection quantity, kg	TMR of products collected, kg	Specific TMR of products collected, kg per kg	CO ₂ e of products collected, kg	Specific CO ₂ e of products collected, kg per kg
Asekol: Mobile Containers	1570	19708	13	15.96	0.01
Axion: BHF	349	8316	24	7.17	0.02
Axion: Dixons	281	7953	28	7.19	0.03
Axion: John Lewis	66	1738	27	1.6	0.02
Ecodom: Market Squares	1321	18437	14	15.83	0.01
Ecodom: Schools	399	7053	18	5.96	0.01
RecyclingBörse: ReBag	163	1115	7	0.57	0
RecyclingBörse: ReBox	95	300	3	-0.02	0
RecyclingBörse: Schools	2134	34100	16	34.8	0.02
Re-Tek: B2B	777	18937	24	19.83	0.03
Re-Tek: Halls	1	26	29	0.02	0.03
Re-Tek: HWRC	2186	55501	25	59.26	0.03
Re-Tek: Schools	169	4782	28	4.4	0.03
Re-Tek: Social Enterprise	345	9170	27	9.3	0.03

Table 31 above presents information from the trials' evaluation report providing an environmental assessment of the collection trials. The total material requirement (TMR) for the products collected and the CO₂e emissions for those products are reported. The TMR and CO₂e have been calculated based on the contents of CRMs, multiplied by the quantities of products collected, combined with data records from Ecoinvent.

Economic benefits: The collection trials involved local authorities, education sector and private re-use/community enterprises. The opportunity for increasing the number of NGOs that could take learnings from the project were realised via dissemination activities (such as the interim and final project events), and from the policy options identified in B3.

Systems were put in place to assess and understand the economic impact and benefits of the collection and recovery activities that could be scaled up, linking to policy and infrastructure recommendations in work-packages B3 and B4. Trial partners also saw a value in this information. For example, the British Heart Foundation trial undertook an economic assessment of their collection activity to understand the value of continuing the activity once the trial has completed.

Overall the results of the economic assessment of the collection trials did not show them to be economically viable. High costs associated with labour outweighed the revenue for all but one of the trials. Excluding media from ongoing costs was considered to improve viability but, without marketing activities, use of the trials was expected to be too low and as such, this was ruled out.

The collection trial that was found to be viable recovered its cost by reusing a high proportion of the items collected. This high collection: re-use ratio was achieved because the products collected were newer and higher value than products collected by many of the other trials. Co-locating the collections within a retail store may have contributed to this effect.

The recovery trials were not shown to be economically viable but, due to their small-scale laboratory nature, the assessment does not represent their likely scaled-up potential and as such should not be taken as an assessment of ongoing viability.

Social benefits: As each trial was inherently different in its structure and approach, challenges were faced in relation to extrapolating comparative data necessary to demonstrate benefits at scale. There was greater commonality between collection trials. Survey data was used to assess the convenience of collecting electrical and electronic equipment from people at the different types of location used by the trials, compared to the services they are used to using.

The surveys found convenience to be a key factor in encouraging use of collection infrastructure. An important learning from the trials was that convenient services maximised the number of items that were able to be collected. Trials were located at a variety of locations to make them as accessible to local communities as possible, ranging from town centres and schools, to large retail stores, in the workplace and alongside existing collection infrastructure.

Well located, and advertised services encouraged people to bring items for collection which might otherwise have been kept, as many respondents to the survey stated they would have hoarded the item if they had not dropped it off for recycling, even though they were no longer being used. Convenience, as well as trust in the service (especially concerning equipment holding personal data such as ICT equipment), were identified as key barriers that effective

trials must overcome to be successful. Trials located with trusted organisations, such as recognised high street retailers, were found to be trusted. Marketing messages targeted at overcoming the barriers of convenience and trust would help to maximise collection rates of WEEE in future trials as well as the potential to recover CRMs.

In total over 2000 items were measured in the evaluation and sent for re-use as a result of the trials. Types of items re-used vary, with display equipment most likely to go for re-use. The practice of re-use brought €9500 revenue to the trials and provides potential social benefits to customers of social enterprises responsible for their re-sale.

Long term benefits may accrue from the recovery of CRMs as the recovery trials demonstrated the feasibility of new technology being developed in the EU. Findings from the project identified that a greater Corporate Social Responsibility (CSR) focus on the traceability of CRMs may result in the EUs future exports of CRMs to manufacturers elsewhere in the world receiving a premium relative to other suppliers.

However, lower exports of usable technology to less developed countries may adversely affect economic activity in those destination countries by reducing the number of jobs required in electrical repair. It may also reduce the supply of technology to people who may not be able to afford more expensive new equipment.

Social benefits of individual trial activities were also evident. For example one of the collection activities tested (collection hub at Strathdon Primary School) was so successful that the school arranged with Re-Tek to continue it. Re-Tek have arranged with social enterprise, Forestview Centre (who support adults with learning difficulties), to collect the WEEE from the school hub, acting as a storage for the WEEE until the concentrations are large enough for a viable collection for Re-Tek.

The Axion collections with British Heart Foundation created a wider social benefit as Axion and the paid store staff trained the many volunteers in the participating shops. They were trained in all aspects of the collection trials so that they were able to interact with members of the public who came into the shops.

It was evident from the trials that there is potential to scale-up some of the recovery technologies that achieved positive outcomes, where it was demonstrated that the technology worked successfully at a very small scale. The laboratory nature of the trials for this project means that it was not possible to draw conclusions about operationalising the technology on a larger scale, and called for further research to demonstrate viability and benefits on a larger scale.

To be effective the trials needed either to pilot new technology, or to operationalise effective (already tested) technologies. Once well underway, due to difficulties recruiting trial partners, the project had to work at a level of market-readiness that the participating trial partners had not yet achieved. Future research could build on the early findings of the new technologies.

Benefits from replicability, transferability, co-operation and best practice lessons

The main objective of the Critical Raw Materials Closed Loop Recovery project (CRM Recovery) was to investigate if changes to the way WEEE is collected could result in the economic recovery of CRMs through re-use and the development of innovative recovery methods. Specifically, the project aimed to demonstrate collection and recovery methods,

which if scaled-up, could increase the recovery of target CRMs from WEEE by 5% by 2020 and 20% by 2030.

The project replication report set out the actions taken by the project to achieve these aims and objectives. Specifically, the report identified outcomes of the project's trials and their potential for replication, services that are currently being undertaken which have replicated trial activities and/or have been set up as a direct result of the project. In addition, the report provided recommendations for additional replication activities necessary to increase the recovery of CRMs from WEEE and demonstrated how the scaling up of activities undertaken during the project trials would achieve the project targets to increase CRM recovery.

The replication report highlighted that whilst the recovery trials (and in particular bio-leaching), proved effective at increasing the recovery of CRMs from WEEE, to achieve the economies of scale necessary for commercial viability, separate collection of CRM-rich WEEE is necessary. Significant investment is also necessary to further develop the recovery methods tested, to increase their technology readiness levels (TRL), and develop these methods to a demonstration stage. Further investment will be needed to achieve commercial readiness.

The project proved that currently, the most effective way to recover CRMs is through re-use operations. However, whilst technically proven, many re-use activities are loss-making, and operate in a fragmented market dependent on charitable organisations, social enterprises, and less frequently commercial enterprises, for their continued delivery. The CRM Recovery project demonstrated that, through the use of collaborative business models involving charities and private sector retailers, re-use models could increase their profitability. Furthermore, the project demonstrated the importance of high-quality collections which require both the separation of CRM-rich WEEE and limited damage during the transportation phase.

Findings from the project also identified the importance of raising consumer awareness to increase WEEE collections and their financial viability and reduce product hoarding. Therefore, in order to increase the recovery of CRMs through the scaling up of re-use models, it may be necessary to invest in high profile consumer engagement campaigns, as well as behaviour change interventions, to encourage consumers to both correctly dispose of WEEE and to separate CRM rich products.

Work in this area has progressed well and a dedicated Replication Report has been produced. This report sets out the actions taken by the project to achieve these aims and objectives. Specifically, the Replication document reports on the outcomes of the project's trials and their potential for replication, as well as services that are currently being undertaken which have replicated trial activities and/or have been set up as a direct result of the project. In addition, the report provides recommendations for additional replication activities required to increase the recovery of CRMs from WEEE and demonstrates how the scaling up of activities undertaken during the project trials would achieve the project targets to increase CRM recovery.

The project's work around replication potential highlights that whilst the recovery trials (and in particular bio-leaching), proved effective at increasing the recovery of CRMs from WEEE, to achieve the economies of scale necessary for commercial viability, separate collections of CRM-rich WEEE is necessary. However, significant investment is required. Findings from the project are highlighted in the full replication report which includes more information on the replication, and transferability prospects of the project (*Annex E1.4 - Replication Activity report – final (D1)*).

Best Practice lessons

Project trials

The overall aim of the trials was to ascertain whether there was a demonstrable link between the collection phase and the recovery phase of the trials and identify best practice lessons for wider rollout across Europe.

There is an argument that collecting greater amounts of WEEE increases the chances that it will be captured, rather than it being hoarded by households or ending up in landfill. However, the corollary of this is that if you don't collect WEEE in an appropriate manner for the end process then many of the products that could have been re-used will be too damaged and CRMs that could have been extracted if they had been sorted and disassembled at an early stage are more likely to be lost due to WEEE shredding. Therefore the quality of the collection is as important as the quantity that is collected.

Based on the recovery systems trialed, it appears to be economically and environmentally sound that collection systems enable as many items as possible to be processed for re-use markets, prior to recovery/ recycling. If re-use is the final form of CRM recovery then the evidence from the trials is that collections need to target newer, high specification items with a relatively high resale value.

However, depending on the CRM recovery process it may be optimal to target older WEEE that have a high concentration of components used, e.g. PCB's. Development of a product database including knowledge of embedded CRM content will produce sorting criteria that could be used much earlier in the collection stage, for example in the marketing of the collections, encouraging citizens to bring CRM-rich WEEE for collection and reminding them of the need to handle their products with care.

Economic analysis of the project trials showed that economic viability clearly depends on successful coordination with other collection activities (e.g. the combined collection of WEEE and textiles) or cooperation with existing infrastructures (e.g. household recycling centres) or the retail sector. Additional collection infrastructures just for CRM-rich products will be difficult to establish due to insufficient economic viability. The adoption of best practices and lower relevance of investments might lead to more positive effects in the long run. At the same time it should be considered that the average value of products might decrease if the "good products" had already been returned, perhaps motivated by the communication on positive environmental benefits. The best practice findings of the trials have been utilised to develop the policy and infrastructure recommendations and are therefore reflected in these reports.

Project management

In terms of the project management activities there were several examples of best practice that aided monitoring and kept deliverables and milestones on track. A number of these have already been mentioned in the technical sections and as part of section 6.3 Evaluation of Project Implementation, the main areas to highlight are:

Governance as detailed in the Project Manual. This document was produced to establish Standard Operating Procedures and ensure appropriate/consistent project management was

conducted throughout the project. The manual provided particularly important information during the period of staff changes, as the project ran over a 3.5 year period and did experience a number of staff changes both across lead and also some of the beneficiary partners. The manual gave detailed information on areas such as reporting, file sharing, up to date team structures, project financing, time recording, expense procedure and various other critical project management areas. Without a document of this nature it would have been much more difficult to manage staff changes and would have also been much more resource heavy in terms of getting new staff up to speed on the critical project management processes.

Another area of best practice were the **one-to-one partner meetings**, which were led by the WRAP project manager. These meetings were used to provide updates on progress against actions, discuss upcoming deliverables and to raise any issues or questions specific to each individual partner. These enabled regular conversations about progress and requirements and discussion regarding how to address areas which were felt to present potential issues for project delivery.

Task and finish groups again were key in delivering some of the main outputs of the project and allowed a dedicated focus to be given in order to achieve the required project results.

As part of the project we had various **reporting requirements** to complete to detail all activities undertaken. Most helpful was the reporting that we added as an additional project management requirement, which was the monthly updates to Neemo. These allowed us to frequently report, document and discuss any issues or changes. The project management team felt that these reports were much more beneficial than the quarterly reporting carried out under the E1 deliverables.

Internal project management audits and ISO 9001 standards - Throughout the project we were subject to various internal and external audits. In 2017 the project and its processes were used as the sample case for the WRAP ISO 9001 annual audit inspection, which it passed with high praise. We have also been subject to an internal audit in 2018 which considered the project bid objectives and the evidence available to substantiate delivery in relation to the bid which the project passed with just a few minor recommendations. In early 2019 our external financial audit looked at over 200 items across all partners and the lead beneficiary and used a random sample selection from the start of the project up until December 2019.

Neemo contact throughout the project has been useful and should be seen as a best practice example. We feel that the various communications channels (monthly calls & emails), ease of access, open and honest conversations with our monitoring officers at Neemo have helped considerably to deliver the project on time and to EU requirements.

Contact with our EASME Officer should also be highlighted as an example of best practice as it has proved highly beneficial to the project to have a direct line of communication between the project lead and EASME officer. Various examples can be given with the most significant being the speed and ease of dealing with the required change to one of the 4 trial countries. The time taken from the start of the conversation about changing from Turkey to the Czech Republic, to written consent being received, was less than 8 weeks. This assisted greatly in helping us to achieve the project deliverables within the B1 & B2 deadlines.

Communication and dissemination

It is important to quickly develop a project-wide communications plan that outlines your intended audience, how you are going to reach them and also schedule in activity around major activities (events, release of key public deliverables, end of project).

Start event preparation a minimum of 6 months in advance. This helps to initiate (and maintain) awareness and momentum within a project partnership and its audience. Early confirmation of date, location and agenda helps to develop a large audience.

Try to develop visuals to accompany your project's dissemination activities. For example, the creation of an infographic summarising the project's 5 key policy recommendations was incredibly useful in raising awareness on social media and was used in numerous communications including the project newsletter, external presentations and the layman's report.

Internal project management of the communication and dissemination activities is also vital to success. Within the KTN, fortnightly meetings were scheduled to ensure that activity was maintained and progress monitored. Convening regular, wider project group meetings around key events (e.g. the Final Conference) is also recommended, to create momentum and ensure actions are carried out.

Innovation and demonstration value – development of supply chains to facilitate the demonstration trials was in itself a unique approach to project delivery, and one that was replicated within the LIFE funded ECAP Project.

The intention of the project was to deliver activities that were new to the region, trial partner, or market. As highlighted in the CRM Recovery project plan, many of the recovery activities trialled utilised new, innovative, and beyond the state-of-the-art methods to maximise the extraction of Critical Raw Materials from target WEEE. For example, the Axion trial extracted whole components from circuit boards by de-soldering for potential use in secondary markets. By funding these trials, we were able to progress research on the recovery of CRMs from WEEE and understand where commercial opportunities could follow.

Policy implications – work package B3 was to develop recommendations policy derived from the outputs of both the collection and recovery trials. Notably this focused on Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE). Actions from the trials supported many of the statements within the Directive; for example, *“Where appropriate, priority should be given to preparing for re-use of WEEE and its components, sub-assemblies and consumables. Where this is not preferable, all WEEE collected separately should be sent for recovery, in the course of which a high level of recycling and recovery should be achieved”*. Article 11 within the Directive was also directly relevant to the project. B3 together with the infrastructure recommendations (B4) enabled assessment of future benefits.

A best practice element of the project policy work is evident in the extent of the desk research undertaken as a part of the work package and stakeholder consultation and feedback gathered to define and finalise the policy recommendations.

As highlighted in the evaluation section above, a key lesson learnt from the B3 and B4 work was that not enough time has yet passed to enable comment on the implications, impact or take-up of the project recommendations. It is worth noting that the project undertook detailed

research which highlighted potential barriers to implementation as part of the recommendations development (see *Annex 3.1 – Supporting Files, Overview Barriers & Opportunities*), and which were included in the policy recommendations report. However, further passage of time is necessary to establish the success of the policy recommendations. A continuation of CRM recovery research and knowledge sharing is required to scale-up the recovery activities undertaken, from lab-based to commercial operations and to evidence their impact. An online platform to foster continued research efforts, alongside a continuation of available funding from the Commission has been recommended, to ensure experts in the field can progress CRM recovery within the EU.

The project level results are presented in section 7 below, where results for each of the project-level indicators are summarised in table format.

The environmental benefits delivered by this project include the quantity of items that were diverted to reuse, and the environmental benefits of the collection trials in terms of Total Material Requirement and Specific CO₂e (see Table 31 in section 6.4 above).

The economic assessment is summed up on page 92, (Table 32). Overall the collection trials were not found to be economically viable, except for one of them which successfully diverted additional material into reuse. The recovery trials were carried out at laboratory scale and as such their scaled-up potential could not be assessed in the evaluation.

Users of the collection trials fed back that they provided a convenient way of collecting WEEE. These collection approaches could be applied generally to various waste streams arising from private households, like batteries or lamps. Furthermore, waste streams that are not regulated for specific collection could be investigated. Especially in the medical and (mobile) day care sector, lots of products are discarded in the general waste bin. Examples are insulin pumps, incontinence products, single use medical instruments or scalpels made of stainless steel.

The project originally indicated that there were over 3 million tonnes of target WEEE that were collected at EU level at the start of the project. Eurostat data for WEEE collected in 2015 and 2016 has now been revisited. Categories of WEEE included were large appliances, small appliances, and IT and telecommunications equipment reported by member states for 2015 and 2016 and reported by Eurostat in table env_waselee. For the EU-28, the quantity collected in 2015 was 3.014 million tonnes of WEEE. The quantity collected in 2016 was 3.591 million tonnes of WEEE. This large increase provides partial evidence for the potential growth in collected WEEE. The total quantity of WEEE placed on the market has also increased during this time, (see the work for this project on WEEE flows). Taken together, this would suggest that quantities of WEEE that will be collected will continue to grow over time, and the potential source for both CRM-rich material and also reusable products is therefore also growing. At commercial entities like EARN and ERP selected replications will take place in the course of the core business of WEEE collection. The CRM Recovery project team is open to apply for other joint funding opportunities, if available at EU level.

7. Project Specific Indicators

Table 33 below illustrates all of the project's indicators along with updates up until the 29th of March 2019 as shown on the European Commission's KPI (Key projects indicators of LIFE Projects online portal).

*These indicators only have targets for year five after project so will be reported on once the period is over.

**No set targets agreed, data will be based on any actual replication after 5 years.

Table 33 Project indicators

	At Project Level						
Descriptor	Units	At the beginning	At the end	Beyond 5 years	Update as at29/03/2019	Summary/Comments	Directly because of the project
1.5 Project Area Length							
Partial reduction of specific pressures/threats affecting the spatial extent of the project in comparison to the present level.	Km2	0	5550	5550	150,009km ²		
1.6 Humans to be influenced by Project							
Persons concerned by the project independent of the project area	Humans Influenced	0	200	200	2,359	Achieved, for this measurement we have only used the number of individuals completing the project surveys.	
3 Waste Management							

3.1 Wastes from electrical and electronic equipment	Tons per annum	118507	118,464	118,335	3229	9.9 Ton of the 43 tons collected WEEE were evaluated. The amount fed into the re-use and recycling trials can differ. Further the number cannot be referred to a time.	9.9 of 43 Tonnes collected were evaluated as additional target WEEE directly as a result of the project; 3229 tonnes increased in the trial areas during just one year.
8 Climate Change Mitigation							
8.1 Greenhouse Gas Emissions							
CO ₂ Industrial Production	Kg per annum [UK/UKM, UK/UKE, UK/UKD, IT/ITC, DE/DEA, CZ/CZ0)	2,152,792	2,152,611	2,150,792		The production of 8 selected CRMs contained in 9.9 tonnes of collected WEEE have an impact of 182 kg CO ₂ e. The number cannot be referred to a time.	
10 Governance							
10.1 Involvement of non-governmental organisations (NGOs) and other stakeholders in project activities	No. of organisations	0	50	60	50	This is based on organisations that have been involved in the project activities for 5hrs or more and includes stakeholders, trial partners and policy support partners.	
11 Information and awareness raising to the public							

<i>11.1 Website (Mandatory)</i>							
Dedicated project website	No. of individuals visits	0	300	300	12,375 page impressions	This is based on webstats data	
	Number of unique visits	0	300	300	Website: 8,124 users	This is based on webstats data	
	No of Downloads	0	35	35	114	This is based on case studies, policy and infrastructure report downloads	
Average duration of visits	Minutes	0	2	2	2.2	This is based on webstats data	
11.2. Other tools for reaching/raising awareness of the public							
	Publications/ reports	0	2	2	2	The Policy and Infrastructure reports are the project's 2 main publications, these are available on the CRM website	
	Print Media	0	300	300	600	The project has 2 versions of its project brochure leaflet and its layman's report. In total 750 copies of these were printed with over 600 being distributed.	
	Displayed Info/Posters/ Info boards	0	6	6	56	We have displayed 53 noticeboards across trials hosts and partners and project partners, and posters have been displayed at 3 events.	

	Events/ Exhibitions	0	3	3	4	Based purely on project led events: Interim Event June 15 th 2017 Final Event 20 th March 2019 Launch event Jan 2016 Policy webinar 19 th March	
11.3 Surveys carried out regarding awareness of the environmental/climate problem addressed							
1,100 sample size individual survey; smaller number of depth interviews with stakeholders	No. of individuals covered/ survey	0	1175	0	2,542	This is based on the number of responses received from the trial surveys.	
Surveys conducted	No. of surveys	n/a	n/a	n/a	1. Economic interview 2. Pre-trial socio-economic survey 3. Post-trial socio-economic survey	All surveys distributed amongst trials	
12. Capacity Building							
12.1 Networking Target audience and number of individuals whose awareness is raised through the networking tools used	No. of individuals	0	500	600	1376	Include businesses/individuals attending project events/policy briefings/networking events and the social network subscribers)	
13 Jobs							

	Number of FTE	0	3	3	5	This is based on the number of hours work based on the full time equivalent.	
*14 Contribution to Economic Growth							
14.1 Running costs/operating costs during the project and expected in case of continuation/ replication after the project period	€	0	927500	400000	?	This figure is based on actual project end figure	
14.2.2 Operating expenses expected in case of continuation/replication after the project end	€	n/a (only after 5 years target)	n/a (only after 5 years)	50000	n/a (only after 5 years target set)		
14.3 Future Funding	€	n/a (only after 5 years target)		50000	n/a (only after 5 years target set)		
14.4 Continuation/replication/transfer after the project period							
14.4.1 Entry into new entities/projects	NUTS code regions (levels 0 and 1)	No set targets	No set targets	No set targets	No set targets	See replication report for updates	
14.4.3 Entry into new geographical areas	NUTS code regions (levels 0 and 1)	No set targets	No set targets	No set targets	No set targets	See replication report for updates	

