

PROMOTING CIRCULAR ECONOMY THROUGH RESOURCE-EFFICIENT ELECTRONIC RECYCLING ACROSS LATIN AMERICA

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Abstract: Latin America faces important challenges in carrying out environmentally sound management (ESM) of waste from electrical and electronic equipment (WEEE) and moving towards a circular-economy model. This document aims to report on the contributions made by the UNIDO-GEF project “Strengthening of National Initiatives and Enhancement of Regional Cooperation for the Environmentally Sound Management of POPs in Waste of Electronic or Electrical Equipment (PREAL)”. The project strengthens national initiatives and improves regional cooperation to upgrade the conditions for carrying out WEEE management and for creating enabling conditions for the efficient recycling of WEEE into new resources or products, which paves the transition to a circular economy model.

Keywords: circular economy, persistent organic pollutants, EEE, WEEE (E-waste), plastic recycling, BAT/BEP.

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1. INTRODUCTION

From refrigerators to smartphones, electrical and electronic equipment (EEE) play an increasingly important role in our day-to-day lives. While EEE contributes to enhancing living standards across the world, the question of how to manage products once they lose functionality, become obsolete, or are rejected by the consumer is a matter of global concern. This is due to both the composition of such equipment and the high amounts of waste (WEEE) generated, linked to increased dependence on technologies, short life cycles, limited repair options, and our consumption habits.

The Global E-waste Monitor 2020 [1] points out that in 2019, the world generated 53.7 million metric tons (Mt) of electronic waste. This is an increase of 21% since 2014. However, only 17.4% of this waste was officially documented as properly collected and recycled. Although the treated amounts have grown by 1.8 Mt since 2014, total e-waste generation increased by 9.2 Mt. This means that recycling activities are not keeping pace with the global growth of e-waste.

In Latin America, the situation is even more critical. In 2021, UNIDO (through the PREAL project), the United Nations University (UNU) and the United Nations Institute for Training and Research (UNITAR) prepared the study “*Regional monitoring of electronic waste*” for the thirteen countries participating in the UNIDO-GEF PREAL project [2]. The study showed that the generation of electronic waste in the region increased by 49% between 2010 and 2019, rising from 0.9 Mt (4.7 kg / inhab.) to 1.3 Mt (6.7 kg/inhab.). Just 3% of this waste was officially documented as properly collected and recycled. These data suggest that increasing collection rates is key to promoting circular economy and the reuse and recycling of materials in Latin American countries.

WEEE often contains chemical substances that can cause health and environmental problems if not properly handled. However, they can also be resources of economic and strategic importance. The challenge of recovering these resources and introducing them into new production cycles involves carrying out environmentally sound

management (ESM) of potentially hazardous chemical substances present in WEEE.

The ESM of WEEE is a challenging issue in the Latin American region, and its inadequate management poses significant threats to human health and the environment. Available data suggest that continuous technological change and the frequent replacement of EEE, especially in developed countries, are causing a rapid global increase of e-waste, both in volume and complexity. Until now, political and public concerns about e-waste handling and treatment have arisen mainly due to the presence of heavy metals, Persistent Organic Pollutants (POPs), and other substances that are harmful to the environment. Several of these substances represent a serious health risk, such as lead, mercury, arsenic, cadmium, selenium, hexavalent chromium, and brominated flame-retardants (BFRs) present in the plastic casings of many appliances. Other substances are harmful since they deplete the ozone layer (e.g. chlorofluorocarbons) or have global warming potential (e.g. cyclopentane). These substances can be released into the environment through inappropriate handling of WEEE practices, for example open burning. Such dangerous waste management practices can even release u-POPs (unintentionally produced POPs), like dioxins and furans. These highly toxic chemicals remain intact for a very long time and travel long distances in the environment. This way they become ubiquitous, accumulate in living organisms, including humans, and appear in higher concentrations at higher levels of the food chain, causing severe toxic effects to both humans and wildlife. Thus, WEEE collection, storage, dismantling, recovery, treatment, and final disposal should include effective technical, safety, occupational, and environmental management practices.

On the other hand, WEEE is considered an 'urban mine,' as it contains ferrous metals (iron, steel), non-ferrous metals (copper, aluminum), precious metals (gold, silver), strategic materials (rare earth elements, cobalt, germanium), and engineering plastics (ABS, PC), which, if recycled, can be used as secondary materials (Fig 1 and 2). According to The Global E-waste Monitor 2020 [1], the value of raw materials in WEEE generated globally in 2019 is equivalent to approximately USD 57 billion. Iron, copper, and gold are the main contributors to this value. From an environmental point of view, the recycling of iron, aluminium, and copper contributed to a net saving of 15 Mt of CO₂eq potential emissions that did not occur thanks to replacing virgin materials with secondary raw materials.

2. BACKGROUND OF THE PREAL PROJECT

Migrating towards a circular economy model in managing WEEE in Latin American countries begins with creating favourable conditions based on the region's challenges: regulatory, logistical, infrastructural, economic, and public-awareness related, among others. Likewise, there is still little statistical information that allows an understanding of the quantities of EEE placed on the market or the volumes of WEEE generated and its management. This information would make it possible to define long-term national policies aimed at reducing e-waste generation, promoting reuse, repair, refurbishment, recycling, and generating jobs in the recycling sector. One of the main problems the region faces is the lack of comprehensive and enforceable national policies that promote the formal collection and ESM of WEEE. These policies are usually based on Extended Producer Responsibility (EPR) and, without them, it becomes difficult to ensure high collection rates and ultimately to address problems related to hazardous substances, such as POPs.

Consequently, most countries lack formal collection mechanisms that allow their citizens to return their WEEE easily. Although all countries have facilities to disassemble and recycle some materials, investment in the proper handling and disposal of hazardous substances is scarce. This makes it difficult to find facilities with high environmental standards and sustainable business models for WEEE management. In addition to these logistical and infrastructural challenges, the public generally has a low level of knowledge about the ESM of WEEE and information on the environmental and health risks related to its improper management is not readily available. Moreover, the lack of national knowledge and information management systems, the absence of regionally harmonized WEEE management policies, and insufficient South-South cooperation add to the complexity of the problem.

To tackle this reality, in 2017, the Global Environment Facility (GEF) endorsed and funded the UNIDO project "Strengthening of National Initiatives and Enhancement of Regional Cooperation for the Environmentally Sound Management of POPs in Waste of Electronic or Electrical Equipment in Latin American Countries" (PREAL by its acronym in Spanish). The project is fully aligned with objective 1 of the GEF-5 Chemicals Strategy (i.e. Phase out POPs and reduce POPs releases).

Other international institutions, such as the Swiss State Secretariat for Economic Affairs (SECO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the German Agency for International Cooperation (GIZ) have

also supported e-waste initiatives in Latin America in recent years. Nevertheless, the PREAL project represents the first regional project of its kind in Latin America. The project "also has the potential to contribute to the fulfilment of many SDGs, including Goals 3, 5, 8, 9, 12, and 13. In particular, this project contributes to SDG 17 on Partnerships by bringing together governments, UN organizations and IGOs,

businesses, industry, NGOs, workers, and civil society across the region and beyond to share best practices, lessons learned, and future ambitions to help to transform e-waste management and protect human health and the environment."¹

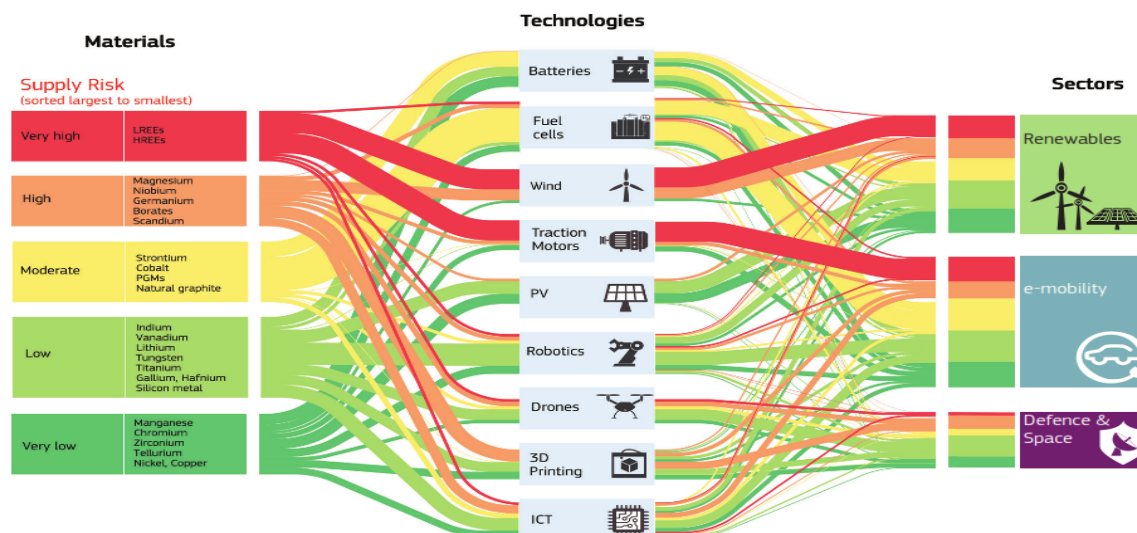
Figure 1. Composition of WEEE Fractions

Components \ Fraction	Precious Metals: Gold & Silver	Copper	Aluminum	Cables Copper	Ferrous Metal (Iron)	Cables Plastic	Rare Metals	Lead	Tin	Plastic	Brominated Plastic	Glass	Fire Retardant	Silicon	Mercury	Americium	Barium	Cadmium	Nickel	Cobalt	Arsenic	Lithium	PCB Oil
PCB	•	•	•		•		•	•	•	•			•	•	•	•							
Metal Frame					•			•	•	•				•									
CRT Monitor		•	•		•			•	•	•		•	•	•			•	•	•	•			
LCD Monitor		•	•					•	•	•		•	•		•			•					
Florescent Lamps	•	•	•					•	•	•	•	•	•		•			•					
Lead Batteries								•	•	•											•		
Lithium Batteries									•	•												•	
External Electric Cables		•				•				•													
Wiring		•	•			•				•													
Motors		•			•					•													
Plastic Frame										•	•		•										
Transducers / Capacitors			•							•													•

■ Heavy Metal ■ Hazardous Material

Source: Assessment of WEEE dismantling business opportunities, Sustainable Recycling Industries, 2017.

Figure 2. Semi-quantitative representation of flows of raw materials and their current supply risks



Source: European Commission, Joint Research Centre

¹ Mr. Alfredo Cueva, Project Manager, UNIDO

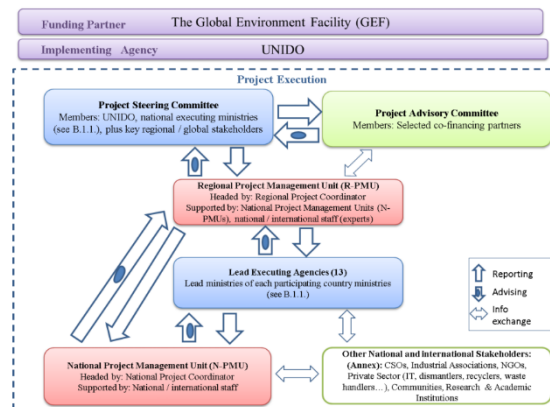
3. APPROACH FOR ACHIEVING RESOURCE-EFFICIENT ELECTRONIC RECYCLING

The PREAL project, launched in March 2018, is financed by the Global Environment Facility (GEF) with support and co-financing from a wide range of partners. The project is implemented in 13 Latin American countries: *Argentina, Bolivia, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Peru, Uruguay, and Venezuela*. It involves a wide range of partners across Latin America, such as the Stockholm and Basel Convention Regional Centers, universities and national NGOs. It also brings international partners working globally, such as the International Telecommunications Union (ITU), the United Nations University (UNU), the World Health Organization (WHO), the International Labour Organization (ILO), the Swiss Federal Laboratories for Materials Science (EMPA), the U.S. Environmental Protection Agency (EPA), the International Solid Waste Association (ISWA), StEP, and Dell, among others.

The project implementation builds on the coordinated capacities of the national and regional partners. The policy-oriented activities involve high-level public officials and other senior partners, while the technically oriented associates jointly implement technical matters and demonstration activities in coordination with the corresponding authorities. Figure 3 summarizes the overall project structure and implementation arrangements. The project established a Project Steering Committee (PSC) consisting of UNIDO, national representatives of the ministries that are the leading project executing counterparts and additional stakeholders depending on the specific needs or topics. The Project Advisory Committee (PAC) monitors and evaluates activities and makes recommendations and suggestions. On the other hand, the project set up a Regional Project Management Unit (R-PMU) consisting of a regional project coordinator (RPC) supported by minimal administrative staff. The R-PMU is responsible for guiding and following up on day-to-day project execution, harmonizing activities throughout the region, promoting regional activities and supporting the countries in exchanging information and knowledge. The regional coordinator works in very close cooperation with the UNIDO project manager. Finally, at the national level, the lead executing agencies are the relevant ministries,

which are in charge of the project in their respective countries². As part of the national execution, every national executing partner established a National Project Management Unit (N-PMU) consisting of a National Project Coordinator (NPC) and one or two support staff to supervise day-to-day project activities and to report to the RPC, country officials and UNIDO.

Figure 3. Institutional arrangements for project implementation



The project brings together all the required stakeholders to build the foundation for effective e-waste management. It consists of four components: (1) strengthening of national e-waste management initiatives; (2) enhancing national capacities on e-waste dismantling and recycling facilities and infrastructure; (3) enhancing regional cooperation on e-waste management; and (4) project monitoring and evaluation. The first two components directly relate to project execution in the participating countries, whereas component 3 is implemented at the regional level. Components 1 to 3 and the corresponding implementation in the 13 participating countries is described below.

3.1 Strengthening of national e-waste management initiatives

This component promotes the development of regulatory frameworks that establish the responsibility of all actors in the EEE value chain and promote circular models for managing WEEE in the participating countries. The involvement of the general public, private, and public sectors has been a

² These include the Secretary of Environment and Sustainable Development in Argentina, the Ministry of Environment and Water of Bolivia, the Ministry of Environment of Chile, the Ministry of Health of Costa Rica, the Ministry of Environment of Ecuador, the Ministry of Environment and Natural Resources of El Salvador, the Ministry of Environment and Natural Resources of Guatemala, the Secretariat of Natural Resources and Environment (SERNA) of Honduras, the Ministry of Environment and Natural Resources (MARENA) of Nicaragua, the Ministry of Health of Panama, the Ministry of Environment of Peru; the Ministry of Housing, Land Planning and Environment of Uruguay, and the Ministry of People's Power for Ecosocialism and Water of Venezuela.

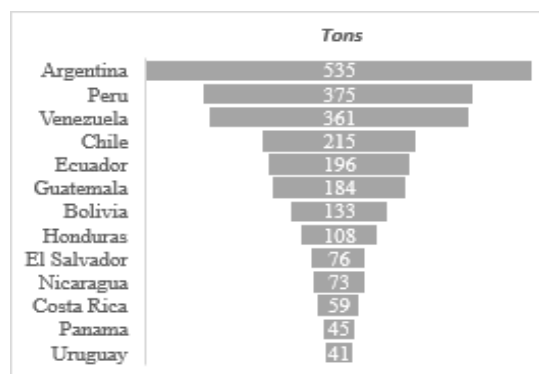
key factor to ensure the successful implementation of such models.

The starting point of this component is the regulatory framework. In countries where there is no established framework, UNIDO helps guide the development process, and if there are gaps in national environmental, health, and labor policies and regulations, the project hires experts to fill them. On the other hand, building national capacities and training key national actors is crucial to achieving their empowerment in the development of a WEEE management system. The project supports each participating country to develop its human, scientific, organizational, and institutional capacities. Each country organizes face-to-face meetings and webinars on specific topics, prepares educational materials, and uses social networks to disseminate issues of interest. The design and implementation of a centralized system that enables the development, collection, processing, and sharing of relevant information and knowledge on e-waste management processes at the national level is an important part of this process. The national PMU also negotiates interventions and agreements with universities to include electronic waste in their study plans and research programs. Likewise, the media have also been engaged through various meetings, with the aim of promoting an enhanced understanding of the issue and to convey the message that the end user of EEE should receive. Recognizing the pivotal role of the media, the project prepared a guide on electronic waste that was presented to a group of journalists. Finally, the promotion of training and awareness activities among the general public is part of the backbone of this component since e-waste management requires broad participation and social support. This has been achieved by carrying out collection campaigns with the support of at least one relevant producer and a WEEE recycler company, awareness campaigns, and the development of educational material to raise awareness about the problems of electronic waste.

3.2 Enhancing national capacities on e-waste dismantling and recycling facilities

The general objective of this project component is to support WEEE dismantling and recycling facilities so that they learn how to identify, separate and dispose of hazardous fractions, particularly those that may contain POPs. The project aims to tackle 600 tons of brominated plastics annually, totalling 2,400 tons during the project lifespan. The safe final disposal of this fraction will provide the core of the GEF intervention in this output. This way, each country achieves streams of depolluted materials that are ready to become raw materials for further production processes. Figure 4 shows the distribution of the 2,400 tons goal of Plastics with BFR per country.

Figure 4. Goal per country (tons) of BFR plastics to be collected for final disposal.



Source: PREAL, 2022

To achieve the above objective, each participating country has selected at least two existing facilities for an in-depth assessment of the processes they currently carry out. Based on these diagnostics, they formulate improvement options with emphasis on the proper handling and disposal of the fractions that may contain POP-PBDEs from EEE plastics (e.g., ICT equipment, CRT cases, carcasses of TV sets and monitors) or other circuit parts (e.g., PCBs from small condensers and ballasts) to seek full compliance with the Stockholm Convention (SC). Once the recycling facilities are selected, the project provides training and support to strengthen and improve e-waste management according to Best Available Techniques/Best Environmental Practices (BAT/ BEP). The objective is to improve the current processes, practices, and operations. Support covers all stages of the e-waste management process, including collecting, dismantling, and safely treating e-waste fractions containing POPs, ultimately enabling their safe final disposal.

According to statistics compiled by UNEP on the percentage of the various types of EEE present in the waste streams, the fraction of plastic polymer and the content of POP-PBDEs can be estimated. Therefore, based on the project's objective of separating 2,400 tons of BFR plastics, the e-waste generated by the 13 project participating countries represents estimated emissions of around 26 - 60 tons of POP-PBDEs per year. To identify these plastics, the PREAL project has relied primarily on the experiences and results of Colombia. The Colombian project COL 98841-94749 "Reducing the release of unintentional POPs and mercury from hospital waste management, WEEE, metal scrap processing and biomass burning", implemented by the Colombian Ministry of the Environment and UNDP identified three lists of risks that have become the basis of initial distinction of our project.

Based on those lists, the PREAL project prepared the guide "*Recommendations of best practices and techniques available for the*

identification, classification, and separation of plastic waste with brominated flame retardants." This guide shows participating countries the step-by-step process for carrying out the identification of BFR plastics through 4 methods: 1) symbology following ISO 11469 standard, 2) tests for reactions to solvents such as limonene and acetone; 3) tests of physical properties such as flexibility/rupture and hardness; and 4) sinking and floating tests where plastics with BFR will potentially sink. Another method used in the Project is X-Ray Fluorescence Spectrometry (XRF), where the equipment detects the bromine concentration in the plastic given a direct and most likely accurate measurement. Recyclers and national PMUs have learned to implement the guide and keep a detailed record of the identified and separated volume of plastics.

The most suitable final disposal option found in the participating countries is co-processing in cement kilns, under the SC guidance, given its availability, the high temperatures reached in the kiln, and the high level of destruction achieved with this technology. The PREAL project also disseminates international technical documents, such as the Sustainable Recycling Industries (SRI) practical manual on the management of WEEE plastics, the main references of which are condensed in another guide produced by the project entitled *"Instruction guidelines for the destruction of WEEE plastics in cement."*

The project also seeks to assess the potential for greater benefit in the plastic recovery and recycling chain. For this purpose, it has contacted the Plastic and Rubber Research Institute of Colombia in search of suitable business models that facilitate circularity and enable the long-term sustainability of the facilities.

3.3 Enhancement of Regional Cooperation on e-waste management

An essential aspect of the project is the enhancement of South-South cooperation, as coordination and cooperation among countries within the sub-regions and the whole region will result in a more environmentally sound and effective way of collecting, recycling, and processing WEEE. The project has designed various mechanisms and strategies to promote cooperation between the participating countries and has involved public, private and civil society actors, and the Basel and Stockholm Convention Centers present in the region as major players in the project.

The sustainability of the strategy for addressing e-waste management in this context includes several initiatives that aim to create harmonized technical and legal standards and regulations, regional-level playing field conditions, and the commitment to incorporate extended

producer responsibility as a regional principle. Additionally, the strategy includes the interchange of good practices, information, and knowledge about implementing extended producer responsibility following the socio-economic conditions of participating countries. Furthermore, the strategy also includes cooperation on the definition and implementation of national information systems on e-waste generation, collection, and final disposal that can communicate with one another efficiently and potentially generate indicators and knowledge.

Among the tools designed by the project to achieve the proposed objective are "PREAL Tuesdays" and periodic training events, which have become essential strategies for promoting knowledge management. PREAL Tuesdays are weekly meetings in which technical representatives of the Ministries in charge of implementation, national coordinators, and technical teams from the 13 participating countries participate. International experts are sometimes invited. PREAL Tuesdays are a tool for producing, compiling, and exchanging on focused topics related to the project's development. The main work topics have included general guidelines for the preparation of national regulations, the homogenization of criteria, the application of extended producer responsibility, the inclusion of the informal sector in recycling, the presentation and discussion of the main challenges that the participating countries are facing and the exchange of produced materials.

Likewise, the project set up a website (<https://residuoseelectronicosal.org/>) that contains information on the regulations and documents that the countries have produced within the framework of the project. To further facilitate the exchange of information between the countries, an Intranet system and a YouTube channel have also been created that feature all the videos of the meetings and audiovisual materials to promote the dissemination of knowledge and the transparency of information. As part of the communication strategy, a WhatsApp group facilitates immediate communication between the participants, including the UNIDO coordination team. The project also prepares monthly newsletters that contain information on the progress made by the countries, upcoming events, and general information of interest that facilitates the implementation of the project at the national and regional levels.

Finally, the improvement of regional cooperation has also been strengthened thanks to close coordination with initiatives led by other UN organizations, in particular, ITU, UNU/UNITAR, WHO, and ILO, with whom activities and pilot projects have been carried out in several of the participating countries.

4. PRELIMINARY RESULTS

It is important to understand that although the Latin American region presents great cultural similarities, the implementation of the proposed activities depends largely on the socio-political situation of each country, its interests, and its national priorities. This means that methodologies or strategies that works in one country, may not work similarly in another. For this reason, although the 13 countries show important advances, these can occur in different areas.

4.1. Strengthening of national e-waste management initiatives

In terms of policy development, Costa Rica and Peru have reviewed and updated their E-waste policies dating from 2010 and 2012, respectively, and introduced new rules, such as mandatory collection rate targets and new controlled WEEE categories. The Government of Ecuador issued its first regulation on E-waste in 2022, while El Salvador, Chile, Uruguay, and Venezuela have already drafted their regulation proposals and are awaiting approval from their governments. In Argentina, after several failed attempts in the last decade, the country's Congress approved the Domestic Waste Law, which will be the basis for implementing the national WEEE regulation. The remaining countries have already implemented different initiatives, including inventories, diagnoses, collection pilots, and education campaigns for the public, and expect to finalize their draft policies before the third quarter of this year.

As presented in the previous section, training and capacity-building activities are relevant themes of the project. As of December 2022, more than 200 activities had been carried out, including E-waste academies (EWAM), webinars, workshops, and training aimed at officials and key stakeholders. In total, the project has trained 4,417 people (51% women) and has reached an additional 13,797 people (52% women) through information and awareness events held by the participating countries. As part of the communication strategy that the participating countries have implemented, information booklets, brochures, and promotional materials have been prepared to raise awareness among the public. Within the multi-stakeholder approach of the project, 18 universities from different countries participated in including WEEE management in their academic agendas, either through research proposals or by participating in practical activities such as supporting the collection of statistical data or the preparation of documents. Likewise, a guide on WEEE has been prepared for the media, and 1,836 journalists (51% women) have been trained on this topic.

4.2 Enhancing national capacities on e-waste dismantling and recycling facilities

Regarding strengthening the recycling sector, the national PMUs have evaluated 117 WEEE dismantling and recycling facilities, but have selected only 17 so far, according to the project requirements. However, there is still little experience in identifying BFR plastics, an activity to be reinforced in 2023. Similarly, recovery practices of depolluted plastics and the final disposal of contaminated plastic in cement kilns (co-processing) will be promoted as the best option for environmentally sound disposal chosen by the project.

To fulfil the purpose of this line of action, the project developed the Guidelines *"Recommendations of best practices and techniques available for the identification, classification, and separation of plastic waste with brominated flame-retardants"* and *"Instruction guidelines for the destruction of WEEE plastics in cement kilns."* The selected e-waste facilities in each country have gradually applied these recommendations. However, not all have been able to apply the physical separation methods or use XRF equipment. As a first stage, the recyclers have focused on separating WEEE that is most likely to contain BFR-POPs, according to the risk lists provided by the Colombian project, mentioned in the methodology section.

The selected recyclers began implementing the Guidelines mentioned above in July 2022, and identified and separated 20 metric tons of WEEE plastic with brominated flame-retardants, by December 2022. Notwithstanding, by early 2023, the managed WEEE fraction increased to 99 metric tons, almost 80% above the 2022 value. It is worth mentioning that there was a significant delay in the implementation of these activities due to the challenging working conditions derived from the COVID-19 pandemic and the need to overcome several administrative obstacles in accordance with the reality of each participating country.

On the other hand, in October 2022, 15 people from the national PMUs participated in face-to-face training, with emphasis on the technical foundations and practical methodologies for the identification of WEEE plastics that contain BFR classified as POPs and recovery options for decontaminated plastic, which showed the participants practical examples of companies that already carry out these processes. Following this training, some countries began to prepare business models for recycling decontaminated plastics in their countries, within the circular economy framework.

4.3. Enhancement of Regional Cooperation on e-waste management

The PREAL Project has systematically articulated, disseminated, and supported knowledge

management (KM) and information and communications systems (ICS) in the region, contributing to establishing a culture for the ESM of WEEE within Latin America. KM campaigns, training, and awareness-raising activities at the national and regional levels have improved South-South cooperation and national capacity building.

PREAL Tuesdays have become one of the most powerful tools for harmonizing regional project activities, supporting knowledge management, and building capacity. In 2022, PREAL held 43 meetings addressing diverse topics such as the planning and organization of training events, general guidelines for implementing EPR regulations, financing mechanisms for WEEE management, progress and experiences in implementing WEEE regulations in more developed countries, and the separation and recovery of WEEE plastics, among other themes. Experts from the participating countries and beyond helped to address these topics. Overall, PREAL Tuesdays have become the space where countries share their own experiences and exchange useful documents and materials with others. PREAL Tuesdays have also served as a mechanism that facilitates setting working groups for issues of regional interest. Such groups have been involved in mapping existing collection points in participating countries, discussing technical guidelines for WEEE management, and recommending guidelines for regulations aimed at limiting POPs in imported EEE.

As mentioned, the project has ICS that allows it to disseminate the activities carried out and promote the exchange of experiences among the participating countries. The website (www.residuoselectronicosal.org) presents essential information on WEEE by country and a documentation center that is updated with documents generated within the project and by the international community. Updated information on WEEE is also provided through news and events. The YouTube channel (<https://www.youtube.com/channel/UCBivkHq8zXRr05kBdbMZylQ>) has more than 200 subscribers and 6,000 visits, with information generated on PREAL Tuesdays and presentations of international meetings that countries use as support material for the implementation of the activities. On the other hand, the Intranet site facilitates internal communication among project participants and contains documents, guides, and other materials for each project output, which have been developed by the participating countries and others.

The involvement of other UN organizations, such as ITU, UNU/UNITAR, WHO, and ILO, has facilitated the implementation of pilot projects and key regional activities. For instance, UNU/UNITAR worked with the UNIDO team to organize one face-to-face and two virtual EWAMs (E-waste Academy for Managers). In addition, an EWAS (E-Waste Academy for Scientists) was held in September 2022 to expose doctoral students to diverse normative and

positive perspectives on e-waste management and provide them with multiple teaching and learning methodologies, through lectures, workshops, presentations, study tours and group work. The EWAS involved 21 scientists both from PREAL countries and around the world. The alliance with UNU/UNITAR allowed the issuance of the first E-Waste Monitor for Latin America, which includes statistical data on EEE imports, and WEEE generation and collection rates, among others.

Other important developments under the project include a study of the EEE-WEEE value chains with emphasis on decent work and working conditions, developed by ILO; studies to strengthen WEEE management with emphasis on health protection, developed by PAHO/WHO, and the implementation of ITU recommendations on WEEE management. The project also interacts with other organizations, such as the Partnership for Action on Computer Equipment (PACE) and the Solving the E-Waste Problem Initiative (StEP).

5. NEXT STEPS: TOWARDS CIRCULAR ELECTRONICS

It is widely recognized that linear economic models based on the extraction of natural resources result in their depletion, are unsustainable, lead to soil degradation, and generate hazardous emissions, waste and pollution. The COVID-19 pandemic, aggravated by its economic and social downturns, has deepened the triple planetary crisis (climate change, biodiversity loss, and pollution) and exposed the fragility and consequences of this model. International commerce difficulties have increased prices of raw materials, commodities and energy.

The shortages of virtually all components required to build EEE threaten the electronics industry in general and many other related industries, such as the automotive, automation or video game industries. This situation highlights the urgent need to build virtuous models that consider an inclusive and resilient recovery of materials, where WEEE has immense potential as an urban mine.

Although some Latin American countries, such as Argentina, Brazil, Colombia, and Mexico produce electrical and electronic equipment, the region generally tends to import EEE.

This situation allows us to aspire to a regional circular economy model that encompasses the redesign of EEE to minimize waste and the extraction of primary resources alongside the design of policies that truly favour repairing, refurbishing, recycling, remanufacturing, and reusing materials as much as possible.

Such a model would bring economic recovery and growth prospects to the region, as well as enormous environmental and social benefits, in terms of job creation, reduced pollution and a healthier environment.

In February 2021, the 21st Meeting of the Forum of Ministers of the Environment of Latin America and the Caribbean pointed out that the region recognizes circular economy as an alternative, resilient economic development model aligned with the SDGs for the post-Covid-19 era [4]. Nonetheless, achieving this aspiration requires meeting certain pre-conditions, such as creating and supporting recycling systems that create a market for higher value secondary material.

The PREAL project has taken the first steps towards the road to circular electronics in the region. It has shown that engagement of the public with the private and public sectors is necessary to bring about long-lasting impact and system change. This change must be underpinned by triggering sound national policies; an enabling environment; and, economically-sustainable and environmentally-friendly business models.

With such policies, enablers and business models, built national capacities within the public and private sectors must partner to overcome these challenges. Above all, society needs to be fully educated and sensitized on these issues.

Although this project has contributed to paving the way, there is still much to do to successfully transition towards a circular economy model in the region.

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