SPECIAL

Presentation

I ANNUAL RECYCLIA REPORT

Trends in the WEEE and battery recycling industry in Spain

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Study conducted by

Afi

for

recyclia

Luis Pérez Bermejo
President of RECYCLIA

It is evident that electronic devices offer a world of opportunities for development across virtually all social sectors. However, this new environment that technology is creating also requires an overhaul of our current production system and the way we consume by using and discarding.

This rethink hinges on creating a circular economic system in which these electronic devices are no longer seen as a problem at the end of their useful life but treated as a valuable resource, halting the overexploitation of raw materials (many of which are critical due to their scarcity), protecting the environment and our health, and creating quality employment.

Better understanding of the flows and management of waste electrical and electronic equipment (WEEE) and the batteries and battery packs supplying them are essential for supporting the transition and implementation of this new economic model. Only then will we be able to harness the opportunity that they provide in facilitating the rollout of a sustainable production model which reduces the consumption and waste of raw materials, water and energy.

With this objective in mind, Recyclia has commissioned this initial annual report on trends in the WEEE and battery recycling industry in Spain, which, for the first time ever, presents the main socio-economic indicators of a sector that has slowly gone from strength to strength.

In fact, this document in itself can be considered a milestone in consolidating the pioneering work started by Recyclia's waste management collection systems (Ecofimática, Ecoasimelec, Ecolum and Ecopilas) over two decades ago in order to achieve a sustainable economy and efficient use of resources.

Also of note is when exactly this report was published—December 2020, a year marked by the struggle against the COVID-19 pandemic, which leaves behind an extremely complicated economic scenario in its wake. Tackling the aftermath will require concentrating efforts on upgrading sectors to diversify the activities that are currently shoring up our economy, creating a competitive industrial model which is self-sufficient in terms of raw materials, and of course, sustainable, carbon-free and efficient.

In this way, the incipient socio-economic impact of managing electronic waste and batteries stated in this report shows, without doubt, the potential for our sector to become one of the levers of economic recovery, whilst also progressing with the inclusion of national and European green agendas, as ambitious as they are urgent.

José Pérez García
CEO of Recyclia

At Recyclia, the umbrella entity for the Ecopilas, Ecofimática, Ecoasimelec and Ecolum foundations, we have been recycling waste electrical and electronic equipment (WEEE) and batteries for over two decades, giving us, in addition to experience, extensive knowledge and consequently, the ability to research and develop more and better practices in the field.

Much can be done in two decades in recycling, including becoming (sometimes unwittingly) a market pioneer. For example, before Spanish and European legislation defined and regulated recycling, Recyclia had already started not only to design their own regulations, but also implement them, turning us into a benchmark for developing prevailing legislation, which we have also managed to export to other countries, both in Europe and in Latin America.

This concern for recycling has been precisely what has led us once again to attempt to contribute to its evolution, even more so now with the Government's own strategy placing heavy emphasis on sustainability with the creation of a department to lead and drive it: the Ministry for the Ecological Transition and the Demographic Challenge (MITECO).

For this reason, and motivated by this desire, which as I have mentioned, I believe to be pioneering, we are undertaking the job of assessing the reality and trends of the WEEE and battery recycling industry in Spain for the first time.

It has been a Herculean task but one well worthwhile, as it provides this sector with a framework which it has been lacking up to this point. I am positive that it will help to extend the knowledge and value of recycling, set to play a fundamental role in the Spanish economy.

It is our pleasure to make this report available to you now, and as you will see it is divided into four main parts. The first lends itself to identifying the value chain of our activity and all the agents involved. The second analyses the amount of waste, both electronic equipment and batteries, generated in Spain from the quantity of products on the market, to go on to quantify the impact of our activity on Spain's economy in the third section of the report.

Finally, in the last section, we have examined the contribution of recycling to the modernisation of Spain's economic activity and we have also attempted to outline a series of opportunities that we believe bolster the competitiveness of our recycling industry.

In short, I hope and wish that this report is of interest, but above all, that it can become a useful tool for all of us to create a more sustainable planet, or at least, make some headway in that direction.

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Executive summary

▸ The collection, management and recycling of waste electrical and electronic equipment (WEEE), as well as batteries, accumulators and battery packs involve a great number of economic agents. These include manufacturers, importers and distributors of equipment and batteries, extended producer responsibility systems (such as Ecoasimelec, Ecofimática, Ecolum and Ecopilas, belonging to Recyclia), local public entities, treatment and recycling plants, other operators in the value chain and the general public, without whose collaboration and commitment waste is not separated for collection and recycling.

▸ The amount of electrical and electronic equipment sold has steadily increased in recent years. In 2019 some 734 million pieces of equipment were sold in Spain, equivalent to more than 900 kilotonnes, according to data from the Spanish Ministry of Industry, Trade and Tourism. This is a 25% year-on-year increase in terms of tonnes. Approximately 182 kilotonnes or 600 million batteries, accumulators and battery packs entered the Spanish market in 2019.

▸ The WEEE recycling rate in Spain has been increasing and since 2017 has been above the European Union average, according to data from Eurostat. In general, there has been little change in the amount of waste batteries, accumulators and battery packs collected in recent years, although some categories, such as portable lithium batteries are expected to rise significantly in the future. Practically all used batteries, accumulators and battery packs that are collected are sent to be recycled.

▸ The activity of the main entities managing and handling the recycling of electrical and electronic waste, as well as that of those managing and recycling batteries, accumulators and battery packs, generated a direct gross value added (GVA) of over 350 million euros in Spain. This figure is equivalent to 5.9% of the GVA of the whole of the waste collection, handling and disposal sector. This activity also provides employment with 5,900 green jobs (full time positions), or as a percentage, 5.6% of employment in the waste collection, handling and disposal sector. Recycling WEEE and batteries contributes over 150 million euros to the Spanish treasury.

▸ If in addition to the direct impact of the WEEE and battery recycling industry, indirect impacts (associated with supplies from other sectors) and induced impacts (linked to spending the income - salaries and business profits - generated by the other two impacts on the economy) are also taken into consideration, total

GVA exceeds 955 million euros. For every euro of final demand in the WEEE and battery recycling sector, the economy generates 2.2 euros of direct and indirect added value. In turn, the total contribution to employment entails the generation and maintenance of more than 16,500 full-time positions.

Various materials obtained from recycling WEEE and batteries (secondary raw materials) can be re-introduced into production processes, for the manufacturing of new products and applications, promoting the sustainability of production (and consumption) models and thus contributing to the principles of the Circular Economy and Sustainable Development Goals (SDG 12 concerns responsible production and consumption). Secondary raw materials are also those which add value to recycling and endorse the importance of properly managing waste. From an environmental perspective, they reduce pollution and use natural resources in a more sustainable way, avoiding the overexploitation of virgin raw materials. From an economic perspective, they stop the loss of valuable resources and materials, as well as seek sustainability in supplies, especially in essential raw materials that are not primarily found in Spain or Europe.

▸ The European Commission's new Circular Economy Action Plan includes important measures for the recycling industry value chain, such as promoting the re-use of secondary raw materials and strengthening their markets. Similarly, the 'Circular Spain 2030' strategy seeks to increase recycling, whilst applying the principle of waste hierarchy. It should be said that Spain has been an EU pioneer in setting specific objectives for reusing waste electrical and electronic equipment.

▸ WEEE is the fastest growing type of waste worldwide (WEF, 2019), while at the same time contains various scarce materials of high value (precious metals, critical raw materials and others). The recovery and recycling of these materials, known as urban mining, offers a range of benefits, from obtaining certain scarce metals, to reducing the environmental impact. Within this context, boosting the existing capacity for recycling certain items with great potential, together with developing secondary markets of raw materials and leveraging the applied research and innovation will lead to greater resilience of the Spanish economy.

▸ However, trends in e-mobility and energy storage systems forecast higher demand for lithium-ion batteries, whose potential growth could exceed 30% a year in the next ten years (European Commission, 2020). The energy transition that must be undertaken in the EU and Spain (European Green Deal and 2021-2030 Integrated National Energy and Climate Plan), also involves developing energy storage technology such as batteries (for both mobility and stationary storage). These contain lithium, cobalt and other critical raw materials subject to increasing demand. According to European Commission forecasts, with the momentum

from electrical vehicles and energy storage systems, demand for lithium could be eighteen times greater in 2030. Cobalt could be five times greater.

▸ The European Commission is adapting the regulatory framework for batteries, to increase the efficiency of their recycling and promote the recovery of materials from them. The future Spanish Energy Storage Strategy is also contemplating the priority use of secondary raw materials and the development of business models that would allow for battery waste to be better exploited (currently elements like lithium (Li-ion) and cadmium are recycled elsewhere).

▸ Under this framework, the strategy entails boosting the battery recycling industry (implementing economic recycling systems that are environmentally sustainable), as well as preparing for electric propulsion vehicle batteries to be re-used and given a second stationary use. Directing research and innovation efforts into battery sustainability is also important.

In short, the WEEE and battery recycling industry raises various challenges and opportunities, with significant economic, social and environmental impacts. The actions proposed for capitalizing on the opportunities and tackling the challenges include the following initiatives:

- Strengthening of inter-territorial co-ordination and information systems.
- Strategic visioning and planning within the industrial policy, for upgrading the production model.
- Driving forward green employment.
- Fostering R&D&i to improve competitiveness in the recycling industry.
- Improving certain waste collection mechanisms.
- Developing secondary raw material markets in Spain.
- Co-operating for progress to be made in ecodesign.
- Supporting activities with strong potential linked to future mobility.
- Expanding activities related to preparation for re-use.
- Carrying out regular WEEE and battery recycling awareness campaigns.

Introduction

The generation of flows of waste electrical and electronic equipment (WEEE) and batteries (including accumulators and battery packs) are highly dynamic, not least because the former are the fastest-growing type of solid waste in the world. It is therefore necessary to handle this waste in the most appropriate way, as well as encourage sustainable production and consumption.

This report on trends in the WEEE and battery recycling industry in Spain is the result of a pioneering initiative to broaden the knowledge and increase the value of an activity that is key in tackling many of the challenges faced by the Spanish economy, some of which have been aggravated by the impact of the COVID-19 pandemic. As such, economic recovery efforts have to allow the recycling industry to showcase their ability to contribute to achieving the Sustainable Development Goals and progressing with the Circular Economy, generating green employment, promoting innovation and increasing industrial competitiveness, with a long-term view.

The first section of the report details the value chain, both of WEEE and batteries, in order to identify the breadth of activities and agents involved in the collection and handling processes of this waste in Spain. Following on from this, the main indicators of WEEE and battery generation are analysed, based on the amounts introduced onto the electrical and electronic equipment markets, as well as that of batteries and battery packs, to gauge the activity of the recycling industry and any recent changes.

The third section includes a quantitative estimate of its economic importance, in terms of gross value added (GVA) and employment, and the contribution that recycling WEEE and batteries makes to the Spanish treasury. This estimate also allows the economic weight of the biggest sector of 'collection, handling and disposal of waste; and value recovery' to be approximated.

The last section, prior to drawing any conclusions, highlights the contribution of the WEEE and battery recycling industry to sustainability and the modernisation of the Spanish economy. This contribution involves recovering and handling materials, such as secondary raw materials, for their re-use in value chains, directly applying the principles of circularity. A series of opportunities are also identified to start initiatives that not only increase the competitiveness of the recycling industry, but also facilitate the shift towards a more circular and resilient economy. These initiatives involve the agents of the industry's value chain, as well as the government and all of society.

The value chain of the WEEE and battery recycling sector

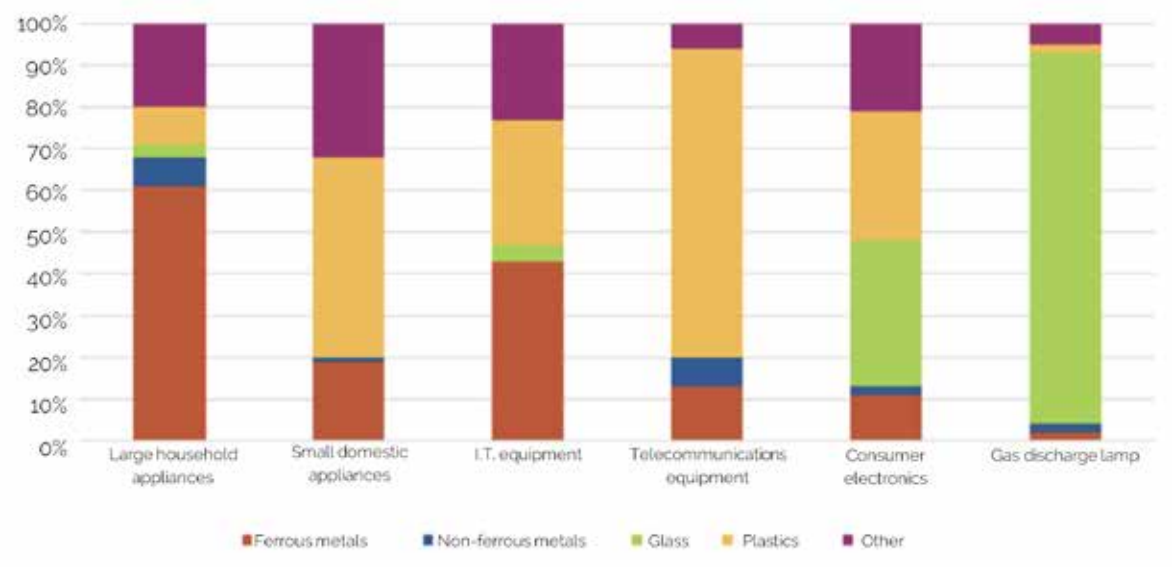
The economic agents involved in managing waste electrical and electronic equipment include manufacturers and importers of an extensive variety of products (from heat exchange equipment, to photovoltaic panels, monitors and displays,

or I.T. and telecommunication equipment, among others[1]), different types of operators in charge of collecting this waste, and the various managers involved in storage and handling.

It must be remembered that electrical and electronic equipment (EEE)[2] contains a great diversity of different kinds of components: from metallic and plastic pieces, to cathode ray tubes, batteries, battery packs, liquid crystal displays, cables, electrical and electronic items (including motors), a variety of fluids, and even printing cartridges with microchips, among many other items (see Appendix I - Electrical and electronic equipment categories).

1 In the context of new electrical and electronic equipment and devices being regularly launched onto the market, this list of products is becoming increasingly longer.
2 EEE refers to "electrical and electronic equipment or EEE means equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in Annex IA and designed for use with a voltage rating not exceeding 1 000 volts for alternating current and 1 500 volts for direct current", in accordance with EU Directive 2012/19 of the European Parliament and of the Council, of 4 July 2012, on waste electrical and electronic equipment (WEEE).

Graph 1 - Examples of electrical and electronic equipment and their composition



Source: Afi, Ministry for the Ecological Transition and the Demographic Challenge

In general, the materials used are metals, both ferrous and non-ferrous (including precious metals), as well as polymers, glass and others (wood, card, etc.), arranged in various ways depending on the equipment. However, the EEE also contain some hazardous elements (mercury, cadmium, phosphorus, lead, arsenic, hazardous oils, and gases such as chlorofluorocarbons, hydrochlorofluorocarbons and hydrofluorocarbons (present in cooling circuits and insulating foams of certain equipment)[3] that can pose environmental and/or health risks. These hazardous components are removed during the decontamination process.

Given the wide diversity of elements present in EEE, it is particularly important for WEEE to be collected separately for the aforementioned hazardous substances to be properly handled, as well as for scarcer materials with higher extraction costs to be harvested, providing the WEEE with greater value.

The value chain of WEEE and battery recycling

Subsequent to electrical and electronic equipment being sold, any used equipment that cannot be re-used as second-hand equipment enters into the WEEE management circuit. Producers of this equipment (see Appendix II - Profile of

3The use of some of these substances is restricted in WEEE (i.e. mercury, lead, cadmium and others), according to Royal Decree 219/2013, of 22 March, on restrictions of use of certain hazardous substances in electrical and electronic equipment.

electrical and electronic equipment producers), in virtue of the 'extended producer responsibility' established in the regulatory framework, are responsible for accepting and managing the waste (both physically and financially), which they can do through independent or collective systems.

In turn, waste management entails various activities and the involvement of different agents, including the general public, whose actions are key to the successful collection of this kind of waste. In this way, education and raising awareness of the importance of collecting and recycling WEEE are essential, as well as the use of bins and modes of disposing of used equipment, so that the subsequent stages can be properly carried out. These generally amount to separate collections of WEEE, possible preparation for re-use, classification and specific handling of this waste. Also worth noting is the above-mentioned figure of the extended producer responsibility systems (independent or collective), in charge of organising and co-ordinating the different agents, to oversee the collection and recycling of the WEEE in the various stages of the process.

▸Separate collection of WEEE for depositing and storing[5]. The following agents are involved in this stage, allowing for effective separate collections and traceability of the WEEE collected:

•Local Entities: must have separate collection systems for the domestic WEEE of users / households (at no cost), as well have the capacity to collect domestic WEEE from small distributors. To do so, they can opt for: (i) a storage facility room or recycling points (permanent or mobile), or other temporary storage centres; (ii) door-to-door collection; (iii) another collection system in line with local by-laws; or (iv) the establishment of agreements with authorised collection facilities or with social economy entities.

•Distributors and establishments selling EEE (including e-commerce distributors), who are obliged to collect used EEE when they hand over an item of new equipment.

•Authorised managers (private companies that collect WEEE, thus offering a comprehensive waste service).

•EEE producers / manufacturers through their collection networks operated by independent or collective extended producer responsibility systems.

4 Difference between domestic WEEE and professional WEEE. The former comes from households or commercial, industrial, or institutional sources or other types which due to their nature and amount, are similar to those which come from households. The latter is professional WEEE.

▸Classification Subsequent to collection and pre-selection, the WEEE is classified for handling, unless the item of equipment can be recovered, in which case it would be taken to a preparation centre to be re-used. Distributors, authorised managers and producer collection networks are mainly those who send the WEEE collected to these centres to be classified as reusable.

▸Specific handling of WEEE[5] in facilities suitable for the extraction of components and elements from the equipment, as well as the specific handling required, in accordance with established technical procedures[6]. The handling will divide up the waste into fractions for recycling, energy recovery and disposal (which must be minimal). The fractions obtained from the recycling processes are generally re-used in manufacturing new products, contributing to the principles of the Circular Economy.

5 Appendix XIII of RD 110/2015 on RAEE, establishes the 'Requirements for specific WEEE handling'.
6 Spain has 60 specific WEEE handling plants able to manage more than one category of these products, according to data from the General Sub-directorate of Waste, Ministry for the Ecological Transition and the Demographic Challenge (MITECO).

Figure 1 - WEEE generation and management circuit

Source: Afi, Ministry for the Ecological Transition and the Demographic Challenge, CEN-CENELEC, Recyciia

The companies dedicated to recycling WEEE may specialise in this type of waste or handle diverse multi-waste.

To perform these activities, WEEE and its fractions need to be transported between the various facilities in the described circuit by authorised transporters[7].

7 Note that such authorisation is not required in the case of logistic operators linked to Distribution.

It is also worth highlighting that activities for repairing and re-using EEE are likely be increasingly important for the economy[8]. Producers in Spain already have targets for 'preparation for re-use'. In addition, EU Directive 2012/19 of the European Parliament and of the Council, of 4 July 2012, on waste electrical and electronic equipment[9], advocates the prevention of generating WEEE and promoting the preparation for re-use of the equipment, starting with a design that is manufactured to facilitate repair, upgrades, re-use, disassembly and recycling. The ultimate goal is to minimise the disposal of WEEE, as well as recover valuable secondary raw materials contained within this waste.

The entire WEEE recycling process corresponds with the inverse supply chain or logistics concept[10]. In other words, a piece of equipment thrown away by its owner as waste has to be collected and subject to progressive disassembly in order to make use of the various components and materials, for it to re-enter a productive process. It is these materials (secondary raw materials) that add value to the process. As such, waste tracking is fundamental, both from an environmental perspective to reduce contamination, and an economic perspective, to avoid the loss of valuable materials and resources.

In the case of batteries and battery packs, the process is similar, with different collections for portable used batteries/battery packs and automotive batteries (see Appendix III - Type of batteries).

Used batteries can be deposited by consumers in bins provided for this type of waste (batteries will generally be collected within the circuit of professional services, technical services, repair workshops or similar).

After being collected from the bins, the batteries are transported to interim stores, for their subsequent transport to classification and/or recycling plants. Here, they will be disassembled and handled (crushed/distilled) to obtain the metals that can be used in new production processes. As such, the materials obtained from recycling batteries can be used to produce new batteries and battery packs, helping to achieve a circular economy.

8 The potential generation of employment associated with the preparation for re-use of WEEE is now estimated to stand at 4,700 direct jobs in the Project Biodiversity - Employ Green programme 2007-2013.
9 Included in Spanish law by Royal Decree 110/2015, of 20 February, on waste electrical and electronic equipment (which also contains new measures introduced by Law 22/2011, of 28 July, on waste and contaminated land).
10A New Circular Vision for Electronics Time for a Global Reboot. World Economic Forum. (2019)

Table 1 - Materials obtained from handling and recycling batteries and battery packs

Type of battery / battery pack	Materials arising from the recycling
Standard batteries	Graphite and manganese dioxide; metal base Hg, Cu, Ni, Zn and Cd; zinc sulphate solution; manganese salts.
Button cells*	Metal caps and mercury
IT equipment batteries, smartphones, tablets, laptops, etc.	Cobalt, nickel, copper, iron, aluminium, cadmium, titanium, lithium and others.
Vehicle start-up batteries	Lead (can be used to produce new batteries)

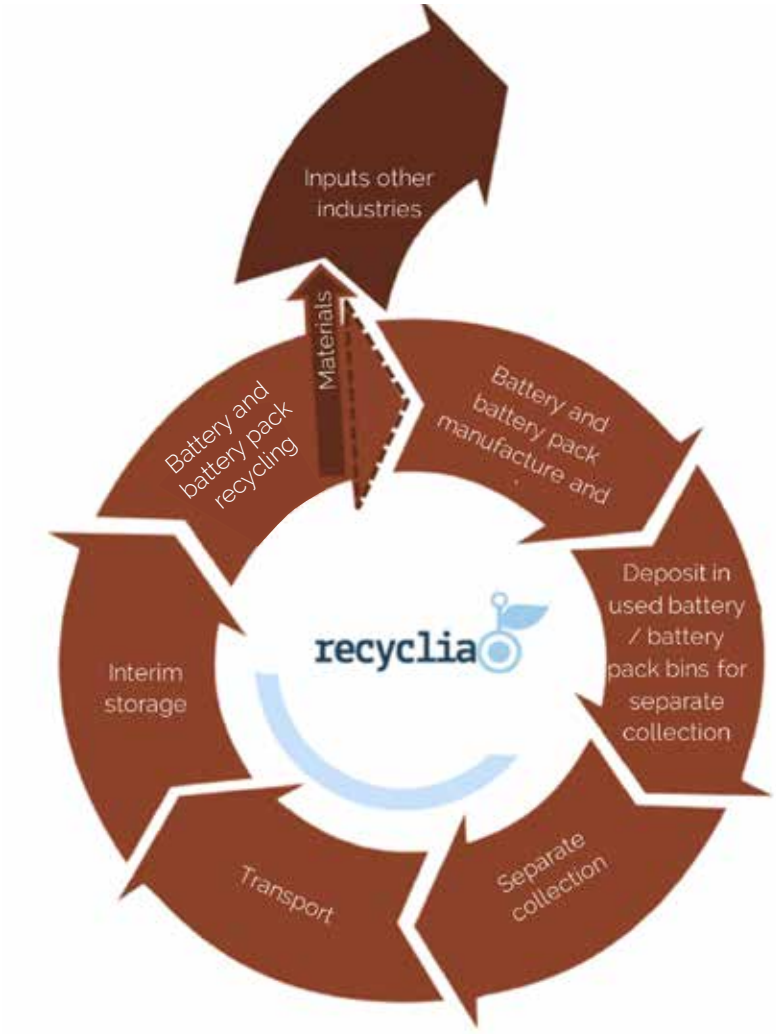
(*) Note that in mercury button cells this component will be recovered, although increasingly less so, given mercury is no longer included in new batteries. Primary lithium button cells are more common instead.

Source: Afi, Ministry for the Ecological Transition and the Demographic Challenge

All producers have to take responsibility for the collection and management of the amounts and types of used batteries, accumulators and battery packs they have brought out onto the market, for sale to end users in Spain, taking into consideration the sales channels (direct, electronic, by mail or via vending machines). In doing so they may opt for one or some of the following (according to article 5.2 of RD 710/2015):

- Configuration of an independent extended producer responsibility system (belonging to the producer).
- Participation in a collective extended producer responsibility system.
- Establishment of a deposit, refund and return system, as either an independent or collective system of extended responsibility.
- Economic contribution to public management systems in place.

Figure 2 - Battery and battery pack generation and management circuit



Source: Afi, Ecopilas

Key figures in the WEEE and battery recycling in Spain

The amount of electrical and electronic equipment brought out onto the market by the 3,171 producers operating in Spain has been growing steadily in recent years, according to data from the Integral Industrial Register for EEE (IIR-EEE) kept by the Spanish Ministry of Industry, Trade and Tourism. The majority of these producers are established in Spain (91.7% of the total) and have opted for the collective system of extended producer responsibility (CSEPR) to manage WEEE (96.6%).

In 2019 some 734 million items of electrical and electronic equipment were placed on the market, of which more than half (54%) were small appliances, and another 26% were small I.T. and telecommunications equipment. Nevertheless, the annual amounts introduced onto the market of lamps and large equipment are also significant, as in both cases they exceed 50 million units (see Table 2 for the complete breakdown).

Table 2 - Units of EEE placed on the market in Spain, 2019

	Category	Total (Mill. units)	Domestic (Mill. units)	Professional (Mill. units)
1	Heat exchanging devices	5.01	4.55	0.46
2	Monitors, screens and equipment with displays	10.16	9.61	0.55
3	Lamps	68.78	68.78	0.00
4	Large equipment	54.40	20.03	34.37
5	Small equipment	398.49	259.65	138.84
6	Small IT and telecommunications equipment	193.22	193.22	0.00
7	Large photovoltaic panels	3.97	0.00	3.97
	Total EEE	734.03	555.84	178.19

Source: Afi; Spanish Ministry of Industry, Trade and Tourism (IIR-EEE).

Although the weight differs substantially between the various EEE, given that for example, the weight of a washing machine would be the equivalent of more than 350 mobile telephones, last year more than 900 kilotonnes (kt) of total EEE were introduced onto the market (see Table 3 for breakdown by category). It gives a picture of the significant annual volumes of equipment that will have to be managed in the future once it has reached the end of its useful life (which will also vary depending on the EEE category).

Table 3 -Tonnes of EEE placed onto the market in Spain, 2019 (kilotonnes)

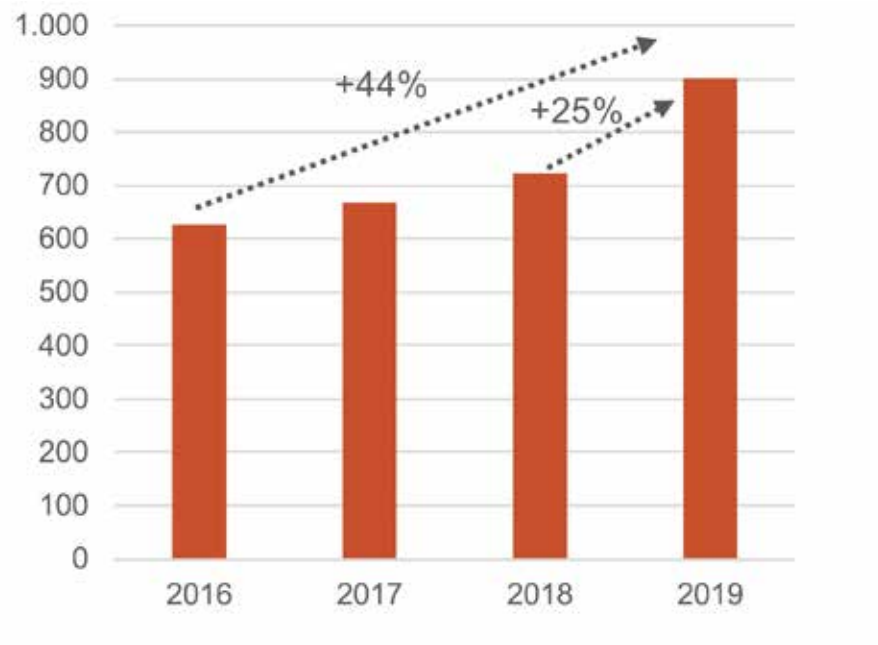
	Category	Total (Kt)	Domestic (Kt)	Professional (Kt)
1	Heat exchanging devices	198.16	169.10	29.06
2	Monitors, screens and equipment with displays	47.92	44.08	3.84
3	Lamps	5.50	5.50	0.00
4	Large equipment	400.29	301.46	98.83
5	Small equipment	136.19	111.35	24.84
6	Small IT and telecommunications equipment	27.35	27.35	0.00
7	Large photovoltaic panels	86.18	0.00	86.18
	Total EEE	901.59	658.84	242.75

Source: Afi; Spanish Ministry of Industry, Trade and Tourism (IIR-EEE).

The tonnes of EEE placed on the Spanish market have seen a year-on-year increase of 25% in 2019, and an increase of 44% compared to 2016. This trend reflects, on the supply-side, the launch of new devices and equipment and with it, the increased range of items that comprise EEE. It also reflects though, the changes in the demand for electrical and electronic equipment as part of growing digitalisation, changes in lifestyle habits and consumption patterns. For example, in 2019 around 81% of Spanish households had one computer, with this figure having increased 3.8 percentage points compared to 2016, according to the Spanish National Institute of Statistics[11]. The general trend also shows that electronic products and components also form part of furniture, vehicles, buildings and other infrastructures[12]. Nevertheless, future technological developments and models of sustainable production and consumption will determine the amount of EEE placed on the market.

11 On the other hand, technological progress has also allowed a device, such as a smartphone, to replace others: a music player, camera, digital watch and GPS, among others.
12 Parajuly, K. et al. (2019). "Future e-waste scenarios". StEP Initiative, UNU ViE-SCYCLE y UNEP IETC.

Graph 2 - Evolution of kt of EEE placed on the market in Spain, 2016 - 2019



NB: in 2018 the lists of equipment registered in the EEE records were extended. The end of the transitional arrangement of the scope of application of RD 110/2015 occurred on 15 August 2018, and therefore, only new EEE declared in the fourth quarter of that year are included.

Source: Afi; Ministry for the Ecological Transition and the Demographic Challenge; Spanish Ministry of Industry, Trade and Tourism.

From the amounts of EEE placed on the market, and taking as a reference the weight of the equipment introduced onto the market in the previous three-year period, the Ministry for the Ecological Transition and the Demographic Challenge set a minimum target[13] of separate waste collection for this equipment (WEEE) of 430.6 kt for 2019, equivalent to 9.22 kg per inhabitant. This target is established in a proportion of 85% for domestic WEEE (366.6 kt) and 15% for professional WEEE (64 kt). In 2020, the target for collection is higher, reaching 489.4 kt.

This all reflects a growing activity for the whole of the WEEE recycling industry, faced with meeting the collection and management needs of the waste generated.

13 It is equivalent to 65% of the average of the weight of the EEE placed on the market in 2016 – 2018.

The latest data available on the collection and management of WEEE, including its handling, recovery and recycling, relates to 2018, when the minimum collection target was 347.8 kt. This target was 92% achieved, according to data published by Eurostat on tonnes of WEEE collected in 2018. In the same year approximately 276.5 kt were recycled, or 16% more than the previous year

Table 4 - WEEE collection and management in Spain, 2017 and 2018

WEEE	2017		2018	
	Tonnes	Kg per capita	Tonnes	Kg per capita
EEE placed on market	667.367	14.32	722.636	15.44
WEEE collected	287.210	6.16	320.622	6.85
Domestic	262.463	5.63	279.100	5.96
Other sources	24.746	0.53	41.522	0.89
WEEE handled	280.338	6.02	326.250	6.97
WEEE recovered	253.277	5.44	299.596	6.4
WEEE recycled	238.680	5.12	276.496	5.91

Source: Afi; Eurostat.

Looking at categories of WEEE between 2017 and 2018, the increase in the recycled amount of vending machines (+137%), photovoltaic panels (+135%) and electrical and electronic tools (+87%) is notable.

Table 5 - Amount of WEEE recycled in Spain, 2017 - 2018*

WEEE recycled	2017 (t)	2018 (t)	2018/17 (% var.)
Large equipment	150,498	178,385	19%
Small equipment	22,210	21,831	-2%
IT and telecoms equipment	21,430	30,849	44%
Consumer electronic equipment and photovoltaic panels	29,644	28,447	-4%
Consumer electronic equipment	29,542	28,207	-5%
Photovoltaic panels	102	240	135%
Lighting equipment	4,602	5,066	10%
Electrical or electronic tools	1,263	2,357	87%
Toys, leisure and sports equipment	3,104	1,917	-38%
Health products	1,016	1,144	13%
Surveillance and control instruments	805	837	4%
Vending machines	1,575	3,733	137%

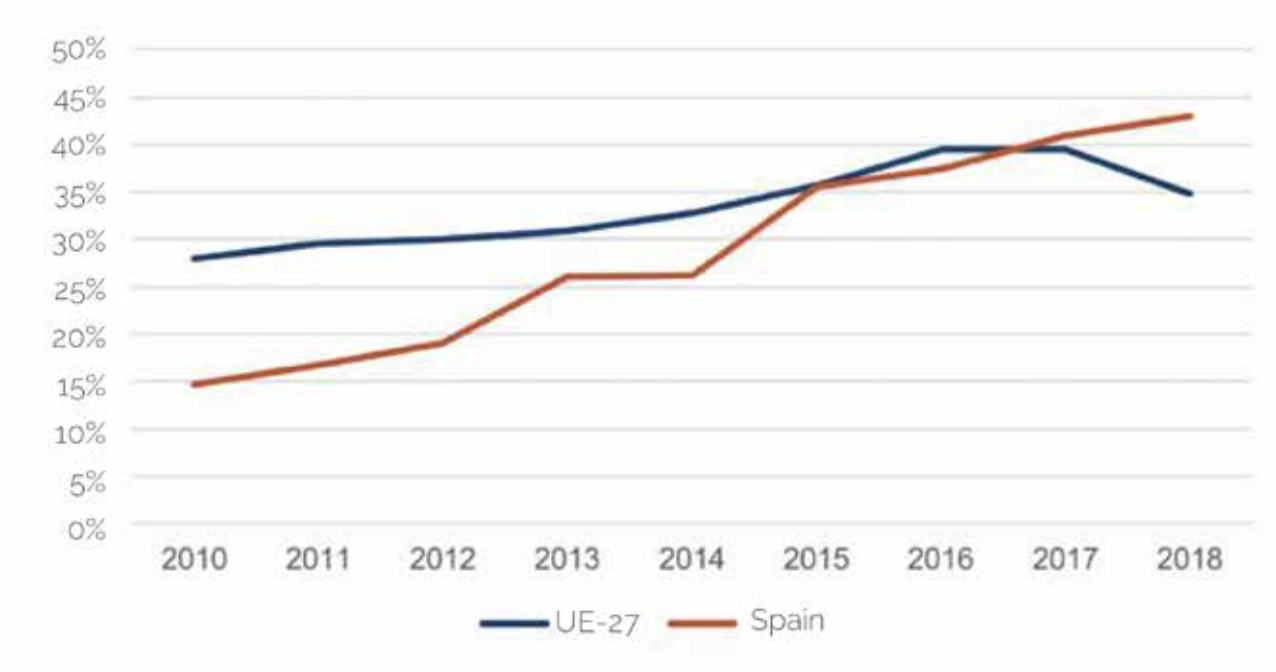
(*) According to WEEE classification into 10 categories, valid until 2018.

Source: Afi; Eurostat.

The WEEE recycling rate in Spain has been increasing in recent years and since 2017 has been above the European Union average, according to data from Eurostat[14]. As such, in 2018 (last available year), this rate rose by 43%, reaching 8.2 percentage points above the EU 27.

14 The WEEE recycling rate (%) is calculated from multiplying the collection rate by the recycling and re-use rate, determined in the WEEE EU Directive 2012/19. The collection rate (%) is equivalent to the volume (kg) of WEEE collected in the year in question, divided by the average amount (kg) of EEE sold in the previous three-year period. The recycling and re-use rate (%) is the result of dividing the weight (kg) of WEEE entering the recycling and preparation for re-use facilities by the weight (kg) of the WEEE obtained from the separate collection (according to the WEEE Directive), taking into account that the WEEE collected is sent to handling and recycling plants.

Graph 3 - Changes in the WEEE recycling rate in Spain and in the EU, 2010 - 2018



NB: EU-27 data, estimated by Eurostat.

Source: Afi; Eurostat.

With regards batteries, accumulators and battery packs, there are 1,467 producers and the amount placed on the Spanish market exceeded 182 kt in 2019, equivalent to some 600 million items, according to data from the Integral Industrial Register of Batteries and Accumulators (IIR-B&A), kept by the Spanish Ministry of Industry, Trade and Tourism. Just as with the EEE, the majority of producers are based in Spain (91%), and also largely use a collective system of extended producer responsibility (although to a lesser extent than for the EEE).

In the segment of batteries and portable accumulators, 583 million units more were placed on the market in 2019, equivalent to 13,599 tonnes. The category that is largest is that of standard batteries, which represent around 69% of the total, both in terms of units, with over 402 million, and in weight, exceeding 9,350 tonnes (see Table 6).

Table 6 - Batteries and portable accumulators placed on the market in Spain, 2019

Category	Amount (Mill. units)	Weight (t) j
Button cells.	117.32	204.26
Standard batteries.	402.57	9,350.14
Portable Accumulators	63.61	4,044.45
Total batteries and portable accumulators	583.50	13,598.85

Source: Afi; Spanish Ministry of Industry, Trade and Tourism (IIR-B&A).

Source: Afi; Spanish Ministry of Industry, Trade and Tourism (IIR-B&A).

In turn, 7.46 million batteries, accumulators and vehicle batteries were placed on the market last year, equivalent to some 127,416 tonnes.

Table 7 - Batteries, accumulators and automotive batteries placed on the market in Spain, 2019

Category	Amount (Mill. units)	Weight (t)
Batteries, accumulators and industrial batteries with cadmium	0.33	694.68
Batteries, accumulators and industrial batteries with lead	2.54	31,716.17
Batteries, accumulators and industrial batteries without cadmium or lead.	2.71	9,794.71
Total batteries, accumulators and industrial batteries	5.58	42,205.56

Source: Afi; Spanish Ministry of Industry, Trade and Tourism (IIR-B&A).

The segment of batteries, accumulators and industrial batteries reported 5.58 million units placed on the market in 2019, equivalent to almost 42,206 tonnes (see Table 8). Both those containing lead, and those that do not contain either lead or cadmium, exceed 2.5 million units placed on the Spanish market for the year in question (45.6% and 48.5% of the total respectively). Nevertheless, in terms of weight, the former (those of lead) correspond to three out of every four tonnes.

Table 8 - Batteries, accumulators and industrial batteries placed on the market in Spain, 2019

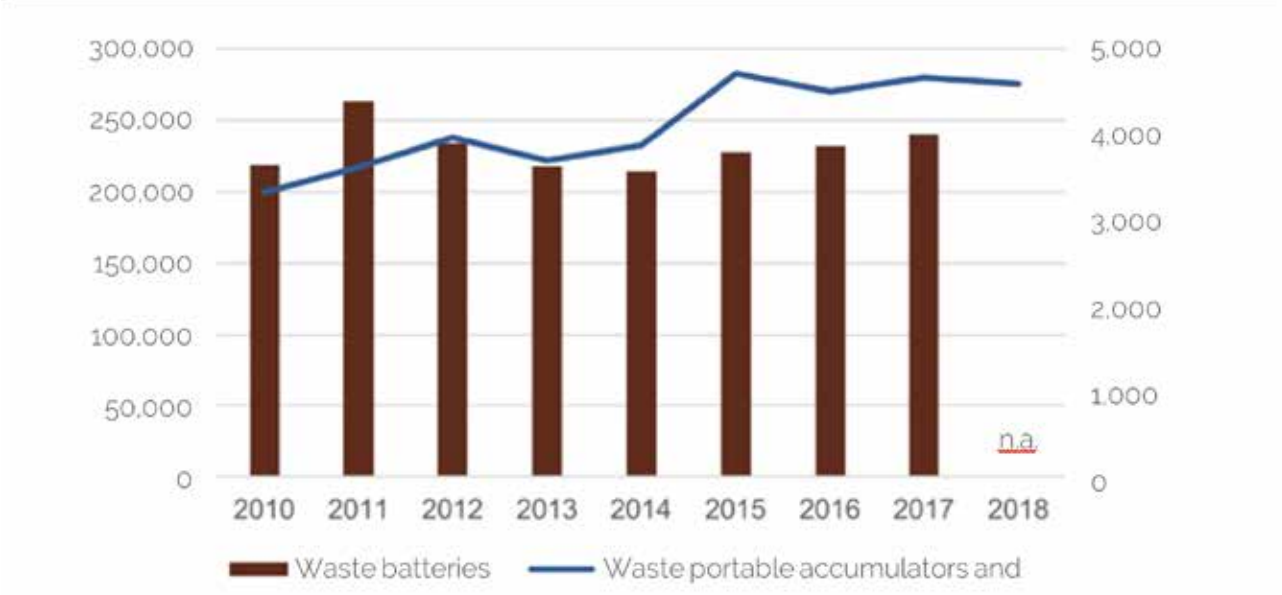
Category	Amount (Mill. units)	Weight (t)
Batteries, accumulators and industrial batteries with cadmium	0.33	694.68
Batteries, accumulators and industrial batteries with lead	2.54	31,716.17
Batteries, accumulators and industrial batteries without cadmium or lead.	2.71	9,794.71
Total batteries, accumulators and industrial batteries	5.58	42,205.56

Source: Afi; Spanish Ministry of Industry, Trade and Tourism (IIR-B&A).

The recent change in batteries and portable accumulators reflects a rise in the tonnes of button cells placed on the market with a year-on-year increase of 3% in 2019, according to data from the Spanish Ministry of Industry, Trade and Tourism, evident in its growing presence in various devices and consumer goods. Within this group, lithium batteries have increased by 2.5% over the last year, exceeding 105 tonnes in 2019. At the same time, the weight of portable accumulators of rechargeable lithium-ion placed on the market in the same year, grew by 7.2% compared to the previous year.

With regards the collection of waste batteries and accumulators, recent years have proven to be much the same. In the case of batteries and portable accumulators, there has been a slight year-on-year drop of 2%, in terms of the tonnes collected in 2018 (latest available).

Graph 4 - Change in tonnes of waste batteries and accumulators collected in Spain, 2010 - 2018



Source: Afi; Eurostat, Spanish National Institute of Statistics,

Currently, waste batteries and accumulators collected are almost entirely sent for recycling, with just one tonne sent to landfill in 2017 (latest data available). With regards the amount of battery waste recycled, it is worth pointing out that 134 kt of lead was recycled in 2018, a similar level to the previous year. In turn, other batteries (not nickel-cadmium batteries) and accumulators, recorded a year-on-year growth close to 41%, reaching 7.8 kt.

Table 9 - Amount of waste batteries recycled in Spain, 2017 - 2018 (tonnes)

Waste batteries	2017	2018
Recycled		
Lead batteries	133,177	134,059
Nickel-Cadmium* batteries	-	-
Other batteries and accumulators	5,579	7,844

(*) Inexistence of facilities in Spain for the handling/recycling of this type of battery, which are collected separately and sent elsewhere for handling/recycling.

Source: Afi; Eurostat.

In the future, it will be interesting to analyse the impact of the growing number of rechargeable lithium batteries and battery packs entering the market and its relative significance within the portable battery section, as well as the generation of waste and collection for recycling said battery packs. It will also be useful to analyse the growth of portable accumulators (which have a longer useful life than standard batteries) and learn more about the behaviour of electric vehicle batteries, within the category of industrial batteries.

Economic weight of the WEEE and battery recycling sector in Spain

The economic importance of waste electrical and electronic equipment recycling activities, as well as batteries, can be measured through their contribution to gross value added (GVA)[15] and employment, as well as to the Spanish public treasury, applying the Input-Output methodology (see Appendix IV - Methodological note on estimating the economic relevance of the WEEE and battery recycling industry).

The main companies specialising in the WEEE and battery recycling process, including separate waste collection, classification and handling, generate direct GVA in Spain of over 350 million euros, equivalent to 5.9% of the GVA of the entire waste collection, handling and disposal sector (CNAE 38).

15 A similar scale to GDP, given that GDP is calculated as the sum of the value added from the production process, and therefore identifies with the sum of the Gross Value Added (GVA) and the indirect taxes on the products minus subsidies.

In terms of employment [16], the companies involved in WEEE and battery handling directly provide full-time work for some 5,900 people in Spain, which represents 5.6% of employment in the waste collection, handling and disposal sector.

The economic contribution of handling electrical and electronic waste and batteries to GVA and employment in the sector is more than ten times greater than its weight in terms of volume (tonnes), which is approximately 0.48% of the total waste managed. This difference can be explained by the greater relative value of the materials present in WEEE and batteries, as well as greater complexity and sophistication of the handling processes of said materials, which positively impacts on its economic contribution (World Economic Forum, 2019).

It can also be observed that the WEEE and battery recycling industry contributes more in terms of GVA than it does in terms of employment, which clearly shows greater relative productivity, in line with the aforementioned complexity of some of the tasks involving the handling of this waste.

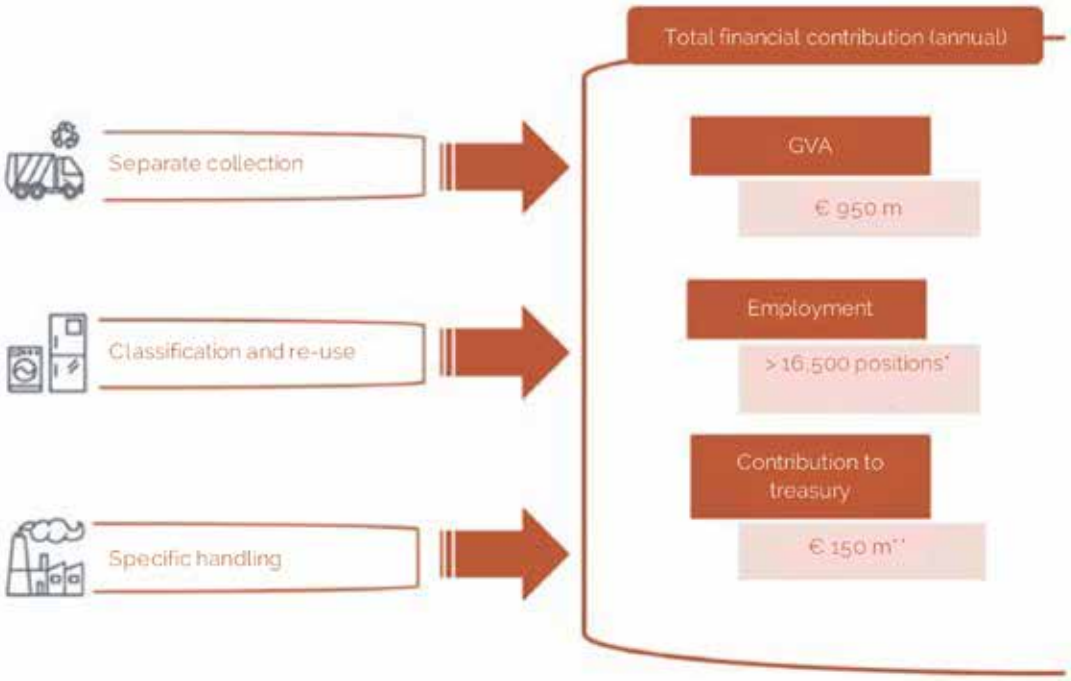
In addition to the direct impact of the WEEE and battery recycling, there is also the contribution arising from the demand of supplies to other sectors (indirect impact), as well as that linked to spending the income (salaries and business profits) generated by the direct and indirect impacts on the whole of the economy (induced impact).

As such, the sum of the direct, indirect and induced impacts linked to WEEE and battery recycling generate a GVA of more than 955 million euros, equivalent to 0.8% of Spain's GDP. It also contributes to the creation and maintenance of 16,500 jobs, which represents 0.09% of the national total.

The economic contribution also extends to income for the public treasury, as tax and social contributions. In effect, each year the WEEE and battery recycling industry directly contributes more than 150 million euros of tax revenue to the State[17].

16 Note that references to employment refer to full-time positions.
17 Revenue arising from indirect and induced impacts is not recognised.

Figure 1 - Total economic contribution of the activity of the main companies specialising in WEEE and battery recycling in Spain

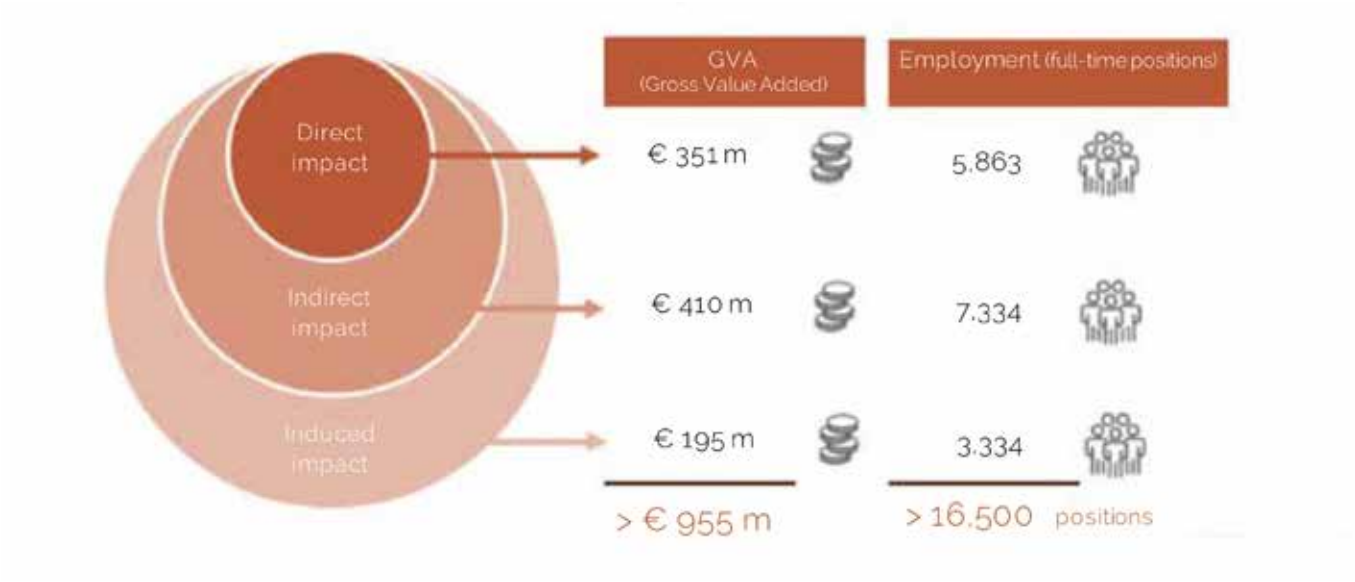


(*) Full-time positions. (**) Contribution derived from the direct impact of WEEE and battery recycling. Includes social contributions.

Sources: Afi, from the Spanish National Institute of Statistics and the Commercial Register. Estimate applying the Input-Output methodology

For every euro of final demand in the WEEE and battery recycling sector, the economy generates 2.2 euros of direct and indirect added value, and 2.7 euros if induced impacts are taken into account. Figure 2 shows the breakdown of the direct, indirect and induced impacts of the recycling industry in terms of GVA and employment.

Figure 2 - Economic weight of the activity of companies specialising in WEEE and battery recycling, depending on type of effect



Sources: Afi, from the Spanish National Institute of Statistics and the Commercial Register. Estimate applying the Input-Output methodology.

The contribution (direct impact) to the public treasury is distributed as follows: 63 million in social contributions to Social Security, 41 million in Value Added Tax (VAT), 39 million in Personal Income Tax, and 9 million in Corporate Tax. In this way, social contributions and VAT are the items with greatest significance, contributing 41.5% and 26.9% of the total, respectively.

Table 1 - Breakdown of the contribution to the public treasury by WEEE and battery recycling

Tax	Revenue (millions of Euros)
Social Contributions.	63
VAT	41
Personal Income Tax	39
Corporate Tax	9
Total	**152**

Sources: Afi, from the Spanish National Institute of Statistics and the Commercial Register.

Contribution to sustainability and modernisation of the Spanish economy

Assessing the value contribution of the recycling activity can be done in various ways: One main way lies in the actual essence of the activity itself, which transforms waste into material or elements so that they can be re-used for their original purpose or in another production process, promoting sustainability in production models and circularity of the waste. This halts the overexploitation of virgin raw materials and promotes a more sustainable use of natural resources, as well as ensures sustainability in the supply processes for economies like Spain (self-sufficiency of raw materials), which do not have vast reserves of raw materials used for manufacturing batteries and electrical and electronic equipment. This is especially relevant in the case of critical and valuable raw materials with supply risks.

The contribution of the recycling sector to sustainability and more specifically, to the Sustainable Development Goals (SDG) approved by the United Nations in 2015 (as part of the 2030 Agenda), is especially relevant to SDG 12, relating to responsible production and consumption[18]. Among the objectives included within this goal are: to considerably reduce the generation of waste through prevention, reduction, recycling and re-use; as well as ensure that people have the information and knowledge for sustainable development (which would be aligned with the awareness actions for recycling WEEE and batteries, promoted by the sector).

On the other hand, the continuing transition towards a Circular Economy[19] is a priority of the European Union's industrial strategy and the European Green Deal, as well as for Spain. The European Commission, after designing a preliminary Circular Economy Action Plan in 2015, defined a new Plan in March 2020 which includes some important measures for the recycling industry value chain, such as promoting the re-use of secondary raw materials and strengthening their markets. With regards re-use, it should be said that Spain has been pioneering within the EU for setting specific objectives for re-use within the WEEE regulatory framework.

The electronics and battery sector is one of those mentioned expressly in this Plan and includes the analysis of the product life-cycle to promote competitiveness, and also is priority for research and innovation (as it can lead to patents relating to waste management). It is no surprise that the circular economy is an area

18 Note that the contribution to sustainability of the WEEE and battery recycling industry includes more Sustainable Development Goals, such as SDG ODS 3, 6, 8, 11 and 14.
19 Emphasis on ecodesign and the evaluation of the life-cycle of products.

earmarked for channelling funds from the Horizon Europe programme for the 2021-2027 period. Similarly, recycling techniques, together with batteries, form part of the intervention areas in climate, energy and mobility (linked to climate change and decarbonisation) in the Spanish Science, Technology and Innovation Strategy 2021-2027.

Spain has also outlined the 'Circular Spain 2030' strategy, which seeks to increase recycling, whilst applying the principle of waste hierarchy. Its lines of action include the generation of products (production) which are easily recyclable at the end of their useful life, as well as the management of waste that allows for high rates of recovery and recycling, as well as the use of secondary raw materials to encourage the sustainability of natural resources and boost responsible consumption. Applied research and innovation must also be considered as the ways to make the use of secondary raw materials more feasible, not only from a technical standpoint, but economically and environmentally as well.

Figure 3 - "Circular Spain 2030" strategy's lines of action

Source: MITECO

Proper implementation of the principles of the circular economy in electronics industry and WEEE is likely to create new jobs in Spain, with the creation of millions of jobs worldwide predicted, including increasingly more qualified employment (WEF, 2019). The recycling and waste management sector is also one with the potential for creating green employment, as recycling rates increase (OECD, 2017).

Harnessing the potential of secondary raw materials Towards greater development of urban mining of WEEE.

WEEE generation is experiencing a high level of growth. Globally, more than 53 million tonnes of WEEE were produced in 2019 (12 million in Europe, which leads WEEE generation per capita, with 16.2 kg/person compared to the 7.3 kg world average) and could reach 75 million tonnes by 2030 (Forti V. et al., 2020). WEEE is already the fastest growing type of waste in the world (WEF, 2019).

This WEEE contains various scarce and valuable materials (precious metals, critical raw materials and others). For example, a tonne of smartphones is estimated to contain a hundred times more gold than a tonne of the mineral gold itself; and the annual value of WEEE[20] would triple the production of silver mines across the world. Recycling many of the components is both a challenge and an opportunity for the development of new business models.

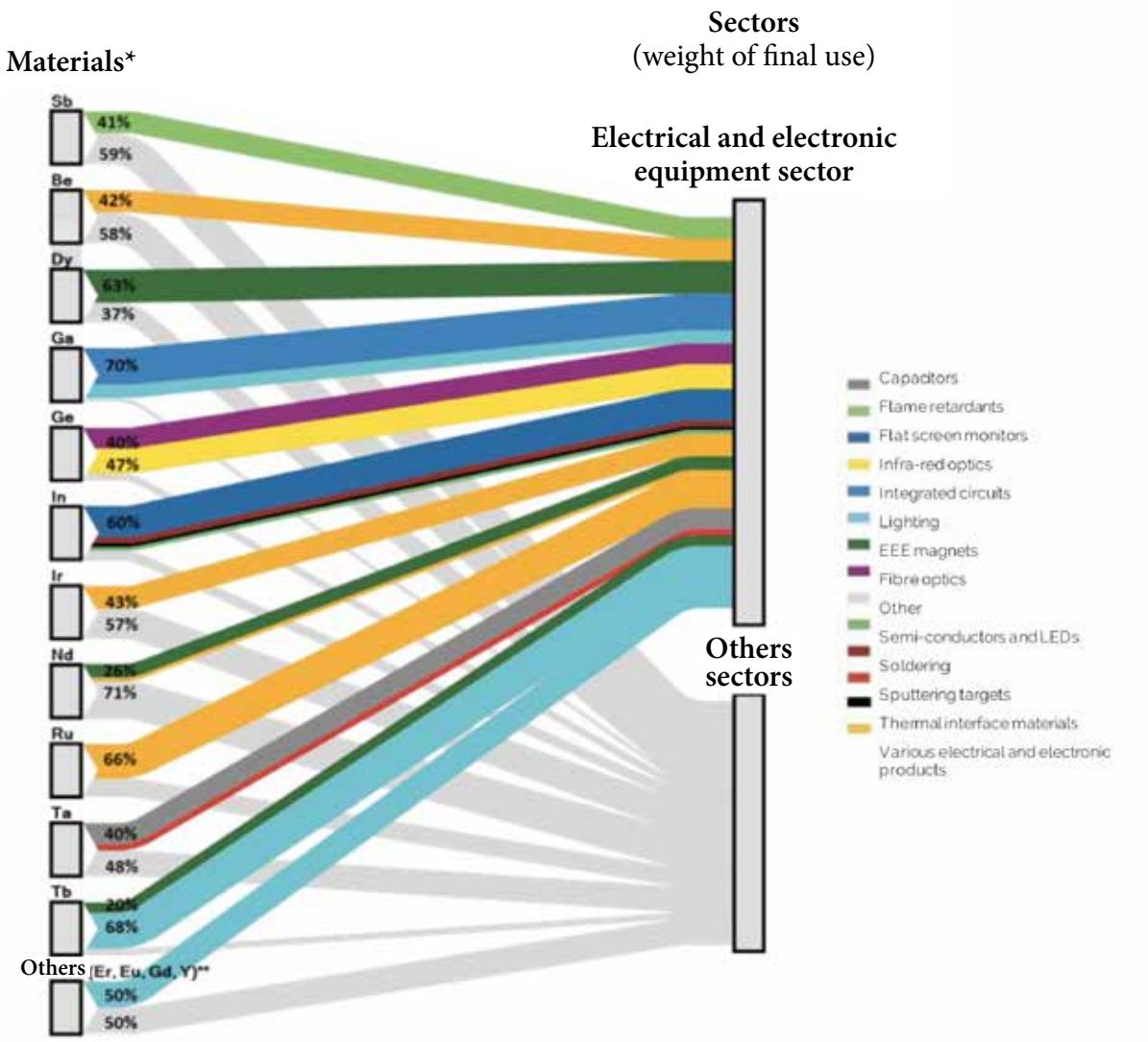
Table 1 - Breakdown of WEEE generated in Spain in 2015

Element	Tonnes	% of total
Iron	397,073	76.7%
Aluminium	45,469	8.8%
Copper	31,084	6.0%
Chromium	15,466	3.0%
Lead	5,820	1.1%
Zinc	3,738	0.7%
Magnesium	2,098	0.4%
Cobalt	54	0.0%
Silver	12	0.0%
Gold	2	0.0%
Other	16,628	3.2%

Source: Afi, from Urban Mine Platform

20 The value of the raw materials extracted from waste generated in 2019 is around 57 billion dollars. (Forti V. et al., 2020).

Figure 4 - Distribution of critical raw materials in EEE



(*) Includes only a subgroup of critical raw materials, used in the electrical and electronic equipment (EEE) sector. Other critical raw materials associated with this sector are: Ce, Co, fluorspar, Hf, He, La, Mn, natural rubber, Pd, Pt, Pr, Rh, Sm, Si, W y V. (**) Average quote for Er, Eu, Gd e Y.

Source: European Commission (CRM assessment, 207).

The recovery and recycling of these materials (urban mining) has numerous benefits: the possibility of extracting certain metals which are scarce in nature; reduction of the environmental impact of traditional mining, thanks to the efficiency of waste separation and handling; availability and accessibility of materials from a geographical perspective (not subject to location and provision of natural deposits).

Although the recycling rates of certain materials such as iron, aluminium and copper are relatively high[21], in the case of precious metals and rare earths, secondary raw materials obtained from recycling only marginally contribute to satisfying demands (less than 1%). This is because usually the primary extraction of these materials is cheaper than their recycling, taking into account that only small amounts of these components are used in the production of electrical and electronic equipment (European Union, 2018). Ecodesign initiatives, together with the trend for increasingly smaller components has reduced the weight and the size of certain items included in electronic and electrical equipment, for example circuit boards, which contain precious metals. However some demand trends, such as the growing diameter of displays, indicate otherwise, generating a greater volume of materials for urban mining. In spite of the miniaturisation process, the recovery of precious metals is expected to increase in coming years, with the recovery of gold present in LCD display circuit boards being crucial (European Commission, 2018).

On the other hand, while the copper content of EEE has gradually reduced as a result of fewer wires and reels for LCD screens, the amount of steel and aluminium, very much present in the new components, has risen.

In spite of the limitations that exist in the near future in terms of the potential of recycling critical raw materials linked to ICT technologies (Marscheider-Weidemann et al, 2016), supporting existing facilities for recycling certain elements with greater potential (in line with the development of secondary raw material markets and leveraging applied research and innovation) will result in greater resilience for the Spanish economy and lesser dependence on the supply of raw materials from third countries.

Battery recycling in light of the challenges of the energy transition and electrical mobility.

21 Recycling iron, aluminium and copper contributed to a net saving of 15 million tonnes of CO2 in 2019, calculated by the difference between the emissions arising from obtaining secondary raw materials and those of extracting virgin raw materials.

In the area of batteries and battery packs, there is a marked trend set off by developments in e-mobility trends (penetration of plug-in hybrid vehicles and electric vehicles) and energy-storage systems. Given the advantages that they offer in terms of power and energy performance compared to lead batteries, lithium-ion batteries are consolidating their presence on the market, featuring in electric vehicles as well as portable electronic devices and in stationary energy-storage systems. The demand for these batteries is expected to grow to annual rates of over 30% in the next decade (European Commission, 2020a).

The energy transition, within the framework of the European Green Deal and the 2021-2030 Integrated National Energy and Climate Plan, is one of the key levers for modernisation and recovery from the battering by the current crisis of the Spanish economy. This transition includes the development of energy storage technologies, such as batteries (mobile and stationary), which need lithium, cobalt, nickel, graphite and other raw materials for their production. The lines of action of the Spanish Energy Storage Strategy[22] do include some measures relating to the circular economy. It foresees the priority use of secondary raw materials and the development of business models that would allow for battery waste to be better exploited in the Spanish market, given that currently some of the elements like lithium (Li-ion) and cadmium are recycled elsewhere and not in Spain.

Table 1 - Raw materials used in lithium-ion batteries

Critical raw materials	Other raw materials	Main global suppliers
Niobium ▲▲▲▲	Manganese ▲	China 32%
Phosphorus▲▲▲▲	Tin ▲	Latin America 21%
Cobalt ▲▲▲	Aluminium ▲	Africa 21%
Natural graphite ▲▲	Nickel ▲	Rest of Asia 11%
Lithium ▲▲	Iron ore ▲	Russia 3%
Fluorspar ▲▲	Copper ▲	Rest of Europe 3%
Titanium ▲▲	Lead ▲	Other 1%
Silicon metal ▲▲		USA 1%
		Japan 1%
		UE-27 1%

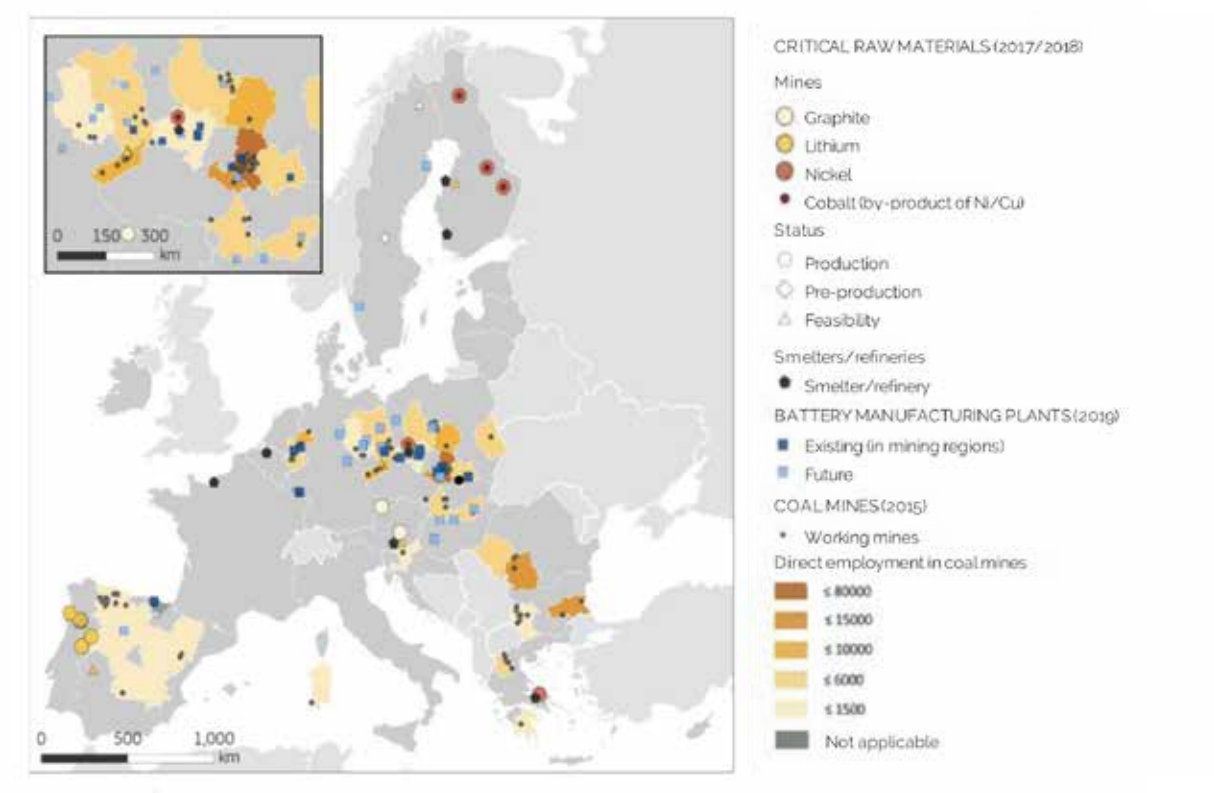
Key: supply risk: high (▲▲▲▲), moderate (▲▲▲), low (▲▲) and very low (▲).

Source: Afi, from the European Commission (2020a).

22 In accordance with the draft of the Spanish Energy Storage Strategy disseminated by MITECO (2020).

It must be remembered that batteries contain various critical raw materials (defined as such due to their economic relevance and supply risk) such as cobalt, graphite, and lithium, which has been recently added (in September 2020) by the European Commission for said category. However, in Europe, only 1% of the raw materials required for manufacturing batteries are produced. In the case of lithium, Chile owns 40% of the global production mines for this mineral and Australia another 29%; meanwhile China has 45% of the lithium ore refineries in the world. Nevertheless, the short- and medium-term forecasts do not foresee incidents in the supply of lithium for producing batteries (European Commission, 2020a). The European Battery Alliance, of which Spain[23] is a member, has channelled public and private investments into guaranteeing an internal supply. Among other developments, these investments allow 80% of the demand of lithium in Europe, for the battery value chain, to be met within the EU by 2025.

Figure 5 - Battery manufacturing plants and mines for extracting raw materials for batteries



Source: European Commission - JRC

23 For example, in 2019, within the Alliance framework, six Spanish companies joined the Important Project of Common European Interest (IPCEI) for applied innovation in batteries, according to the Spanish Ministry of Industry, Trade and Tourism.

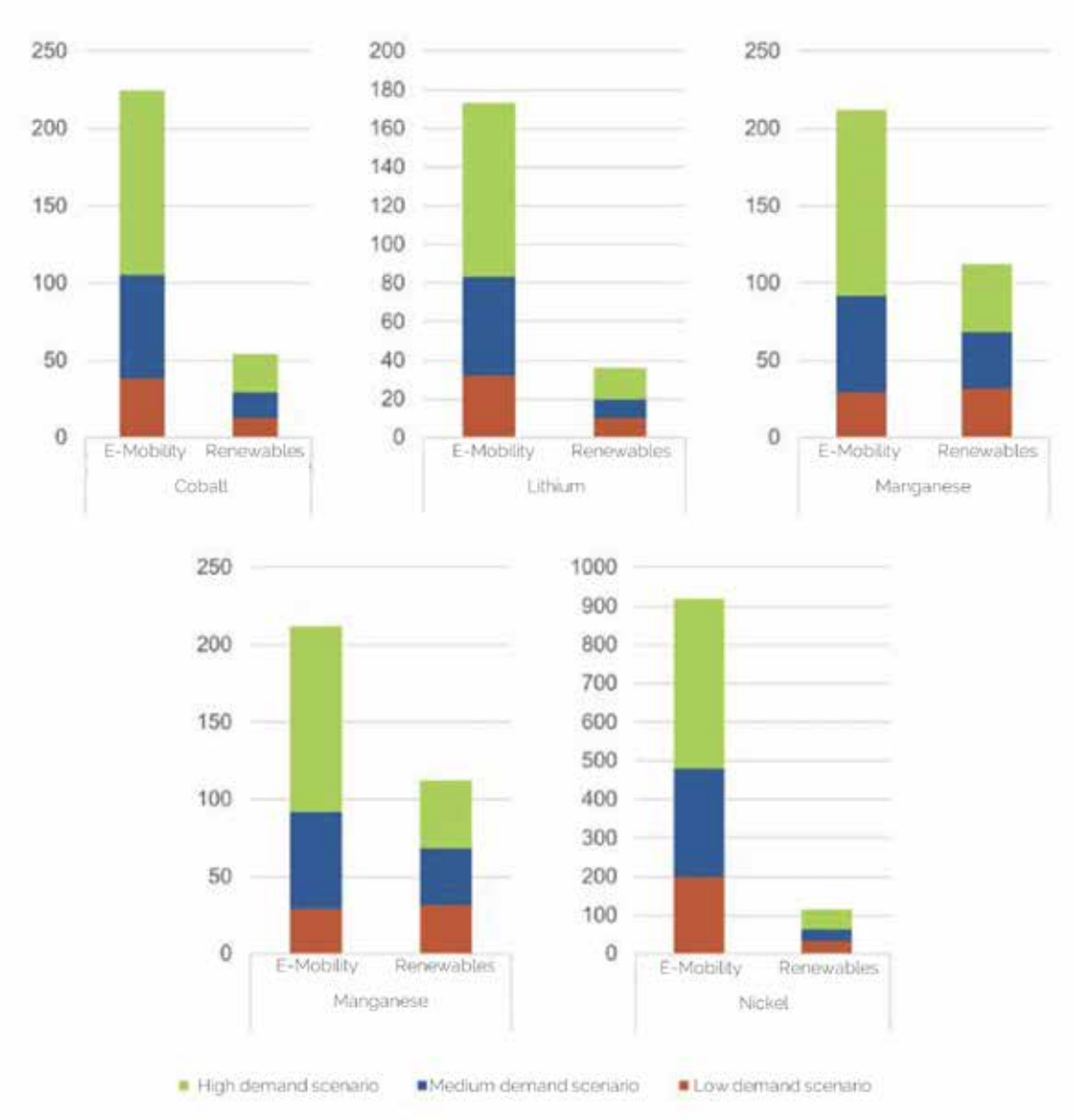
However, in general, the supply risk for raw materials in the battery value chain is high. European Commission forecasts for the demand of materials such as lithium and cobalt, determined by the rise in electrical vehicles (evolution of the fleet of electrical vehicles) and energy storage systems, predict that demand for lithium could multiply by eighteen and cobalt by five, by 2030. Looking a little further ahead, to 2050, the supply needs would rise to sixty and five times the current demand for lithium and cobalt, respectively. These predictions are a call to action, to avoid future supply problems and meet demand.

The demand pressures for manufacturing energy storage batteries are also based on climate change. If global warming reaches 2°C by 2050, it could bring with it a 1000% rise in the raw materials used in batteries (World Bank, 2017).

In this context, the momentum for the battery industry and their recycling is seen as strategic (European Commission, 2020a). The preparation for re-use of electric propulsion vehicle batteries, in order to give them a secondary stationary use in electrical installations of self-consumption, or in smart grids, could be a source of opportunities for the Spanish market. The re-use of batteries does represent an emerging sector, and in 2030 some 2.25 GWh could be obtained from the second use of some 105,000 batteries from electric vehicles that are no longer used (Element Energy, 2019). This re-use would also promote the energy storage and expansion of renewable energies, with fewer relative costs of second-use batteries in energy production, as well as a reduction in carbon emissions.

On the other hand, it is important to promote recycling activities to recover and re-use certain materials for battery manufacturing, such as cobalt, lithium, manganese and nickel, for which the foreseen demand exceeds the availability of these raw materials on the European market. In turn, encouraging recovery and recycling is essential in fostering ecodesign, introducing secondary raw materials /recycled materials in the new product production processes.

Graph 5 - Forecast of raw materials required for batteries, for electrical mobility and renewable energies in 2030 (kilotonnes)



Source: Afi, from the European Commission (2020a).

Research and innovation initiatives are also relevant. Research is currently looking at improving energy density, the safety and durability of lithium-ion batteries, by analysing silicon metal, titanium and niobium, which are some of the other critical raw materials in batteries. Battery sustainability will need to be the direction in which research efforts are made in the future.

Implementing recycling systems that are both economic and environmentally sustainable is required, which take into consideration energy consumption (recycling cost) and environmental value (recovery of raw materials). In this regard, it is worth pointing out that lithium batteries are different from traditional portable batteries in that they require an alternative kind of waste management. For example, electric vehicle batteries, unlike traditional batteries, must be disassembled before the chemical recycling process and therefore the content of valuable marketable materials is reduced (Eurobat, 2019). Lithium is also a hazardous element, which requires special measures for appropriate handling.

The European Commission though, is working on adapting the regulatory framework for batteries, to promote the recovery of materials from all types of batteries. The establishment of collection taxes, degree of recycling efficiency and recovery of materials, as well as the content actually recycled, are some of the aspects that will be covered by this new regulation, which logically will be transposed into national law.

Lastly, it is worth mentioning that the European Union is investing significantly in the battery value chain, in an attempt to increase capacity: from the current 3 GWh to 40 GWh for 2021 - 2023 (European Commission, 2020a)[24].

Opportunities for the WEEE and battery recycling industry's value chain in Spain.

The challenges facing the Spanish economy in the coming years in promoting the green and digital transitions, moving forward with the development of the circular economy and reinforcing the competitive capacity of the Spanish industry, also translates into opportunities for the value chain of the WEEE and battery recycling industry.

There are various lines of action that can be worked on to improve existing capacities and make use of a key industry to tackle the transition towards a more circular and inclusive system. The actions required also need the involvement and commitment of not only WEEE and battery manufacturers, but also public institutions, and the general public as a whole.

24 Nevertheless, it will be Chinese companies, with the right technology, who will increase their production capacity for lithium-ion cells (last component in the value chain). Strong competition is also expected within the chain, for access to critical raw materials.

Below are a series of actions, outlined from the previous analysis, as well as an overview by sector experts. The agents involved are also identified for each line or opportunity. Many initiatives will require public-private involvement for implementation.

Lines of action / Opportunities				
Strengthening of inter-territorial co-ordination and information systems. Centralised and efficient management of waste flow data, particularly in WEEE, less excessive red tape for operators, for proper planning and decision-making. Use of new technologies (AI solutions and others) for loading and monitoring information in the e-platform. Implementation of mechanisms for detection of operators / flows of materials not included in the official circuits / system.	■	■	■	
Strategic visioning and planning within the industrial policy, for upgrading the production model. Identification of industrial lines of development with high potential to cover capacity deficits of facilities for handling / recycling certain waste fractions in light of current / expected demand. Promotion of large-scale projects and business niches with potential for generating the necessary economies of scale. Support of applied innovation. Alignment with other public plans and policies, promoted on an EU-scale and also nationally (including the Circular Spain 2030 and 2021-2030 Integrated National Energy and Climate Plan). Incentives for public-private collaboration, involving technological and research centres, agents involved in fund management to promote innovation, as well as academic experts from disciplines such as mining engineering, among others. Strengthening of support system focused on the specific needs of agents in the WEEE and battery recycling environment.	■	■	■	
Driving forward green employment. Creation of new jobs for developing projects linked to the Circular Economy and the WEEE and battery recycling chain (including ecodesign activities for re-using equipment, designing educational campaigns, handling new recycling equipment, etc.). Development of continuous and specialised training initiatives (active employment policies), which allow for an appropriate response to the industry's human capital demands and technological advances (including new materials and new waste management systems), but that also guarantee adaptation to regulatory changes and compliance with safety when performing waste management and handling activities. Additional systems of incentives for the creation of jobs and training actions.	■	■	■	■

Lines of action / Opportunities				
Fostering R&D&i to improve competitiveness in the industry. Development of new business lines and solutions for handling and recycling materials which improve efficiency and circularity (i.e. in processes for recovering critical raw materials, re-introducing plastic components into the production cycle, or developing new methods for recycling photovoltaic panels for recovering large amounts of materials). Process innovation. Collaboration at the heart of the university system - research centres - companies. Attract and efficiently use European funds (including Horizon Europe 2021-2027) for financing R& D activities and projects applicable to the industry. Inclusion of lines of research and innovation linked to recycling WEEE and batteries within the priorities of the regional strategies for smart specialisation (RIS3).	■	■	■	
Improving certain waste collection mechanisms. Overall concept of recycling point, overseeing proper separation and classification of waste (to facilitate decontamination and handling processes) and management of the entire flow for handling said waste (particularly hazardous waste). Review of the location and operating models of certain recycling points to encourage their inclusion into other social and environment initiatives, in order to enhance their effectiveness. Adoption of good practices and assessment mechanisms.	■	■	■	■
Developing secondary raw material markets in Spain. Identification of obstacles and potential solutions for the development of markets of valuable secondary raw materials (nickel, cobalt, lithium, rare earths, etc.) obtained from WEEE and batteries, which shore up Spain's competitive capacity for stockpiling critical raw materials and helping to promote the Circular Economy, as well as the generation of industrial activity. Industrial policy (strategic vision).	■	■	■	
Co-operating for progress to be made in ecodesign. Driving forward of joint initiatives between EEE manufacturers and recyclers to ensure sufficient and efficient waste handling processes. Configuration of working groups. Identification of new projects which would improve the competitive capacity of the industry, leveraging sustainability. Development of regulations regarding eco-modulation.	■	■	■	

Lines of action / Opportunities	Producers	Recyclers	Government	General public
Developing secondary raw material markets in Spain. Identification of obstacles and potential solutions for the development of markets of valuable secondary raw materials (nickel, cobalt, lithium, rare earths, etc.) obtained from WEEE and batteries, which shore up Spain's competitive capacity for stockpiling critical raw materials and helping to promote the Circular Economy, as well as the generation of industrial activity. Industrial policy (strategic vision).	■	■	■	
Co-operating for progress to be made in ecodesign. Driving forward of joint initiatives between EEE manufacturers and recyclers to ensure sufficient and efficient waste handling processes. Configuration of working groups. Identification of new projects which would improve the competitive capacity of the industry, leveraging sustainability. Development of regulations regarding eco-modulation.	■	■	■	
Supporting activities with strong potential linked to future mobility. Assessment of the positioning and competitive ability to accommodate lithium battery recycling and production in Spain, as well as the promotion of the industry preparing electric-vehicle batteries to be re-used for stationary batteries. This is in light of forecasts that indicate a market dominated by large lithium batteries and local energy storage. Attraction of investments. Development of projects researching battery durability and sustainability. Accompanying industrial policy strategy.	■	■	■	
Expanding activities related to preparation for re-use. Search for joint responsibility across the whole value chain. Adoption of repair standards for re-use. Review of concept of recycling points (location/design/operations) to encourage flows of repair and generate greater awareness of the appropriate handling of waste. Visibility of the positive social impact (collaboration of agents with the third sector / social entities).	■	■	■	■
Carrying out regular WEEE and battery recycling awareness campaigns. Design and participation in regular information and awareness campaigns regarding selective collections and WEEE and battery recycling (given its positive medium-long-term impact. Development of initiatives with schools / educational centres Organisation of campaigns by central government, not just local-scale actions.	■	■	■	■

■ Agent involved. ■ Leadership

Conclusions

▸ Electrical and electronic equipment placed on the market in Spain in 2019 have seen a year-on-year increase in tonnes of 25%, with a minimum target set for separate collection of this waste at 9.22 kg per inhabitant. The last two years have also seen an increase in WEEE recycling in Spain, which is above the average for the European Union. The amount of batteries, accumulators and battery packs placed on the Spanish market exceeded 182 kt in 2019. Their collection rate stayed relatively stable, with practically all of the tonnes collected being recycled. Nevertheless, certain categories will have to be monitored, such as lithium batteries and battery packs, as well as the requirements provided in new European regulations for batteries.

▸ The activity of the main companies devoted to recycling WEEE and batteries helped to generate a total GVA of over 950 million euros, as well as maintain more than 16,500 full-time jobs in Spain (considering direct, indirect and induced impacts of this activity). In the same vein, the management and recycling of both types of waste directly provides more than 150 million euros a year to the Spanish treasury.

▸ Growth opportunities for the WEEE and battery recycling industry exist in the various links of the value chain and are backed by EU and Spanish priorities and market trends. In this regard, a priority would be to increase urban mining, for the recovery and recycling of critical materials contained in WEEE, which are defined as strategic according to the growth forecasts for demand and existing capacities. This would involve efforts on the industrial front and also in terms of research and innovation, boosting the competitive capacity of the Spanish WEEE industry.

▸ The field of action in managing and recycling batteries also offers up interesting opportunities, namely in energy transition processes and the growth of e-mobility. Preparation for re-use and recycling lithium batteries, as well as research and innovation regarding battery sustainability, are areas for strategic action.

▸ More generally, opportunities have been outlined in strengthening inter-territorial co-ordination and information systems, improving certain waste collection mechanisms, expanding the preparation activity for the re-use of WEEE and working together to move forward with ecodesign. Also required of the battery recycling industry are upgrades to the current industrial model, the generation of green employment, fostering of R&D&i, development of secondary raw material markets, and harnessing of the potential associated with mobility of the future. All this must be done without neglecting the awareness-raising initiatives regarding recycling WEEE and batteries, which underlie the commitment by the general public to separate this waste for collection.

▸ The WEEE and battery recycling chain is to play a significant role in the transition towards a more circular and resilient economy, in line with the strategic priorities of Europe and Spain, redefined by the crisis arising from the COVID-19 pandemic.

▸ Agents involved in the value chain must be pro-active in proposing initiatives, generally financed with recovery funds, to secure investments that support competitiveness in the recycling industry. As such, commitment to new lines of applied research and development of innovative project will be significant.

▸ Areas of opportunity are extremely diverse, both in the field of WEEE and batteries and battery packs. However, an appropriate way of strategic thinking is required, which allows large-scale projects and initiatives with high potential to be identified, with industrial vision and long-term, integrated production models. Public-private collaboration is much needed, in order to define a solid roadmap and prioritise the actions that can deliver better performance, in economic, social and environmental terms.

Bibliography

Alves, P et al. (2018). "Cobalt: demand-supply balances in the transition to electric mobility". JRC - Comisión Europea.

Baldé, C.P. et al. (2017). "The Global E-waste Monitor 2017: Quantities, flows and resources". UNU, ITU and ISWA.

Banco Mundial (2017). "The Growing Role of Minerals and Metals for a Low Carbon Future".

Cedefop (2018). "Skills for green jobs in Spain: an update".

European Commission (2018). "Report on Critical Raw Materials in the Circular Economy".

European Commission (2019). "European Green Deal". COM(20ig) 640. December 2019

European Commission (2020a). "Critical Raw Materials for Strategic Technologies and Sectors in the EU. A Foresight Study".

European Commission (2020b). "Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability." COM(2020) 474. September 2020.

Element Energy (2019). "Batteries on wheels: the role of battery electric cars in the EU power system and beyond".

Eurobat (2020). "Batteries Directive Review".

Forti V. et al. (2020). "The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential". UNU / UNITAR, ITU and ISWA.

ILO (2012). "The global impact of e-waste: Addressing the challenge".

International Telecommunication Union (ITU) (2018). "Successful electronic waste management initiatives".

Marscheider-Weidemann, F. et al (2016). "Raw materials for emerging technologies 2016". German Mineral Resources Agency (DERA).

MITECO (2020a) "Draft of Energy Storage Strategy".

MITECO (2020b). "Spanish Circular Economy Strategy. Circular Spain 2030"

OECD (2017). "Employment Implications of Green Growth: Linking jobs, growth, and green policies".

Parajuly, K. et al. (2019). "Future e-waste scenarios". StEP Initiative, UNU ViE-SCYCLE and UNEP IETC.

European Union (2018). "Raw Materials Scoreboard 2018". European Innovation Partnership on Raw Materials.

World Economic Forum (2019). "A New Circular Vision for Electronics. Time for a Global Reboot".

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Appendix I - Categories of electrical and electronic equipment

Box 1 - Main categories of EEE

1. Heat exchange equipment (except: electrical heat exchange chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC), hydrofluorocarbons (HFC) and ammonia (NH3); electrical air-conditioning equipment; and electrical equipment with oil in circuits or condensers).

2. Monitors, screens and devices with displays larger than 100 cm2.

3. Lamps.

4. Large equipment (any outer dimension larger than 50 cm), including, among others: electrical appliances, consumer equipment, I.T. and telecomms equipment, luminaires, sound playing or image displaying equipment, music equipment, electrical and electronic tools, toys, sports and leisure equipment, health products, monitoring and control instruments, vending machines and equipment for generating electrical current. This category does not include the equipment considered in categories 1 to 3 or 7.

5. Small equipment (no outer dimension larger than 50 cm), including, among others: electrical appliances, consumer equipment, luminaires, sound playing or image displaying equipment, music equipment, electrical and electronic tools, toys, sports and leisure equipment, health products, monitoring and control instruments, vending machines and equipment for generating electrical current. This category does not include the equipment considered in categories 3 and 6.

6. Small I.T. and telecomms equipment (no outer dimension larger than 50 cm).

7. Large photovoltaic panels (any outer dimension larger than 50 cm).

Source: RD 110/2015, of 20 February, regarding WEEE (Appendix III)

Appendix II - Profile of electrical and electronic equipment producers

Box 2 - EEE producers in Spain

Producers, natural or legal persons, are responsible for initially placing the electrical and electronic equipment onto the Spanish market, can fall into one of the following groups (according to RD 110/2015):

- Be established in Spain and:

  √ Manufacture EEE under their own name or brand, or design or manufacture and sell under their name or brand in Spain; or

  √ Resell EEE manufactured by third parties (not EEE sellers whose producer brand features on the equipment) under their own name and their own brand, or

  √ Work to introduce EEE from other countries into the Spanish market.

- Be established outside of Spain and sell EEE via media outlets remotely, directly to individual households or professional users in the Spanish market. They can appoint a representative in Spain. However, if the company sells to a distributor established in Spain, and the company selling is not a producer or does not have an authorised representative in Spain, the distributor is regarded as the producer.

It must be remembered that the same brand of EEE can be placed on the Spanish market by different producers (each will be responsible for the equipment they introduce onto the market).

Each producer (or their authorised representative) must be registered in the IIR-EEE and provide information, on a quarterly basis, of EEE placed on the Spanish market.

If an EEE manufacturer located in Spain exports their entire production, then they will not be considered an EEE producer in the Spanish market.

Source: RD 110/2015, of 20 February, regarding WEEE

Appendix III - Type of batteries

Table 10 - Type of batteries, accumulators and battery packs, according to their use

Portable	B	Button cells.
	B	Standard batteries.
	A	Portable Accumulators
	H	Other types:
Automotive	D	Batteries, accumulators and vehicle batteries
	H	Other types:
Industrial	E	Batteries, accumulators and industrial batteries with cadmium
	F	Batteries, accumulators and industrial batteries with lead
	G	Batteries, accumulators and industrial batteries without cadmium or lead.
	H	Other types:

Appendix IV - Methodological note on estimating the economic relevance of the WEEE and battery recycling industry.

Estimating the relevance of WEEE and battery recycling activities in the Spanish economy has been performed using the Input-Output analysis, a methodology developed by the economist Wassily Leontief (Nobel Laureate in Economics in 1973) and used extensively in these types of sectoral analysis exercises. The Input-Output tables created in Spain by the National Institute of Statistics, are a simplified representation of the economic structure and allow for the following elements to be known:

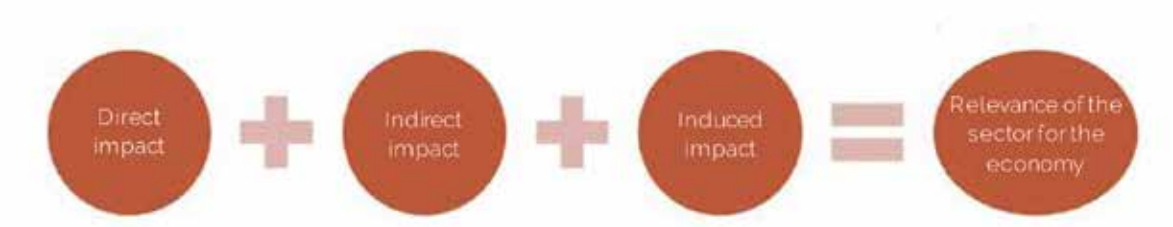
I Cross-sector dependencies Firstly, it shows the amount of intermediary consumptions that each sector requires to produce a unit, as well as the sector from which these intermediary consumptions originate. In other words, the carry-over effect upstream. Secondly it shows the part of production of each sector that is devoted to responding to the final demand, and the part assigned to the intermediate demand, in other words, the part that is provided as intermediary consumptions for the production of other activities (the carry-over effect downstream). It is also worth noting that, although the economy evolves continuously and is subject to constant circumstantial changes, the productive structure of a country tends to record alterations more slowly. For this reason, cross-sector dependencies or relations reflected in the Input-Output tables are structural in nature.

II Modelling shocks. The design of the Input-Output tables allows the impact that a shock in the activity has on the economy in general to be measured. This shock can come from variations in the household consumption, in investment, public spending, exports or imports. The Input-Output tables allow the impact of the shock to be known for each of these items, as well as the effects on the generation of income (employment and capital). The statistical content by sector allows for a breakdown of each of the estimated impacts by sector.

III Estimating the economic relevance of a sector. Information relating to cross-sector dependencies, together with the results from modelling shocks can be used to estimate the contribution of a production sector to the whole of the economic activity. Analysing the Input-Output tables determines that the impact of a sector on the economy is the result of a combination of three inter-related effects:

- *Direct impact:* direct impact of collection and handling activities of waste electrical and electronic equipment, and batteries.
- *Indirect impact:* impact on sectors that supply intermediate services or goods to activities affected by the direct impact, so that these can develop.
- *Induced impact:* result of income (salaries and business profits) generated by the direct and indirect impacts being spent on the rest of the economy.

Estimation of the weight of the sector in the economy, through the Input-Output analysis.



Source: Afi

The aggregated impact of the three effects mentioned is usually measured in terms of: Gross Value Added (GVA), a similar scale to GDP (with this equivalent to the sum of GVA and the indirect taxes on products, minus subsidies), and employment, measured as the number of full-time jobs.

It is also possible to calculate the contribution that the recycling industry makes to the treasury, applying the average rates of the following taxes and contributions: Corporate tax, personal income tax, value-added tax (VAT) and social contributions.

Lastly, it is worth pointing out that for estimating the relevance of WEEE and battery recycling activities for the Spanish economy, the turnover of the main operators in the industry, including the extended producer responsibility systems, has been taken from their latest annual accounts (Commercial Registry database).

recyclia

C Orense, 62. 28020 MADRID
T 91 417 08 90
F 91 555 03 62
recyclia@recyclia.es

www.recyclia.es

ecopilas ecofimática ecoasimelec ecolum