

Compliance of companies selling electrical and electronic equipment

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Abstract: In the circular economy, waste will become the main resource. As electrical and electronic waste is a sector with a major growth, it is imperative to develop policies and strategies that lead to increased collection of this type of waste. Most end-users lack knowledge of proper recycling or reuse, often disposing of electronic waste as household waste. Improper disposal threatens life and ecosystems. Electronic and electronic waste is a resource of rare materials but is also rich in toxic metals and other pollutants. Implementing an environmental management system at the level of companies selling WEE can help the compliance process of these companies.

Keywords: environmental management system, circular economy, electrical and electronic waste, Markov chain

1. Introduction

Since 2003, with the publication of Directive 2002/96/EC, the European Union has managed WEEE with the extended producer responsibility principle, ensuring that producers have the possibility to fulfill their obligations either individually or collectively. The final text of the new Directive (2012/19/EU) on waste electrical and electronic equipment introduced several important changes to strengthen the European Union's efforts for sustainable development, with a view to overcoming some of the problems that occurred during the first years of implementation in the Member States. One of the main changes introduced by the new Directive concerns the redefinition of the collection target for Member States [2].

If Directive 2002/96/EC required Member States to reach a collection target of 4 kg of WEEE per capita by 31 December 2006, the new 2012 Directive includes a number of important and fundamental changes in collection targets related to collection targets that are no longer defined for all Member States as kg per capita but are linked to specific market conditions in individual Member States. After an initial transitional period, the Member State will be able to choose to express the collection target as "percentage of the average quantity of EEE placed on the market in the previous 3 years or "percentage of WEEE generated".

Recycling of waste electrical and electronic equipment is an important resource due to materials that can be recovered from the technological processes used in recycling.

The development of an efficient and environmentally sound recycling system is extremely

important because it brings value in the context of the circular economy.

Thus, at European Union level, during the period 2012-2020, the placing on the EED market, their collection and the degree of treatment are presented in the following table.

Table no.1: Electrical and electronic equipment (EEE) put on the market and waste EEE collected, treated, recovered, recycled and prepared for reuse, EU, 2012–2020
(thousand tonnes)

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total put on the market	7.627	7.283	7.549	8.038	8.513	9.075	10.301	11.260	12.373
Total collected	2.971	3.032	2.963	3.226	3.578	3.760	4.005	4.487	4.689
Total treatment	3.109	3.189	2.919	3.148	3.556	3.749	3.937	4.404	4.636
Total recovered (incl. recycling, energy recovery...)	2.599	2.718	2.644	2.841	3.273	3.432	3.593	3.994	4.293
Total reused and recycled	2.418	2.508	2.426	2.606	3.013	3.158	3.277	3.654	3.908

Source: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Waste_statistics_-_electrical_and_electronic_equipment

European environmental policy requires the development of action programs covering all areas with an environmental impact. At the level of companies that sell electrical and electronic equipment, an efficient process management can be achieved that leads to the compliance of the organization by implementing an environmental management system.

The implementation of this management system in the case of companies that sell WEE can be an effective tool in the management of waste from this equipment, as it is part of the overall management system of the organization and includes planning, accountability and resources for implementation, review and maintenance of environmental policy [1, 6, 8].

The implementation of an environmental management system based on the standard “ISO 14001: 2015 – Environmental management systems – requirements with directions of use” for companies marketing this type of electronic and electronic equipment is in line with the requirements of the circular economy. This process will lead to the development of a waste management plan leading to their collection and disposal [9.10].

2. Methods

Because companies selling electrical and electronic equipment are required to collect waste from this equipment, it is necessary to develop procedures specific to this process. Thus, by implementing an environmental management system that involves the compliance procedure can develop a tool to manage this process in the best possible conditions.

The tool used is based on the mathematical prediction obtained by using Markov chains in which at each moment the probability of a future state depends only on the state of the current moment (t_0), without depending on how the system was brought into this state.

Markov processes are “memory-free” processes. The entire evolution of the system is rendered by the last observed moment.

The mathematical model commonly used forms the Markov chains. This analysis involves the following main steps:

- Definition of system states and components;
- Establish the logical structure of the system by considering all the states of the components and the system;
- Determining the probability of transition from one state to another;
- Obtaining solutions in time functions, which represent the probabilities of the system state;

Thus, the proposed mathematical model, the Markov chain, is based on the development of a transition probability matrix that will be used to provide estimates of probability. Therefore, based on a recent history, it is possible to identify the quantities of equipment to be collected. This helps the company to comply and meet the proposed targets.

3. Results

By applying the aforementioned algorithm, it is necessary to analyse the weight and implicitly the value of the five categories of equipment placed on the market and waste collected from the category of electrical and electronic equipment. Thus, we assume that a company that sells electrical and electronic equipment, through its compliance procedure, wants to collect as much waste as possible from this equipment. We will analyse the quantities of equipment in five categories that we will analyse (large household appliances, small household appliances, it and telecommunications equipment, Tools, leisure and sports equipment, electrical and electronic tools) in relation to the total quantities of equipment in the same period.

Table no.1: The quantities related to the five categories analyzed in the total equipment placed on the market

(tonnes)

Categorie deseuri	Luna 1	Luna 2	Luna 3	Luna 4	Luna 5
Large household appliances	13.629	13.779	16.361	18.173	19.450
Small household appliances	2.279	2.980	3.209	3.522	3.826
IT and telecommunications equipment	4.699	4.909	4.805	5.108	5.467
Toys, leisure and sports equipment	200	211	191	208	224
Electrical and electronic tools	667	890	969	1.240	1.347

Sources: own contribution

In order to make estimates using the Markov chain, the share of the quantities for the five categories analysed in the total equipment placed on the market must be calculated.

Table no.1: The share of the quantities for the five categories analyzed in the total equipment placed on the market

	Month 1	Month 1	Month 1	Month 1	Month 1
(Total annual quantity of the several equipment/ total quantity of electrical and electronic equipment places on the market)%	71%	77%	79%	79%	81%

Sources: own contribution

Having the total quantity of the five categories of equipment placed on the market can identify the quantities of each of the 5 categories of equipment analysed by applying the algorithm related to the Markov chain presented above.

Analysing the quantities in the 5 months can be obtained by applying the algorithm related to the Markov chain the following quantities of electrical and electronic equipment placed on the market in the following month out of the five categories of equipment analysed:

Table no.1: Quantities of electrical and electronic equipment put on the market in month 6 (tons)

Large household appliances	63,40%	1.948.143,34
Small household appliances	11,40%	349.019,52

IT and telecommunications equipment	18,20%	559.949,82
Toys, leisure and sports equipment	2,70%	82.984,44
Electrical and electronic tools	4,30%	126.772,68
TOTAL	100,00%	3.073.497,912

Sources: own contribution

According to EU legislation, member countries must collect at least 45% of the quantity placed on the market (annual average of the previous 3 years). Thus, extrapolating at company level, for the month of 6 the target of collecting waste was to be 1,383,074.06 tons.

It is known that in the European Union there are countries that attach maximum importance to the recycling process and implicitly to the circular economy and countries that have much to recover in this regard. In this context, the minimum value of 45% has been exceeded in some countries.

4. Discussion

Applying such an algorithm can accurately identify the evolution of the total quantities of electrical and electronic equipment that will be placed on the market.

In the context of the adoption of the Green deal -- the European Green deal, which sets out a set of initiatives and policies by which the European Commission has set out to make Europe the first climate and pollution neutral continent by 2050, a unified and targeted approach to electrical and electronic waste is important [2].

Implementing an environmental management system in accordance with the requirements of ISO 14001: 2015 may be appropriate in the process of identifying solutions for companies to overcome the constraints and difficulties they face in the process of recycling and collecting waste electrical equipment. and electronically. Removing potential barriers and strengthening economic incentives should be the main objectives for businesses to pursue coherent and coherent environmental policies [13.14].

5. Conclusions

The production of electrical and electronic equipment (WEE) has an upward evolution due to technological developments and the need of consumers. This development leads to an increase in waste electrical and electronic equipment (WEEE).

Given the environmental issues involved in WEEE management, many countries have developed national legislation to improve reuse, recycling and other forms of recovery of WEEE, so as to

reduce disposal. WEEE recycling is an important subject not only in terms of waste treatment but also in terms of the recovery of valuable materials [11.12].

The unified approach through a clearly defined model leads to the implementation of the Green deal's Circular Economy requirements, which provide policies for the development of "sustainable products" to support the circular design of all products. Efforts must be focused in particular on resource intensive sectors such as the electrical and electronic products sector.

It is worth mentioning that developing a sustainable recycling process is important both for waste treatment and for the recovery of valuable materials. By 2014, recycling was the most preferred option for waste treatment of electrical and electronic equipment, with the same rate performance, over 80%, regardless of country, with efforts in each country to develop special collection points, recycling facilities and support tools.

Waste electrical and electronic equipment is a complex mixture of materials and components that can cause damage to the environment and human health and safety. But at the same time, in the structure of these wastes there are also rare resources that can be reused in the manufacturing process of new equipment.

Due to the high consumption of waste from electrical and electronic equipment, new models must be adopted for sustainable management.

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