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A characterization of the Brazilian market of reverse logistic credits (RLC) and an analogy with the existing carbon credit market

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ABSTRACT

Reverse logistics implementation of electrical and electronic equipment waste (WEEE) and its components has been a major concern for the Brazilian government and the private sector in the last decades. This paper proposes a description of the Brazilian WEEE proper disposal or reverse logistics credits (RLC) market and also an analogy with the carbon credit market. In order to reach this purpose a descriptive research was carried out, focusing on the study of the RLC market of WEEE in Brazil. Some specialists involved in this context were consulted regarding their perspectives for this market and the main motivations for environmental appropriate disposal of WEEE. It was discovered that the majority of the stakeholders agree that the reverse logistics credit market is a possibility, but currently there are multiple obstacles to its implementation. Regarding the comparison of RLC with the carbon credit market, there are still many aspects to be developed before the RLC market becomes a reality. The Brazilian RLC market still does not have any legal support to work on, no organization to control and audit the market, and no support from the government.

1. Introduction

Solid waste management policy in Brazil is regulated by each of its 26 states and the Federal District, and more recently, at a federal level, with the Law no. 12,305 and the Decree no. 7404, both from 2010. These recent regulatory documents govern the Brazilian Policy of Solid Waste (BPSW). While European countries and some Brazilian states have adopted the principle of the extended producer responsibility (EPR) (Wagner, 2013), in Brazil the BPSW considers the innovative principle of shared responsibility (also called Product Stewardship – PS), for the product life cycle, from which society, business and government share responsibility related to residues management. According to Article no. 33 of that law, traders, distributors, importers and producers of pesticides, batteries, tires, lubricants, fluorescent lamps and, electronic products and their components are required to implement reverse logistics systems to treat waste belonging to these categories (Brasil, 2010a,b). Therefore, the implementation of the reverse logistics of waste electrical and electronic equipment (WEEE) and its components has been a major concern for the government and the private sector (Guarnieri, 2013).

WEEE and its components, due to its risk and toxicity, require the correct equation of its parts, making the reverse logistics of these products subject of recent decrees and laws worldwide (Oliveira et al., 2012; Wang et al., 2012). This way, with the approval of BPSW, Brazil followed the trend set by the United States, Europe and Japan (Appelbaum, 2002a,b). What was once only concern of some environmental friendly organizations becomes mandatory for all producers, distributors and consumers of such products. Moreover, a company's current consumption increases, due to the large volumes of equipment purchased and rapid planned obsolescence, discarding significant amounts of products every day. The junk features, according to Chi et al. (2011), are one of the largest sources of heavy metals and pollutants and has been one of the fastest growing

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in volume dropped, which causes serious problems in developing countries.

As foreseen in the BPSW, in 2013 was published a "Proclamation calling for the development of a sectoral agreement for the implementation of the reverse logistics of consumer electronics products and its components". This proclamation was published after completion of the study outlined by the technical and economic viability of WEEE reverse logistics by Technical Group Advisor, created by the Steering Committee for the Implementation of Reverse Logistics Systems. The notice proposes the signing of a sectorial agreement upon submission of proposals by interested parties and sets quantitative targets, such as collection and proper disposal of 17% by weight of household electronic products and components with voltages not exceeding 220 V placed from the market in the year to sign the agreement, i.e., in the year 2012 (Brasil, 2013).

Thus, the agents included in the proclamation, are seeking practical solutions to the adequacy and compliance of the BPSW. According to Guarnieri and Cerqueira-Streit (2015), much of the waste from electrical and electronic equipment in Brazil is handled by waste pickers and scrap dealers inadequately. These workers, most often are unaware of the security and operational requirements for managing this waste category (Corrêa and Xavier, 2013). On the other hand, some companies already have implemented practices of reverse logistics and anticipated statutory requirements. The conclusion of this sectorial agreement was scheduled for December 2013 and did not occur as planned. The alternative provided in the BPSW, is the development of a regulatory decree by the federal government.

The market value of electronic waste is quite attractive to key managers. Besides that, there are indications of a future shortage of inputs used in the production of components of electronic equipment. Several companies have seen the recycling of materials as being the solution to this problem, which has motivated an 'urban mining' (Guarnieri and Seger, 2014). Furthermore, operational costs and logistical constraints still make unfeasible parts of the reverse logistics system. Thus, as an alternative mechanism, it is being proposed in Brazil the implementation of market mechanisms for the reverse logistics credits or proper disposal, analogous to what occurs in the carbon credits market, in order to facilitate the implementation of policies of public environmental and sustainable development (Stock Exchange of Rio de Janeiro BVRio, 2013).

Porter and Kramer (2011) agree that the moment for a new conception of capitalism is now. This is interesting because even traditional leading business researchers now recognize the importance of the environmental crisis challenging people, and the inadequacy of traditional capitalist modes of organization in the face of these contests (Böhm et al., 2012). This initiative, coordinated by BVRio resembles the carbon market, created in 2005, which was the deadline date established in the Kyoto Protocol for the Annex parties to take initiative on reducing their carbon emission. Thus, it was born the Clean Development Mechanism (CDM), regulated by the United Nations Framework Convention on Climate Change (UNFCCC, 2016a,b; which allows a portion of the goals of Greenhouse Gas (GHG) emissions reductions to be accomplished by the purchase of carbon credits. The CDM is a flexibility mechanism created to make an alternative for a few industrialized countries to meet their emission targets, and allows developed countries to invest in clean energy project; the credits generated and used with the purpose of offsetting their environmentally damaging emissions (Fernandes, 2009).

The main link between CDM and WEEE management is twofold (i) the energy consumption during the life cycle and (ii) the energy consumption avoided by the closed loop of materials and components enabled by the reverse logistics procedures. In a very synthetic way, the reason for encouragement of the bonus shares through the RLC related to WEEE reverse logistics lies on the undesired environmental costs of WEEE landfilling or dump siting (regarding life cycle of landfills and GHG emissions) for one hand, and the cost avoided or the incomes through WEEE materials and components recycling (regarding the energy consumption along the product life cycle, recycling and respective GHG emissions), on the other hand. Many authors have discussed this in different approaches (Rada et al., 2014; Lu et al., 2014; Sun et al., 2016). On the other hand, specific methods for energy consumption economy are provided in the UNFCCC manuals (UNFCCC/CCNUCC, 2016). Nevertheless, the reverse logistics credit main aspect is focused on the exceeding recycling and reverse logistics capability rather than the economy provides in energy consumption.

Since the BPSW is based, among others, in the polluter pays principle, the credits of reverse logistics (RLC), as well as carbon credits, are mechanisms that enable the implementation of this principle in practice. The carbon credit market is a preferred politic-economic market-based tool for attacking climate change (Böhm et al., 2012) and a key component of a promising new 'green economy' (UNCED, 2012). However, the complexity of carbon markets and the several implications of their application have resulted in questions about the effectiveness of these policy instruments, and about their social, economic and environmental impacts (Lohmann, 2009; Newell and Paterson, 2010; Böhm et al., 2012; Newell et al., 2012).

The purpose of this article is to characterize the Brazilian market of WEEE reverse logistics credits (RLC), known also as adequate destination credits (ADC) and to make an analogy with the carbon credit market (CCM) as a tool of policy development. This article has the purpose of contributing to the discussion of the creation of a RLC market of WEEE in Brazil and its feasibility.

In order to reach this purpose, a descriptive and qualitative research was carried out. The chosen research strategy was the case study of the RLC market of WEEE, which is being traded in Brazil by an Environmental Stock Exchange. Considering the originality and the novelty of this subject, it is considered relevant to know the opinion of some specialists involved in this context, regarding the perspectives for the RLC market and the main motivations for environmental appropriate disposal of WEEE. The eight participants of the study consist of stakeholder members of the productive chain of electronics goods. The choice of respondents was held by the criteria of representativeness and accessibility, given the senior positions they occupy and the strategic information they possess. It is important to highlight that these participants work actively in the groups of discussion related to WEEE reverse logistics in Brazil, elaborating rules of adequate disposal and guidelines for sectoral agreements. This investigation also considers the environmental specific legislation in Brazil, which obligates companies to implement the WEEE reverse logistics system.

Therefore, it was possible to verify that the RLC market is an alternative to companies attend the law and considering the opinion of the most of specialists consulted, it has been accepted in Brazil, despite being an initiative without specific legal support yet. In this context, the strategy of the proposal and the potential of this market in terms of environmental sustainability are also evaluated. It is important to emphasize that the Environmental Stock Exchange, which proposes the trading of the RLC has already negotiated these credits, related to packaging with some companies from cosmetics industry from Brazil. Additionally, the main difficulties related to the correct destination of WEEE, demanded by the announcement 01/2013 from Brazilian Government were discussed.

The article is structured as follows, besides this introduction section: In Section 2 it were discussed the theoretical background, including: WEEE in Brazil, reverse logistics of WEEE, credits of carbon and reverse logistics credits (RLC). In Section 3, the description of the material and methods used was presented. In Section 4, it is

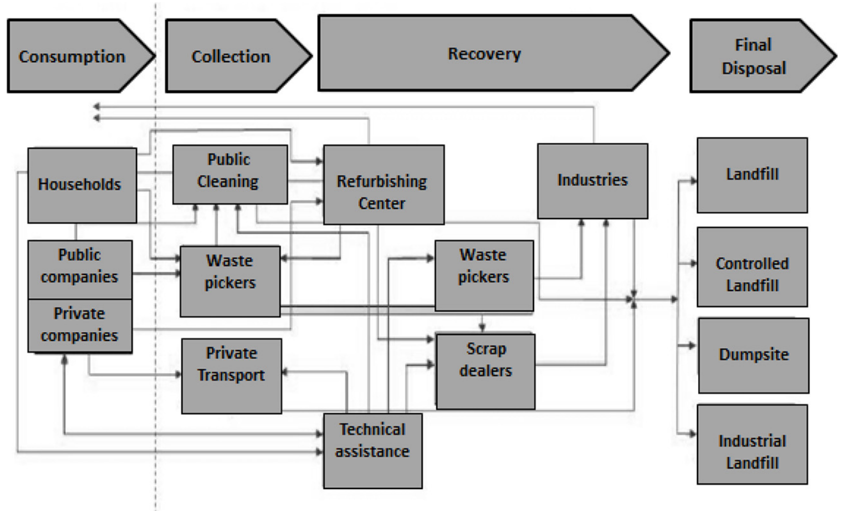

Fig. 1. Electronic Waste Flow in Brazil.

Source: Adapted from Franco and Lange (2011).

presented the main findings and the discussion. Finally, in Section 5, the concluding remarks were presented.

2. Theoretical background

2.1. Waste of electrical and electronic (WEEE) in Brazil

The electronics segment represents today, in Brazil, between 2 and 4% of the environmental impact of its operations. However, it develops products, services and solutions that meet 96–98% of the rest of the market economy. However, about 30% of the electronics market in Brazil is informal (Cempre, 2014). A UNEP study (2009) shows that, e-waste recycling in Brazil exists countrywide and specializes on material fractions, which have a high aggregated value (such as printed wiring boards, stainless steel, copper containing components, etc.). Therefore, it is observed that e-waste recycling currently is done on a cherry-picking basis and not in a sustainable way.

Around 680 thousand tons/year of WEEE are generated in Brazil, and estimations based on the Brazilian formal labor market indicate that no more than 1% of electronic waste produced has an adequate environmental treatment (Environmental Foundation of Minas Gerais – FEAM, 2010). Electrical and electronic products in general have several basic modules. The common basic modules are assemblies/printed circuit boards, cables, cords and wires, plastics flame retardant, switches and mercury switches, display equipment, such as screens, cathode ray tubes and liquid crystal displays, batteries and accumulators, means of data storage, light devices, capacitors, resistors and relays, sensors and connectors. The most troubling substances, from the environmental point of view, in these components are heavy metals such as mercury, lead, cadmium and chromium, greenhouse gases, halogenated substances, such as chlorofluorocarbons (CFCs), polychlorinated biphenyls (PCBs), chloride polyvinyl chloride (CPC) and brominated flame retardants, as well as asbestos and arsenic 8 (Waste Electrical and Electronic Equipment – WEEE, 2004; Tsydenova and Bengtsson, 2011; Wang et al., 2012).

In key emerging markets such as Brazil, China, India and South Africa, the growth of e-waste will be between 200% and 500% in the next decade (UNEP, 2009). This increase includes only the remains of televisions, computers and mobile phones for internal use, and not the tons of e-waste exported to these countries, most of them illegally. Furthermore, sales of electronic products retailers exploded in emerging economies, but there is no ability to collect, recycle toxic contents and convert them into valuable materials (UNEP, 2009; Wang et al., 2012).

The flow chart of electronic waste and the participants in the reverse logistics in Brazil are shown in Fig. 1.

According to Fig. 1, in Brazil, the participants of the reverse flow of electronics are waste pickers, recycling industries, landfills, producers and distributors. The waste pickers play two roles in different stages of the electronics waste cycle: in the collection and in the recovery of recyclable material. They collect materials from Consumer and Reconditioning Center agents, forwarding them to the Public Cleaning Companies Moreover, they contribute to the recovery of the material through the disassembly of the equipment received for technical assistance or other agents and the sale of parts for scrap dealers and recovery and recycling companies. The amount of electronic materials received by this agent is variable, and is mostly obtained by donations from businesses, c door to door selective collecting, municipal and private donations directly to cooperatives of waste pickers (Franco and Lange, 2011).

The scrap dealers role, within the electronics waste cycle in the recovery stage of equipment, is performing the disassembly of the material received by technical assistance and reconditioning centers, and then selling the parts that can be reused for companies of recovery and recycling. The recycling industries receive pieces of waste pickers and scrap dealers for installation of new equipment, which will return to the consumer market. The material that is not used is then send to the final disposal (Franco and Lange, 2011). In Brazil, NGOs also participate in the reverse flow of electronics, acting similarly to scrap dealers. These entities receive several donations from consumers and public and private companies (Guarnieri, 2013).

The landfills operate as final waste disposal sites. They receive materials frompublic cleaning companies, private transportation and recovery and recycling materials companies. The final disposal site is set according to the possibilities and needs of each region. In turn, producers and distributors act on the beginning of the electronics waste cycle, from manufacturing and distribution of electronic equipments. This way, producers and distributors can to enable the consumption of these devices by consumers agents' (households, public and private companies) (Franco and Lange, 2011).

Guarnieri et al. (2016) highlighted the major benefits related to implementation of the RL of e-waste: i) generation of income;

ii) formalization of jobs in the areas of collection and sorting; iii) inclusion of informal workers such as waste pickers; iv) digital inclusion of users of educational and social institutions; v) reduction of environmental impact; vi) reduction of the amount of waste disposal in landfills and, vii) environmental protection. The authors also propose four categories of actions to be developed (i.e., strategic, environmental, economic and social), which denotes that the responsibility falls not only on the government, but also on companies that produce, import, distribute and sell electronics, which in turn should educate consumers to properly dispose of e-waste to enable RL.

It is possible to perceive that the categories identified by Guarnieri et al. (2016) involve all the dimensions of sustainability, considering the TBL concept, besides including the strategic issues of members of the supply chain. The strategic decisions can be related to the fact that some companies decide to outsource their logistics process to the 3PRLP and NGOs as emphasized by Guarnieri et al. (2015). The main reason is the low volume of e-waste returned by customers and the high specialization necessary for collection, sorting, refurbishing, remanufacturing and recycling.

2.2. Reverse logistics of WEEE

Reverse logistics – RL is the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or of proper disposal (Tibben-Lembke and Rogers, 2002). Furthermore, the operational activities of RL include collection, packaging, storage, sorting, transaction processing, delivery and integration, and/or correct disposal (Meade and Sarkis, 2002). Basically, the RL process uses the same activities of forward logistics, the difference lies in the moment that this activities start, from the time that the forward logistic ends.

In addition, it should be emphasized that reverse logistics is necessary for extending the life of materials, and plan and operationalize the return of products to logistics cycle. These aspects are considered critical to reducing environmental impacts of industrial operations, and solve the problem of scarcity of raw materials (González-Torre et al., 2010), which meets the concept of urban mining, which is already well established in countries like Italy, Spain and Japan (Halada et al., 2009; Krook et al., 2011; Cossu et al., 2012; Di Maria et al., 2013; Guarnieri and Seger, 2014).

Although the activities employed in the reverse process are basically the same of forward logistics, it is important point out that the physical return of the post-consumption products is characterized by small volumes of different items with irregular frequency. So, it is essential to identify, early in the process of reverse logistics, the ways to collect, triage and distribute these items in an efficient manner and economically viable (Tibben-Lembke and Rogers, 2002).

Many managers only care about reverse logistics from the moment in which the waste is generated and needs to be sent for recycling or environmentally correct disposal. However, it should be considered the life cycle of the product, inserting the reverse logistics from the product design. Thus the basic life cycle of a product goes through the following stages: concept, design, manufacture, use, return, recycle and/or disposal in landfills. Furthermore, inserting reverse logistics only in the last stages, the possibility of the economic viability of the waste return becomes limited (Bernon and Cullen, 2007; Cullen et al., 2010). Recycling of e-waste is composed of different products like glass, plastics and metals making their task very challenging for managers (Ravi, 2012).

In this context, some researches can be detached. Fleischmann et al. (2000) proposed a conceptual model based on the design of the reverse logistics networks. Using the common features in several case studies, the authors rated the product recovery networks into three types: (i) recycling networks by mass, (ii) products remanufacturing and (iii) reuse networks. Each kind of network has been identified by a specific set of characteristics, including the degree of centralization, integration with the operations of existing supply chains and, whether the products would be returned to the manufacturer to a third party reverse logistics providers (3PRLP) for reprocessing. Through this analysis, the authors propose a conceptual descriptive model that distinguishes between types of network based on product function: recycling, remanufacturing and reuse.

In the Brazilian case of electronic waste networks, it can be perfectly applied. Silva et al. (2016) carried out a study in Brazil and pointed out the existence of three basic networks:

a) Recycled raw-materials market: The market for raw-materials is composed of the "junk yards", deposits of solid waste and recycling cooperatives.
b) Secondary market (remanufacturing): This market is characterized by the purchase and sale of electronic products (TVs, computers, radios, cell phones, among others) and is strictly related to retailers, or still large lots of computers are bought and resold piece by piece in retail banking.
c) Marginal activities (reuse): This market niche is characterized by activities often linked to education and digital inclusion, through government initiatives or not.

Actually, recyclers need to face the uncertainty in terms of both the quantities (as well as the quality) of electronic waste. Moreover, they must adjust their decisions through some form of dynamic process associated with the sources (Nagurney and Toyasaki, 2005). The study of the United Nations Environment Programme – UNEP emphasises the barriers to the transfer of sustainable e-waste recycling in South Africa, Morocco, Colombia, Mexico, Brazil, which are: (i) policy and legislation; (ii) technology and skills and (iii) business and financing (UNEP, 2009). This barriers or were also pointed by Nnorom and Osibanjo (2008) that highlighted the challenges in the management of electronic waste for developing countries.

Fandel and Stammen (2004) suggested a new perspective of strategic management of the supply chain, which considers the business processes involved during the life cycle of the product in order to include its reverse logistics. The authors use a model of mixed integer linear programming, which is designed to optimize the company's profit after tax. Nagurney and Toyasaki (2005) proposed a model for managing the reverse supply chain, considering the collection, treatment and recycling of electronic waste, which integrates the management, modeling, analysis and mapping of materials and their respective costs. The model focuses on the context of multiple decision makers and assumes that they can compete at a certain level, but at the same time can cooperate between the layers of the reverse supply chain. Guarnieri and Seger (2014) highlighted the difficulty of controlling the production chain of WEEE in Brazil, mainly because in view of its economic value, even after the machine stops having utility for the first user, this hardly returns to the industry, as sales channels to secondary market are very present in Brazilian culture.

The Law no. 12.305 of Brazilian Policy of Solid Waste (BPSW), approved in August 2010, establishes the compulsory implementation of reverse logistics, based on the 'polluter pays' principle. This obligation provides a central component of the law, especially as it applies to following categories of residues: a) pesticides and associated packaging; b) batteries; c) tires; d) lubricant oils and associated packaging; e) fluorescent, sodium and mercury vapour bulbs; f) electronic products and its components and g) all kinds of packaging (Brasil, 2010a).

After the approval of BPSW, the Brazilian government established a working group in order to define the rules and procedures of WEEE management and disposal, which has three sub-groups composed by: i) manufacturers, importers and distributors ii) transporters and recyclers iii) government, scholars and non-governmental organizations. The conclusion of the WEEE sectorial agreement did not occur as planned. As required by the BPSW, it will be necessary to provide a regulatory decree to regulate WEEE reverse logistics. As highlighted by Alamgir et al. (2012) the preparation and implementation of adequate institutional arrangements and enforcement of appropriate regulation is essential to the successful waste management strategies in developing countries.

However, in the absence of a legal factor that structures the reverse channels, economic mechanisms to encourage and enable the management of reverse flows can be developed. The RLC market is a proposal, already implemented in Brazil by an Environmental Stock Exchage, which will be further addressed in the next section.

2.3. Carbon credits and reverse logistics credits market

Sustainable development was first suggested in the Brundtland Report (World Commission on Environment and Development – WCED, 1987) with aim to propose solutions to civilization's multiple environmental crises. One of the solutions is the carbon market introduced in 1997 by the Kyoto Protocol and endorsed in the Rio + 20 Conference, carried out in Brazil in 2012, which recognized this mechanism as the most appropriate instrument to achieve that goal (Bernstein, 2002; UNCED, 2012).

The Kyoto Protocol set legally binding emissions targets for the most industrialized countries and although the United States refused to ratify the treaty, the emissions trading market mechanisms proposed nevertheless became a key element of the Kyoto Protocol, making it the most important political milestone in international climate politics to date (Böhm et al., 2012).

The core of comprehensive climate legislation will be a cap-and-trade program (or mechanism) that creates a market for greenhouse gas (GHG) emissions. These programs operate by establishing a limit (cap) to the amount of GHGs that firms are allowed to discharge. These allowances (for each ton of capped emissions) can be traded to other market participants and this gives firms the flexibility either to reduce their own emissions or to buy allowances from another firm. This process minimizes the economic cost of the program, as it be responsible for encourage firms with the lowest marginal cost of abatement to make the cheapest reductions first (Peace and Juliani, 2009; Böhm et al., 2012). Cap and trade is one of two ways to put a price on pollution, taxation is the other (Grubb, 2012)

Besides the cap and trade mechanism, the Kyoto Protocol also provides a framework for the introduction of the CDM. The CDM is a system by which participating countries can meet some of their greenhouse-gas reductions by buying certified carbon credits from projects in developing countries that reduce emissions. Besides that, the CDM is a carbon compensation market facilitating the most developed countries to purchase carbon credits from so-called 'clean development' projects, in terms of their carbon footprints, placed in the Global South, which are based in those developing countries, mainly in BRICS (Brazil, Russia, India, China and South Africa), that are not legally intended to reduce their own carbon emissions instead their major impact on future emission dynamics (Blanford et al., 2009; Bosetti et al., 2009; Peace and Juliani, 2009; Böhm et al., 2012).

According to the current CDM statistics, more than 7900 CDM projects are in the pipeline, of which more than 7700 are already registered; these projects are expected to produce more than 3.2 billion Certified Emission Reduction Units (CERs) by August, 2016 (UNFCCC, 2016a,b).

In 2015, the transaction volumes reached 7 billion tons of carbon dioxide equivalent (CO2e) that represents only 12% of annual GHG emissions (Roome, 2015).

Some authors consider carbon markets as a viable tool for dealing with climate change, since it provides financial resources that can be invested to reduce carbon emissions (Peace and Juliani, 2009; Newell and Paterson, 2010; Michaelowa, 2011). There are, however, several criticisms. One of the most open opponent has been Lohmann (2009, 2010) who highlights the ineffectiveness and unethical expansion of carbon markets (in terms of justice or equity in relation to calculating and efficiently managing the atmosphere as resource) and their negative social, economic and environmental outcomes supported by other authors as Heartfield (2008), Mueller and Passadakis (2008), Foti (2009), Whitman et al. (2010), Sullivan (2010) and Randalls (2011). Furthermore, Böhm et al. (2012) pointed out that the politic-economic dynamics of carbon markets are not really new because they correspond to a logic driven by the need for constant expansion of opportunities for capital accumulation because they exacerbate preexisting inequalities, through the unequal distribution of new carbon commodities, enhancing opportunities for capital accumulation by some as opposed to others. These authors highlighted that this is the logic of capitalism in its historical development.

In January 2005, the EU Emission Trading Scheme (ETS) was created. That year was the deadline established on the Kyoto Protocol for Annex I countries to demonstrate progress towards the commitments ratified by the protocol (Sabbaguia and Sabbaguia, 2011). ETS is the biggest cap and trade market exchanging carbon credits, and it is regulated under the CDM.

On ETS and other existing markets, the carbon credit is traded in the form of certified emission reductions (CERs). For trading purposes, one carbon credit is considered equivalent to one tonne of carbon dioxide emissions, and is considered a commodity. In the carbon market, CERs can be exchanged between businesses or bought and sold in international markets at the market prices (Wong et al., 2009). The CERs are basically an incentive to the development and use of clean technologies, such as wind farms, and small hydro power plants, which are a better choice for the environment in comparison to coal plants, for instance. That way, Annex I countries can buy CERs directly or over the counter from projects in developing countries which are better for the environment (Goularte and Alvim, 2011).

There are many studies being held on the helm of sustainable development and carbon credits. Grieg-Gran et al. (2005) studied the carbon market development and the impact of market mechanisms in forests. Mathews (2008) covered the use of carbon allowances as a stimulus to the adoption of clean and renewable technologies. Hunt (2008) described the adoption of a carbon credit system in Australia in order to minimize pollution from greenhouse gases. Perdan and Azapagic (2011) presented a wide review about emissions trading schemes currently in operation.

Nevertheless, related to reverse logistics there is not a regulated mechanism such as the CDM, so it is of the upmost importance to analyze consolidated markets, such as the carbon one in order to fully comprehend and propose market mechanisms that would allow electronic waste recycling in Brazil to be more effective. As stated before in this paper, we will focus on the critique of the carbon credits market as a policy tool for development, comparing it with RLC market of WEEE in Brazil, which is nowadays being created. Although there is no regulation on the RLC, in Brazil it is already being implemented by an Environmental Stock Exchange, mainly related to packaging. Some law specialists state that Law 12,305/2010, which regulates the National Policy of Solid Waste (BPSW) in Brazil, has a comprehensive understanding on the alternatives to implement reverse logistics and RLC can be one of them.

However for other specialists, it is still necessary to create a specific regulation in order for the RLC to be traded (Caiado et al., 2014).

According to BVRIO (2013), which proposes to be a stock exchange of environmental assets, and whose trading platform is already working, retailers and distributors must carry out the collection and return to the manufacturers or importers of products and packaging. On the other hand, importers and producers should ensure the environmentally sound disposal of products and packaging received. In this context, BVRio is developing the creation of Recycling and Reverse Logistics Credits (RLC), as an appropriate tool for the fulfilment of the obligation established in the BPSW (BVRIO, 2013). For this initiative BVRio won the 2013 Katerva Category Award. The British NGO Katerva awards the best ideas in the area of sustainability, with less than two years old and have good prospects to succeed (Katerva, 2013).

The recycling company that performs environmentally appropriate disposal will receive a RLC, which can be sold to the producer or importer, so that they can fulfill their obligations in an environmentally appropriate disposal by the competent environmental authority (BVRIO, 2013), as is the case of reverse logistics of WEEE, for example. Considering the proclamation in 2013 related to sectorial agreements of reverse logistics of WEEE, the companies must properly allocate 17% of products on the market in the previous year, by weight, regardless of brand. Thus, if a company properly allocates more than 17%, which is the legal obligation, they can sell its surplus of RLC.

Regarding the polluter pays principle, a critic to the carbon credit market is that given that it is often much cheaper and easier to fund new development projects in the Global South than to cut emissions in the Global North. Northern participation in the CDM has proven particularly popular, suggesting that Northern companies prefers to offset their emissions, rather than to reduce them at their source (Dale, 2008; Newell and Paterson, 2010; Böhm et al., 2012). An analogy with the RLC is that producers may find it easier and cheaper to invest in the purchase of reverse logistics credits compared to the cost and efforts of the investment in reducing and preventing the generation of WEEE, another principle of the Brazilian policy on solid waste. On the other hand, the market price of recycle and reverse logistics permits will impose a cost upon those firms that need to buy the permits and this will be reflected in the firm's cost structure. Once emissions are priced, this price will be determinative to push the prevention and reduction or the contrary. This logic has already been implemented in the case of packaging, which is collected by waste pickers, sold to recycling companies and thus, the credits are sold for cosmetics industries in Brazil.

When we think about the polluter pays principle it is necessary to associate to the economic responsibility, which means that the producer is responsible to cover all or part of the expenses (the collection, recycling or final disposal) in the life cycle of the their products. These expenses could be paid directly by the producer or by a special fee (Nnorom and Osibanjo, 2008). In cases of environmental pollution in developing countries, a different variation of the polluter-pays principle emerged focused primarily on the need to provide immediate compensation (Luppi et al., 2012).

According to Andrew et al. (2010), the efficiency of an Emissions Trading Schemes (ETS) is not guaranteed as an economic mechanism: it is possible to control the price or the quantity of a commodity but not both at the same time. The European Union ETS evidence of the failure their First Phase that has been attributed to an oversupply of permits by the regulatory authorities (Tan et al., 2008), in which the prices of the trading permits decreased by 70%, which caused many companies working on this area to go bankrupt. The government must control the total of emissions because "the market will not do this" (Andrew et al., 2010). For an ETS to succeed, regulation of emissions as well as regulation of trading permits is necessary (Stranlund et al., 2005). If we compare it to the RLC, the regulatory context in this case, WEEE pollution still depends on government intervention mainly because the sectoral agreement has not occurred.

In real world situations with imperfect information, transaction costs and external shocks affects carbon trading (Helm and Hepburn, 2009) and will also influence RLC. The cost-effectiveness of climate policy is critical to its success or failure, because "our willingness to pay is limited and the costs of mitigation are substantial" (Fankhauser and Hepburn, 2010). There may be constraints in linking up systems because of excessive cost differences (Flachsland et al., 2009). As the interaction of carbon markets with other instruments is very important as pointed out by several authors, the RLC market also needs to be supplemented by other instruments.

Table 1
Main characteristics of respondents sampling.

No.	Age	Function	Organization
1	20 – 30	Environmental analyst	Company of collection, handling and recycling of WEEE
2	30–40	Researcher	Federal research foundation
3	40–50	Researcher	Company of Information Technology from government
4	40–50	Environmental technician	Center of disposal and reuse of WEEE in a Brazilian federal university
5	Classified	Classified	Non-profit association of the industry of electric and electronic products
6	50–60	Director	Non-profit association of the recycling companies of electric and electronic products
7	30 –40	Laywer	Stock Exchange of environmental assets
8	40–50	Classified	Brazilian Ministry of Development, Industry and external trade (MDIC)

3. Material and methods

In order to reach the purpose of this article, a descriptive and qualitative research was conducted. So, a case study strategy was chosen, which is justified considering the originality and the novelty of this subject. So it was considered relevant to know the opinion of some specialists involved in this context, which work actively in the groups of discussion related to WEEE reverse logistics in Brazil, elaborating rules of adequate disposal and guidelines for sectoral agreements. This investigation also considers the new mandatory legislation in Brazil, which obligates companies to implement the WEEE reverse logistics.

The participants of the study consist of stakeholder members of the productive chain for electronics goods. This chain consists of: manufacturers, importers, exporters, associations, research foundations, logistics operators, retailers, final consumers and government. The sampling is characterized as non-probabilistic, which is more suitable for a qualitative research. The choice of respondents was held by the criteria of representativeness and accessibility, given the senior positions they occupy and the strategic information they possess, which is necessary for a better understanding of the problem, without thereby belittling the contribution of the information provided. Thus, it was selected significant representatives of the population, whose main characteristics are shown in Table 1.

It is important to highlight that respondents 1, 2, 4 and 6 attended the technical group of electronics logistics, which formulated the technical standards of ABNT (Brazilian Association of Technical Standards) for reverse manufacturing of WEEE (ABNT NBR 16156:20130), while respondentS 5, 6 and 8 represent compa-

Table 2
Research questions.

1. What do you consider to be reverse logistics and what activities are covered by it?
2. Does your organization perform the reverse logistics of WEEE?
3. What is your opinion on the obligation of the implementation of reverse logistics of WEEE by Brazilian BPSW?
4. In your opinion what are the main difficulties of effective implementation of the reverse logistics of WEEE in Brazil?
5. What is your opinion on the announcement 01/2013, which deals with the call of sectoral agreements for reverse logistics of WEEE? Do you consider the demand of correct disposal of the percentage of 17% of WEEE, high, adequate or low? Please justify your answer:
6. Could you highlight the positives and negatives aspects of announcement 01/2013?
7. What are the main difficulties to be faced by those companies involved in the reverse logistics of WEEE?
8. Have you heard about reverse logistics credits of waste? Do you think that it would apply to the reverse logistics of WEEE?
9. Considering that the credits reverse logistics of waste would be those exceeding recycled by companies beyond the stipulated legal targets, and sold to those who did not it. There is the possibility of sale these credits, similarly to the existing carbon credits? Please justify your answer:
10. In your opinion, there is a legal apparatus that allows the creation of WEEE reverse logistics credits market?
11. In your opinion, the use of WEEE reverse logistics credits, is feasible from an operational point of view?
12. What could be done to make the market of these credits a reality?
13. Could the market of WEEE reverse logistics credits to mirror the existing carbon credit market? Please justify your answer:
14. What are the impediments and/or difficulties to the WEEE reverse logistics credits market to become a reality in Brazil?
15. What is your opinion about the Brazilian government support in creating a rule or resolution for the sale of these credits?
16. How do you believe that should be the remuneration of these credits?
17. From the environmental point of view, you believe the market of WEEE reverse logistics credits would be appropriate. Please justify your answer:
18. In the case of the WEEE reverse logistics, you believe that there would be market for trading these credits? Please, justify your answer.
19. In your opinion, who should be the responsible for control and regulate this market? Please justify your answer.

nies and institutions that participated in the technical work group created by Brazilian government, which performed the analysis of technical and economic feasibility of the reverse logistics of WEEE. Respondent 3 is a researcher who works with reverse logistics in a government unit, and respondent 7 works directly with RLCs of several categories of residues in a stock exchange of environmental assets. Therefore, we prioritized the relevance of the contribution of the respondents, all with a close direct relationship with the reverse logistics of WEEE, rather than a broader sample, whose answers were not subsidized by the actual knowledge of this sector.

First of all, a message was sent to the respondents asking for the availability in participating upon this research. Secondly, in order to collect the data, questionnaires with 19 open questions were sent to the respondents by e-mail. The questions are described in Table 2. Even if the responses involve the opinion of respondents, these opinions were guided by the extensive experience of all of them with the practice of reverse logistics. The main goal of our open-questions questionnaire was to determine the perception of the participants of the reverse flow of electronics about the RLC proposal. The questionnaire contained seven categories, discussed later in Section 4, and was applied according to the volunteer collaboration of the main stakeholders on WEEE management in Brazil.

The results from the questions were analyzed through the technique of "thematic categorical analysis", proposed by Bardin (1977). The analysis follows these stages: i) Pre-analysis; ii) Material exploration; and iii) Treatment of results, in which the qualitative analyses of answers of respondents was carried out, performing inferences and interpretations. It should also be pointed out that, the purpose of this research was not to generalize the results, but to explore in depth the phenomena. Based on the respondents answers, the results were set in categories defined *a posteriori*, according the meaning cores.

4. Main findings and discussion

In this section, the results that emerged from the perception of the participants about the RLC most relevant aspects are presented. Therefore, the aspects covered by the questionnaire and related to commitment, commercialization, legal support, and operational feasibility, comparison between RLC and carbon credit market, obstacles and reward system were analyzed.

4.1. Commitment to RLC proposal

In a few words, the CDM proposal aims to foster sustainable development. Despites many initiatives in the environmental side, CDM still have limited focus on waste handling and disposal. Nevertheless, the main goal of RLC is to endorse the environmental commitment to WEEE environmentally sound management and disposal.

Regarding the knowledge of the stakeholders on the concept of RLC of WEEE, it was observed that the 8 respondents have demonstrated previous knowledge of the concept, which is important to the usefulness of the information provided in the survey. However, only 6 respondents agreed on the application of the RLC market to reverse logistics of WEEE at the moment, 2 of them did not agree with the applicability of the RLC of the WEEE. More specifically, it should be pointed out that Respondent 2 states that as long as the credits were proportional to the size of the consumer market, as already used by the distribution of ICMS (Tax on circulation of good and services) model, its application would be feasible. Another suggestion was pointed out by Respondent 3, which states that whether the sectorial agreement is not signed, it could still be a feasible solution. Still, respondent 4 points out that the RLC would be a good stimulus for the sector of EEE at this time.

Additionally, Respondent 7 asserts that there are companies that already perform the procedure of reverse logistics of WEEE, voluntarily, maybe with an incentive, like the RLC, it could increase the volume of WEEE circulating. However, respondent 5 does not believe in the immediate application of the RLC market and states: "[. . .] The RLC market could not work since we have no control over what will be returned and how it will be monitored, whether there would be rigid rules of procedure as for carbon credits, this could be discussed."

Here lies an afterthought, because when we consider the specific case of carbon credits, it is important to highlight that countries have specific and well defined goals to fulfill. According to the CDM Validation and Verification Manual, the purpose of validation is to perform an independent audit of the activities of the CDM, by a DOE (Designated Operational Entity), which is outsourced to ensure that the project meets all the applicable criteria. In Brazil, in the case of RLC there is no manual or guideline, there is only the Law 12,305/2010, which according some law specialists has a gap in terms of the regulation of how the adequate destination of the waste will be implemented (Caiado et al., 2014) and, also we have the proclamation for sectorial agreements of reverse logistics of WEEE, by the announcement 1/2013, which demands that in the case of WEEE, the companies should attest to they collect and adequately destined 17% of the EEE sold, nevertheless, still no agreement is signed yet.

In this context, the DOE shall, by means of an in-person inspection of the project, ensure that all physical aspects are consistent and that the project participants operate as recorded in the Project Design Document (PDD), such as the ability to reduce greenhouse

Table 3
Main findings of the category 1.

Issues	Findings
Knowledge of reverse logistics and context	All respondents demonstrated to know what is reverse logistics, their activities and the context of the obligation of its implementation demanded by Law 12,305/2010.
Applicability of RLC market to WEEE	6 respondents agree and 2 do not agree about the applicability of RLC market to WEEE case.
Main motivations to apply RLC market to WEEE	i) No agreement related to reverse logistics of WEEE were signed or implemented; ii) some companies already implemented reverse logistics of WEEE voluntarily; iii) the consumer market of EEE is expressive, which can motivate RLC.
Main obstacles to applicability of RLC	i) there is no clear goals to destination of WEEE (only the estimation of 17%); ii) there is no mechanism regulating the RLC market; iii) there is no designated operational entity; iv) there is no regulatory or supervisory entity in order to monitor and audit the RLC market.

Table 4
Main findings of category 2.

Issues	Findings
Feasibility of commercialization of RLC	4 respondents agree, 2 believe that it maybe could be work as a temporary solution, 2 do not perceives interest from manufacturers, distributors of EEE industry.
Formal structure of RLC	Necessity of existence of a Designated operational entity
Mechanism to monitor the generation and adequate destination of WEEE	The utilization of SINIR – National Information System on Waste Management can aid this process, however the online platform is still now working.
Operation of RLC	Necessity of creation of a structure very well controlled and audited
Product of RLC	The credits should be issued by third parties, companies that have legal obligations as demanded by BPSW, but go beyond the stipulated goals could sell this excess.

Fig. 2. Issues to be addressed to enable the commercialization of RLC.

gas (GHG) emissions, power meters, and turbine models registered, in case of hydro plants. After that comes the verification step, which is performed by firms of auditors who will examine qualitative and quantitative information in the Monitoring Report. Then, whether these informations are in accordance with calculations and numbers of credits to be issued, they send this document to UNFCCC for issuance of credits. If there are no further questions, the credits are finally issued. In Brazil still there is no mechanism like that in order to regulate the RLC market, which can cause mistrust by some of the stakeholders.

The main findings of this category can be summarized in Table 3.

4.2. *Commercialization of RLC*

When asked about the possibility of commercialization of the RLCs, respondents 2, 3, 4 and 7 agree that this possibility is concrete since there is an adequate structure for it. However, respondent 2 believes that such a market could only work in a similar way as the carbon market, and in order to make it possible it is imperative to create a mechanism for registration and management of WEEE produced and collected by SINIR (National Information System on Waste Management), which is one of the tools outlined by BPSW and in charge of Brazilian government. The SINIR would be a central of monitoring of all WEEE generated and will have an important role to fulfill the provisions of BPSW. Nevertheless it is important to point out that the platform of SINIR is still being developed by the government. Also, respondents 4 and 8 believe that it may work, but not as a permanent solution and that this market would not be feasible immediately.

Additionally, Respondent 6, believes that the RLC market would work only if a structure very well controlled and audited was created, because compliance would be the essential factor and in his point of view. The CDM, which is ultimately controlled by the UNFCCC, has strict rules and procedures, one of the main reason for its success. The same respondent does not seem feasible the RLC market in WEEE, besides he does not believe that this market interest all manufacturers and distributors of EEE industry. The respondent 7 points out that, there is a difference between RLCs and the goals of recycling of WEEE. The credits should be issued by third parties that are part of an environmental service, and in the case of companies that have legal obligations as demanded by BPSW, but go beyond the stipulated goals (17%), they could sell this excess. In the carbon market, within the CDM, this procedure is widely used by businesses that exceed the target emissions stipulated by the Kyoto Protocol, to neutralize their impact and fulfill the treaty. Companies nowadays can buy CERs generated by a series of clean and renewable energy projects (UNFCCC, 2016a,b), and this model might also work with the RLC market, with a company that is obliged to dispose of WEEE buying the equivalent of that in credits from a company with surplus of that. In this point, there is a small difference in comparison to the CDM, because in the latter polluting companies buy CERs from renewable projects, or throughout a stock exchange.

These companies buy the credits issued by third-party projects that use low emission or no emission technology (Table 4).

Indeed, the structure required for the commercialization of RLC is the same as that of CDM, regarding the issues previously discussed. The RLC market can avoid undesired environmental costs of WEEE landfilling or dump siting (regarding life cycle of landfills and GHG emissions) for one hand, and the cost avoided or the incomes through WEEE materials and components recycling (regarding the energy consumption along the product life cycle, recycling and respective GHG emissions), on the other hand. However, there are some issues to be addressed in Brazil yet, which are considered essential for the commercialization to become effective and accepted as presented in Fig. 2.

As presented in Fig. 2, these specific aspects involve the following necessities: i) Obtainment of legal support from Government, such as a decree with guidelines, which can be an instrument of Law 12.305/2010; ii) Identification of a recognized institution for trading of credits, such as a Stock Exchange; iii) Identification of companies performing reverse logistics activities, such as recycling, remanufacturing or reconditioning and companies available to buy the credits; iv) Definition of how these credits will be remunerated and, v) Identification of which supervisory institution will be

Table 5
Main findings of category 3.

Issues	Findings
Legal support	There is no specific document, manual, bill or legislation regulating the RLC market. Some law specialists believe that the BPSW raises the possibility of RLC market.
Precedents	Some organizations sell credits of scrap tires, which was motivated by the creation of Reciclanip (association responsible to promote the reverse logistics of scrap tires); RLC of packaging motivated by BPSW has already been sold.

involved, in order to define how documentation or certification will be required from companies performing RL activities, to give account of the correct disposal of WEEE.

4.3. Existence of legal support for the RLC market

With regard to the existence of legal support, Respondent 1 believes that there is no legal authority to support the creation of the RLC market. On the other hand, Respondent 2 believes that there is the legal support, but he does not know any document or regulation to find this information. The Respondent 4 states: "I believe that the establishment of quotas for industry, as happened with the tire industry can stimulate manufacturers to receive equipment from other brands, to meet quotas, and help to reduce the impact caused by the 'grey products' in the environment". The respondent 7 states that some law specialists believes that the BPSW raises the possibility of creation of RLC market, because the law is very comprehensive.

Respondent 5 does not believe that is possible, at the current time, to implement the RLC market, but stated that in Brazil the sale of certificates of waste tires has already occurred. In this context, there is a successful case of reverse logistics on tires through the creation of Reciclanip, which is a nonprofit organization that seeks to meet the CONAMA Resolution no. 258/99, establishing liability on the producers for product recovery. However this entity does not sell credits but only manage reverse logistics. Additionally, the Environmental Stock Exchange BVRio, has already sold RLC of scrap tires and packaging (Table 5).

It is important to emphasize that the BPSW, Law no. 12.305/2010 has a comprehensive interpretation of adequate destination of waste. Some law specialists' state that in this legislation there is support to create the RLC Market; however this is a contradictory aspect. It would be necessary to regulate the trading of these credits with a proper and specific decree, linked with the law (Caiado et al., 2014). There is also an ongoing negotiation between an Environmental Stock Exchange and the Brazilian Government in order to provide this legal support. However there is no concrete document, formalizing these issues yet.

4.4. Operational feasibility of the RLC market

Regarding the prospect of operational feasibility of the RLC market, six respondents agree that it is feasible because it could be a "facilitator instrument", however they point out that it should not be the only way of achieving the goals established by the BPSW and the proclamation of sectorial agreements of reverse logistics of WEEE. On the other hand, Respondent 5 is not in accordance with the operational feasibility of this proposal. As well as Respondent 6, he states that just skilled reverse logistics providers could operate in this market. Both Respondents 5 and 6 disagree of the systemic compliance of the RLC. Nevertheless, respondent 3 pointed out the importance in the definition of who and how much to pay for the RLCs. Respondent 4 also considers the RLC market feasible because

Table 6
Main findings of category 4.

Issues	Findings
Operational feasibility	6 respondents agree and nominate RLC as a "facilitator instrument" to attend the BPSW; 2 respondents do no agree, because this market needs skilled reverse logistics providers to operate.
Economic feasibility	It is important to define who and how much to pay for the RLC; the assignment of sectoral agreements could establish the economic rules.
Legal feasibility	Necessity of government support; necessity of definition of clear rules, such as carbon credits market; it would be necessary the existence of licensed companies and a 'legislative loophole'

the WEEE can be measured and recorded, therefore the operation of RLC is feasible.

When asked about what means could be used to make the RLC market a reality, it was noted that two respondents, 1 and 7 agree that the missing element is the government's support for the role definition of the stakeholders. Respondent 2 stressed that: "The government should install an efficient system of managing information and establishing clear parameters in the same way the CDM – Clean Development Mechanism works", The opinion of Respondent 5 converges with this idea, stating that there should be clear rules of operation such as the carbon market, which is already well established.

One of the stakeholders, Respondent 6, cites that RLC market is not economically feasible, and this opinion goes against the speech of Respondent 3 that states that there is the pressing definition of the financial issue, but there are also several possibilities for implementation of the RLC market, with or without government involvement. Furthermore, Respondent 4 states that, considering the sectorial agreement, there would be ways to deploy this market immediately, but it would be necessary the existence of licensed companies and a 'legislative loophole' in order to for the RLCs to be traded in a reliable manner (Table 6).

4.5. Comparison of RLC and carbon credit market

Regarding the comparison of RLC and carbon credits markets we found that 5 stakeholders agree that RLC could be reflected in existing market for carbon credits. The main similarity of these two markets is related to the purpose of protecting the environment. Respondent 4 also states that RLC could be similar to the tire waste market. However, it is important to emphasize that it is still object of a bill no. 581/2009, which provides for the prevention and environmental degradation caused by waste tires and environmentally appropriate final destination for manufacturers, importers and reformers. Respondent 3 emphasizes that the RLC market could be reflected in the carbon credit market, but the establishment of parameters is difficult because one must determine whether the credits would be assessed by percentage recycled surplus or recycled by weight, amongst others. Two of the respondents (5 and 6) disagree with the comparison of the two markets, and respondent 8 has no opinion about this issue. However, Respondent 7 pointed out some aspects that would be critical to define a the regulation of this market, which are: Quantities of each material contained in each electronics and amount of WEEE collected, which will depend on the established mechanism of the RLC market (Table 7).

4.6. Obstacles of RLC market

Regarding the obstacles that could derail this market, Respondent 1 highlights the support and encouragement of the government. Two respondents (3 and 5) agree that the exact def-

Table 7
Main findings of category 5.

	Carbon credit market (CCM)	Reverse logistics credit market (RLC)
Purpose	Protecting environment	Protecting environment
Legal support and guidelines	Clear rules	No definition
Parameters	Clear paramers of GHG emissions	There is no clear parameters. There is a doubt whether credits would be assessed by percentage recycled surplus or recycled by weight, amongst others possibilities
Executing agency	Designated operational entity	Environmental Stock Exchange
Compliance of rules	Auditing firms or Independent auditors	No definition
Issuance of credits	UNFCCC	No definition

Table 8
Main findings of category 6.

Main obstacles	
Support and encouragement of Brazilian government	Informality in recycling in Brazil
Lack of transparency	High recycling costs
Definition of parameters	Interest for some parts of WEEE, such as precious metals and not for other parts – need to RLC for each part.
Standardization of RLC market	Demand from stakeholders (manufacturers and distritbutors of EEE).

inition of the parameters that regulate such a market can be seen as an obstacle to the feasibility of RLC market. Another difficulty mentioned by one of the stakeholders (Respondent 6) was the lack of transparency in the process. Moreover, respondent 4 stressed that there is currently a great informality in the recycling process in Brazil, which can be a barrier to the market, and there are also many companies which seek only to profit, recycling only the parts and materials most profitable to them and not the complete WEEE. Another obstacle cited by respondent 3 is the issue of cost, because the parts of WEEE can have different recycling costs, which should have a regulation for the creation of the appropriate RLC for each part of WEEE.

Regarding the need of government support in the standardization of the RLC market, Respondent 2 states that: "The WEEE management needs economic instruments for the feasibility of targets". This idea meets the opinion of Respondent 4, s who believes that government support is a "natural way". Three respondents (3, 5 and 7) agree that government intervention would be a reality if the stakeholders demand it, as well as whether this mechanism has proven more effective than other proposed (Table 8).

4.7. Ways of reward and demand for the RLCs of WEEE

Regarding the reward of RLCs, two respondents, (3 and 7) stated that it would be priced by the market, i.e., supply and demand. Respondent 5, pointed out that it could be managed by an entity that regulates the market, as a sort of stock exchange of environmental assets. Respondent 4 believes that the compensation could be made through tax incentives for both parties, producers and recyclers.

The majority of the respondents, five of eight, agreed that the creation of credit is feasible under the environmental point of view, Respondent 5 disagrees with the environmental feasibility and Respondent 6 states that does not matter what model of management adopted, whether there are concrete goals to be fulfilled. On the side of those who advocate for its viability, we can highlight the statement of Respondent 4: "It is impossible to prohibit the sale of the RLCs, imagining that there will not the manufacturers who will actually do the recycling process, but third parties, who will transfer their credits."

Table 9
Main findings of category 7.

Issues	Findings
Priced by the market (supply x demand)	Considering that third parties can operate the reverse logistics, they will commercialize the credits, there is no way to avoid it.
Entity regulating the market (such as Environmental Stock Exchange)	Responsibility of government or private companies
Tax incentives	Economic incentives would be positive

With regard to the demand for the RLC trading, the respondents agree that there would be a consumer market if the trading was compulsory and if regulations are created for it. Some respondents argue that the government should be responsible for regulating the market and others that should be the private sector. There are some reports supporting the stock exchanges of waste, where the information about waste is exchanged and the materials discarded by some companies are acquired by others, it could be considered as a model for the RLC market.

When we analyze the results, it seems likely that there is a market interested in purchasing the credits, as highlighted by Respondent 2: "The WEEE represents, among the categories prioritized by BPSW, the fastest growing in terms of consumption. Therefore, the agents are motivated to realize economic incentives as positive.T̈herefore, stakeholders agree that the RLC market can become a reality, but according to their responses, it is noticed that there are still many issues and parameters to be equalized for the RLC market becomes to become a reality (Table 9).

4.8. Synthesis of main findings

The main findings pointed out in each section above can be synthetized in Table 10.

The positive impacts of the RLC proposal applied to WEEE management are related to economic and social incentives rather than to environmental ones. The preliminary reverse chains addressed by the RLC of packages and tires will provide efficiency measures and experiences to improve the WEEE system, as well as the commitment of the involved agents can support the maintenance of this economic incentive mechanism. On the other hand, there are some obstacles, such as the lack of governmental support and the high informality among cooperatives and associations, what may cause important disrupts in this system. Table 11 presents the comparison between the RLC and carbon credits.

According to Table 11 RLCs similarities to the existing carbon market are astounding, although there are still many questions that remain unanswered mainly regarding the market mechanisms of the RLC. In the existing CDM, projects have to undergo a series of strict steps in order to be eligible for carbon credit emissions. These steps are regulated by the UNFCCC. Market mechanisms in Brazil are still needed for the RLC market to emerge. The research shows that the commercialization of RLC for WEEE requires a structure that should be established in Brazil. After the research with the specialists and the comparison with the carbon credit market, it was noted that some elements should be developed to ensure that RLC are effectively implemented:

Table 10
Synthesis of main findings.

Category	Main findings
Commitment in RLC of WEEE reverse logistics	- All respondents know RLCs; - Most stakeholders believes that, in future, RLC market will be applicable in WEEE reverse logistics, but not at the moment.
Commercialization of RLCs of WEEE	- It could operate in a similar way to carbon credits; - Necessity of creation of a mechanism for documentation and management of WEEE generated and collected by SINIR; - It works only if a structure very well controlled and audited was created, because compliance would be the essential factor; - The RLCs should be issued by third parties that are part of an environmental service.
Existence of legal apparatus for RLC market	- There is no regulated document related to RLC market, as in the case of Forest Code and the Bill tax for post-consumed Tires.
Operational feasibility of the RLC market of WEEE	- There is no feasibility at the moment; - Just qualified reverse logistics providers could operate in this market; - There is no systemic compliance of the RLC; - Lack of government's support for the mandating and define the role of stakeholders; - It should be established clear parameters in the same way the CDM — Clean Development Mechanism; - It is pressing the definition of financial issue, but also there are several possibilities for implementation of the RLC market, with or without government involvement.
Comparison of RLC of WEEE and carbon credits markets	- The RLC market could be reflected in the carbon credit market, but the establishment of parameters is difficult because one must determine whether the credits would be assessed by percentage recycled surplus recycled by weight.
Obstacles of RLC market of WEEE	- Lack of the support and encouragement of the government; - Lack of the exact definition of the parameters that regulate the RLC market; - Lack of transparency in the process; - Great informality in the recycling process in Brazil, which can be a barrier to the market; - Companies interested in recycling only the parts and materials most profitable to them and not the complete WEEE.
Ways of reward and demand for the RLCs of WEEE	- it would be priced by the market, i.e., supply and demand; - It could be made through tax incentives for both parties, producers and recyclers; - There would be a consumer market if the trading is compulsory and if regulations are created for it; - There is a demand for RLC market, considering that WEEE represent, among the categories prioritized by BPSW, the fastest growing in terms of consumption.

1) The necessity of a legal support from Government, such as a decree with guidelines, which can be an instrument of Law 12.305/2010;
2) The necessity of an institution for trading of credits, such as a Stock Exchange;

Table 11
Comparison between RLC and carbon credits.

Category	RLC	Carbon credit
1) Price	Market prices, established by supply and demand needs.	Market prices, established by supply and demand needs.
2) Sources	Recycling batteries, tires, electronic equipment or lubricant oils, amongst others, can create RLCs.	Carbon credits can have many origins, such as hydro, Forest sequestration, wind farms, amongst others.
3) Regulation	There isn't until the present moment an exact definition of how this market will function.	There is a verification and validation step, all regulated under very strict policies created by the UNFCCC.
4) Buyers	The buyers would be those with mandatory recycling targets established by the BPSW.	The buyers are the Annex I countries with mandatory emission reductions, but there is also a very large voluntary market.
5) Sellers	The Sellers can be either big companies that would recycle for their own targets and sell the surplus or specialized recycling companies selling the RLCs.	The sellers are those who invest on a clean Technologies or low emission projects instead of highly pollutant ones.

3) The necessity of identifying companies performing reverse logistics activities, such as recycling, remanufacturing or reconditioning and companies available to buy the credits.
4) The necessity of determining how these credits will be remunerated;
5) The necessity of identifying which regulatory or supervisory institutions will be involved, in order to define how document or certification will be required from companies performing RL activities, to give account of the correct disposal of WEEE.

Among the highlighted elements, the definition of legal instruments, regulatory institutions and the trading company are essential aspects of coordination for this process. In turn, the definition of potential and engaged companies in this sector, as well as the remuneration mechanism for companies, can be considered market aspects. Therefore, the real use of this unprecedented and promising mechanism requires the discussion of aspects of marketing coordination and legal regulation. Political aspects and financial interests may be an obstacle to the development of these elements in Brazil.

5. Concluding remarks

The majority of the interviewed stakeholders agree that the credit market for reverse logistics is a possibility, but at the current moment there are multiple obstacles to its implementation. One of the main barriers that emerged was the government's support for the regulation of such market, and the lack of registration of all WEEE as proposed by SINIR. In addition, the operational costs of reverse logistics of WEEE, considering that Brazil is a country of continental dimensions was also appointed as major obstacle by stakeholders.

The issue of "orphan products" should be addressed by the government and rules for this kind of waste should be created. Besides that, there is the need to sort out the third party certification for the viability of RLC to be credible. As established in Law no. 12.651/2012, related to the Forest Code, which defines the existence of environmental reserve quotas for compliance, it would be necessary, the existence of the legal support as such for the trading of RLCs. If the government takes the initiative to regulate the market for WEEE RLCs, it will be possible that the implementation of

RLC market is materialized in Brazil. It should be emphasized that this is listed as one of the main difficulties and concerns in enabling the RLC market by respondents.

Regarding the comparison of RLC with the carbon credit market, some stakeholders state that it is possible; however, there are still many aspects to be developed before it becomes a reality. The carbon credit market is well defined with clear parameters, compliance, controlling and auditing aspects. Besides, the creation of the CDM was essential to guarantee the reliability of this market, however the Brazilian RLC market still does not have any legal apparatus to work, no organization to control and audit the market, and no support from government. It can be considered a problematic issue, since the government will supervise the attendance of the BPSW. Furthermore, it is important to define financial issues and mechanisms of registration by SINIR to ensure the transparency in the process.

It is important to point out the limitations of this study. The first one refers to the number of sampling, which was composed by people engaged in companies or institutions that deal with e-waste in Brazil. Regarding this, it is important to emphasize that it is a case study and, the criteria to choose the interviewed was the representativeness and accessibility, which implies that chosen people should be engaged in organizations that have some importance in the segment of e-waste and whom that participated in discussions related to e-waste in Brazil. Additionally, other limitation refers to the focus in a Brazilian context.

Therefore, it is suggested that future researches study this issue in other developing countries, in which the context is similar, regarding the management of e-waste and players involved. Besides that, it is suggested the study of the economic feasibility of RLC market, as well the study of other mechanisms to assist entities responsible for recycling and proper disposal of WEEE. Also it is important to study the creation of RLC for other categories of waste established in BPSW.

The contribution of this article lies mainly in the study of RLC of WEEE as a possibility in Brazil, as an alternative to companies involved in the productive chain of EEE to meet the demands from BPSW, as this issue is not studied yet. The comparison of the RLC market with CDM can also provide insights for researchers and practitioners in order to deepen the study of mechanisms for the implementation of this market. Furthermore, some companies and sectors can benefit from this study because it highlights the opportunities, obstacles, ways to reward and the existence of demand for RLCs, besides aspects related to operational feasibility and legal apparatus for the materialization of the RLC market. This study can also serve as a theoretical basis for other RLC markets related to other categories of residues.

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