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DRIVERS OF ECO-INNOVATION WITHIN WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT FIELD

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Abstract
The need for eco-innovation in the waste electrical and electronic equipment field (WEEE, e-waste) raised not only from environmental or sustainable reasons, but also from economic and social perspectives. This article provides an overview of the literature regarding eco-innovation and distinctive ways to consider its determinants or drivers. In addition, it presents the most important drivers on eco-innovation in European Union. Moreover, it reports specific determinants on eco-innovation in the waste of electrical and electronic equipment field, namely: regulation, policies, funding sources for stimulating eco-innovation, projects related to eco-innovation, cost-savings, customer benefits, knowledge transfer networks, youth education through specific courses, stimulating environmental consciousness, and product standardization.
Keywords: drivers, eco-innovation, knowledge transfer, WEEE.

1. INTRODUCTION

As European Commission (2012) defines it, “eco-innovation is any innovation resulting in significant progress towards the goal of sustainable development, by reducing the impacts of our production modes on the environment, enhancing nature’s resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources”. According to European Commission, it seems that eco-innovation includes both technological and non-technological innovations forms “that create business opportunities and benefit the environment by preventing or reducing their impact, or by

optimising the use of resources" (European Commission, 2012). One of the fields in need for eco-innovation is the electrical and electronic equipment field.

Waste electrical and electronic equipment poses a significant risk to the environment for two main reasons: first, the volume in which it is produced; and secondly, due to the environmental impacts associated with waste recycling (currently the most prevalent method for dealing with this type of hazardous waste in Europe).

This field is one which may contribute to greenhouse gases emissions reduction, so innovation is necessary in order to reduce the produced waste, or to reuse the waste products, to recycle it or to recover waste or materials. Boosting eco-innovation in the WEEE field, means discovering the factors that contribute to its development. Indirectly, eco-innovation helps fighting climate change, and offers new answers to old global problems.

2. OVERVIEW OF THE LITERATURE

Before describing the term of eco-innovation, we consider important to mention some suggestive aspects regarding the concept of innovation and invention. Although they have a similar meaning, innovation refers in general to the realization of new products or services on the market, while innovation is considering more a creation of a new process or activity. Whatever the situation, in order to exist, both versions must be validated by the market (in other words, there must be a producer willing to carry out and a consumer who wants to buy them). A suggestive illustration of this is shown in the figure 1.

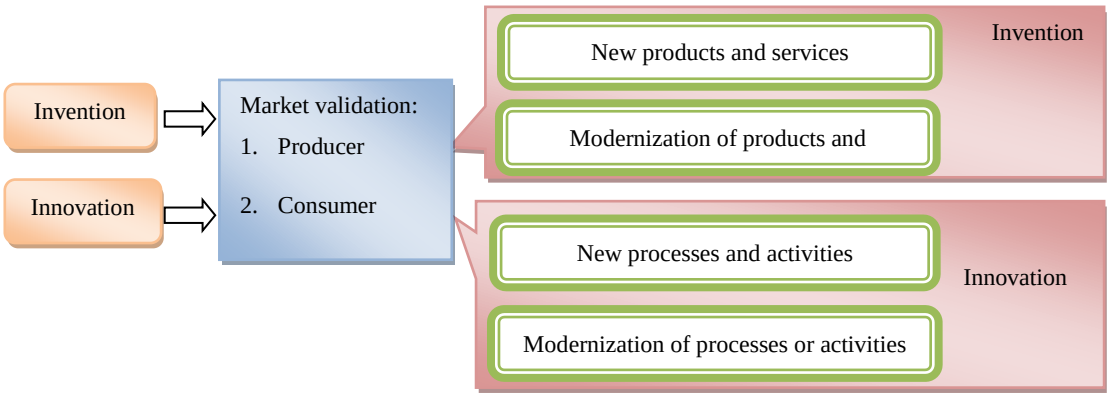

FIGURE 1 - RELATIONSHIP INVENTION – INNOVATION AND MARKET VALIDATION
Source: authors' conception

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Regarding the Eco-innovation concept, we can specify that it is a relatively new concept, born almost two decades ago, when authors started to mention it in their works and developed their researches around it. For instance, Fussler Claude and Peter James are said to be the first ones who used the concept in 1996, in a book called "Driving Eco-Innovation: A Breakthrough Discipline for Innovation and Sustainability" (Morand, 2006). One year later, Peter James daringly defines eco-innovation as "new products and processes which provide customer and business value but significantly decrease environmental impacts" (James, 1997). It seems that till deciding to name it eco-innovation, it was called "innovation toward sustainable development" (Rennings, 2000).

Eco-innovation is part of the "eco-terms" family, along with eco-industry and eco-efficiency. Eco-industry refers to every relevant player on the world markets and a driver of competitiveness in that market (Eco-innovation Observatory, 2011). Eco-efficiency refers to "creating more goods and services while using fewer resources and creating less waste and pollution" (International Institute for Sustainable Development, 2013). Technically speaking, eco-efficiency "is measured as the ratio between the (added) value of what has been produced (e.g. GDP) and the (added) environment impacts of the product or service (e.g. S02 emissions)" (Yu et al., 2013). Furthermore, eco-innovation cannot exist without eco-efficiency. As we stated earlier in this paper, the two broad concept (invention and innovation) cannot exist without a market validation. The same principle is valid for the concept of eco-innovation, which should be accompanied by terms of eco-efficiency. From this point of view, considering the continuous degradation of the environment due to economic development and growth of the last century, the concept of eco-efficiency should be present in every human activity and should not be confined to eco-innovation.

Eco-innovation is a driving force for sustainable development, but is also driven in its turn by several forces. They are often called internal or and external factors (del Río, 2009), or demand-pull, supply-push and regulation drivers (Belin et al., 2011). Rennings (2000) describes the determinants of eco-innovation as: technology push (material efficiency, product quality, product palette, energy efficiency), regulatory push/pull-effect (existing environmental law, standards on Occupational Safety and Health, expected regulation), and market pull (customer demand, image, labor costs, new markets, competition, market share).

Another study (Rave et al., 2011) investigates the objectives and determinants of eco-innovations revealing that cost pressure, dynamic incentives, the opportunity to introduce new products, environmental policy are among the most important. Moreover, it provides new evidence on firm-specific and sector-specific driving forces of eco-innovation.

In the literature, authors separate these forces into several categories. For instance, del Rio (2013) analyzes the main determinants of eco-innovations across different firm sizes (small and large) and firm age (new and old), determinants specific to product or process eco-innovations, or determinants specific to new-to-the-market versus new-to-the-firm eco-innovations. The author proposes several hypothesis and tests them through econometric means. As results, some determinants are common to both small and large firms, some are specific in accordance with size of the firm. The same situation could be mentioned for process or product eco-innovations. For example, reduction of unitary energy/material costs and size. Regarding the age firm, both new and old firms are influenced in similar ways, and there is no clear difference between them. All these research works treat eco-innovation and its determinants or drivers, in general, and not regarding to one special field. Referring to the WEEE field, there are few studies that treat specific factors that contribute to eco-innovation, especially from the macro perspective. O'Hare et al (2006) suggest that the three most significant drivers for eco-design within the specific industry of medical electronics can be grouped under the headings: regulation, sustainable procurement, and competition-driven innovation. A study of Eco-innovation Observatory (2014) regarding eco-innovation in Italy mentions that particular focus should be given on refining and recovering valuable substances such as rare earths and precious metals, with a view to continuously improving the environmental sustainability in the treatment of this particular type of waste. The study presents some drivers or barriers on eco-innovation, namely: the policy mix that points towards supply side compared to demand side measures, the availability of risk capital for eco-innovative projects / start-ups, organisational aspects and limited efficiency gains due to complex bureaucracy and fragmentation of the eco-innovation governance within the public administration system, the strong legal framework concerning environmental protection, social awareness with regard to needs and opportunities in the context of sustainability and ecoinnovation, the diffusion of good practices regarding eco-innovation. From the point of view of electrical and electronic equipment producers, the criteria to implement eco-design in Romania were identified in Ciocoiu, Banacu and Târțiu (2011). The study identifies 4 groups of criteria (socio-economical, technical, legislative and company characteristics) that may affect a successful implementation of eco design, and the results show that company characteristics (company's size, activity field, commitment of the senior management, commitment of the employees, the budget for R&D in eco-design and innovation) are the most important drivers. We will further try to analyze some determinants of eco-innovation in the waste of electrical and electronic equipment field from a macro perspective.

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3. ECO-INNOVATION IN THE EUROPEAN UNION

The Eco-Innovation Observatory is an initiative of the European Commission offering "integrated information source on eco-innovation for companies and innovation service providers, as well as providing a solid decision-making basis for policy development" (Eco-Innovation Observatory, n.d.).

In the Eco-Innovation Observatory database we can find an index called Eco-Innovation Scoreboard, which provide an assessment on eco-innovation performance across the 28 EU Member States. It includes indicators that describe five important aspects: eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes and socio-economic outcomes (Eco-Innovation Observatory, 2015). Based on the data retrieved from the Observatory's database, we constructed the figure 2, with evidence on the best performers in eco-innovation in 2013. There are no more recent data, but observing the chart, we can mention that the best five eco-innovators are Sweden, Finland, Germany, Denmark, and United Kingdom. The results are interpreted in relation to the European Union's average value set to 100. Many countries have a score under the EU average, achieving a smaller level of eco-innovation. Bulgaria, followed by Poland and Cyprus are among the countries with the lowest score.

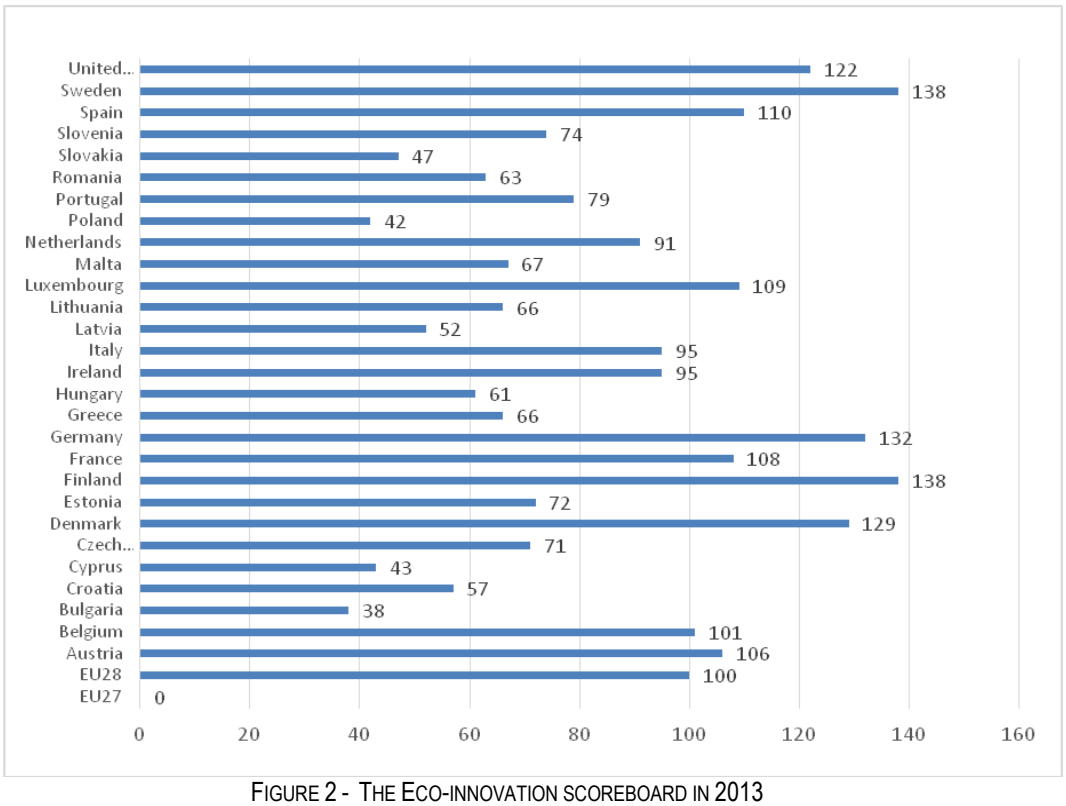

FIGURE 2 - THE ECO-INNOVATION SCOREBOARD IN 2013
Source: authors after the Eco-Innovation Observatory database (2015)

In 2011, the Eurobarometer No.315 provided data on the main drivers for eco-innovation, as considered very important by around 5000 managers from small and medium sized enterprises from countries in European Union. Among the 14 drivers for eco-innovation considered within the study, we selected the five most important for EU-27 (European Commission, 2011a):

- Expected future increases in energy prices;
- Current high energy prices (as an incentive to innovative, to use less energy and decrease the cost);
- Current high material prices (as an incentive to innovate to use less material and decrease the cost);
- Good business partners;
- Secure or increase existing market share.

4. DETERMINANTS OF ECO-INNOVATION IN THE WEEE FIELD

Among the most important drivers of eco-innovation in the waste of electrical and electronic equipment field, we identified:

a) Product standardization

The process of standardization refers to setting up similar uniform characteristics to goods or services, reducing their variety. It also incurs the creation of standards regarding technical aspects of the product. By standardization, the consumer cam make a more informed decision when buying certain goods. In the waste management field, standardization helps reducing waste by assuring a compatibility among components. For instance, standardized labels may help consumer in choosing a recyclable product, or some recyclers in order to trace components of hazardous waste.

OECD (2009) explains that "standards are emerging that aim at stimulating sustainable manufacturing and eco-innovation by creating demand both within firms and among consumers". Not only that standards stimulate eco-innovation, but they also help in spreading the new eco-friendly technologies, products or services by predetermine demand.

b) Stimulating environmental consciousness

Environmental consciousness refers to a type of behavior that characterizes a consumer's decision on purchasing eco-friendly products. This concept is closely related to the one of willingness to pay more

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toward environmentally friendly products. This products may refer to: recycled materials, biodegradable packages, chlorofluorocarbon or CFC free sprays, products conserving energy when in use, products that mitigate the emission of greenhouse gases and others. Stimulating consumers to buy such products requires studying the factors decisive for influencing their choices. Laroche et al. (2001), consider that these factors can be grouped into five categories: demographics, knowledge, values, behavior and attitudes. The most important one is knowledge, which influences the consumer in the decision making process. Laroche et al. (2001) discuss that the decision is influenced by the amount of information used and by how it is gathered and organized.

c) Youth education through specific courses

Education on waste and waste recycling stimulates eco-innovation by providing a learning experience capable to improve the ability of learners to make informed waste management decisions. Courses, workshops and other educational programs in the waste field, provide not only training for participants, but also support for solving waste management problems.

d) Funding sources for stimulating eco-innovation

In general funding opportunities are designed to assist different entities to develop projects in the waste field. These funds may come from grants or subsidies, national or international programmes, state schemes. For example, the National Environment Agency from Singapore has a co-funding scheme called 3R Fund (Reduce, Reuse, Recycle) "to encourage organisations to undertake waste minimisation and recycling projects" (National Environment Agency, 2013).

Projects that have an eco-innovative character in their development, could gain funding from different sources. This funds can cover up sometimes to 50% of the eligible costs of the project. For instance, the Eco-innovation initiative is a scheme of the European Union, directly offering a chance to public or private bodies to fund their projects, and indirectly improving and protecting our environment (European Commission, 2015a). Another initiative is Recycling Innovation Fund developed by New South Wales Environment Protection Authority. One of the three main areas covered by the fund is Innovation in Priority Problem Wastes Management (Environment Protection Authority, 2015).

e) Projects related to eco-innovation

Projects developed around the eco-innovation idea, have an important role in promoting it in the worldwide. The reduction in the environmental impact of products or processes used, is the aim of any eco-innovation, so projects developed around this aim are contributing to economic, social and

environmental improvements for countries, companies and society. We will list several projects related to eco-innovation:

- Eco-Innovation Observatory (EIO). It is an initiative developed as a platform which "aims to provide a much-needed integrated information source on eco-innovation for companies and innovation service providers, as well as providing a solid decision-making basis for policy development" (Eco-Innovation Observatory, n.d.).
- Environment and Innovation (EU INNO). This is a project developed by Sustainable Europe Research Institute (SERI), with the aim to assess "emerging environmental concepts and technologies in terms of their proponents, their potential for further use and their implications for future EU environmental policy as well as for the objectives of the Lisbon Strategy and Sustainable Development Strategy" (SERI, 2015).
- ECO-INNOVERA. This is a platform which "focuses on the support of eco-innovation in research and development" (Eco-innovera, 2015), by providing information, offering support to entities in different areas on eco-innovation and building up a network for them.
- WEEElabex. The 'WEEE label of excellence' or WEEElabex is a project financed from an environmental programme of European Commission, having to major objectives: the first one refers to designing standards related to all processes (collection, sorting, storage, transportation, preparation for re-use, treatment, processing and disposal – according to WEEElabex Organisation (2013)) concerning the waste of electrical and electronic equipment, and the second one is to monitor companies through audits.

g) Regulation

Regulation is known for its stimulating role on eco-innovation. The existing relationship between regulation and eco-innovation was studied by Kesidou and Demirel (2010), who revealed that regulatory requirements influence eco-innovations in less innovative companies. Other authors consider that eco-innovation are "an induced outcome of regulation" (Ahmed & Kamruzzaman, 2010). Even if we talk about performance standards, technology controls, or emission limits, each regulatory measure encourage firms to eco-innovate. For instance, in the WEEE field, the EU Waste Electrical and Electronic Equipment Directive (WEEE) 2012/19/EU and the Restriction of Hazardous Substances Directive (RoHS) 2011/65/EU are two such regulations, that all member states of European Union must comply with.

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h) Policies

Among the most known policy regarding the WEEE, is the one called Extended Producer Responsibility or Product Stewardship. Practically, when products reach their end of life period, the producer should manage the product, either voluntarily, either with help from another company, in order to find an effective way for its disposal (Capel, n.d.). The product's or good's components may be reused or recycled. Many companies conduct in this regard, reuse, buy-back or recycling programs. Another policy is Integrated Product Policy which, according to European Commission (2015b), seeks to mitigate the environmental degradation "by looking at all phases of a products' life-cycle and taking action where it is most effective".

j) Customer benefits

This factor refers to the situation when customers are willingness to pay for a product that could bring added value or a certain benefit. For instance eco-innovations regarding baby foods or clothes bring substantial benefits to customers, as they seem to respond very well to their demand.

In their work abstract, Horbach, Rammer & Rennings highlight that "Customer requirements are another important source for eco-innovations, particularly with regard to products with improved environmental performance and process innovations that increase material efficiency, reduce energy consumption and waste and the use of dangerous substances". For instance, in the WEEE field, we can mention benefits as the improvement in the health and safety of local communities, by using eco-innovations in the recycling process for e-waste.

The Eco-Innovation Observatory provides statistics on Current or expected market demand from customers for environmental innovations (% of total firms) in 2008. This indicator describes, according to the Observatory, the "share of total companies declaring current or expected market demand from customers for environmental innovations as relevant". So, the share of total companies declaring demand for eco-innovation in Finland is 15.82%, almost two times greater than the one registered at the level of European Union with 28 states, 7.85%, and only 1.23% in Bulgaria (figure 3).

k) Cost-savings

According to Belin et al. (2011), cost savings refer to energy or material savings potential of eco-innovations. They also refer to waste management cost reduction by using eco-innovation solutions. The economic benefits generated through cost savings transform themselves in a factor contributing to the development of eco-innovation. Crespi and Quatraro (2015) also recognize the importance of cost savings, considering them as "motivations for eco-innovation".

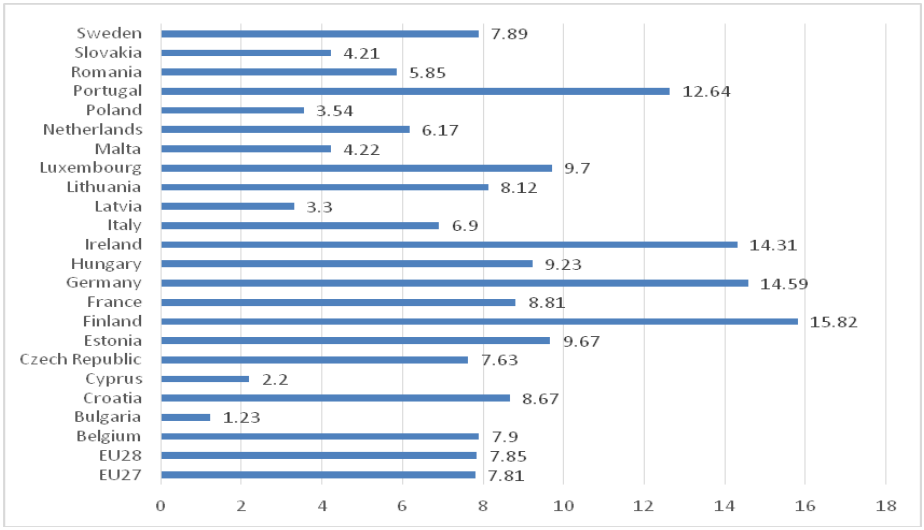

FIGURE 3 - CURRENT OR EXPECTED MARKET DEMAND FROM CUSTOMERS FOR ENVIRONMENTAL INNOVATIONS (% OF TOTAL FIRMS)
Source: authors after the Eco-Innovation Observatory database (2015)

I) Knowledge transfer networks

OECD (2011) presents in a report, the importance of the knowledge transfer networks in United Kingdom, considering that they are "an interesting way to bring research and industry together" and that they provide "an easy means of acquiring and sharing knowledge" (OECD, 2011).

The European Commission reports in a press release that "more than 70% of SMEs pointed to the need for good business partners and good access to external information and knowledge, including technology support services to accelerate eco-innovation uptake and development" (European Commission, 2011b).

According to Barsoumian et al. (2011), networks were developed to support innovation and achieve better environmental performance. Various types of networks (clusters, poles of excellence, and technology platforms) are bringing together stakeholders in their field of interest. Some suggestive examples in this regard are (OECD, 2010):

- In France were developed in 2004, the competitiveness clusters which combine the experience of business, research and education in order to conduct innovation projects in specific country sectors.
- In Greece were developed the innovation poles that focus on environmental issues and bring together industry, companies, education and research institutes.

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- In United States was developed The Green Suppliers' Network which helps "small and medium-sized manufacturers stay competitive and profitable, while reducing their impact on the environment" (OECD, 2010).
- Particularly in the field of waste of electrical and electronic equipment, we can offer several examples of networks focused on transfer of knowledge and best practices in the field:
- WEEEZO, a project developed in partnership by Norway and Poland (International Development Norway, n.d.);
- RECDEV, a project developed for specialized training in the WEEE field (RECDEV, n.d.) with its Innovative 3D training platform for recycling of waste electric and electronic devices;
- OpenIDEO, a collaborative platform for innovation in waste area (OpenIDEO, n.d.).

4. CONCLUSIONS

Regardless the diversity of eco-innovations and their area of implementation, there are several factors that trigger eco-innovation. These factors are seen as drivers for eco-innovation and emphasized in the literature as important determinants. Among those presented in this paper, we can appreciate the following: always, regulation puts pressure on entities to develop and use eco-innovations in order to reduce the negative impact of their activity on the environment; cost savings are among factors that motivate companies to eco-innovate from an economic perspective; knowledge transfer networks, in any of their forms, are among recently explored factors that improve the eco-innovative capacity of firms.

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