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Grau en Enginyeria Química

Treball Final de Grau

Mechanisms to achieve sustainable consumption trough eco-innovation.

Mecanismes per assolir un consum sostenible a través de l'eco-innovació.

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Today, nations, companies and institutions around the world are looking for the formula for growth. A big part of the solution lies in sustainable innovation.

Muhtar Kent

En primer lloc, voldria agrair al meu tutor, el Dr. Joan Mata Álvarez, per confiar en mi, creure en el projecte i sobretot, per guiar-me, ajudar-me i aconsellar-me durant tot aquest temps.

A la meva família per ser-hi, per creure, encoratjar-me i per la paciència que han tingut durant tots aquests anys, no només durant aquest grau, sinó al llarg de tota la meva vida.

I finalment als meus amics i companys per animar-me a seguir endavant, donar-me bons consells i principalment ser una part indispensable d'aquesta etapa.

CONTENTS

SUMMARY

This project is based on a research study of the different ways and mechanisms to achieve sustainable development by making a smarter use of resources, while reducing the negative effects of our economy on the environment, creating economic benefits and competitiveness.

Before starting an eco-innovative project, the pros and cons should be balanced and defined. It is important to identify the barriers to a circular economy which are many and varied. From the opposite position, the drivers enable and help recognize the conditions that benefit environmental innovation. This work focuses on the most important barriers and drivers previously formulated and their classification

On the other hand, it deepens in the different most outstanding theoretical models of today (The Circular Economy Model and the Green Solow Model), that allow to analyze the eco-efficiency, emissions and the environmental damages produced. Also, the work evaluates the eco-innovation performance across the European Union member states and the eco-innovation index and scoreboard developed by the Eco-Innovation Observatory. Worldwide clean technology has been studied, as well as the Global Cleantech Innovation Index classification of companies and countries.

As far as the national and international sphere is concerned, the work has been based on a study of many companies that are already immersed in eco-innovation and how they have improved the situation in the market by achieving a positive impact on the economy and society, developing a commercializing successful innovative solution. Five companies have been selected (Fruits de Ponent, Gamesa, Nestlé, Coca-Cola and Levi's) and their innovative projects and benefits obtained have been studied thoroughly.

Keywords: Eco-innovation, sustainable development, circular economy, innovative projects

RESUM

Aquest projecte es basa en un estudi de recerca de les diferents maneres i mecanismes per assolir un desenvolupament sostenible fent un ús més intel·ligent dels recursos, reduint al mateix temps els efectes negatius de la nostra economia en el medi ambient, generant beneficis econòmics i avantatges competitius.

Abans de començar un projecte eco-innovador, els pros i els contres han de ser equilibrats i definits. És important identificar les barreres a una economia circular que són moltes i variades. Des de la posició contrària, els controladors habiliten i ajuden a reconèixer les condicions que beneficien la innovació ambiental. Aquest treball es centra en les barreres i conductors més importants formulats prèviament i la seva classificació.

D'altra banda, s'aprofundeix en els diferents models teòrics més destacats de l'actualitat (The Circular Economy Model i el Green Solow Model), que permeten analitzar l'eco-eficiència, les emissions i els danys ambientals produïts. A més, s'avalua el rendiment de l'eco-innovació als estats membres de la Unió Europea i l'índex i el marcador d'eco-innovació que ha desenvolupat l'Observatori d'Innovació Eco-Eficient. S'ha estudiat la tecnologia neta en un àmbit mundial, així com la classificació de l'índex d'innovació Global Cleantech d'empreses i països.

Pel que fa a l'àmbit nacional i internacional, el treball s'ha basat en un estudi de moltes empreses que ja estan immerses en l'eco-innovació i com han millorat la situació del mercat aconseguint un impacte positiu en l'economia i la societat, desenvolupant una innovadora solució comercialitzador d'èxit. S'ha seleccionat cinc empreses (Fruits de Ponent, Gamesa, Nestlé, Coca-Cola i Levi's) i s'han estudiat a fons els seus projectes i beneficis innovadors.

Paraules clau: Eco-innovació, desenvolupament sostenible, economia circular, projectes innovadors

1. INTRODUCTION

Over the past years, the phenomenon of environmental pollution, irreversible climate changes, and growing resource insufficiency have increased at an alarming speed and become a major preoccupation for society. Companies, particularly those in the pollution intensive industries, are blamed to be the main contributors to the current environmental state. However, pressure from the government and market incentives has forced companies to be innovative in their business operations in the pursuit of both environmental and economic goals.

1.1. ECO-INNOVATION

Since the beginning of the twenty-first century, the diffusion of eco-innovation in the corporate world has got research underway. Recently, eco-innovation in the corporate setting has gained more attention in many areas such as academic articles, in addition, it is being applied in the industrial sector across the world. Therefore, the adoption of eco-innovation is increasing among companies. Different solutions are being produced to reduce the environmental effect in some stages of the supply chain from production, consumption to disposal. Business management alternatives and public policy also play a significant role in accelerating eco-innovation development and implementation. Companies are progressively adopting these practices by incorporating them into their corporate strategies in order to improve business competitiveness. Nevertheless, the current efforts of firms on eco-innovation persist ambiguous, as well as how firms might manage it to gain a competitive advantage, and particularly, the future researches that will advance the development and knowledge of eco-innovation to reduce environmental impacts.

The concept of the circular economy has become well-known since it was introduced by policy makers from China and the European Union as a key for empowering countries, firms and consumers to lessen the damages to the environment and to close the loop of the product life cycle. The industrial revolution’s linear model whose abusive scientific and technological innovation didn't take into account the collateral damage on the environment and the continuous harm they were causing to the society.

A shift to a circular economy needs eco-innovations to close the loop of the products lifecycle, creating added valued products, meeting the environmental standards and keeping economic progress going. In the literature, the term eco-innovation has various interpretations [1] [2]:

Fussler, C. and James, P. (1996)	*"Is the process of developing new products, processes or services which provide customer and business value but significantly decrease environmental impact"*
Andersen, M. M. (2002)	*"Innovation which is able to attract green rents on the market"*
Arthur D. Little (2005)	*"Sustainability-driven" innovation is "the creation of new market space, products and services or processes driven by social, environmental or sustainability issues"*
Europa INNOVA (2006)	*"The creation of novel and competitively priced, goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for all, with a life-cycle minimal use of natural resources (materials including energy and surface area) per unit output, and a minimal release of toxic substances"*
Kemp, R. and Pearson, P. (2007)	*"The production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives"*
European Commission (2007 to 2013)	*"Any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy"*

Charter, M. and Clark, T. (2007)	*"A process where sustainability considerations (environmental, social, financial) are integrated into company systems from idea generation through to research and development (R&D) and commercialization. This applies to products, services and technologies, as well as new business and organization models"*

Increasingly, countries in the world have adopted measures to promote the circular economy. Japan and some European countries, for example, have already established strategies compatible with circular economic activities. In China, the circular economy has been endorsed by the central government as a fundamental approach for achieving sustainable development. In 2008, the Standing Committee of the Chinese 11th National People's Congress passed the Circular Economy Law and ex-Chinese President Hu Jintao immediately signed it into law [3].

1.2. ECO-INDUSTRY

A broader definition of eco-innovation could have an implication on our understanding of eco-industry. One could say that the definition of *"eco-industry"* should be extended to contain also companies whose innovations qualified as eco-innovations for being less environmentally harmful than relevant alternatives. Eurostat and OECD define eco-industries as *"activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes technologies, products and services that reduce environmental risk and minimize pollution and resources"* (European Commission, 2006) [4].

Bruce Tether in the United Kingdom and Anthony Arundel and Hugo Hollanders at UNU-MERIT appointed all innovative firms to one of four mutually limited categories, depending on the way every firm innovates. Following this, eco-innovators could be classified in one category on the base of how they present environmental innovations [5]:

- Strategic eco-innovators: involved in eco equipment and services areas, develop eco-innovations for sale to other firms.
- Strategic eco-adopters: purposely implement eco-innovations, either developed in-house, obtained from other firms, or both.
- Passive eco-innovators: process, organizational, product innovations etc. that outcome in environmental benefits, but there is not specific strategy to eco-innovate.

- Non eco innovators: No activities for either planned or unintended innovations with environmental profits.

An eco-industrial park is a sector of industrial ecology, which has analogies from natural ecosystems to human industrial systems. Implementing an eco-industrial park can bring environmental, social and economic benefits. Material and energy exchanges between different actors in the area can evolve by themselves over a long period of time. Besides, eco-industrial parks can be planned for a completely new area or around existing operations.

In the literature, the term eco-industrial park is known under different ways, there are some definitions [6] [7]:

Peddle, M.T. (1993)	*"A large tract of land, sub-divided and developed for the use of several firms simultaneously, distinguished by its shareable infrastructure and close proximity of firms"*
Côté, R.M and Hall, J. (1995)	*"An industrial system which conserves natural economic resources; reduces production, material, energy, insurance and treatments costs and liabilities; improves operating efficiency, quality, worker health and public image; and provides opportunities for income generation from use and sale of wasted materials"*
Lowe, E. (1995)	"A community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resources issues including energy, water and materials. By working together, the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would have realized if it optimized its individual interests"
President's Council on Sustainable Development (2005)	*"A community of business that co-operate with each other and with the local community to efficiently share resources (information, materials, water, energy, infrastructure and natural habitat), leading to economic gains, gains in the environmental quality and equitable enhancement of human resources for the business and local community"*

2. OBJECTIVES

The main objectives set for the realization of this work are the following:

- Go deeper into the knowledge of eco-innovation, in order to achieve a sustainable economy and a better future.
- Analyze and be mindful of the barriers and connectors that make possible the implementation of eco-innovation within the circular economy.
- Analyze the situation and performance in terms of eco-innovation within the European Union and around the world.
- Discover and know the theoretical models that allow the calculation of eco-efficiency and the environmental damage caused to the environment.
- Get to know the national and international eco-innovative companies and identify the projects that have been developed to be sustainable and the benefits obtained once implemented.

3. BARRIERS AND DRIVERS

Eco-innovation is *a* key component of sustainable development due to its complex nature in term of its role and types of innovation (eco-innovation product, process, organizational, marketing, social and systemic). The implementation of the eco-innovative product is dependent on several aspects and it is essential for an accurate development to analyse the possibilities and limitations.

The drivers are factors that enable and encourage the transition to a circular economy, while the barriers are technical/financial impediments or regulatory/cultural holdups that complicate transitions to a circular economy.

3.1. BARRIERS

There are several researches regarding progress towards a circular economy in countries, sectors and firms. The most relevant barriers determinant to eco-innovation could be classified in three groups such as: external, internal, and international factors. The main barriers to the development of innovative activity have been identified as the lack of funds in the enterprises, lack of external financing, uncertain demand in the market, uncertain return from investment, unhelpful regulations, lack of knowledge and experience.

In Ukraine the corruption of public officials has had one of the most restrictive impacts on eco-innovative activities of enterprises. Ukraine has the lowest position of eco-innovative efficiency compared with Germany and Poland [8]. But despite the different levels of eco-innovativeness in Ukraine and the European Union members, the principal barriers and drivers to eco-innovation are roughly identical in all of these countries. Particularly worrying barriers to fulfilling the circular economy, a report by Chatham House (The Royal Institute of International Affairs) [9] recognised the following: high up-front costs, complicated international supply chains, resource-intensive infrastructure lock-in, failures in company cooperation, lack of consumer enthusiasm and limited distribution of innovation, through both emergent economies and developed countries.

In other reports, researchers from Centre for European Policy Studies [10] in 2014 surveyed and investigated the most important studies related to eco-innovation. Even though the benefits of the circular economy are progressively recognised, there persist a range of barriers to the transition which include:

- Lack of investment in products, design and production which enable better re-use remanufactures, repair and recycling
- Recent levels of resource estimating which generate economic signals that do not encourage efficient resource use and innovation
- Deficiency of enough incentive owing to the internalization of externalities through policy or other measures
- Non-cooperating and discrepancies of power and incentives among actors to increase cross-sector performance
- Lack of information, know-how and economic incentives for basic components in the supply and maintenance chain
- Deficits in consumer awareness
- Insufficient waste separation at source
- Reduced sustainable public procurement incentives in most public agencies
- Lacking investment in recycling and recovery infrastructure, innovation and technologies
- Difficulties in obtaining suitable finance for such investment
- Limitations in policy coherence at different levels
- Widespread planned obsolescence in products

Several of these barriers are specific to particular materials, products and sectors, needing different types of actions at the European Union, national, regional and local level according to the nature of the barrier faced. In SME's (Small and medium-sized enterprises) [11], in 2015 also used a report review and studied two case studies. They enumerated six principal barriers for the development of a circular economy, explicitly: environmental culture, financial barriers, limited government support, the absence of effective legislation, information deficits, administrative burdens, and relatively low technical skills.

Despite the increasing efforts, there is a necessity for an exhaustive identification of the conditions needed for a circular economy, especially when the concept is related with eco-innovation.

3.2. DRIVERS

The economic investment in innovation is normally based on expectations of higher income level or at the least keeping a positive return on investment. On the other hand, the motivation to assume environmental innovation is substantially complex and might be accepted even when it is not beneficial. Environmental innovation can be driven by such factors as accidents, vision, competition, regulation, and consumer pressure.

Indicators of motivations and drivers behind environmental innovation can help recognize the conditions that benefit environmental innovation and the situations in which environmental management works. Questions on the firm’s incentives for environmental innovation can be formulated as innovation goals. Eco-innovative drivers imply a compliance with present regulations, pre-empting possible future regulations, social responsibility, cost savings and capture of a market for new product. Currently there is a massive focus of how firms can arrange themselves to comprehend the opportunities of eco-innovation and sustainability in ways that will benefit and be acceptable to society and also generate the value that permits them to stay in business. The strategy proposed is based on understanding how businesses have managed the ideas of business social responsibility and eco-efficiency, exploring how they are now handling innovation and technology and finding methods that will bring these approaches together in today’s and tomorrow’s economies.

Principal companies have built their strategies to sustainable development upon principles that can be brief as:

- Guaranteeing the corporation comprehends what society expects of it, in return expressing obviously what the firm itself stands for, then underlining these values in ways that stretch the organization and produce a spirit of incessant improvement.
- Developing methods and tools to improve implementation across the social, environmental and economic pillars of sustainable development and integrating these tools in routine company processes.
- Establishing focused aims and putting in place the resources to measure performance and confirm the targets are being reached.

When it comes to classify the main drivers in the eco-innovation, they have been defined by the following authors in different ways [12] [13]:

Table 1. Eco-innovation drivers

	Drivers
Green, K. (1994)	Cost savings, collaboration or networking, change in supplied components for productivity improvements, personal commitment, environmental regulation, market competence, market share increases and customers pressures
Porter, M. and Linde, M. (1995)	Productivity increasing and cost saving by monitoring, better resource utilization, environmental regulation, substitution of less costly materials or better utilization of materials, costumers demand, reduction of resource inefficiency and waste minimization
Florida, R. (1996)	Productivity increases, research and development, supply chain management, customers demand, technological improvements, environmental regulation, corporate citizenship, relationship with end user and supplier

Rennings K. and Zwick, T. (2003)	Capturing new markets, regulation, demand from users, cost reduction and firm's reputation
Mazzanti, M. and Zoboli, R. (2006)	Firms involvement in group and networking activities, innovative oriented industrial relations, environmental policy related costs, R&D and voluntary environmental schemes
Horbarch, J. (2008)	Technological capabilities developed by research and development investment or further education of the employees, policy stringency and regulatory measures customer demands and public pressure

When asked about the drivers of eco-innovation, respondents justified the phenomenon of corporate responsibility to produce a solution for environmental impact through a municipality owned and operated organization. It is intensely related with environmental motive and targets to create an efficient community which is sustainable in the long period. Environmental responsibility is an important issue for them to make eco-innovative solutions. Their eco-innovative force and motivation might overcome the techno institutional barriers to bring about their anticipated solution.

To conclude, the main drivers which describe in a better way how it benefits firms and environment in general terms are [14]:

- New consumers interested in innovative experiences, less prone to own products.
- Improved services aspiring to fulfil more needs and closer relationship with clients. Looking for a greater loyalty and more opportunities for differentiation and solving customer desires, creating great experiences.
- Legal and policy changes, through regulations on the durability of products and against planned obsolescence. From promotion of circular economy and banning on planned obsolescence.
- Decommoditization, across differentiation from commodities that compete only for prices, across changing a commodity to a unique experience.

- Decreasing environmental impact through less pressure on materials and energy. Making emphasis on durability, efficiency and closing loops, in this way to contribute to a better world.

Several previous studies and empirical evidences were drawn to find the drivers of eco-innovation, there are three major categories of drivers. The general innovation is mainly induced by demand and supply factors, but also, regulation and policy:

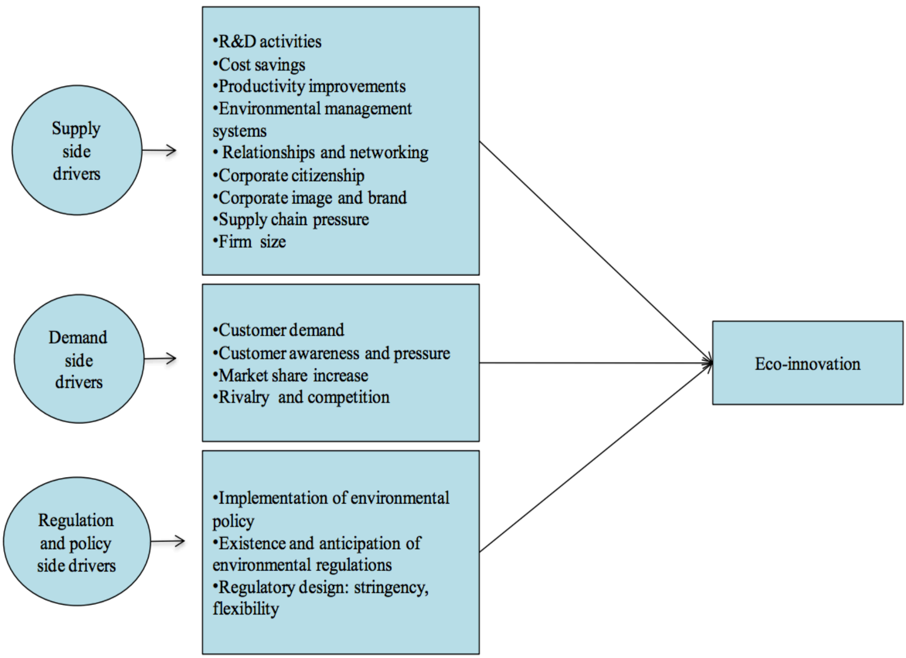

Figure 1. Conceptual drivers model of eco-innovation
(Shohana Ahmed and Mohammad Kamruzzaman, 2010 via Drivers of eco-innovation)

3.3. HARD AND SOFT BARRIERS AND DRIVERS

Given the complementary nature between the hard and soft drivers/barriers, and the obvious fact that they are not always easy to separate in practice, is applied the hard-soft dichotomy to the circular economy transition. It differentiates between hard factors, the more closely related to techno-economic trajectories, and the soft ones, associated with regulatory and cultural issues. Summarized in the following table:

Table 2. Hard and soft barriers and drivers

		Barriers	Drivers
Hard factors	Economic / Financial / Market	High initial costs, significant transaction costs, large capital requirements, asymmetric information and uncertain return and profit	Demand-side trends (rising resource demand and consequent pressures resource depletion) and supply-side trend (resource cost increases and volatility, leading to incentives towards solutions for cost reduction and stability)
	Technical	Lack of technical support and training, inappropriate technology and lag between design and diffusion	Availability of technologies that facilitate resource optimization, re-manufacturing and re-generation of by-products as input to other processes, development of sharing solutions with superior consumer experience and convenience
Soft factors	Cultural / Social	Rigidity of consumer behavior and businesses routines	Environmental literacy, Social awareness and shifting consumer preferences
	Institutional / Regulatory	Lack of a conducive legal system, misaligned incentives and deficient institutional frame work	Associated with increasing, environmental legislation, environmental standards and waste management directives

4. GLOBAL ECO-INNOVATION DEVELOPMENT

4.1. EUROPEAN UNION ECO-INNOVATION

In times of deep technological and social transformation, the competitiveness of the European economy and the well-being of European citizens depend on the capacity of companies to develop and successfully commercialize innovative solutions. Innovation increases efficiency, push up business productivity and supply important benefits to consumers. In order to evaluate the eco-innovation performance across the 28 EU Member States, the Eco-Innovation Observatory has developed an eco-innovation index and scoreboard. The Eco-Innovation Observatory works as a platform for the structured collection and study of an extensive range of eco-innovation information from across the European Union providing an integrated information basis on eco-innovation for companies and solid decision source for policy development.

The Eco-Innovation Scoreboard (Eco-IS) helps Member States to evaluate efficiency, the progress on strategic aspects and recognize policy priorities. On the other hand, the Eco-Innovation Index is a tool to measure and exemplify eco-innovation performance across the EU Member States, it indicates how well individual Member States perform in different dimensions of eco-innovation compared to other EU countries and presents their strengths and weaknesses. The index complements other measurement methods of innovativeness of EU countries and purposes to stimulate a general vision on economic, environmental and social performance [15].

This graphic summarizes the main results from the 2017 Eco-Innovation Index across the 28 European Union countries, where the eco-innovation index average is 100.

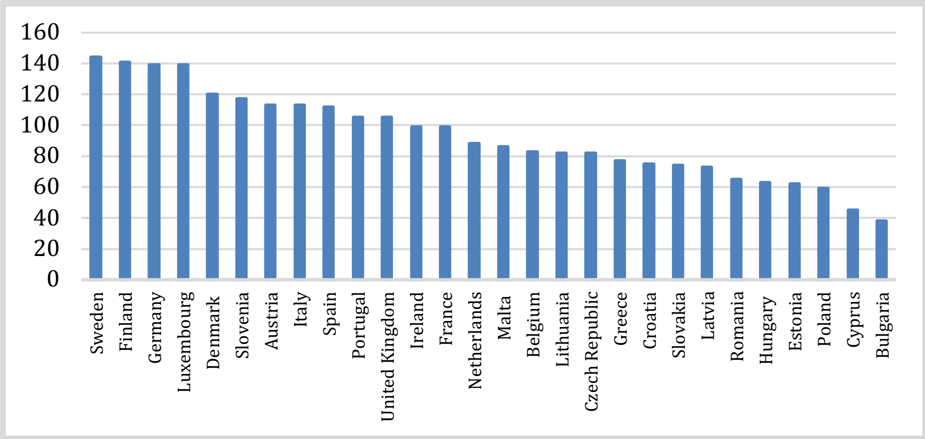

Figure 2. Eco-Innovation index 2017

(Stefan Giljum, Burcu Gözet and Asel Doranova, 2018 via Eco-innovation)

As seen in the graph, in the 2017 Eco-Innovation Index, Sweden leads the ranking of all EU countries, with an aggregated score of 144. Finland (141), Germany and Luxembourg (139 each) follow very closely. Nine Member States obtained scores around the EU average of 100.

Compared to the 2016 edition of the Eco-Innovation Index, most countries achieved a similar eco-innovation index, minor changes in positions can be observed. However, Sweden moved up from 5th rank in 2016 to the leading position in 2017, while Luxembourg dropped from 1st rank in 2016 to 4th in 2017. Most notably, Malta moved upwards (from rank 23rd in 2016 to 15th in 2017), while Latvia ranked only 22nd in 2017, down from 15th in 2016.

The Eco-Innovation Index and Scoreboard aim at capturing the different aspects of eco-innovation by applying 16 indicators grouped into five thematic areas [16] (Appendix 1):

- **Eco-innovation inputs:** Include investments (financial or human resources) aiming to generate eco-innovation activities. The indicators in the Eco-IS include: Governments environmental and energy research and development (R&D) appropriations and outlays, total R&D personnel and researchers and finally, the total value of green stage investments.
- **Eco-innovation activities**: Focus on efforts and activities which companies in a specific country are active in eco-innovation and the indicators to monitor the range

and scale of this activities. In the Eco-IS include: Firms declaring to have implemented innovation activities aiming at a reduction of material input per unit output, firm's implementation of innovation activities looking for a reduction of energy input per unit output and environmental management system.

- **Eco-innovation outputs:** Calculating the outputs of eco-innovation activities in terms of patents, academic literature and media contributions. The indicators are: Eco-innovation related patents, eco-innovation related academic publication and eco-innovation related media coverage.
- **Resource efficiency outcomes:** Relate to effects of eco-innovation on improved resource productivity. Generating two positive impacts on resource efficiency: it can increase the generated economic value, while at the same time reduce pressures on the natural environment. In the Eco-IS include: Material productivity, water productivity, energy productivity and greenhouse gas emissions intensity.
- **Socio-economic outcomes:** Exemplifying eco-innovation efficiency produces positive outcomes for social and economic aspects. This includes changes in employment, turnover or exports that can be related to eco-innovation activities. The indicators contain: Exports of products from eco-industries, employment and revenue in eco-industries and circular economy.

Table 3. Data in the five components of the Eco-Innovation Index 2017 by country [17]

	Eco-innovation inputs	Eco-innovation activities	Eco-innovation outputs	Resource efficiency outcomes	Socio-economic outcomes	Eco-innovation Index
Sweden	166	148	182	154	77	144
Finland	200	155	202	49	102	141
Germany	178	151	130	121	113	139
Luxembourg	104	124	220	183	72	139
Denmark	178	58	154	139	70	120
Slovenia	141	124	153	66	130	117
Italy	66	111	112	180	101	113
Austria	91	142	115	128	89	113
Spain	75	106	139	162	72	112
Portugal	104	134	100	107	81	105

United Kingdom	102	87	65	160	82	105
Ireland	113	58	69	174	55	99
France	118	10	107	110	89	99
Netherlands	88	38	91	111	77	88
Malta	23	116	77	163	7	86
Belgium	94	11	93	95	75	83
Lithuania	29	94	93	91	106	82
Czech Republic	81	126	49	44	111	82
Greece	57	96	142	50	63	77
Croatia	25	93	61	85	105	75
Slovakia	27	90	33	87	124	74
Latvia	41	41	105	75	110	73
Romania	53	37	55	60	113	65
Hungary	39	47	13	76	125	63
Estonia	50	76	90	2	109	62
Poland	43	17	53	38	145	59
Cyprus	4	39	113	62	6	45
Bulgaria	30	37	33	4	92	38

The performance regarding eco-innovation inputs calculated in the time period 2014 to 2017, diverged widely between the EU Member States. Denmark was by far the leading country in the observed period up to 2017 when Finland started leading. Denmark is the first in total employment and R&D personnel and researchers, while Finland, Germany and Portugal had the highest governmental R&D appropriations and outlays in the areas of environment and energy.

The second component, eco-innovation activities, top countries (except for Denmark) had high scores. With a sub-index score of 155, Finland is ranked 1st in this index component, scoring highest in indicator that shows end-user-related environmental innovations. France, the Netherlands and Belgium had low scores in this sub-index due to the fact data from the Community Innovation Survey (CIS), which is the basis for two of the three indicators of eco-innovation activities, are not available for these countries. Austria, Portugal and the Czech Republic achieved well regarding eco-innovation activities.

High eco-innovation outputs were found in most countries of the group of eco-innovation leaders. With a score of 220, Luxembourg led the ranking, essentially determined by a high performance regarding eco-innovation related publications and eco-innovation related media coverage. Also, Finland and Sweden had top-scores in the media coverage, Greece had a relatively high performance in this area. Of all EU Member States, Hungary had the lowest performance regarding eco-innovation patents, resulting in a really low sub-index score.

In the component of resource efficiency outcomes, scores across all EU Member States were quite similar. Finland (ranking 2nd in the overall index) has a strangely low score of 49 in this component. The top-performing country in this area is Luxembourg (scoring high regarding material and water productivity, but low in energy productivity and greenhouse gas emissions intensity), followed by Italy and Ireland. The lowest index scores are observed for Bulgaria and Estonia.

The fifth component, socio-economic outcomes Performance is very varied across all the countries. The high performing countries are Poland, Hungary and Slovakia with scores of 145, 125 and 124, respectively, had a better performance than the eco-innovation leaders. Poland is the best performing EU country regarding employment in eco-industries and circular economy sectors, while Slovakia was the top-scorer for the indicator of turnover (revenue) in eco-industries and circular economy sectors. On the other hand, Sweden, Luxembourg and Denmark obtained scores significantly below the EU average, they had low scores in terms of employment and turnover in eco-industries and circular economy.

4.2. WORLDWIDE ECO-INNOVATION

Cleantech is referred to clean technology, and often used with the term Greentech. It has emerged recently, comprising the investment asset class, technology, and business sectors which include clean energy, environmental, and sustainable or green, products and services [18].

Worldwide investment in cleantech technologies has been growing since 2000s and achieved the peak in 2012. The main investments are in energy generation technologies, transport technologies and energy efficiency. However, the investments are growing in the field of recycling, advanced materials, water technologies, agriculture and food.

Cleantech is applied in many industry and is defined by the following eleven sections: Energy generation, energy storage, energy infrastructure, energy efficiency, transportation, water and wastewater, air and environment, materials, manufacturing/industrial and agriculture, recycling and waste.

The new edition of the Global Cleantech Innovation Index (GCII) has just been launched. The index explores where related to gross domestic product (GDP), clean technology companies are most probable to emerge from over the next 10 years. The GCII studies the results of policies, and other related factors, on producing cleantech entrepreneurs and supporting commercialization of their companies [19].

Over the years investments for Cleantech have increased greatly in some continents, it can be observed:

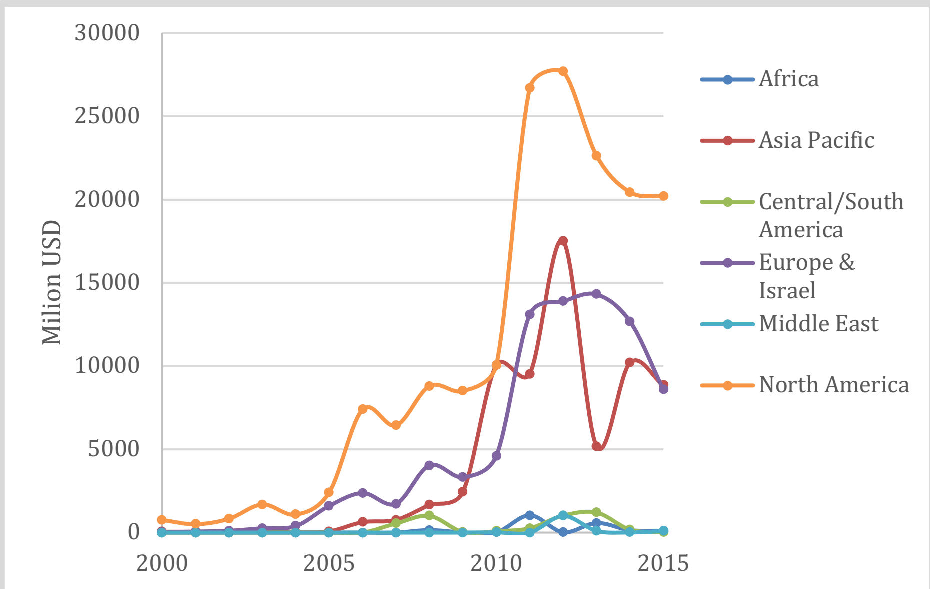

Figure 3. Cleantech investments in main World regions, 2000 to 2015

(Stefan Giljum, Burcu Gözet and Asel Doranova, 2018 via Eco-innovation)

As seen, the investments for Cleantech have been made in Asia Pacific, Europe and Israel and in North America, this last is by far which has deployed the largest amount of money for the Cleantech investments. On the other hand, in Africa, Middle East and Central and South America, investments have been null over the years. It has also been noted an economic decline since 2012.

The Global Cleantech Innovation Index is the global score for each country and is based on the average between inputs to innovation, and outputs of innovation, it explores the cleantech innovation system of 40 countries. These inputs correspond to the creation of innovation and outputs are related to the country's ability to commercialize innovation. Each of these inputs and outputs are determined by four similarly sets of indicators. The four pillars are built from a total of 21 indicators, condensed into 15, drawn from third-party research and Cleantech Group's proprietary data [20]:

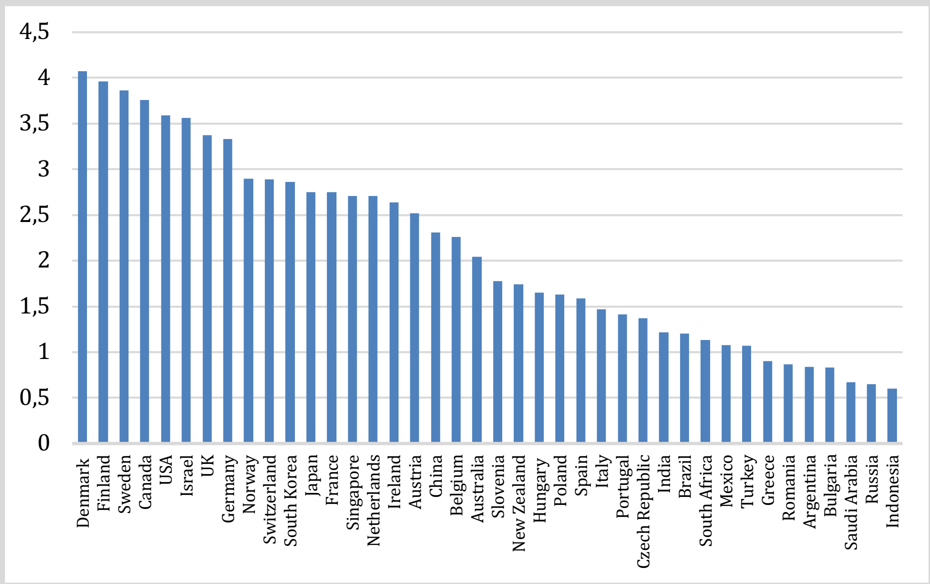

Figure 4. Cleantech countries innovation Index 2017

(Stefan Giljum, Burcu Gözet and Asel Doranova, 2018 via Eco-innovation)

The 2017 Index top performer is Denmark, Finland and Sweden take the 2nd and 3rd places respectively, which is not strange based on very strong positions in the 2014 Index. Canada and the United States complete the top five. The Nordic region performs strongly in 2017 Index where the lowest scoring Nordic country is Norway in the ninth place [19].

Denmark leads the 2017 Index, moving up from 5th place in 2014, based on solid scores in both inputs to innovation and outputs of innovation. The country stands out through its top scores for cleantech-specific drivers and evidence of commercialized cleantech. In commercialized cleantech, the country is far ahead of the other countries on the list. Also shows strong evidence of including cleantech exports, the number of public cleantech companies and the number of renewable energy jobs.

Poland has presented the major change from the 2014 Index, as it rose thirteen places to achieve 24th place. This is principally due to three increases in cleantech-specific drivers. Poland's public cleantech research and development (R&D) expenditure now sits at the global average. The country also improved its score in the Renewable Energy Country Attractiveness Index.

To conclude, there is a positive correlation between inputs to innovation and outputs of innovation. Countries that are enabling investment in innovation, either through public R&D, cleantech-friendly policy, or any other of the inputs, tend to acquire benefits from the commercialization of cleantech companies.

5. ECO-EFFICIENCY ANALYSING METHODS

There are many methods and studies that have been applied to calculate environmental damage and eco-efficiency. In general terms these are the models that are known and used with their respective formulas and methods.

5.1. CIRCULAR ECONOMY MODEL

Donald A.R. George, Brian Chi-ang Lin and Yunmin Chen have established an Environmental Modelling which is designed to focus on the ecological issues of recycling and pollution. The main purpose of this research is to present a theoretical model incorporating the concept of circular economic activities. The circular economy model is based in two types of economic resources, a polluting input and a recyclable input [21].

The social welfare function is equivalent to the discounted present value of a future utility stream dependent on consumption and the stock of pollution, the social planner maximizes this function, given by [22]:

$$U = \int_{0}^{\infty} e^{-\rho t} u(c, P) dt$$

The instantaneous utility function is given by u (c, P) where c equals to consumption and P, the stock of pollution. The parameter ρ is the rate of time preference.

The waste accumulation equation, suppose that output, q is produced via a concave production function ϕ:

$$q = \phi(x, z)$$

Using two factors of production, x (the ratio of use of the recyclable resource) and z (the rate of use of the environmentally contaminating resource, which can usefully be thought of as an extracted resource). Gradually the two inputs evolve, however at every instant in time they can be treated as independent. The unit price of using the polluting resource is symbolised by α and the total flow cost of using the polluting resource is equivalent to αz. An amount produced in any period but not consumed or used for the employment of the polluting resource, accumulates as waste, suppose a proportion β (the recycling ratio) of the waste stock can be recycled each period, and represent the waste stock as S. The dynamics of waste accumulation in the circular economy can consequently be written as:

$$\dot{S} = \phi(\beta S, z) - c - \alpha z - \beta S$$

The pollution accumulation equation depends on the level of pollution produced, the recycling ratio and the self-renewal capability of the natural environment. It is assumed that every unit of the polluting input (z) generates θ units of pollution. In each period, there also exists an amount of waste represented by (1 - β)·S that cannot be recycled for the next period. Finally, the natural environment is supposed to self-renew in a way that stock of pollution decays at a rate δ. Therefore, the net rate of environmental degradation can be written by the following contamination accumulation equation [23]. That is:

$$\dot{P} = \theta z - \delta P + (1 - \beta)S$$

The optimal growth [24] in the circular economy gives the laws of motion of equations and for the two state variables, P and S, the control variables, c and z, to maximize the social welfare function. Is assumed variables λ for the state variables S and μ for the state variable P, the circular economy can be analysed by setting up the following Hamiltonian function, where λ and μ are the discounted prices of waste and pollution, respectively:

$$H = e^{-\rho t} u(c, P) + \lambda \phi(\beta S, z) - c - \alpha z - \beta S] + \mu[\theta z - \delta P + (1 - \beta)S]$$

5.2. GREEN SOLOW MODEL

Developed by William A. Brock and M. Scott Taylor (2010) [25] which focuses on technological progress in pollution reduction and establishes the Environmental Kuznets Curve (EKC) as a necessary by-product of convergence to a sustainable growth path.

Simon S. Kuznets [26] won the 1971 Nobel Prize in Economics for his empirical interpretation of economic growth and its relation to development and social structure. A current revision to Kuznets empirical studies of development associates the increase in real per capita income to an increased demand for improved environmental quality. The common form of this environmental quality-income theory is represented as an "inverted-U" curve and is called the Environmental Kuznets Curve (EKC). This graph shows that economic development, resulting in rising per capita income, initially comes of deteriorating environmental conditions until a certain point (turning point income) after which environmental quality improves. This theoretical relation among economic growth and environmental quality has been shown to have empirical basis for certain types of contaminants (atmospheric particulate matter, sulphur dioxide, nitrogen oxides, water quality) with turning point incomes [27].

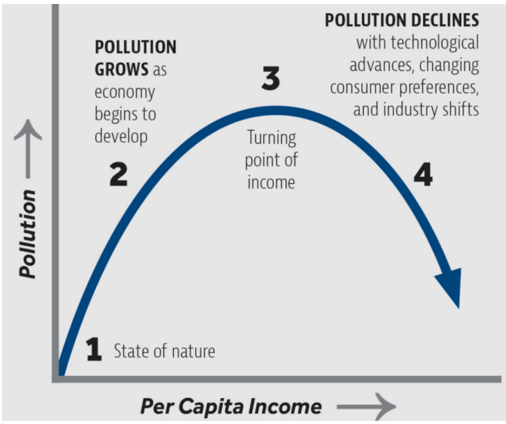

Figure 5. Environmental Kuznets Curve.

(Jon Sanders, 31/1/17 via Spotlight report)

EKC patterns are shown in the following graphs which plot the relationship between per-capita carbon dioxide (CO_2) emissions and the real GDP of China and Sweden. The pattern for each country becomes part of the inverted U-shaped curve, in line with that country's stage of economic development.

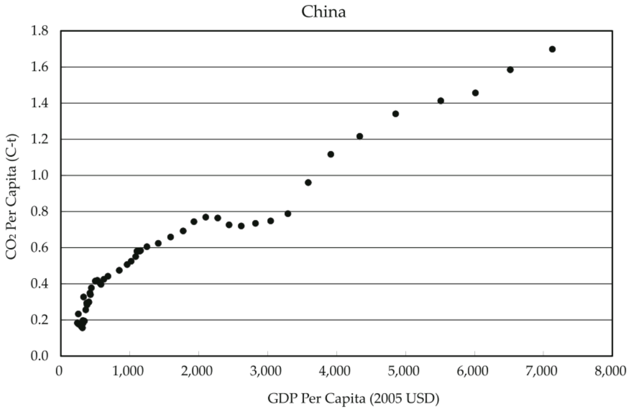

Figure 6. Environmental Kuznets curve of China.

(Uchiyama K., 2016 via Environmental Kuznets Curve Hypothesis and Carbon Dioxide Emissions)

China is a country in process of development, there is a rising curve in the graph showing the fact that the rate of increase in CO_2 emissions per GDP has increased. Moreover, it shows a descent just after the Asian currency crisis, it returned to an upward slant recently.

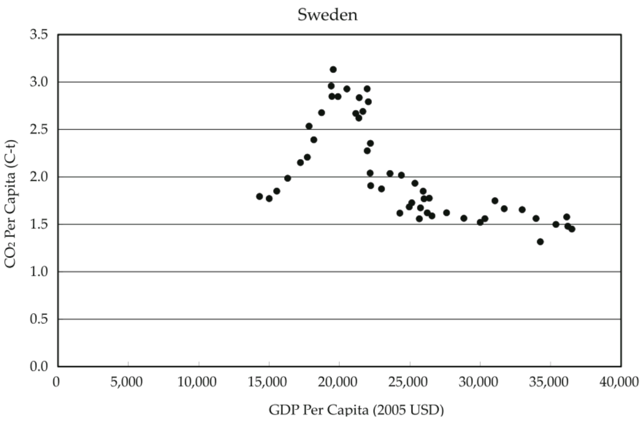

Figure 7. Environmental Kuznets curve of Sweden.

(Uchiyama K., 2016 via Environmental Kuznets Curve Hypothesis and Carbon Dioxide Emissions)

On the other hand, Sweden is an environmentally conscious country in northern Europe. This advanced nation, reached its turning point after an increasing period of CO_2 production; nowadays the curve is decreasing so Sweden's CO_2 emissions are reducing, concurrent with an increase in income.

Returning to the Solow model, it makes predictions closely in line with United Sates and European evidence on emissions, emission intensities and pollution decreasing costs. The model affords an explanation for the confusing empirical results present in the growth and environment literature, while offering a different testing methodology similar to theory.

The pollution data and the related empirical work on the EKC present three goals that need to be resolved by a theory:

- Offer a theoretical explanation for the EKC and features of reduction and emission intensity.
- Use a simple variant of the Solow model where the important drivers are technological progress for diminution and falling returns in capital.
- Develop an estimating equation for contamination convergence.

William A. Brock and M. Scott Taylor point out three key features of the United States data.

1. In Figure is shown the graphic of US data giving emissions per dollar of (real) GDP over the 1950 to 2001 period. There is plot emission intensities for sulfur dioxide, nitrogen dioxide, particulate matter, carbon monoxide, and volatile organic compounds. The emissions tendency per unit of output tend to fall during this period.

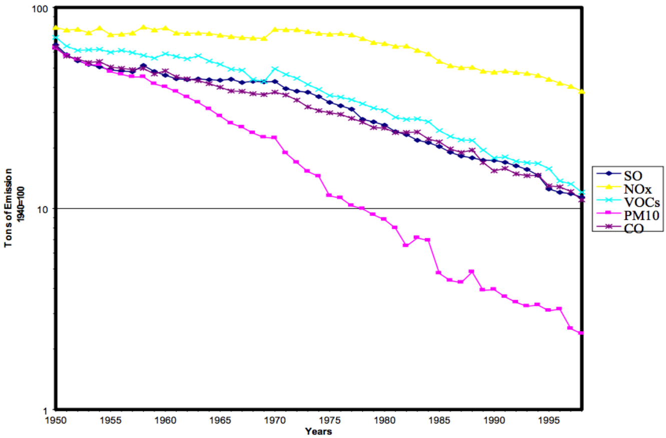

Figure 8. Emissions intensities.

(William A. Brock and M. Scott Taylor, 02/06/10 via Journal of economic growth)

2. In the next figure, there is plotted the corresponding emission levels for the same pollutants over an identical time period. It reflects a tendency for emissions to rise at the beginning then it falls over time following the EKC pattern for all pollutants except nitrogen oxides. So, the plot shows a strong confirmation of the EKC.

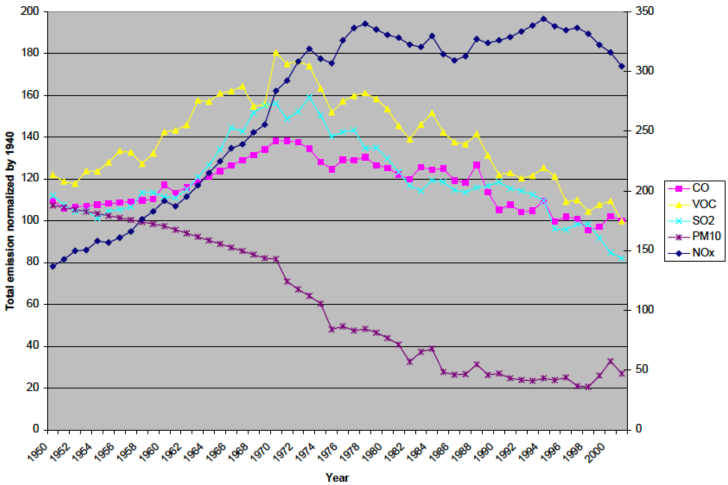

Figure 9. Total emissions by pollutant and year.

(William A. Brock and M. Scott Taylor, 02/06/10 via Journal of economic growth)

3. In the last graph there is shown a plot business expenditure on pollution abatement costs per dollar of GDP over the period 1972-1994 which are the years where data is available. As illustrated, pollution abatement costs rise quite rapidly until 1975 and then remain quite constant.

If it is considered pollution abatement costs specifically directed to the six air pollutants, the ratio is very small around one half of one percent of GDP. There is significant controversy if these statistics represent the full cost of environmental regulation, and if it is ignored the significant abatement done prior to the 1970s by cities and businesses.

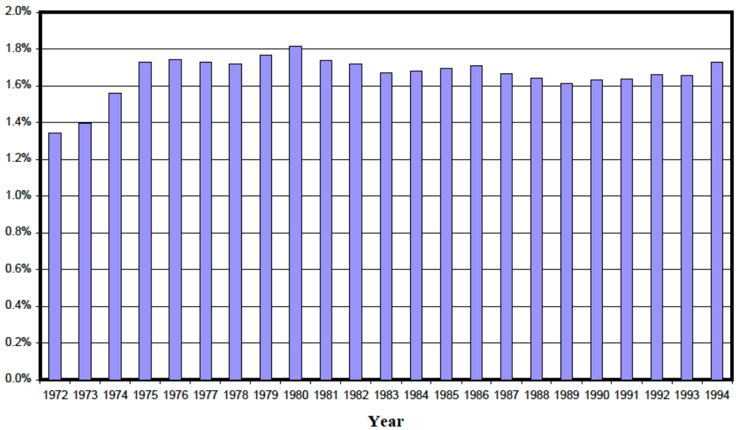

Figure 10. Pollution abatement expenditures.
(William A. Brock and M. Scott Taylor, 02/06/10 via Journal of economic growth)

The Green Solow model proposes an alternative empirical methodology closely to theory. The prediction of the model is the convergence in emissions per capita across countries. This prediction holds when the pollution in question follows an EKC shape reduction, but also holds if growth is unsustainable and no EKC pattern emerges. This convergence prediction can be evaluated in so many ways, and actually there already exists a considerable empirical literature examining convergence in pollution levels.

What the Green Solow [28] model offers is a theoretical structure that links the strength of convergence to observable variables, that makes explicit connections between theory and empirical work. Brock and Taylor developed an augmented Solow model where technological progress in both goods production and reduction leads to constant growth with increasing environmental quality. It follows the textbook Solow model to include pollution and abatement activities.

The standard production function is:

$$Y = F(K, BL)$$

where B is labour-augmenting technological progress that grows at a constant exponential rate g_B. The population grows at rate n and the capital stock grows according to:

$$\dot{K} = sY - \delta K$$

Emission of pollution are given by:

$$E = \Omega F - \Omega A(F, F^A)$$

$$E = \Omega F[1 - A(1, \frac{F^A}{F})]$$

$$E = \Omega F a(\theta)$$

E is emitted pollution; Ω is the pollution from output; F is total economic activity; A is abatement with CRS (Constant Returns to Scale) production function (A (F, F^A)) and technological growth at exogenous rate g_A; F^A is total abatement activity; θ is the fraction of economic activity dedicated to abatement.

The amount of pollution released into the atmosphere may differ from the amount produced if there is abatement. There is assumed that the abatement is a constant return to scale activity and write the amount of pollution decreasing as an increasing concave function of the total scale of economic activity, F, and the economy's efforts at abatement, F^A.

Output available for consumption or investment is then modified as:

$$Y = F - F^A = (1 - \theta)F$$

The model written in intensive form is:

$$y = f(k)[1 - \theta]$$

$$\dot{k} = sy - (\delta + n + g_B)k$$

$$e = f(k)\Omega a(\theta)$$

where k =K/BL, y = Y/BL, and e = E/BL.

Sustainable growth is guaranteed, the growth rate of emissions along the balanced growth path is:

$$g_E = g_B + n - g_A$$

The first two terms in the equation characterize the scale effect of growth on emissions since aggregate output grows at rate $g_B + n$ along the balanced growth path. The second term is a technique effect created by technological progress in abatement.

Technological progress in goods production is required to generate per capita income growth, moreover, must exceed growth in aggregate output for pollution to fall and the environment to improve. The Green Solow model traces out an EKC. To see this, it's considered the following law of motion for emission:

$$\frac{\dot{E}}{E} = g_E + \alpha \frac{\dot{k}}{k}$$

And the law of motion for capital:

$$\frac{\dot{k}}{k} = sk^{\alpha-1}(1-\theta) - (\delta + n + g_B)$$

Brock and Taylor test the hypothesis of (absolute and conditional) convergence in per capita emissions. The following equation is estimated using carbon dioxide (CO_2) emissions. They discuss that CO_2 is the best pollutant for the empirical analysis because there was essentially no abatement of CO_2 prior to 1990 so $\theta_i = 0$, carbon emissions exist for many countries.

$$\frac{\ln\left(\frac{e^c_{i,t}}{e^c_{i,t-N}}\right)}{N} = \beta_0 + \beta_1 \ln(e_{i,t-N)} + \beta_2 \ln(s_i) + \beta_3 \ln(1-\theta_i) + \beta_4 \ln(n_i + g + \delta) + \mu_{i,t}$$

The study combines the textbook Solow model and the EKC relationship. The resulting Green Solow model predicts an EKC relationship and convergence in per capita emissions across countries which does not rely on changes in environmental policy.

5.2.1. GREEN SOLOW MODEL APPLICATION

The Green Solow model generates a pattern of incomes per capita and pollution, also predicts the emissions path, peak level of emissions and the income per capita at peak emissions by country. Brock and Taylor conduct their empirical work with data on carbon dioxide emissions, focusing on carbon dioxide because carbon dioxide data exists for a large group of countries over a significant period of time. Researchers have had great difficulty in making sense of the carbon data. The estimation of the turning point for carbon are often very high and variable, and hence carbon is one pollutant that may not follow an EKC.

There are some studies which have used the Green Solow model for their projects:

Table 4. Green Solow model applications

Study	Basics
Convergence in CO_2 emissions (Vicente Rios and Lisa Gianmoena)	Based in the evolution of CO_2 emissions per capita in 141 countries during the period 1970-2014. The study extends the Green Solow Model to take into account technological externalities in the analysis of CO_2 emissions per capita growth rates. Spatial externalities are used to model technological interdependence, which implies that the CO_2 emissions rate of a particular country is affected not only by its own grade of emissions but also by the pollution produced by the remaining countries [29].
Green growth theory and evidence (Huang, Yongfu and Quibria, M. G.)	Developed a canonical Green Solow model to explore the simple analytics of the Environmental Kuznets Curve (EKC). They believe that the formulation, which deviates from the Brock-Taylor formulation in the specification of the emission function, is analytically much simpler and intuitive [30].

A Modified Environmental Kuznets Curve for Sustainable Development Assessment Using Panel Data (Valeria Costantini)	First, it develops an analytical framework for green growth, emerging a canonical Green Solow model that emphasizes the crucial roles of green investment and climate-friendly technological development in encouraging green growth. Second, it produces an aggregate index for green development based on the green growth indicators proposed by Organization for Economic Co-operation and Development (2012). Third, it uses an improved empirical version of the canonical model to explore the role of policies and other structural determinants in developing green growth. The ideas will be important for designing national polices which can change depending on different national and local circumstances, such as preferences and resources, as well as different stages of development [31].
An Alternative Argument of Green Solow Model in Developing Economy Context in India (Santosh K. Sahu and Arjun Shatrunjay)	The paper tries to understand the meaning of the Green Solow Model, in the context of a developing country such as India. It gives particular importance to the role of population density, in understanding the disadvantages of the Green Solow Model. It further prolongs the argument to study the impacts of the emission regulations on a developing country, by demonstrating relationship between price level on one hand, and abatement costs and emissions on the other. Finally, interactions between countries, given different price settings are studied [32].

6. ECO-INNOVATIVE COMPANIES

Nowadays, the current world is living a moment that demands facing global challenges whose consequences will affect the whole society. The impact of human activities on the environment is greater and greater due to the increasing of consumption of resources, energy expenditure, generation of waste and gas emissions. Companies are and should be one of the most important drivers of this change, moreover this change can be an important business beneficial opportunity. Eco-innovation is the solution and the approach of high profitability for the company and with a strong improvement for the environment in all areas. According to a report by the European Commission, the companies that opt for eco-innovation have an annual growth of 15% compared to situations of flat growth of their markets. It shows that improving the environment it is not an expense but a profitable investment [33].

Eco-innovation is a business strategy that consists in introducing any improvement in the activity of the company that supposes a business benefit and, at the same time, a benefit for the environment. The environmental benefits are focused on the reduction of waste generation and the consumption of commodity, water and energy and, as a direct consequence, emissions of greenhouse gas. The need to respond to environmental problems is not, therefore, only a challenge for governments and administrations, but companies can make a great contribution to its improvement with high profitability and environmental benefits [34].

6.1. COMPANIES SELECTION

Many companies have already submerged and boosted in order to extent eco-innovation. In this study, it was initially made a selection of 57 eco-innovative companies.

These are the 57 national and international companies that were initially considered and that have already promoted an eco-innovative project:

Matorka: Sustainable agriculture	**Mahou San Miguel:** Eco-design and automation in the cleaning process	**Zicla:** Recycled products for the urban environment
TaKaDu: Software solutions for integrated water management	**Van Gansewinkel:** Innovation in the quality of recycled materials collected	**Michelin Solutions:** Energy efficient tires
Salgot: Ecological cold meat with nutritional qualities	**Coca Cola:** Sustainability in the value chain and help for citrus farmers	**Plusfresc:** External software for warehouse supply
Vicinay Cadenas: Environmental product declarations	**SafeChem Europe GmbH:** Chlorinated solvents in a closed cycle system	**Orona:** Energy efficient lifts

Unilever: Dry shampoos that eliminate water and energy consumption	**Patagonia:** Advertising messages to encourage consumers to consume less	**Cosentino:** New products taking advantage of waste of different nature
KH Lloreda: Degreaser respectful with the environment	**Polyplank AB:** Transformation of plastic waste and wood fibers into new products	**Newlife Paints:** paint waste to make new quality emulsion paint
Microsoft: Developed an internal carbon tariff program	**Mud Jeans:** Manufacture of organic and recycled cotton jeans	**Arpe:** Innovation in the manufacture of microfiber towels by digital printing
NH Hotel Group: Strategic environmental plan with concrete measures	**Gamesa:** Eco-design that improves environmental impact and efficiency	**Alcoa:** Innovative technologies in transportation, construction materials, food…

Aqualogy: Solution to recover energy from the integral water cycle	**Axioma Solucions:** Full service of reusable surgical texture	**CAR2GO:** Offer a car sharing service
Schüco: Building solutions that save, produce and store energy	**Max Burgers:** Inform about the environmental impact of the products	**Mercadona:** Logistic model to transport more product and eco-design
Danone: New technologies for the management of carbon emissions	**3M:** Adherent film to the windows that reuses the light	**Philips:** Innovation applied in various sectors such as health care and lighting
Method: Sell natural and biodegradable products	**Ecoalf:** Create a generation of recycled textiles	**TMB:** Design and implements a more eco-efficient bus network model

Fruits de Ponent: New varieties of fruit for a better adaptation to the environment	**Freixenet:** Has robotized the operations in the cellars	**Sprint:** Reuse and recycling of used mobiles
Rolls-Royce: Provide an after-sales service for the engines	**Maersk Line:** Designs its ships with eco-efficiency criteria	**Girbau:** With eco-design, it saves labor, time and energy
Titán: Created a line of organic products with the European eco-label	**Witte y Solá:** Offer a more efficient and functional packaging	**Ricoh:** Recover obsolete multifunction equipment
Newlight: Replace plastics with others produced from greenhouse gases	**Van Houtum:** Innovative solutions for better hygiene of the toilet	**Nestlé:** Use of local raw materials from organic and proximity crops
Comexi: Maximum efficiency printing machinery	**Tarkett:** Eco-design for the pavements	**BSH:** Designs its electrical appliances to reduce its energy consumption

BASF: Produce fuel additives that reduce fuel consumption	**EPSON:** Technological innovation of printing products	**PUMA:** Sustainable packaging of their shoe boxes
LEVI'S: Innovative technique gives an approach to management of the water	**Interface:** Recovery of materials for the manufacture of carpets	**KENCO:** Redesign of the container with a recycling program

Of all these companies, a selection has been made to 5 of which the project was based on a solid eco-innovative plan and it has achieved profitable benefits for the business economy and environment as well.

The 5 selected brands, are the following ones:

National companies:

- Fruits de Ponent
- Gamesa
- Nestlé

International companies:

- Coca-Cola
- Levi's

6.1.1. FRUITS DE PONENT

Fruits de Ponent is a fruit marketing cooperative, created in 1992 in Alcarràs (Lleida). It is integrated by around 200 family units that cultivate one of the three most important producing areas in Europe. The plantations are located in Catalonia and Aragon. The company follows a growing export trend and it is the first Spanish company in stone fruit and one of the leaders of the European Union [35].

In the fruit farms, the aim of the variety of fruit is the primary factor to obtain economic profitability. Currently counting with many plants that are generally new varieties. However, the rigorous selection criteria mean that only 0,1% of them go to the market. The gravelly and drained lands of the area and the climate, with more than 900 hours of cold in winter and constant lighting in summer, favor the organoleptic qualities of the fruit [36]. They have difficulties in the markets: pressure on fruit prices, geopolitical situations that influence final sales, customer complaints... despite this, the cooperative group advances overcoming these setbacks, thanks to its strength and solidity business that has the confidence and credibility of all its stakeholders: partners, customers, suppliers and social environment.

Table 5. Data and company statics

Area	Stats and data
Hectares cultivated in production	2.500
Tons of fruit produced annually	75.000
Stone fruit produced annually	75%
Seed produced annually	25%
Production in the commercializing of domestic market	30%
Exportations	70%
Varieties originate through crosses	17.000
Plants used	140.000

6.1.1.1. ECO-INNOVATIVE PROJECT

The aim is to adopt a business behavior based on ethical, social and environmental criteria, emphasizing that the quality, hygiene and food safety of the products and services offered are a reflection of what the client expects. There is a genetic improvement program for varieties of peach, apple and pear, developed by IRTA (Institute of Food and Agri-Food Technology) together with HortResearch, commissioned by the sector and promoted by the Agriculture Department. It purposes to access to plant material of sweet fruit, develop research and technological improvement programs aimed at the generation of sweet fruit vegetable material, with a sustainable production adapted to local conditions and the needs of the international markets [37].

The company bet on the quality of fresh fruit and the preservation of the environment. On account of this, it uses the agricultural system called integrated production, which certifies the traceability of the product from the field to the expedition and guarantees the food safety of the fruit by reducing the use of phytosanitary products. It seeks to obtain varieties of products to differentiate themselves from the competence. It has as objective and necessity, to obtain a product well adapted to the conditions, innovative and differentiated, in addition to obtaining varieties of production with genetic improvement.

Within the I+D+i (Research, development and innovation, is a new research concept adapted to studies related to technological and research progress) Project, there is [36]:

- Frunatar: They have the industrial need to obtain fruit aromas of natural origin, not chemicals, to apply them to food, especially drinks, due to consumers increasingly reject products of chemical origin.
- Citorfungi: It is based on the control of fungus in the fruit through the use of natural products derived from it.

Fruits de Ponent has its own technical team and a laboratory that verify the excellence of the product. The Cooperative invests in innovation and research jointly with the University of Lleida to improve production. Likewise, it provides continuing training to all partners and workers. Since September 2010, it has implemented an Environmental Management System according to the UNE-EN-ISO 14001. Consequently, the management policy includes the protection of the environment as one of its main pillars. In 2012 started participating in the program of "Acords voluntaris" for the reduction of greenhouse gases. Furthermore, it has an energy efficiency committee that watches over good energy practices.

6.1.1.2. RESULTS

There has also been a differentiation in the market accessing to more demanding and selective markets. It has been reduced in carbon footprint, as in the application of phytosanitary products. Furthermore, it has managed to recycle 100% of the waste generated and stabilized its volume and the electricity consumption. It has managed to promote equality between men and women of the company and promote equity of workers, in addition, social and labor integration of disabled people is encouraged [38].

Table 6. Results achieved by Fruits de Ponent

Area	Improvement
Varieties of products	246
Products in the market	20
Increase in productivity per hectare	10%
Reduction of irrigation water consumption	20%
Increase of sales value	15%
Sales increase	5%
Reduction in farmer's production costs	10%
Carbon footprint	Reduction
Reduction of work accidents	12,5%
Labor integration of people with disabilities (% workers)	2,7%

6.1.2. GAMESA

In 1994 Gamesa began the business of design, manufacture, installation, operation and maintenance of wind turbines, as well as in the promotion, construction and sale of wind farms based in Zamudio (Spain). It is currently among the top ten manufacturers in the sector and presence in more than fifty countries. It has three research and development centers in Spain

(Pamplona, Madrid and Zamudio) and engineering firms resident in India, Asia Pacific, the United States, Latam and Brazil [39].

Gamesa has eight technology centers around the world in which it develops technological innovation projects and provides the necessary technical support to the different activities of the company. The eco-design methodology was introduced as a management system for the design and development of products in the company. As a result of this commitment to innovation, the 5.0 MW platform emerged that consolidates Gamesa in the multi-megawatt wind turbine sector.

The installation of wind turbines, as well as the construction and sale of wind farms are, however, industrial activities with a potential impact on the natural environment. In the environmental aspect, there are global impacts on biodiversity, climate, ozone layer or acid rain and, on a local scale, on the consumption of natural resources, emissions, waste, discharges or impact visual landscape. Nevertheless, each kWh produced with wind energy has 21 times less environmental impact than that produced by oil, 10 times less than that of nuclear energy and 5 times less than gas.

The company assumes, on a global basis, voluntary commitments in the areas of sustainability, climate change and the defense of human rights and fundamental freedoms. Among the most outstanding initiatives at global level stand out [40]:

United Nations Global Compact	Since 2005, it supports and has been committed to human and labor rights, protecting the environment and fighting corruption. Annually, it publishes the Progress Report (COP).
Global Reporting Initiative	The organization since 2006, has focused on the creation of a transparent and reliable information exchange environment in terms of sustainability, through the development of a common application framework for all types of organizations.

Caring for Climate: The business leadership Platform	Since 2007, it seeks the involvement of companies and the fight against climate change. With the commitment to increase energy efficiency, reduce greenhouse gas emissions and collaborate positively with other public and private institutions.
Carbon Disclosure Project	The company collects information on the risks and opportunities identified related to climate change, emission reduction plans and the transparency of corporate actions to mitigate climate change since 2009.
Adherence to the Declaration of Luxembourg	In 2014, Gamesa is associated with the "European Network for the Promotion of Health at Work" (ENWHP). It has signed the "Letter of adhesion to the Declaration of Luxembourg", which includes the contents of the European Network for Health Promotion.
University of Cambridge Institute for Sustainability Leadership (CISL)	It has joined the United Nations Framework Convention on Climate Change (UNFCCC). In addition, in 2015 Gamesa has reaffirmed its commitment to a safe and stable climate in which the increase in temperature is limited to less than 2 degrees Celsius, with adherence to the "Paris pledge for action".

Adherence to the Diversity Charter	Since 2015, it has adhered to the Diversity Charter, promoted by the Diversity Foundation and promoted by the European Commission and the Spanish Ministry of Equality, with the commitment to respect the equality and anti-discrimination regulations.
Network of companies for a society free of gender violence	In 2015, "Companies for a society free of gender violence" joined the network through a collaboration agreement with the Ministry of Health, Social Affairs and Equality to promote awareness of gender-based violence and the employment of victims.
Advanced Management System	In 2015, it adheres to the advanced management system integrating concepts of knowledge management, total quality, management excellence, innovation and corporate social responsibility.

On October 25, 2016, the Extraordinary General Meeting of Gamesa Technologic Corporation, approved the merger with Siemens Wind Power. On April 3, 2017, the merger of Gamesa with the wind business of Siemens became official.

6.1.2.1. ECO-INNOVATIVE PROJECT

Gamesa considers I+D+i as a key element for its future development and its international positioning in the sector. The main objective of the I+D+i activities is to reduce the costs of generating power to improve its competitiveness, due to, this source plays a fundamental role in optimizing the overall costs of energy generation of electric system. In the search of the reduction of the environmental impact of the operations, different actions are carried out such as the reduction of emissions, biodiversity programs, energy efficiency activities, which require a sustainable use of natural resources; the prevention of pollution and the adequate management of the waste generated by the activities. Likewise, it seeks to make rational and sustainable use of water and manage the risks related to its scarcity.

The vision for 2025 is a recognized model for its own, differential and distinctive business model committed to creating value and sustainable development. This vision is specified in Gamesa's Corporate Social Responsibility (CSR) strategy, which works on positioning in the long term, addressing the relevant aspects for stakeholders: compliance with the global CSR policy and the policies associated with its development and the intention to turn the company into a reference partner for clients and investors and a reference model in management [40].

In 2004, the G128-4.5 MW wind turbine was designed, Gamesa's largest I+D+i project to date, with an investment of more than 100 million euros and a team of more than 150 people. The wind turbine consisted of a tower of up to 140 meters and shovels of 62.5 meters. In 2012 the G128-4.5 MW obtained the eco-design certification, guaranteeing the minimum environmental impact of the product, the greater energy efficiency and the lower energy cost throughout its life cycle. Gamesa continues to develop leading sustainable products in the market and in 2014 it achieved its second eco-design certificate [41]. The company has an important role in the wind energy industry, an industry that is a key solution for climate change, air pollution, energy security, price stability and conducts new industries and employment. It takes on the challenge of achieving carbon neutrality in 2025, it involves a process of calculation, reduction and compensation of emissions.

Some outstanding I+D+i projects in which Gamesa has actively participated in 2016 are [39]:

- Windtrust: A set of technologies that can substantially increase the reliability of wind turbines. Several technologies have been applied successfully on the rotor, the wind turbine control and the power electronics.
- Demowind: Focused on the development of new control functionalities that pursue the increase of the energy produced in certain operating conditions of the machine and the wind resource.

6.1.2.2. RESULTS

The G128-4.5 MW registers efficiency improvements in all the indicators: less use of materials, optimized production, less packaging and less civil works. Maintenance saves on lubricating oil, hydraulic oil and air filters. The number of stages in production are reduced, energy consumption and harmful substances are minimized. During the operation of a G128-4.5 MW turbine, important quantities of annual emissions of CO2, SO and NOx are avoided.

Concerning to the Organic Law for Effective Equality of Women and Men was materialized in September 2010, Gamesa signed the first Equality Plan together with the social representation. In September 2014 Gamesa reinforced its commitment by signing its second Equality Plan. In 2015, Gamesa signed three collaboration agreements with the Ministry of Health, Social Affairs and Equality to encourage the balanced participation of women and men on the board of directors, to increase the presence of women in management positions and to promote sensitivity to violence of gender and the labor insertion of victims.

This recent years, sales have grown as a result of the company's strong competitive positioning and its presence in markets, due to a diversified geographical presence, an extensive customer base, and a broad product catalog.

Table 7. Results achieved by Gamesa

Area	Improvement
Increase of G128-4.5 MW wind turbine production	Multiply by 3,4 the energy production of conventional turbines
Sales increase	32%
Benefits	300 M€
G128-4.5 MW lubricant oil saving	31.590 L
G128-4.5 MW hydraulic oil saving	2.140 L
World wind manufacturer in number of patents	9th position
Number of new wind turbine	4.262
Tons of CO2 saved every year	58 million

6.1.3. COCA-COLA

Coca-Cola is a leading consumer packaged company in Europe that produces, distributes and markets beverages. It is the largest beverage company in the world, offering more than 500 brands to the costumers. Through the world's beverage distribution system, its products are consumed at a rate of 1.800 million a day.

A strong commitment to build sustainable communities, Coca-Cola is focused on initiatives that contribute to reduce environmental impact, supporting a healthy and active lifestyle, and creating a safe work environment for its members. A healthy agricultural supply chain is essential to the well-being of the communities in which the company operates and is basic for the success of the business. Coca-Cola seek to mitigate business risk by addressing challenges to the availability, quality and safety of agricultural ingredients. The sustainability and success of Coca-Cola are not only quantified numerically; the company has been analyzing the three dimensions of sustainability for years: financial, social and environmental. It strongly bets on the development of projects related to the protection of the environment, culture and education. Specifically, within its commitment to sustainable agriculture, Coca-Cola has developed and implemented the Sustainable Agriculture Guiding Principles (SAGP) standard that seeks environmental protection, the defense of human rights and the rights of workers. The company plans to work in collaboration with its suppliers to ensure that all agricultural ingredients have a sustainable origin. In this way, Coca-Cola hopes that they will direct their work towards more sustainable practices and compliance with the SAGP standard, taking into account aspects such as carbon footprint, water footprint, fertilizer use, soil erosion or biodiversity. The promotion of sustainable agriculture is one of the pillars of the company's commitments for the future (2020 Sustainability Commitments) [42].

6.1.3.1. ECO-INNOVATIVE PROJECT

Since the introduction of the Cola-Coca Company's Sustainable Agriculture Guiding Principles in 2013, farmers and producers working with Coca-Cola European Partners (CCEP) have benefitted from external certification and more efficient resource use, while CCEP has increased supply chain security. Developing sustainable smallholder supply chains can improve farmer livelihoods and reduce their vulnerability while improving The Coca-Cola Company's license to operate and security of supply. SAGP is a keystone of its strategy for achieving its commitment to sustainably source by 2020. These principles promote sustainable social policies, such as eliminating forced labor on farms, as well as conservation practices including water saving techniques and soil protection, which can reduce farmer vulnerability in the face of climate change.

The company has launched a new sustainability plan, it is a joint strategy between The Coca-Cola Company and Coca-Cola European Partners, where its corporate responsibility objectives are set for 2025 in the Western European markets. Coca-Cola is evolving to become a total beverage company offering consumers a variety of options with lower sugar or no sugar content. The goal is to reduce the average sugar per liter by 10% in the supply of beverages in the Western European markets between 2015 and 2025, in addition, they aim, that 50% of the sales come from low-calorie drinks.

Over the last few years, among the projects that Coca-Cola has started with the aim of promoting sustainability and growth of the agriculture sector in Spain, is the "Guía Fanta de Buenas Prácticas Sostenibles en el Cultivo de Cítricos". With this initiative, the guide was developed that proposes strategies, such as traceability, efficiency in irrigation; the optimization of fertilization or the control of pests, diseases and weeds. The Guide is an instrument to communicate and distribute to all Spanish citrus suppliers of Coca-Cola the actions to improve from an environmental perspective. The main investigations carried out have been developed from the following specific projects: implementation of Sustainable Agriculture Initiative (SAI) and Sustainable Agriculture Guiding Principles (SAGP), experimental analysis of fertilization and distribution of nutrients in the components of the system, evaluation of soil erosion, evaluation of biodiversity management and quantification of the carbon and water footprint of oranges and lemons [43].

Good Sustainable Practices (BPS) are a set of actions that can be implemented by farmers to manage their crops efficiently and sustainably. The actions are aimed at maintaining or increasing the productivity of a crop, causing the lowest possible environmental impacts.

Figure 11. “Guía Fanta de Buenas Prácticas Sostenibles en el Cultivo de Cítricos”.
(Coca-Cola, 11/02/15 via Coca-Cola Journey)

Advantages offered by the Guide are the following:

1. Reduction of costs.
2. More efficient and profitable harvests.
3. Reduction of CO_2 footprint.
4. Lower water footprint.
5. Better pollination conditions.
6. Greater availability of nutrients and organic matter.
7. Bigger use and efficiency in water consumption.
8. Lower costs and use of fertilizers.
9. Savings in fuel, labor and machinery use.
10. Better management and conservation of the soil, minimizing the growth of weeds.
11. Greater confidence in the product.
12. More competitiveness.

However, there are as well disadvantages, because there is a higher initial economic investment, a complexity of the distribution chain in which numerous fruit purchasing centers participate that implies more farmers, a need for qualified personnel with agronomic knowledge, a necessity for annual planning and a use of complementary instruments that allow to trace and validate the correct operation of the crop: periodic controls, water analytics, nutritive solution analytics, etc.

6.1.3.2. RESULTS

Table 8. Results achieved by Coca-Cola

Area	Improvement
Cost savings	20%
Reduction of the cost production of citrus fruits	15%
Increase in productivity of the harvest	1-5%
Water use by cultivation	90%
Water savings for the next two years	1.800 L
Water use by gravity irrigation	65%
Reduction of phytosanitary products	60%
Reduction of the carbon footprint	23%
Hectares for plantation in 2019	750

With the help of citrus suppliers to implement good practices, considerable results have been achieved. The reduction of nitrogen fertilization has slashed the cost of production of citrus fruits, on the other hand, avoiding loss rates of soil in citrus farms, it has resulted in an increase in the productivity of citrus fruits harvest. The organic matter has improved the infiltration of water in the soil and helped to reduce the water footprint of the crop, moreover, with proper fertilization, the use of phytosanitary products and the carbon footprint derived from their use have been reduced. All this supposes an improvement of the profitability of the agriculture productions that reverts in the protection of work position in rural zones [44].

6.1.4. NESTLÉ

Nestlé is the leading global food company, which objectives are to be recognized as the world leader in nutrition and health. In the work centers, the aim is to offer people and families products, services and knowledge that improve the quality of life and contribute to a healthier future. This will help to achieve the company's aspirations by 2030: help 50 million children to adopt healthier diets and lifestyles.

Solís is a brand that was born in the Spanish market in 1964, it launched the first fried tomato on the market, which was a great revolution. In 1985, Nestlé became the owner of the brand, which is currently one of the leaders in its sector. In Spain, the multinational has 11 production centers, where 44% of the total production is destined for export, mainly to European countries [45].

Currently, white brands are gaining more and more ground thanks to their low prices. Faced with this situation, Nestlé has chosen to differentiate itself from the rest in order to maintain its market share through “Solís Responsible” initiative launched in 2014 and a system for the complete collection and recycling of coffee capsules. With this, it is committed to local agriculture and low environmental impact, to be able to differentiate from the rest and maintain long-term viability. The environmental aspects are a focus of attention in the company to slow down climate change [46]. The response of Nestlé has been overwhelming, with the establishment of very ambitious medium-term objectives, among which are those related to the emission of greenhouse gases, the fight against waste and food waste. The company is committed to youth employment, not only within the company but also inviting business partners to join the initiative through the "Alliance for YOUth" [47].

6.1.4.1. ECO-INNOVATIVE PROJECT

There are three main initiative which the company is focused:

Solís Responsable	An initiative that supports a management model based on the use of local raw materials from organic and local crops. It is proposed to minimize water consumption, have a natural control of pests and minimize the use of fertilizers. It is based on a model of responsibility with the local crop, where all the

	tomatoes come from the Vega del Guadiana crops of local farmers. They have the environmental responsibility to collaborate with farmers in the application of cultivation techniques that respect the environment with the objective of reducing the consumption of irrigation water. And finally, a responsibility with nutrition, which are concerned to offer balanced products, with 100% natural flavor, at the point of salt and without preservatives.
System of comprehensive collection and recycling of coffee capsules	This project is in response to consumer concerns about the impact of capsules on the environment. The clean points of the city collect the coffee capsules to take advantage of the raw materials and obtain high quality compost. The objective of the system is the integral recycling, both of the materials that make up the capsule and the organic waste of its interior. It was necessary to manage the treatment of the used capsules, since they could not be treated as a container for their specific combination of two residues that follow differentiated recycling chains, plastic and organic matter [48]. The plant will separate: • The coffee grounds, which remain in the plant for agricultural applications, allowing the reduction of fertilizers of chemical origin. • The plastic will be sent to a recycling plant.
Coffee ground boiler project for the Girona factory	Its objective is to use coffee beans (biomass) as fuel to generate steam for the process of making soluble coffee. An injection of more than 100 million euros has been made for the soluble coffee factory in Girona, this will mean an increase in the production capacity of what is now one of Nestlé's most important coffee factories worldwide. At the Nescafé factory in Orbe (Switzerland), coffee beans are also incinerated to

	generate steam, transforming what could have been waste into energy. The steam generated is used in the different stages of the manufacturing process of Nescafé products and greatly reduces the dependence on natural gas. Currently, in Nestlé activities around the world there are 22 factories that use coffee beans as a renewable fuel.

6.1.4.2. RESULTS

Since the introduction of these initiatives, consumers value products more positively. In 2015, Solís sales grew in value, increasing its Nestlé turnover in Spain, as well, 8.886 products have been transformed for nutritional and health reasons. In the tomato processing of the Solís Responsable, optimum organoplastic characteristics are achieved and the global SAI (Sustainable Agriculture Initiative) Certificate of Conformity is available, which verifies the obtaining of high quality agricultural products through the use of more sustainable methods and practices. With the project of collection and recycling of coffee capsules, an innovative process of urban furniture has been developed with its reuse of plastic coffee capsules. Moreover, a rice project in solidarity with the fertilizer obtained from the recycling of the Nespresso capsules has permitted to fertilize 33 hectares of rice fields of the Delta del Ebro.

Table 9. Results achieved by Nestlé

Area	Improvement
Increase sales value	2,8%
Invoicing increase	1,1%
Liters of water saved	255M L
Fertilizers reduction	31%
Reduction of pest control operations	25%
Coffee seedlings distribution	129M
Reduction of emissions per ton of product	60%
Waste reduction per ton of product	24%

6.1.5. LEVI'S

Is a pioneer clothing company that designs, markets and sells sports and denim clothes for men and women under the following brands: Levi's, Dockers, Signature by Levi's and Denizen. Levi's jeans are now present in all continents, it is one of the largest clothing companies whose products are sold in more than 110 countries worldwide. For more than 25 years, Levi Strauss & Co. has been a pioneer in sustainability. From introducing the industry's first comprehensive supplier code of conduct, setting strict water quality standards for all products manufacturing in and implementing a ban on harmful chemicals. As well, Levi's led the industry in fair labor standards, establishing some terms of engagement to promote worker rights that has become the industry norm [49].

Recently, Levi's has begun a green campaign involving a sustainable future, joined with a line of green jeans manufactured with organic cotton. The business continues innovating its products by evaluating profitability and values. It has the "Eureka Innovation Lab", located in San Francisco, is a collaboration center for their designers, merchants and innovation experts.

Textile production at Levi Strauss & Co. depends seriously on water. The life cycle analysis of several of its products identified the water problem throughout each stage, from cotton fields to production processes. This dependence on water puts the company at risk given the prospect of future shortages. The company has established the priority of reducing its water footprint, it became the first company in the sector to establish guidelines on water disposal. These requirements limit pollution levels and reduce impacts on local aquifers.

6.1.5.1. ECO-INNOVATIVE PROJECT

The company has embarked on an extension of its strategies, there are three main projects which Levi's is really involved:

Water<Less project:

The company has developed an innovative technique, they try to give a new focus to water management keeping the same processes and materials. Combining several wet processes in one, incorporating ozone in the washing of the fabrics, the product can be manufactured with a lower consumption of water.

Aiming to reduce water impact, in 2007, the company conducted a lifecycle assessment (LCA) on a pair of Levi’s jeans. The results showed how much water was being consumed at each stage of the lifecycle and where they could make a difference. Although it doesn’t represent the biggest area of water use (only 5% of the total water consumption took place in the production phase), manufacturing is where the business has the most control, due to this fact in 2011 a group of designers produced jeans with less water. The techniques used was called Water<Less, which can save up to 96 percent of the water used to make a pair of jeans. So far, the company has saved nearly 2 billion liters of water, and today, 40 percent of all their products by volume are made using Water<Less techniques [50].

Worker well-being project:

More than 25 years ago, Levi's established the industry’s first comprehensive code of conduct for suppliers. In 2011, the company introduced this initiative which represents the next generation of sustainable labor practices; this project provides a framework for suppliers to implement worker programs focused on financial empowerment, health and family wellbeing, and equality and acceptance.

The worker well-being project has reinforced the theory that it is good economics investing in both the company and workers. It consequently decreases an absenteeism whereas it drives productivity up.

Better Cotton Initiative:

The Better Cotton Initiative exists to make global cotton production better and an improved sector’s future. Levi’s aims at transforming cotton production worldwide by developing Better Cotton as a more sustainable conventional commodity. Through this initiative, Levi Strauss & Co. works with cotton producers to reduce their water consumption and with consumers to ensure proper washing and maintenance.

Levi's is a pioneering member of the Better Cotton Initiative, which promotes the use of cotton farmed to higher environmental, social and economic standards. The project is increasing each year the percentage of Better Cotton that the company source. Furthermore, the initiative benefited more than 1,4 million farmers, who had higher than average profits and cotton yields. Levi's was also one of the top five buyers of Better Cotton last year, which helped to drive the sales of the sustainably produced fiber.

6.1.5.2. RESULTS

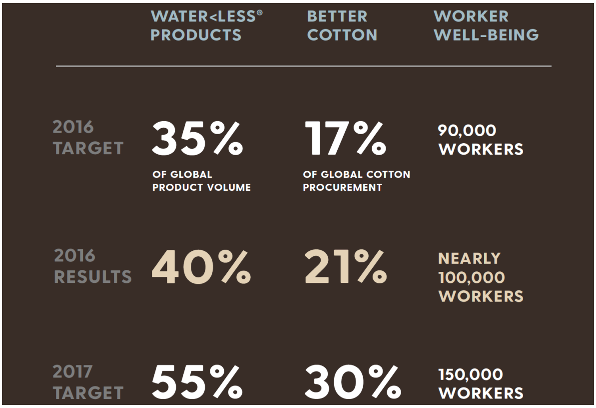

Figure 12. Strategies progress.

(Levi's, 11/02/15 via Annual report)

Levi's has experimented significant success from its various efforts to decrease water consumption. The dyeing procedures evolved in the Water<Less campaign have reduced the energy used and water usage has decreased considerably. The reinvention of finishing techniques for their textiles has led them to be the first company to reduce their water consumption without modifying the final product. From 2011 to 2013, more than 50 million Water> Less clothes were produced, saving millions of liters of water in their final processing.

Currently within Worker well-being project, 60 percent of business product volume is being produced by suppliers that are implementing Worker Wellbeing programs, reaching nearly 100.000 workers. By 2020, Levi's goals are to reach 80 percent of product volume and more than 200.000 apparel workers.

The Cotton grown as part of the Better Cotton Initiative uses less water, energy, chemicals, and time, resulting in 20% higher profits for farmers, and the resulting products have been shown to sell faster than regular Levi's. In 2016, Levi's did even better than predicted, using 21 percent Better Cotton instead of the targeted 17 percent expected. Last year, through the Better Cotton Initiative, the cotton suppliers used an average of 11 percent less water, 12 percent less pesticide and 16 percent less synthetic fertilizer.

Table 10. Results achieved by Levi's

Area	Improvement
Reduction of water requirements	28%
Operating income increase	7%
Operating margin improve	10%
Water saved in the final process	699M L
Energy reduction of the dyeing process	60%
Operating activities cash flows	$307 million
Cotton grown in the world	12%

7. CONCLUSIONS

The discussion about sustainable economy is still open so this project tries to explain the role of eco-innovation in the transition to a circular economy, analyzing academic sources. The review of academic literature permitted a scientific identification of some observed truth, as the evaluation of the most significant circular economy barriers and drivers. Generally, the circular economy is driven predominantly either by social, regulatory or institutional factors. Similarly, barriers are associated to the availability of technical solutions and financial factors, which can harm the expansion of the circular economy.

Eco-innovation is considered to be a basic driver for overcoming barriers to a circular economy transition. Different solutions are produced to reduce the environmental effect: business management alternatives and public policy play an important role in accelerating eco-innovation growth and implementation. Companies are increasingly adopting these practices by introducing them into their business strategies to improve corporate competitiveness.

Global investment in clean technologies has kept rising steadily *as* a result significant and positive steps have been made towards improving the environment. The main investments are in cleaner energy, transport technologies and energy efficiency. In North America, governments have made big investment effort to reach eco-innovation goals, followed by Asia Pacific and Europe. But, in Africa, the Middle East and Central and South America, investments have been null over the years. The European Nordic region stands out for its strongly eco-innovation performance, Denmark, Finland and Sweden are the top three worldwide countries ahead of Canada and the USA. Countries that are enabling investment in innovation, either through public research and development, cleantech-friendly policy, or any other of the inputs, tend to acquire benefits from the commercialization of cleantech companies.

Currently, numerous methods and studies are being applied to calculate environmental damage, emissions and eco-efficiency. Many theories and postulated calculation have been developed still their application are not widely recognizable and used. This project is focused on Circular Economy Model and Green Solow Model. The first method presents a theoretical model incorporating the concept of a circular economic activity is based on two types of economic resources, the polluting and recyclable input. The second method focuses on technological progress in pollution reduction and establishes the Environmental Kuznets Curve.

To conclude, companies are and should be one of the most important drivers of eco-innovation. The business strategy consists in introducing improvements in the activity of the company likely to generate profit in an environmental friendly. The European Commission's results show that the companies opting for eco-innovation have an annual growth of 15%. The 5 companies (Fruits de Ponent, Gamesa, Coca-Cola, Nestlé and Levi's) having implemented the eco-innovative project have obtained considerable benefit showing that eco-innovation is a winning choice for companies.

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ACRONYMS

BPS: Bureau of planning and sustainability

CCEP: Coca-Cola European Partners

CIS: Community Innovation Survey

COP: Communication on Progress

CSR: Corporate Social Responsibility

DMC: Domestic Material Consumption

ECO-IS: Eco-Innovation Scoreboard

EEA: European Economic Area

EIO: Energy Informed Operations

EKC: Environmental Kuznets Curve

ENWHP: European Network for Workplace Health Promotion

EPO: European Patent Office

EU: European Union

GCII: Global Cleantech Innovation Index

GDP: Gross Domestic Product

GHG: Greenhouse gas

I+D+I: Research, Development and Innovation

IRTA: Institute of Food and Agri-Food Technology

LCA: Life Cycle Assessment

NAIC: National Association of Insurance Commissioners

OECD: Organization for Economic Co-operation and Development

R&D: Research and Development. In Spanish I+D

SAGP: Sustainable Agriculture Guiding Principles

SAI: Sustainable Agriculture Initiative

SME: Small and Midsize Enterprises

UNE-EN-ISO: Spanish standards in Europe in the International Organization for Standardization

UNFCCC: United Nations Framework Convention on Climate Change

UNU-MERIT: United Nations University - Maastricht Economic and Social Research Institute on Innovation and Technology

APPENDICES

APPENDIX 1: ECO-INNOVATION INDEX 2017

The Eco-Innovation Index is a tool to measure and show eco-innovation performance across the EU Member States. The index captures the different aspects of eco-innovation, grouped in 16 indicators into five thematic areas: Eco-innovation inputs, eco-innovation activities, eco-innovation outputs, resource efficiency outcomes and socio-economic outcomes

Documentation of indicators: From Eco-Innovation Observatory technical note.

The following list of tables provides a documentation of each indicator in the eco-innovation index, with a description of the below listed characteristics: Name of the indicator, short description, unit of measurement, original data, data provider, and update in Index 2017.

Indicator group: Eco-innovation inputs

Table 11. Governments environmental and energy R&D appropriations and outlays

Name of the indicator	Governments environmental and energy R&D appropriations and outlays
Short description	The relative priority given by governments to investing in research and development in the areas of energy, including renewables, and environment
Unit of measurement	Percentage (of total employment)
Original data	Million Euros
Data provider	EUROSTAT
Update in Index 2017	Updated to 2016

Table 12. Total R&D personnel and researchers

Name of the indicator	Total R&D personnel and researchers
Short description	Indicator of the knowledge and research capabilities of a country. Since the data for R&D personnel involved in eco-innovation or environmental or cleantech research is not available, the generic indicator in used
Unit of measurement	Percentage (of GDP)
Original data	Share of total employment
Data provider	EUROSTAT
Update in Index 2017	Updated to 2016

Table 13. Total value of green early stage investments

Name of the indicator	Total value of green early stage investments
Short description	The value of early stage investments in cleantech industries
Unit of measurement	USD/capita
Original data	USD per country
Data provider	Cleantech
Update in Index 2017	Updated to 2016

Indicator group: Eco-innovation activities

Table 14. Enterprises that introduced an innovation with environmental benefits obtained by the end user

Name of the indicator	Enterprises that introduced an innovation with environmental benefits obtained by the end user
Short description	Based on the EUROSTAT's Community Innovation Survey (CIS), 2014 version
Unit of measurement	Percentage (of total firms)
Original data	Number of companies per country
Data provider	EUROSTAT / Community Innovation Survey (CIS)
Update in Index 2017	Data for 2014 (no update)

Table 15. Enterprises that introduced an innovation with environmental benefits obtained within the enterprise

Name of the indicator	Enterprises that introduced an innovation with environmental benefits obtained within the enterprise
Short description	Based on the EUROSTAT's Community Innovation Survey (CIS), 2014 version
Unit of measurement	Percentage (of total firms)
Original data	Number of companies per country
Data provider	EUROSTAT / Community Innovation Survey (CIS)
Update in Index 2017	Data for 2014 (no update)

Table 16. ISO 14001 registered organizations

Name of the indicator	ISO 14001 registered organizations
Short description	The importance of observing environmental management requirements for business. Can be seen as a proxy indicator for the level of environmental awareness and management capability of business
Unit of measurement	Number per million population
Original data	Number of organizations per country
Data provider	ISO Survey of Certifications
Update in Index 2017	Updated to 2016

Indicator group: Eco-innovation outputs

Table 17. Eco-innovation related patents

Name of the indicator	Eco-innovation related patents
Short description	According to OECD's scoping of patents in environmentally related technologies: Energy generation from renewable and non-fossil sources PLUS Combustion technologies with mitigation potential PLUS Emissions abatement and fuel efficiency in transportation PLUS Energy efficiency in buildings and lighting PLUS Complementary Patstat queries conducted by EIO team
Unit of measurement	Number per million population
Original data	Number of patent per country
Data provider	Patstat database of European Patent Office (EPO)
Update in Index 2017	Updated to 2014

Table 18. Eco-innovation related academic publications

Name of the indicator	Eco-innovation related academic publications
Short description	Institutions being involved in publications with the following list of English key-words in title and/or abstract: eco-innovation, energy efficient/efficiency, material efficient/efficiency, resource efficient/efficiency, energy productivity, material productivity, resource productivity
Unit of measurement	Number per million population
Original data	Number of publications
Data provider	Scopus
Update in Index 2017	Updated to 2016

Table 19. Eco-innovation related media coverage

Name of the indicator	Eco-innovation related media coverage
Short description	Number of hits in all electronic media covered by "Meltwater News" with key-word "Eco-innovation" (translated in all EU-28 languages)
Unit of measurement	Number per million population
Original data	Annual hits Number of electronic media sources
Data provider	Online media monitoring
Update in Index 2017	Updated to 2017

Indicator group: Resource efficiency outcomes

Table 20. Material productivity

Name of the indicator	Material productivity
Short description	Illustrates the GDP generated by material consumption of a country
Unit of measurement	GDP/Domestic Material Consumption
Original data	Domestic Material Consumption (DMC)
Data provider	EUROSTAT
Update in Index 2017	Updated to 2015

Table 21. Water productivity

Name of the indicator	Water productivity
Short description	Illustrates the GDP generated by domestic water consumption
Unit of measurement	GDP/total fresh water abstraction
Original data	Total fresh water abstraction
Data provider	EUROSTAT
Update in Index 2017	Updated to 2011

Table 22. Energy productivity

Name of the indicator	Energy productivity
Short description	Illustrates the GDP generated by domestic energy use
Unit of measurement	GDP/gross inland energy consumption
Original data	Primary energy consumption
Data provider	EUROSTAT
Update in Index 2017	Updated to 2015

Table 23. Greenhouse gas emission intensity

Name of the indicator	Greenhouse gas (GHG) emission intensity
Short description	Illustrates the amounts of GHG emissions generated per unit of GDP
Unit of measurement	CO_2 emissions/GDP
Original data	GHG emissions
Data provider	European Economic Area (EEA)
Update in Index 2017	Updated to 2015

Indicator group: Socio-economic outcomes

Table 24. Exports of products from eco-industries

Name of the indicator	Exports of products from eco-industries
Short description	Based on selected list of trade codes referring to "environmental goods and services"
Unit of measurement	Percentage (of total exports)
Original data	Eurostat COMEXT
Data provider	EUROSTAT
Update in Index 2017	Updated to 2016

Table 25. Employment in eco-industries and circular economy

Name of the indicator	Employment in eco-industries and circular economy
Short description	Indicates the share of employment in eco-industry and circular economy in total employment. Total employment is an aggregate employment in all companies across sectors in a specific country. Eco-industry company population was selected based on NAICS codes for eco-industries, including waste treatment, water sector, environmental technologies, recycling, reuse and recovery. The selection excludes companies engaged in energy generation and storage.
Unit of measurement	Percentage (of total employment of all companies in Orbis database)
Original data	Number of employees in companies in eco-industry sector in a specific country (aggregation of micro level data)
Data provider	Orbis database
Update in Index 2017	Updated to 2016

Table 26. Revenue in eco-industries and circular economy

Name of the indicator	Revenue in eco-industries and circular economy
Short description	Indicates the share of revenue from eco-industry in total revenue across sectors in a specific country. Total revenue is aggregate revenue in all companies across sectors in a specific country. Eco-industry company population was selected based on NAICS codes for eco-industries, including waste treatment, water sector, environmental technologies, recycling, reuse and recovery.
Unit of measurement	Percentage (of total revenue of all companies in Orbis database)
Original data	Annual revenue of companies in eco-industry sector in specific country (aggregation of micro level data)
Data provider	Orbis database
Update in Index 2017	Updated to 2016