Universidad del Rosario

Rennes School of Business

CSR as a primary agent to cope with growing energy demand: Green it as a strategy for change.

Graduating Project

Valentina Medina López

August 31st, 2023

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International Business Administration

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TABLE OF ABREVIATIONS

CSR: Corporate Social Responsibility

GCE: General Electric Company

GHG: Greenhouse Gas

GWH: Energy Generation

IT: Computing and Information Technology

LCA: Life Cycle Assessment

SIN: National Interconnected System

OATH OF PERSONAL WORK

I undersigned Valentina Medina López, declare that the following graduating project is my ownwork. No part of this research has been submitted in the past for publication or for degree purposes. I am fully responsible for the truthfulness of this declaration.

Date: 31st August 2023

CONFIDENTIALITY AGREEMENT OF GRADUATING PROJECT

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TITLE OF THE GRADUATING PROJECT

CSR as a primary agent to cope with growing energy demand: Green IT as a strategy for change.

Date of submission: 31st August 2023

Appendices: YES

Confidentiality: YES

GLOSARIO

Responsabilidad Social Corporativa: Es una conducta de dirección resposable dentro del entorno empresarial basado en la generación de impactos positivos dentro de la sociedad y dentro de la misma empresa.

Tecnologías de la información verde: Son herramientas y técnicas responsables que buscan el bienestar den entorno social y ambiental.

Fuentes de Energía Renovable: Son recursos naturales ilimitados que pueden ser utilizados para obtener energía mediante herramientas adecuadas.

Consumo Responsable: Consumo consciente de productos, servicios y procesos, donde se busca el bienestar social y ambiental.

Ciclo de Vida Útil: Es el ciclo estimado de utilidad de un producto, cumpliendo correctamente su función para la que fue creado.

Gases de Efecto invernadero: Son gases liberados que se acumulan en la atmosfera terrestre, los cuales son contaminantes ya que retienen y aumentan el calor de la atmosfera provocando daño.

ABSTRACT

The purpose of this final project is to propose a different perspective on how to address the energy crisis in a responsible way where the primary actors of social, economic, and political progress are the companies, the agent of change, and do so through tools that are currently booming as are the green information technologies or green computing.

In order to respond to this problem, the methodology used was a quantitative study with structured surveys, focused on two types of publics, those in the technology industry and those in the sustainable industry. The purpose of this was to find out from professionals in the technology industry what is their knowledge about the effects generated on the environment, to define the priorities of this industry to solve environmental problems, what solutions they have proposed, and which have given better results than others. Similarly, additional questions were asked to professionals who develop and are directly related to the sustainable development sector, particularly with respect to the energy industry that uses renewable sources, to know what the main needs are presented by customers in this industry, if they know what the feasible conditions are to install this type of technology and what benefits it brings to the customer and its environment.

In addition, exhaustive research was carried out to cover the necessary material to understand one of the most important and demanding challenges in recent years. In this way to have reasonable and useful tools to address this challenge generating welfare in society and economy, with supplies that are safe and stable and sustainable.

The results obtained have shown that there are benefits and trends shared by the two target audiences of the study, the main ones were the following: alternative energy sources are in fact an opportunity to reduce costs for both companies and natural individuals within their homes, also affects the value obtained by the places where renewable energy sources are installed, finally there is a need and willingness to align with existing government incentives. Participating in the energy transition and promoting responsible practices is now a priority.

Keywords

Corporate Social Responsibility, Green IT, Energy Demand, Renewable Energy Sources, Responsible Consumption, Technology Industry, Social Responsibility, Utility Life Cycle Greenhouse gas emissions

RESUMEN

El objetivo de este proyecto fin de carrera es proponer una perspectiva diferente sobre cómo abordar la crisis energética de una forma responsable donde los actores principales del progreso social, económico y político sean las empresas, agente de cambio, y hacerlo a través de herramientas que actualmente están en auge como son las tecnologías verdes de la información o informática verde.

Para dar respuesta a este problema, la metodología utilizada fue un estudio cuantitativo con encuestas estructuradas, enfocado a dos tipos de públicos, los de la industria tecnológica y los de la industria sostenible. El objetivo era conocer de los profesionales de la industria tecnológica cuál es su conocimiento sobre los efectos generados en el medio ambiente, definir las prioridades de esta industria para resolver los problemas ambientales, qué soluciones han propuesto y cuáles han dado mejores resultados que otras. De igual forma, se realizaron preguntas adicionales a los profesionales que desarrollan y están directamente relacionados con el sector del desarrollo sustentable, particularmente con respecto a la industria energética que utiliza fuentes renovables, para conocer cuáles son las principales necesidades que presentan los clientes de esta industria, si conocen cuáles son las condiciones factibles para instalar este tipo de tecnología y qué beneficios aporta al cliente y a su entorno.

Además, se ha llevado a cabo una exhaustiva investigación para cubrir el material necesario para comprender uno de los retos más importantes y exigentes de los últimos años. De esta forma

disponer de herramientas razonables y útiles para abordar este reto generando bienestar en la sociedad y en la economía, con suministros que sean seguros y estables y sostenibles.

Los resultados obtenidos han demostrado que existen beneficios y tendencias compartidas por los dos públicos objetivos del estudio, los principales fueron los siguientes: las fuentes de energía alternativas son de hecho una oportunidad para reducir los costes tanto para las empresas como para los individuos naturales dentro de sus hogares, también afecta el valor obtenido por los lugares donde se instalan fuentes de energía renovables, por último existe la necesidad y la voluntad de alinearse con los incentivos gubernamentales existentes. Participar en la transición energética y promover prácticas responsables es ahora una prioridad.

Palabras Clave

Responsabilidad Social Corporativa, Tecnologías de la información verde, Demanda de Energía, Fuentes de Energía Renovable, Consumo Responsable, Industria Tecnológica, Responsabilidad Social, Ciclo de Vida Útil, Gases de Efecto invernadeo

INTRODUCTION

Contextual framework

One of today's most important global issues is sustainability in the corporate framework (Sheehy & Farneti). Is known that the most relevant actors for society are companies because they are the ones that generate the most profit and inherently contribute to social, economic and political progress. (Brtitzelmaier & Kraus, 2012), This is of vital importance because, as a change-producing representative, it must have responsibility not only with the internal public, those who make up the company, but also with the external public, who are the members of society. This is because the movement with more influence and impact for the external public is to make socially conscious purchases and feel that they are contributing to the conservation of the environment, i.e., the responsible consumption.

Currently this recognition and corporate duty handles a concept that has surprised with its reception within the business world, Corporate Social Responsibility or CSR for its acronym. This term includes the impact generated by the company with respect to the productive activity to which it is dedicated. In other words, companies have the responsibility to respond to the current needs of society and take care of them, so that one of its pillars is to generate sustainability in their processes and thus contribute to the preservation of the environment and in turn promoting social welfare (Chen & Chou, 2016).

The tool that has been used by everyone and that has contributed the most to the progress of society has been technology. Information is just a click away, our learning has accelerated and above all, it has simplified tasks that previously would have taken us decades to solve. (Papageorgiou*, 2002).

A tool used on a large scale by companies, since it is basically part of the organizational structure. Everything in a business environment is related to information technologies, from the data collected to the place where it is stored, what is known as data centers, in addition to the necessary communication and coexistence between colleagues and customers, alluding to electrical and electronic devices. However, studies show that technology has played a leading role in environmental issues such as climate change. (Rodríguez, 2019).

Nowadays, there are tools that help to combat environmental crises, in fact, the tendency to be sustainable and the promotion of green alternatives has been growing for several decades.

The conceptualization of sustainable development has its origin in the Brundtland Commission, formed by the General Assembly in 1983, which presented a report called "Our Common Future" in 1987 (United Nations, 2023) where it established the term sustainable development as that which, in the words of the Brundtland Commission, allows satisfying the needs of present generations without compromising the possibilities of future generations to satisfy their own needs, in addition to meeting the demand for environmental protection and ensuring the progress of underdeveloped countries. (United Nations, 2023).

For this reason, the spheres of sustainability constitute socioeconomic components, i.e. the three pillars of the term are economic, social and environmental policies. (United Nations, 2023).

Problem statement

The need for and dependence on technology is so great that there is a greater demand for devices and updates for them, there is a greater volume of information, so it is necessary to increase processing capacity or, ultimately and more easily, to increase the number of data centers, among other things.

But what does this mean for the environment? Well, the exponential growth of information technologies translates into greater consumption of electronic devices and mobile devices because there is undeniably a greater volume of information that needs to be charged and consequently more modules that require energy. In other words, the demand for energy is growing as the popularity of technology takes effect.

However, the concept of sustainability had a greater impact until recent years. We can affirm that this exponential reception is largely due to the creation of social networks and the availability of technological devices, creating a trend and generating importance can be achieved in a couple of seconds, it is enough to publish some relevant information and that's all, the world has access to such publication. (Watsh & Act, 2023).

To this day, there is concern about several environmental crises, of course there are tools to face these challenges, but there is still work in their implementation and development, either because there are people who do not risk moving to sustainable solutions or simply the practices take some time to be implemented and be welcomed within the business or natural community. One of the challenges facing our planet is the energy demand, transcending globally to alternative energy sources has not been an easy task.

By way of a brief contextualization, the mining industry, which is responsible for the extraction of raw material that forms the basis of mobile devices, has generated controversy due to the quality and working conditions in which it operates, the way it extracts and the frequency with which it does so to supply the growing demand for mobile devices. Understanding the above, conventional energy sources have brought catastrophic and overwhelming consequences for the ecosystem and community welfare. Addressing this issue and dealing with the collateral damage must be a priority.

Significance

Covering such a global need as energy demand is quite important, even more so because of the number of environmental effects it causes. That said, there is a huge opportunity that corporate companies must execute; Green IT, technologies that focus on sustainability; in other words, the use of responsible IT resources that mitigate the consequences of technological pollution, its effects

on our society and on the environment such as excessive consumption of electronic devices, and also improves the quality of life of people while generating awareness and responsible consumption. (Chen & Chou, 2016).

This study has been conducted with the aim of providing professionals in the technology industry and the community interested in taking on the challenge of being sustainable; green tools on how to address social issues from sustainable perspectives and solutions, providing the current actions and solutions from some other most influential companies around the world. This would help to a great extent to face not only energy challenges but also to combat climate change, abusive consumption, social unconsciousness, technological pollution and more challenges. In general terms, this project has the purpose of redirecting the concept of sustainability while instilling awareness to evaluate one of the most known and necessary challenges worldwide, energy. This from the perspective of corporate social responsibility as a primary agent for social change and progress.

Research Question

In order to provide not only a new perspective on the concept of sustainability, but also to function as an instructive to implement and learn about responsible practices within the corporate environment, this project focuses on the following research question: **How can Green IT be a CSR tool to meet the growing demand for energy in Colombia?** Certainly, technology has been an opportunity to progress with greater strength, however, its excessive consumption and bad

practices have caused technological pollution and brings with it additional social and environmental problems as mentioned above.

For this reason, we will now explain in greater depth the way in which technological growth has taken place within a society with a tendency towards the necessary sustainability and responsible consumption.

Toward facilitate the reading, a brief research organization will be provided. The first steps will be the definition of the three macro concepts, then a contextualization of the influence that technological growth has had together with its effects on the social and environmental surroundings, fourthly, the topic of responsible management of technology in the corporate framework will be discussed including the effects on the environment and finally, the previous literature review will be analyzed with respect to the answers obtained in the surveys to professionals of the technological and sustainable industry.

Objectives

General Objective

Propose a different perspective on how to address the energy crisis in a responsible way at the corporate level in the information technology industry in Colombia.

Specific Objectives

1. Execute a general description of the role played by the technology industryon the society as protagonists of this crisis.
2. Execute a general description of the way in which the most relevant entitiesin the technology field have made incursions on sustainability solutions.
3. Establish the relationship between corporate social responsibility and greentechnologies.
4. Identify the points of greatest impact where these entities have coincided, onhow to address the energy crisis at the corporate level, with benefits applicable globally.

LITERATURE REVIEW

Theoretical framework

DEFINITION OF CONCEPTS

It should be clarified that the previous literature review for this research helped to have more clarity on each of the concepts such as green technologies, corporate responsibility, their relationship with sustainability and their joint effect to mitigate the energy crisis. Being these the basis of this study, the information gathered is mainly about the changes that technology companies have had to generate corporate awareness about the importance of consuming responsibly.

The data that will also be mentioned below summarize the effects of digitization and centralization of processes, to be more effective, efficient, and thus timely when carrying out business activities, as well as to analyze the benefits at the humanitarian level that are obtained by implementing responsible practices within the company and its effects to generate closer, more productive and relevant relationships within the work environment. (Eckert & Osterrieder, 2020).

With the afore mentioned, we will begin to define the macro concepts dealt with in the

study:

CSR

Corporate Social Responsibility has taken an impressive reception in the last decade, because of its very accurate statement and congruence to meet the needs of external and internal public and current sustainable trends. However, the question here is how did this concept become so necessary and relevant within business? Well, by being located in the 1930s, just the time when the debate on this term was born, the number of definitions and issues that were believed to cover was different and very broad.(Brtitzelmaier & Kraus, 2012).

Some authors stated that social responsibility has always existed (Bernal Conesa, Briones

Peñalver, & de Nieves Nieto, 2017) and has always been the responsibility of managers, others comment that responsibility is inherently a social obligation, putting this in perspective, in reality it is a complex concept that has been studied for quite some time, with principles and strategies such as the commitment to responsible social management, strengthening the company's public image, attracting conscious customers (tendency to be sustainable), organizational transformation and others.

In the direction of having more clarity on this concept, a table with the particular definition of the authors who have studied the CSR concept, and their own dilemma is provided below. This allows to understand how this practice prevails today in the organizational structure, and its position as a primary strategy of a company to generate sustainability, improve costs, image and perception of consumers and potential customers. (Brtitzelmaier & Kraus, 2012). When we understand a strategy like this, it allows us to reconstruct our conception of the role of a company and its contribution to economic, social, political, and environmental progress.

Figure 1

Definition from the Scholars, 2005

Scholars	**CSR Definitions**	**Critical Questions/Dilemmas**

Bowen (1953)	"What responsibilities to society may businessmen reasonably be expected to assume?" [CSR] refers to the obligations of businessmen to pursue those policies, to make those decisions, or to follow those lines of action, which are desirable in terms of the objectives, and values of our society. "Interest in politics, in the welfare of the community, in educations, in the "happiness" of its employers, and, in fact, in the whole social world about it. Therefore, business must act justly as a proper citizen should."	What constitutes "reasonable" and "unreasonable" expectations of businessmen? What, if the "objectives and values of our society" are irresponsible? How does business combine "interest in politics" with being an impartial,

		responsible citizen, e.g. lobbying for controversial legislation?
Frederick (1960)	"Social responsibility in the final analysis implies a public posture toward society's economic and	Why is "social responsibility" only "a public posture toward… resources"?

	human resources and a willingness to see that those resources are used for broad social ends and not simply forthe narrowly circumscribedinterests of private persons and firms."	What about intangible mattersof CSR?
Sethi (1975)	"Social responsibility implies bringing corporate behavior up to a level where itis congruent with the prevailing social norms, values, and expectations of performance."	How does it address businesses' influences on "social norms, values, and expectations of performance"?
Carroll (1979)	"The social responsibility of business encompasses the economic, legal, ethical and discretionary expectations that	How to balance society' expectations with business' responses? Does

	society has of organizations at a given point in time."	it imply that business only responds to expectations?
Drucker (1984)	" … the proper social responsibility of business is to tame the dragon, that is to turn a social problem into economic opportunity and economic benefit, into productive capacity, into human competence, into well-paid jobs, into wealth."	What about non-tangible, noneconomic benefits? How to measure these opportunities?

Wood (1991)	Argues that the basic idea of corporate social responsibility is that business and society are interwoven rather than distinct entities	How does society evaluate business' social responsibility if, being interwoven, it may be influenced by business' irresponsibility?
McWilliams andSiegel (2001)	CSR is "situations where the firm goes beyond compliance and engages in actions that appear to further some social good, beyond the interests of the firm and that which is required by law."	What are the boundaries of "some social good"? How to address potential disparity between different social groups' understanding

		of "some social good"?
Kotler and Lee (2005)	"Corporate Social Responsibility is a commitment to improve community well-being through discretionary business practices and contributions of corporate resources."	Does this exclude business organizations' internal wellbeing?
Hopkins (2007)	"CSR is concerned with treating the stakeholders of the firm ethically or in a responsible manner. 'Ethically or responsible' means treating stakeholders in a manner deemed acceptable in civilized societies. Social	How to define universally acceptable benchmarks of "civilized

	includes economic	societies"? How to represent nature as a valid stakeholder? What constitutes "higher and higher standards of living"?

	responsibility. Stakeholdersexist both within a firm and outside – for example, the natural environment is a stakeholder. The wider aim for social responsibility is to create higher and higher standards of living, while preserving the profitability of the corporation, for people both within and outside the corporation.”	

Note. Obtained from International Journal of Management Volume 14 Issue 4, Page 284

Figure 1 shows that there is a direct relationship between social and environmental concernsand third parties, which would be companies. (Brtitzelmaier & Kraus, 2012). In fact, a common point that can be found in each definition is the importance of having an ethical work environmentand exercising environmental policies. (Brtitzelmaier & Kraus, 2012), Accordingly CSR can be define in this project as the essence of exercising the corporate activity in an ethical way, prioritizing society and generating awareness, this leads to a direction to which the reader surely already knows, a social commitment to the external and internal public and the environment. (Bernal-Conesa, Briones-Penalver, & De Nieves-Nieto, 2016).

In simpler words, social responsibility according to the above definitions suggests idealizedviews about

companies, where they perform activities in favor of environmental and social protection, in fact, they do more than necessary to serve and cover economic interests and related to the internal structure of the organization. This statement is precisely to exercise in the field of business in an ethical and eco-friendly way, a commitment to the environment and social responsibility (Brtitzelmaier & Kraus, 2012).

CSR has been a pioneer in addressing and promoting sustainable trends and the needs thatthe external public has generated toward instill in them the idea of responsible consumption, but do we know the reason? Its evolution developed as follows:

Figure 2

Phases of development of the term CSR, 2005

	Phases of CSR	**CSR Drivers**	**CSR Policy Instruments**
CSR 1 1950s-1960s	Corporate Social Stewardship Corporate philanthropy – acts of charity, managers as public trustee-stewards, balancing	Executive conscience, company image/reputation	Philanthropic funding, public relations

	social pressures		
CSR 2 1960s-1970 s	Corporate Social Responsiveness Social impact analysis, strategicpriority for social response, organizationalredesign and training for responsiveness, stakeholder mapping andimplementation	Social unrest/protest, repeated corporatemis behavior,public policy/government regulation, stakeholder pressures, think tank policy papers	Stakeholder strategy, regulatory compliance, social audits, public affairs function, governance reform, political lobbying

CSR 3 1980s-1990 s	Corporate/Business Ethics Foster an ethical corporate culture, establish an ethical organizational climate,	Religious / ethnic beliefs, technology driven value changes, human rights pressures, code of	Mission/vision/values, statements, CEO leadershipethics

	recognize common ethical principles	ethics, ethics committee/officer audits, ethics training, stakeholder negotiations	
CSR 4 1990s-2000 s	Corporate/ GlobalCitizenship stakeholderpartnerships, integratefinancial, social, and environmental performance, identify globalization impacts,sustainability of companyand	Global economic trade/investment, high- tech communication networks, geopolitical shifts/competition, ecological awareness/concern, NGO pressures	Inter-governmental compacts, global audit standards, NGO dialogue, sustainability

	environment		audits/reports

Note. Obtained from International Journal of Management Volume 14 Issue 4, Page 287

Managing and leading responsibly is a task that requires basic characteristics and principles. Among them are clearly those mentioned in figure 2, philanthropy, social responsibility, ethical corporate culture being an honest and honest organizational climate, and finally an integration between stakeholders to congenial and contribute to the next step of social progress facing challenges such as globalization, digitization and more needs that arise year after year. (Eckert & Osterrieder, 2020).

For a better understanding, the authors of the study ***A literature review on corporate social responsibility: definitions, theories and recent empirical research*** point out that this term has had an important evolution in several aspects, which is why it was categorized as a rationalization of the concept, stating that the prospect of analysis went from being macro social to organizational, and clearly to the ethical organizational structure, which has become more implicit than explicit.

(Brtitzelmaier & Kraus, 2012). It is understood from the latter that social commitment is already taken for granted in a business structure, it should go as another part of the root that sustains a company, along with ethical practices and eco-friendly processes.

After having understood the relationship between the multiple definitions over the years and the evolution of the concept. The relationship between the concept of corporate social responsibility and sustainability must be interpreted. The latter comprises three terms: economic growth, social equality, and environmental protection. (Chen & Chou, 2016).

In order to progress economically, society needs financial stimulants and secure services, while an egalitarian society requires the protection and maintenance of human rights and quality of life; this in turn is related to the power that business exercises over society. (Chen & Chou, 2016), whether it is the method of extraction of raw materials, their working conditions, who integrates the workforce, among others that must necessarily emphasize fairness and equity in terms of the development of public policies. Finally, it would be the preservation of the environment, being this referring to healthy ecosystems, quality of life, social welfare, and others. (Chen & Chou, 2016).

Sustainability and corporate social responsibility are perfectly linked. According to this it may be considered that sustainability is a pillar of CSR, being this not only two concepts that share the same social commitment, but in fact sustainability is a bone of the backbone of a company, without sustainable processes there is no responsibility.

GREEN IT

The term refers to the use of responsible technologies, practices that focus on sustainability. (Sydle, 2023). In fact, as there is so much technological evolution, the changes are called innovation, allowing to know more efficient, safe, beneficial to society and the environment. processes, while bringing cost reduction and optimized processes within a company (Mann, Grant,& Singh Mann, 2009).

The following table shows a comparison of the different terms used and their precisedefinition according to studies by the Technical University of Berlin.

Figure 3

Definitions of Green IT and Green IS, 2005

Search term	Reference	Source	Citations	Definitions of Green IT and Green IS
Green IT	Murugesan (2008)	IT Professional	246	**Green IT** refers to environmentally sound IT. It's the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems efficiently and effectively with minimal or no impact on the environment.
	Molla, Cooper, Pittayachawan (2009)	International Conference on Information Systems	58	This paper conceptualizes **Green IT** from the IT infrastructure and capability perspective. This implies that eco-sustainability considerations need to be incorporated within the IT technical and human infrastructure and IT managerial capability dimensions of the IT infrastructure to solve both IT and non-IT (by using IT) related sustainability problems.
Green IS	Watson, Boudreau, Chen, Huber (2008)	Information Systems – A Global Text	71	**Green IT** is mainly focused on energy efficiency and equipment utilization. **Green IS** refers to the design and implementation of information systems that contribute to sustainable business processes.
Green information	Jenkin, Webster, McShane (2011)	Information and Organization	53	'**Green IT**', which addresses energy consumption and waste associated with the use of hardware and software, tends to have a direct and positive impact. '**Green IS**' refers to the development and use of information systems to support or enable environmental sustainability initiatives and, thus, tends to have an indirect and positive impact.
Sustainable information systems	Watson, Boudreau, Chen (2010)	MIS Quarterly	211	In the practitioner literature, much of the current attention is devoted to "**Green IT**." We argue that this exclusive focus on information technologies is too narrow and should be extended to information systems, which we define as an integrated and cooperating set of people, processes, software, and information technologies to support individual, organizational, or societal goals. To the commonly used **Green IT** expression, we thus prefer the more encompassing **Green IS** one, as it incorporates a greater variety of possible initiatives to support sustainable business processes. Clearly, **Green IS** is inclusive of **Green IT**.
Information systems sustainability	Melville (2010)	MIS Quarterly	186	We define **IS for environmental sustainability** as IS-enabled organizational practices and processes that improve environmental and economic performance.
	Chen, Boudreau, Watson (2008)	Journal of Systems and Information Technology	81	IS can be leveraged to achieve eco-efficiency, eco-equity and eco-effectiveness through automating, informating (up and down) and transforming organizations, respectively.

Note. Obtained from Green IT and Green IS: Definition of Constructs and Overview ofCurrent Practices, page 4

According to Figure 3, it can be seen that green IT is in fact a corporate strategy within the functional areas of a company's organizational structure. These can be procurement, operation and disposal of IT infrastructures, IT governance and business processes. (Loeser, 2013). For this reason, sustainability is an inherent part of green technologies are the cover of his book.

To be sustainable is to use green technologies, to be responsible is to implement these

technologies by knowing the characteristics, to be aware is to know the positive impact of implementing green technologies within a company or even within our daily life. By way of example, to be and to have a sustainable conscience is to consider that there has been an energy crisis for some years now, and for this reason we want to contribute (Chen & Chou, 2016). With this being conscious, is to promote initiatives to use renewable energy sources such as solar energy, and a green technique is to install solar panels in our home or business.

To have a better view of the above, this study permits considers as a conclusion that green IT is the science and practice of efficiently and successfully developing, manufacturing, utilizing, and disposing of IT equipment, such as computers, servers, displays, printers, storage devices, and mobile devices. Green IT aims to achieve economic viability, enhanced system performance, and ease of use while upholding social, legal, and ethical obligations inside organizations. It is not just about technology and the environment (Zaman & Sedera, 2015).

RENEWABLE ENERGY SOURCES

It is important to emphasize at this point that for a long time most of the world's energy has come from fossil fuels, but their extraction, refining, distribution and use has greatly harmed our ecosystem and the society in which we live. (Área Metropolitana del Valle de Aburrá, 2019). Certainly there is a progressive abuse and depletion of these natural energy resources, therefore there is a social trend known as energy transition, which has imposed awareness to transcend in terms of obtaining energy and begin to use resources that are conceived as inexhaustible resources,

which are called renewable energy sources, these are the sun, wind, water bodies, the inner heat of the earth, in fact we consider them today as alternative sources of energy (Área Metropolitana del Valle de Aburrá, 2019).

Renewable sources are those that, as their name indicates, are related to the planet's natural cycles, which allows them to be used permanently or cyclically. (Área Metropolitana del Valle de Aburrá, 2019). However, in order to generate electricity, heat, motive power or fuel, each source requires a different type of technology. Alternative energy is a technology that has not been massively implemented. (Área Metropolitana del Valle de Aburrá, 2019).

The information below was obtained from the study conducted by the Metropolitan Area of the Aburrá Valley, data that belongs to and is authored by the National Government of Colombia. The alternative sources are classified as follows:

1. **Solar energy:** It comes from sunlight; it is the primary source of the earth. To generate it, the solar radiation that reaches the planet is used and is obtained through solar panels, but the sun's heat can also be used through solar collectors. (ÁreaMetropolitana del Valle de Aburrá, 2019).

2. **Biomass energy**: this energy refers to organic materials from living beings, considering their quantity and chemical composition, humidity characteristics, particular weight and chemical, physical or thermal process. It can be used to obtain electrical and

mechanical energy, biofuels and/or alcohols. (Área Metropolitana del Valle de Aburrá, 2019).

3. **Hydropower:** Is energy that uses the force of bodies of water, such as rivers,lakes or tides. From there it is transformed when the water passes through a hydraulic turbine, and thus transmits the energy to an alternator converting the energy into electricity. (Área Metropolitana del Valle de Aburrá, 2019).

4. **Wind Energy:** Wind is in fact a form of indirect energy from solar energy.The moving air particles originate from the temperature distinction caused by solar radiation on the earth. By obtaining two layers of air, those that by their lower density rise and those of cold layer descend, electrical energy can be obtained by means of windturbines or in motive force using windmills. (Área Metropolitana del Valle de Aburrá,2019).

Although energy production depends mainly on variations in wind speed and direction. Wind turbines are noise generators, which can also be an important factor fortheir implementation. (Área Metropolitana del Valle de Aburrá, 2019).

5. **Ocean Energy**: We know that the oceans make up 70% of the earth's energy.Therefore, there are two types of energy: thermal energy comes from solar heating andmechanical energy originates from tides and waves. (Área Metropolitana del Valle de Aburrá, 2019).

6. **Geothermal energy:** It originates from the heat coming from the center of the earth. It is transmuted by drilling deep boreholes in order to use the heat force beneath the earth's surface to produce electricity. One advantage is that this energy is in fact pollution-free. However, it is extremely expensive to implement.(Área Metropolitana del Valle de Aburrá, 2019)

TECHNOLOGICAL GROWTH

In this study the term of digital transformation is categorized as the greater friend of human progress. When we talk about digitalization, it refers to adapting processes or systems to operate it with a computer and the internet. Positioning on the concept of digital technologies, there are different main types such as big data, artificial intelligence, internet, cloud backup and distributed ledger technology with blockchain as a common form (Eckert & Osterrieder, 2020).

Advances in technology have made social interaction, study and so on so much easier that in fact there are now over 3.5 billion mobile devices and over 22 billion electronic items connected to the internet (Varela, 2020). At this very moment you make use of one to read this study.

Technological popularity is a 21st century movement that will inevitably double in number, including segments of the population, thanks to emerging technologies such as 5G. Well, the more devices available to each person, the more they will be obliged not only to connect to an internet network but also to use energy to charge the battery (Varela, 2020).

Sustainability is not constantly related with technology, but it is the tool to make the movements easier and at the same time addresses the organizational innovation.

Industrial revolution and technology adoption

For the purpose of provide ease to the reader, we speak of revolution when there is an abrupt change in the perceived and the time. That is to say that when speaking of revolution in the technology industry, it refers to a new perspective and a new tool that is being introduced in the era and that will probably change the perspective and the way in which society develops (Schwab, 2016).

The industrial revolution marked a historic period in socio-cultural and socioeconomic progress and transformation. It was the starting point in the improvement of transportation, productivity and increase in per capita income (Selva Belén & López, 2016) In the words of Selva and López, this period began in England in the second half of the eighteenth century (1750-1780) (PALACIOS, 2004), some authors point out that it was in the year of 1760 (Selva Belén & López, 2016) and was a process of intense social, cultural, economic, and technological evolution.

To get into the subject, it is essential to bear in mind that in history there are four periods of the industrial revolution (Selva Belén & López, 2016). Each change in the different revolutions was due to the search to improve the process, to be faster and more efficient, as in the case of the

cylinders suitable for the steam engine (PALACIOS, 2004). Each industry is listed below with the approximate year in which it was created, according to author Klaus Schwab:

1. **First Industrial Revolution:** Coal in 1760 and oil 2000

2. **Second Industrial Revolution:** Gas in 1870: Discovery of electricity, gas,
3. **Third Industrial Revolution:** Electronics and Nuclear in 1960
4. **Fourth Industrial Revolution:** Internet and Renewable Energies in the year

In reference to the first one, this process of bringing about change was slow but substantial and impactful (PALACIOS, 2004) The need for change accentuated the need for energy. Thus, driving the use of coal as a primary source in the eighteenth century to such an extent that at that time the British world power was producing 100,000,000 tons per year (PALACIOS, 2004). This enormous need for energy meant that, until the advent of electricity and nuclear power, the world's most important industrial areas were located near coal mines (PALACIOS, 2004). The event of industrialization was ultimately the result of interconnected technological changes that replaced human skill with mechanical tools that required ***inanimate energy*** (Buchanan, 2023).

The steam engine was in fact the spectacular protagonist in this revolution, it gave way to its creation thanks to the willingness of that time to get compounds such as iron and coal. (Selva Belén & López, 2016). The technical innovation that took place at that time was pioneering to achieve advances, the need for potentiation and efficient methods were the driving force. As an example, the coal requirement was the starting point to boost the mining industry with deeper and more frequent excavations, which generated water seepage, an undesirable situation that was solved with the creation of water Wells (PALACIOS, 2004).

However, there were different consequences that the revolution triggered.

1. **Political Causes:** The installation of the concept of capitalist movement began.

2. **Socio-economic causes:** Urban industrialization, a term used by Palacios in 2004, was in fact a negative effect, due to collateral effects, such as garbage, smokestacks, inadequate sanitation processes and poverty. Additionally, control of trade, increase of labor force due to increased productivity (Selva Belén & López, 2016).

3. **Geographical causes:** The ease with which England was able to obtain certain types of raw materials was an important factor in this revolution (Selva Belén & López, 2016), and because it was an island territory with the help of the steamship it had an advantage in trade (Selva Belén & López, 2016).

In this context of technological changes, new machines were born, among them the steam engine, pioneer in the exploitation of thermal energy, the origin of the thermodynamics development. Given that, the energy obtained by the water wheel was insufficient (PALACIOS, 2004). At this point was where James Watt in 1765 innovated, creating a steam engine that instead of the same in the cylinder, was connected to another device to achieve condensation, event that is located in the second industrial revolution (UpKeep, 2023).

Adaptation needs such as the progress of the textile industry by adopting the steam engine, where Edmund Cartwright patented a mechanical loom in 1787 (PALACIOS, 2004), as well as advances in maritime and land transportation.

In conclusion, after having ventured into the era of the use of coal, the contemporaneity where the engine machine is implemented. In the nineteenth century, the era of electricity, a time when the use of oil is implemented on a large scale, making inroads in the internal combustion engine and in the field of transportation, the automobile is born (PALACIOS, 2004). The efficient development of technology gave rise not only to greater use of oil energy, but also in the 20th century to back propulsion and nuclear energy, events that are among the most influential in the history of mankind (Buchanan, 2023).

The inevitable and necessary expansion that arose from modern industry brought about the progress we know today and at the same time, unfortunately, the environmental crises that have become present.

Definition of information technologies

According to the Colombian Constitution, Article 6 of Law 1341 of 2009, the Information and Communication Technologies (ICT) are the set of resources, tools, equipment, computer programs, applications, networks and media that support the collection, processing, stock, transmission of information in voice, data, text, video and images (Ministerio de Tecnologías de la Información y las Comunicaciones, 2021).

Technology innovation

Innovation can be taken in many forms, progress, new perception, more optimized processes, ease, and other concepts that refer to what we know today as digitization, being this the optimization of processes, cost reduction, development of programs for philanthropic, cultural, and economic purposes, among others. However, for more specific purposes, the term and conceptualization of digitization will be taken as a reference in this study from the book by Klaus Schwab, German economist, and businessman whose main event was the founding of the World Economic Forum, organization of which he is executive president.

Energy innovation is thus the digital revolution characterized by being global and mobile, presented and with elements consisting of sensors with greater capacity, power and smaller size. Digitalization is also composed of artificial intelligence and automatic machine learning (Schwab, 2016).

The fourth industrial revolution comprises not only systemic and interconnected techniques, but also constitutes, in Schwab's words, genetic sequences, nanotechnology, renewable energy sources and quantum computing. (Schwab, 2016), For the purpose of this study, in order to cover the above, the concept of emerging technologies will be used, as they generated changes in less time than previous events, for example, the Internet permeated globally in just a decade, making an approximation.

In the modern world, the fourth revolution has not yet come to an end, in fact it is for this reason that renewable energy sources are also known as alternative sources, because conventional

methods still exist, such as the extraction of zinc, copper, iron, aluminum and other precious metals. (Varela, 2020), This topic will be addressed in chapter 2.3. Mass consumption of technology.

So much progress we have experienced that the fourth industrialization has produced unimaginable amounts of tangible results, by way of contextualization, digital manufacturing technologies, in the words of the economist and founder of the world economic forum, can in fact interact with the biological world; synthetic biology that can interact between microorganisms, organisms such as our bodies, the products we consume and so on (Schwab, 2016).

Schwab calls this outcome ***the Platform effect***, which argues that interconnection between digital organizations produces networks involving buyers and sellers belonging to a wide range of product and service options. Subsequently, is possible to enjoy increasing ***returns on a large scale.*** (Schwab, 2016)**.**

The era of digitalization is known to involve mega trends or common drivers, Schwab classifies them as four types:

1. **Autonomous vehicles:** Technologies such as sensors and artificialintelligence alone are connected to give rise to autonomous machines (Schwab, 2016). Technologies that in fact allow the progress of other disciplines such as the implementationof drones in agriculture provides precise practices to apply fertilizers or water on crops.

2. **3D printing or auditory fabrication:** The creation of

physical /three- dimensional objects using digital templates (Schwab, 2016), here we can refer to medical progress as it can generate implants biologically compatible with the human body.

3. **Advanced Robotics:** Robots that participate in tasks that require greater precision; these computerized robots have shown to have less margins of error than humanlabor (Schwab, 2016). Therefore, in areas such as medicine, they are in fact a very viable option, however, they are still under study before being commercialized in a wide and general way.

4. **New materials:** It is not yet known where else the fourth revolution will leadus; however, it can be taken as advanced nanomaterials and even materials that help us to combat the environmental crises, we face (Schwab, 2016).

Recognizing what are the drivers of technological innovation, we can position ourselves for emerging technologies, such as renewable energy sources (Schwab, 2016). These have gained momentum due to the need to address environmental problems that require safe results on an international basis.

The renewable energies enable local power generation, which will transform supply chains and enhance the ability to design parts on demand, even in remote on-demand parts, even in remote locations (Schwab, 2016).

Innovating in the business unit is the path to success because with provides a competitive

advantage in the market, the detail that makes the business different, efficient, and better that the others. Innovation means developing creative perspectives to address the need or problem that must be resolved, seizing the opportunities generated by digitalization and emerging technologies is the key to the innovation process, as discussed above.

In this process there a strong relationship with Green IT since it is the methodical exhibition of practices that enable the mitigation of the environmental impact of IT, increase productivity and permit for company-wide emission reductions based on innovations (Zaman & Sedera, 2015) In fact, Green IT is part of the emerging technologies (Schwab, 2016).

Most influential technology companies and their influence on sustainable development.

According to the new york times, one of the most influential newspapers in the world originating in the United States since 1851, **The New York Times** is one of the most influential newspapers in the world. (Encyclopaedia Britannica , 2023). Established in 2017 the top 5 most influential technology companies worldwide, which were, Amazon, Apple, Facebook, Microsoft,and Alphabet, in that order (Chayka, 2017).

According to the technology magazine, in its article published in 2022 the same companies and adds others that have had important impacts within the industry and in the organizational structure of any industry, these are System Analysis Program Development SAP, Deloitte, IBM, among others (Tuck, 2022).

In the disposition of not being too broad on the subject, this project will take case studies from **Apple** and **SAP** companies. The first was founded in 1976 which in 2017 reached $800 billion in market capitalization, the first public company to do so. Current CEO Tim Cook laid out financial results for the fiscal fourth quarter in 2021, which demoed that by the end of September. The company had record revenues of $83.4 billion, up 29% year-over-year (Tuck, 2022).

Additionally, Cook points out that it is infusing value into everything they create and develop which has allowed them to move closer to their 2030 goal of being carbon neutral throughout the supply chain and the entire life cycle of their products. Always advancing their mission to build a more equitable future (Tuck, 2022). Through this premise it can be affirmed that Apple, being one of the most influential companies in the world, assumes and faces the transition from IT to Green IT, in fact in the case study Sustainability of three apple production systems addresses this progress.

System Analysis Program Development SAP on the other hand was founded in 1972, originally from Germany and operates in the information technology and service industry as opposed to Apple which operates in the consumer electronics industry (Tuck, 2022).

Company that has grown exponentially, according to the technology magazine article in the year 2022 had more than 230 million cloud users, more than 100 solutions concealing all corporate functions and the largest portfolio of cloud products of all vendors (Tuck, 2022). In fact, 77% of

global transactional revenue is now primarily generated by an SAP system, according to its current CEO Christian Klein, who is the youngest CEO in comparison to other technology powerhouses according to Germany's DAX index (Tuck, 2022).

In fact, SAP is one of the top ten companies, according to one of the world's most influential and credible magazines in sustainability news and articles, because its corporate strategy is based on helping companies practice smart and sustainable practices. (Sustainabilitymag, 2023). As the leading software application company, it helps companies of all sizes to develop in the best way, in fact, SAP consumers generate 87% of the total global market (Sustainabilitymag, 2023).

Among the company's priorities is to provide its customers with ideas, tools, advanced analytical technologies, and guidance for them to stay ahead of the competition by being more efficient and better optimizing and digitizing processes. (Sustainabilitymag, 2023). This can be taken as a demonstration of SAP's commitment not only to address emerging technologies to help its customers develop better but also the need for them to be made aware of the sustainable changes that could be implemented and that undeniably foster competitive advantage.

ENERGY DEMAND

Since industrialization began in approximately 1760 (PALACIOS, 2004) According with Marcelo Justo, writer member of BBC News the world has witnessed an exponential growth in population, development opportunities, quality of life and more. These socio-economic changes

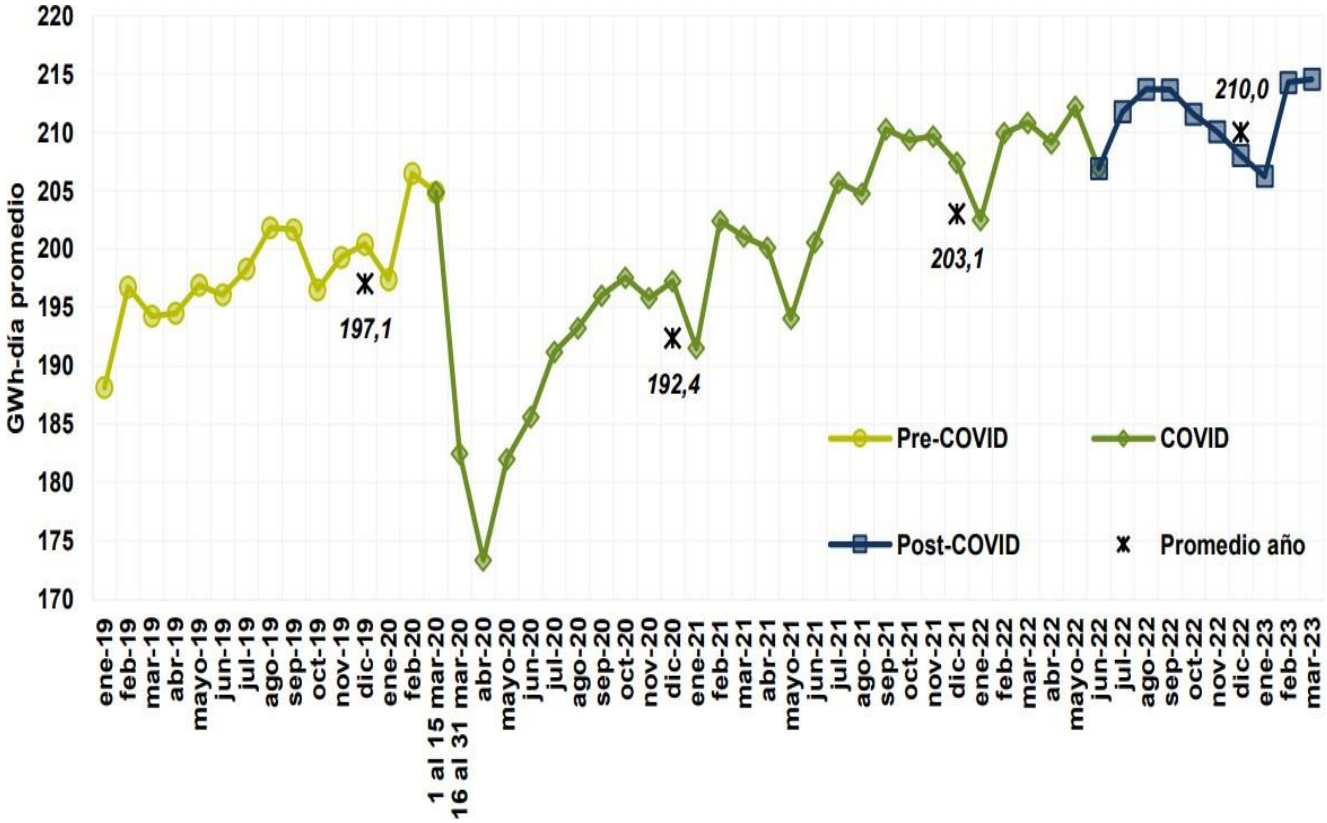
have given rise to social classes, jobs with different qualifications (Justo, 2014) , with it the education and especially the ability to access certain technological implements, the greater the economic capacity, greater technological accessibility will have, this refers to the latest model, greater storage capacity, number of devices, among others.

The national government of Colombia launched a study in 2021, in which it set out projections for the range of years between 2022 and 2036. It works in three spheres to study the energy phenomenon demand for liquid fuels demand estimates with regional distribution in terms of gas and electricity and the last one referring to trends in electricity consumption such as household appliances and gas appliances (Flórez, Morillo Carillo, & Martínez Moreno, 2021).

The following is the data obtained from the Colombian government's study on energy demand in Colombia and its projections:

Figure 4

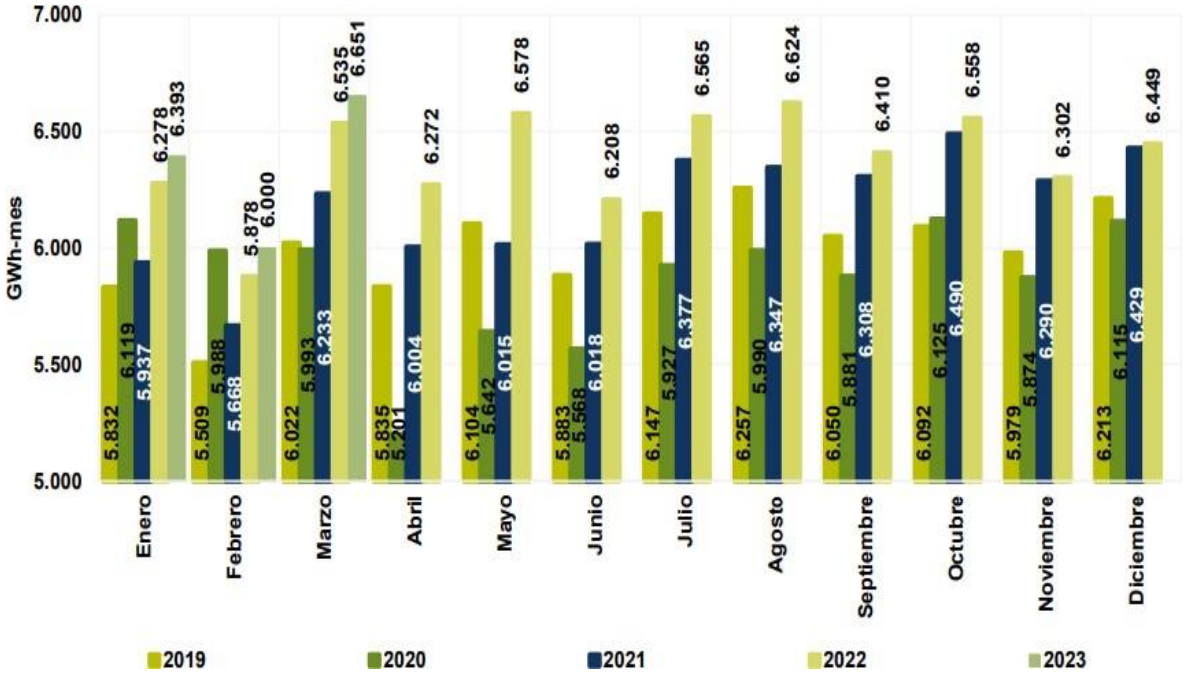
Monitoring of electricity demand in the National Interconnected System (SIN) to 2023,2021



Note. Obtained from Poryeccion de la demanda y de energía eléctrica y potencia máxima2023-2037, page 6

Figure 5.

Monthly electricity demand in the SIN to 2023,2021

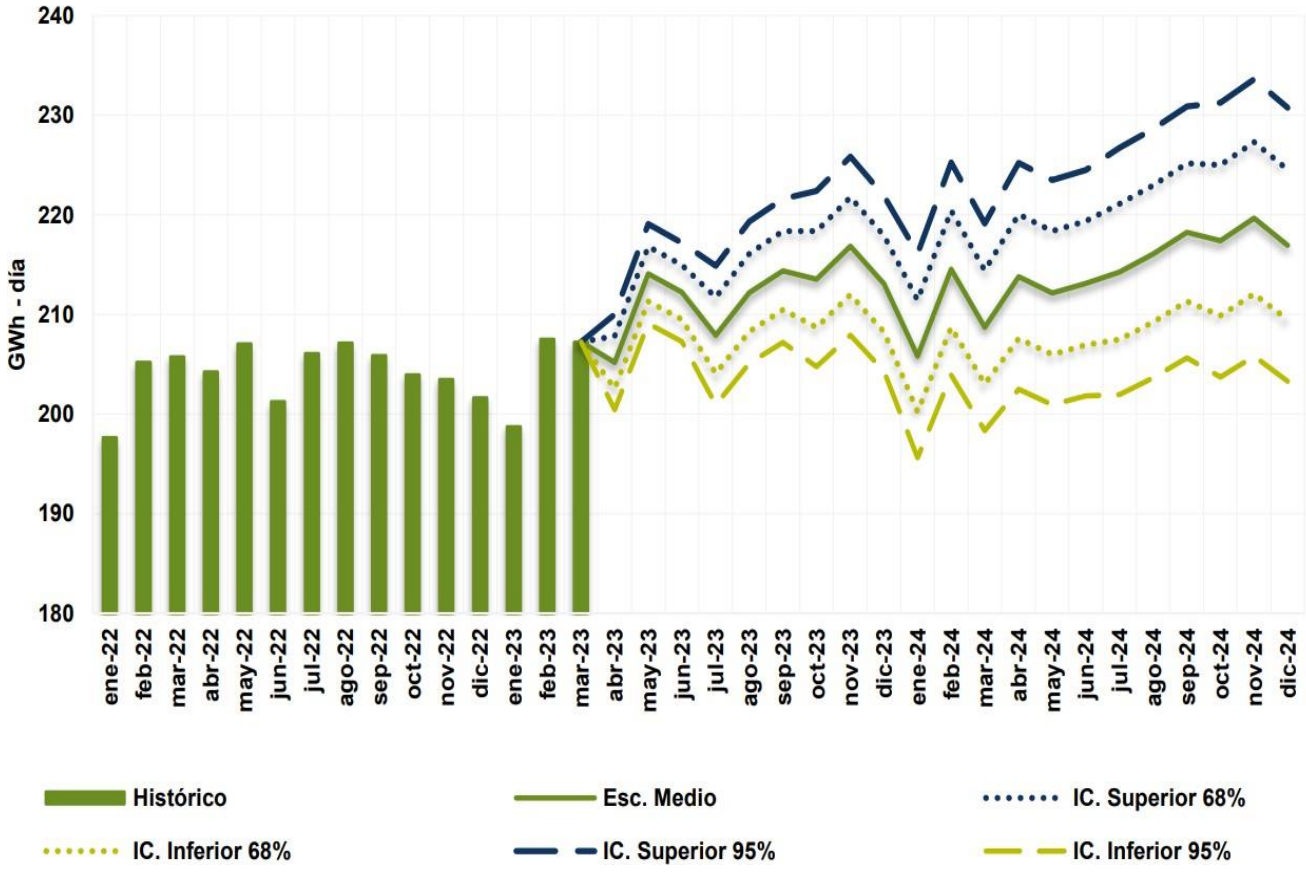


Note. Obtained from Poryeccion de la demanda y de energía eléctrica y potencia máxima2023-2037, page 7

According to the results presented in Figure 4 and 5, between the years 2019 to 2022, the average monthly energy demand 5,869 197,1 GWh-day, 5,869 192,4 GWh-day, 6,176 (203,1 GWh-day), and 6,231(206,2 GWh-day). respectively. Data representing the average increase per year of 4.0% in 2019, -2.1% in 2020, 5.2% in 2021 and 3.4% in 2022 (Flórez, Morillo Carillo, & Martínez Moreno, 2021).

Figure 6

Daily average monthly projection of electricity demand (GWh-día) – sin GCE, 2021



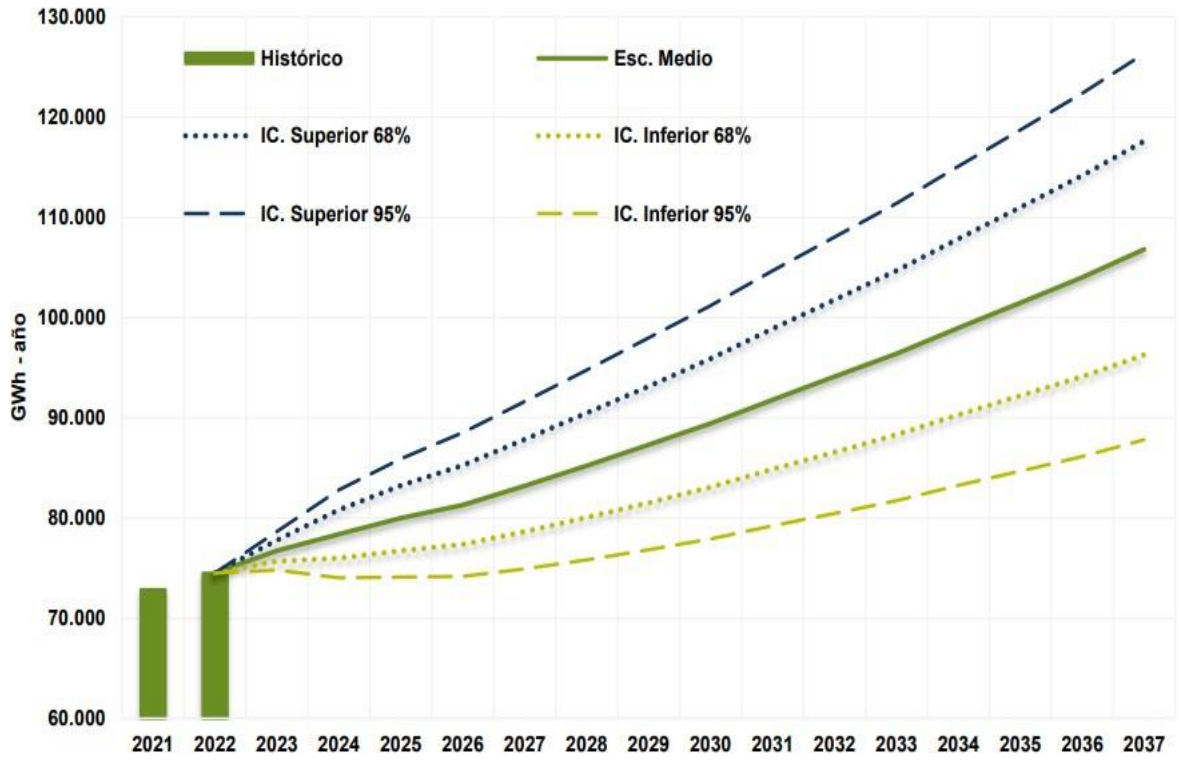
Note. Obtained from Poryeccion de la demanda y de energía eléctrica y potencia máxima2023-2037, page 19

Figure 6 shows the electricity demand projection of the SIN (national interconnected

system) where you can see the average monthly-daily demand considered with their respective intervals in the years 2023 and 2024, here it is estimated that in this short term a range of 196 to 234 GWh-day in the 95% confidence interval, likewise with a confidence interval of 68% is expected a range of demand between 199-227 GWh-day (Flórez, Morillo Carillo, & Martínez Moreno, 2021).

Figure 7

Annual projection of electricity demand (GWh-year) - without GCE, 2021



Note. Obtained from Proyección de la demanda y de energía eléctrica y potencia máxima2023-2037, page 20

The Figure 7 expose an estimated increase in electricity demand between 2023 and 2037, which could average 1.65% to 2.99%.

Demographic and economic growth

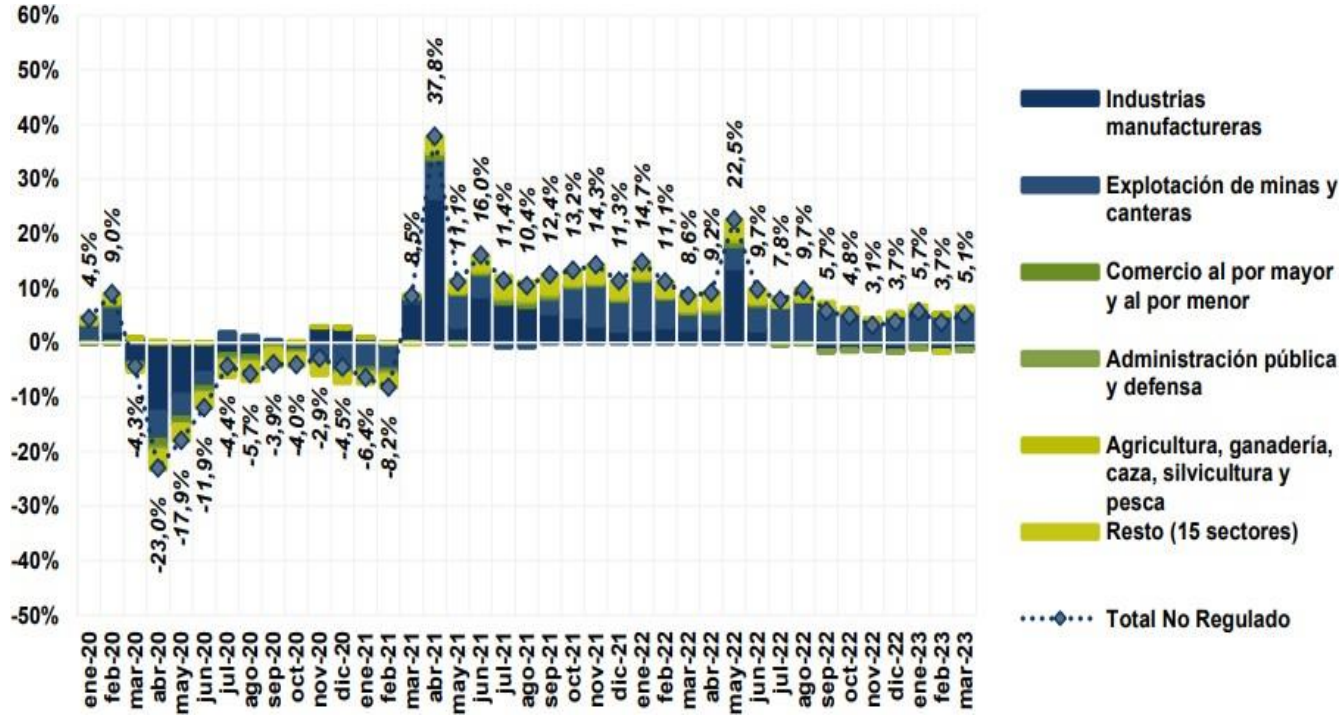
The demographic changes brought about by the different stages of industrialization have been due to various factors, such as the increase in life expectancy. In the 20th century, life expectancy worldwide was around 31 years, but today, in the 21st century, it is over 70 years (Justo, 2014), in fact, studies this year have shown that in the United States it is projected that more than half of the population will be 65 years old (Justo, 2014). life expectancy in latin america evenincreased by 20% (Justo, 2014).

As the number of emerging technologies spread around the world, they trigger different needs in the external public, the more devices, the more Wi-Fi connection is required, demand for education, cultural goods, tourism activities (Justo, 2014) and many more novelties, whether vital or recreational.

This translates into a larger population that needs to be covered with technology development skills. More individuals going out into the world with communication and hard skills improvement needs.

Figure 8

Sectoral contribution to the growth of Non-Regulated commercial demand (%), 2021



Note. Obtained from Poryeccion de la demanda y de energía eléctrica y potencia máxima2023-2037, page 10

According to item 2.3 where the projections of electricity demand in Colombia for a period from 2019 to April 2023, with estimates between 2023 and 2037 reflect an understanding of the economic dynamics and other determinants of electricity consumption in Colombia. comprehension of the economic dynamics and other determining factor of energy consumption in Colombia (Flórez, Morillo Carillo, & Martínez Moreno, 2021).

According to Figure 8, it can be seen that the trade activity with the highest incidence in

Colombia's sectors are manufacturing industry and mining and quarrying (Flórez, Morillo Carillo, & Martínez Moreno, 2021), The areas with the highest incidence of manufacturing, mining and quarrying are the Caribbean and the Orient (Flórez, Morillo Carillo, & Martínez Moreno, 2021).

This is certainly alarming since Colombia is considered one of the countries with the largest flora and fauna in the world. If these trade activities continue without sustainable techniques, since resources are limited, there will be a point of exhaustion.

Digitization

Based on chapter 2.2.3 Technological innovation, the move to digitalization is an organizational transformation that has been booming within the corporate environment, due to:

- Cost reduction
- Competitive advantage
- Process efficiency and effectiveness
- Ease and accuracy
- Reliability
- Secure information
- Convenient
- Fast accessibility
- Reduce Fraud

Benefits taken from the article **How digitalization affects insurance companies: overview and use cases of digital technologies** page12.

However, although these effects seem to be the eighth wonder, in many cases they have had repercussions on technological pollution, a topic that will be discussed in chapter 2.4 Massive consumption of technology. In this study is important to clarified that the detrimental effects on the environment are due to the misuse and consumption of technologies.

Digitization is in fact a green opportunity and tool to commit in the direction of being sustainable because it generates:

1. Energy savings by managing files in the cloud, it saves physical spaces thatconsume or could consume electrical energy (Berrly, 2022).
2. Saves resources because according to studies, 90% of waste generated in anoffice is paper and cardboard, in fact, 50 kilograms of paper are obtained per employee peryear. But in 2021, Spain produced only 6.1 million tons of paper and cardboard (Berrly, 2022), which shows that there are changes and more countries are joining the environmental commitment.

MASS CONSUMPTION OF TECHNOLOGY.

The world is facing a challenge: the growing demand for energy. It is well known that conventional energy sources are limited and certainly their excessive use and frequent extraction has generated transcendental repercussions on the planet's ecosystem. (Rodríguez, 2019). This

added to the demographic and economic growth makes it impossible to propose and generate effective solutions in a short time.

The unbridled consumption of technological devices has triggered environmental and socio-cultural crises that take decades to be restored, whether due to the way raw materials are obtained, the working conditions in which they are obtained or the final disposal of technological products (Varela, 2020).

Technological Pollution

The growth and adoption of technologies has been directly proportional to the amount of waste generated and its detrimental effects (Aguilera, 2010). Several studies have exposed that IT area has been critical in facing problems, but the need remains to involve the whole organization towards achieve significant results (Aguilera, 2010). They also pointed out that IT's negative impact on the environment can be mitigated through technological and behavioral changes. The former should focus on improving IT and business infrastructures to transform them environment friendly (Mann, Grant, & Singh Mann, 2009).

This study will focus on three activities by which technological pollution is sustained. The manufacture, consumption, and disposal of electrical and electronic equipment.

The most well-known environmental crisis, global warming, the growing demand for energy and the increase in pollution, place environmental issues high on government agendas, leading to a series of increasingly stringent environmental policies. The concept of sustainability has generated so much trend that it forces companies to work in a responsible way and adapt products, services, raw material procurement, work environment, programs within the company, among others, to the environment. (Demirel & Kesidou, 2018). This means that companies are gradually becoming mediators of sustainability and generators of social awareness and responsible consumption.

A. Manufacture of technological products

First, to produce an electronic device, a particular raw material is needed, here the mining industry is actively involved as it is responsible for extracting the material, refining it, and delivering it. This supplier obtains minerals and metals from developing countries, such as the Democratic Republic of Congo and Rwanda, practically the entire African continent. Countries where unfortunately there is no concrete stability, there are failed states, corrupt rulers, no concrete environmental policies and among others (Varela, 2020).

According to the study carried out by the Equinoctial Technological University by LuisHidalgo Aguilera, the following metals can be found within the contaminating electronic was:

Base Metals

- Copper: 20%-50%.
- Iron: 8%-20%.
- Nickel: 2%-5%.
- Tin: 4%-5%.
- Lead: 2%.
- Aluminum: 2%-5%.
- Zinc: 1%-3%.

Precious metals

- Gold: 170g-850g approximately 0.1%.
- Silver: 198g-1698g approximately 0.2%.
- Palladium: 3g -17g approximately 0.005%.

In addition to metals, there is also the presence of bismuth and heavy metals that are toxic because they are bioaccumulants, such as arsenic, chromium, cadmium, mercury, selenium and lead. This means that since they are not biodegradable, they remain in plants or are ingested by

animals causing intoxication and negative health consequences (Gobierno de Argentina , 2023).

Accumulator devices, batteries, capacitors, resistors, relays, sensors, conductors, printed circuit boards, data storage media, light, sound and heat generating elements, are equally polluting (Aguilera, 2010).

The form of extraction is not exclusive, it has been seen in the ecosystems where the bulldozers are located, damaged and with arid lands, being limited natural resources, once the extraction is finished in a particular place, the industry will have to look for alternative places, leaving traces of harmful practices and devastating results (Varela, 2020). Event that can be replaced by sustainable practices as long as alternative sources are used and techniques, in fact a study by theKarlsruhe Institute of Technology (KIT), Germany, has shown that it is possible to use sustainable screens for mobile devices, which after being discarded would not become electronic waste but would be fertilizer for the earth, since the life cycle is altered and recyclable material is used (Journal of Materials Chemistry., 2021).

B. Use of Technological Products

In 2021, according to La Republica, one of the most influential newspapers in Latin America, the use of smartphones in Colombia increased by 48% after the Covid-19 pandemic.(Murcia, 2021). Furthermore, according to Digital 2021Global Overview, the number of

connected mobile devices in Colombia has increased to 60.83 million. Of that total, approximately 76.4% are active on different platforms such as Tik Tok, Instagram, YouTube, among others (Murcia, 2021).

In retrospect, the pandemic unleashed the need for connectivity and was therefore conducive to an increase in almost all areas of digital and connectivity. Even the number of users joining social networks increased by 11.4%, with a total of four million new profiles (Murcia, 2021).

Under the same dynamic, smartphone usage increased by 4.5% compared to the 2020 annual report. In addition, the use of non-smartphones decreased by about 3.5%, i.e. without internet access and other functions related to emerging technology. So in 2021 around 32.92 million users were using mobile devices to access the Internet, translating to 94.8% of Internet users (Murcia, 2021).

Based on the above figures, it can be stated that the growing demand for electronic devices was generated by the need for connectivity and social trends such as social networks. Dynamics that has not changed until today, that said, it is pointed out and supports the assertion that the technological demand is growing and with it the increase in energy demand that must be covered.

There are also situations in which programmed obsolescence occurs, which is one of the best-known cases of technological contamination, so that they consciously reduce the average life of an electronic device to force the consumer to buy a new one, generating greater demand in

society (Varela, 2020).

Not to mention the number of new active users who become potential customers in companies, which means an increase in the volume of data that is stored in the data centers of each company (Varela, 2020), whose space is supposed to be so much that will require more energy expenditure to achieve adequate storage, along with the cooling techniques for such centers which require another amount of energy.

C. Final disposal of technological products and environmental effects

Main products that become technological waste at the end of their useful life cycle, based on Aguilera´s study:

1. Electronic cards used in industrial control.
2. Electrical tools.
3. Fluorescent lamps.
4. Desktop computers.
5. Laptop computers.
6. Monitors.
7. Printers.
8. Scanners.
9. Video cameras.
10. Audio Equipment.

11. Television sets.
12. DVD PLAYERS.
13. Electronic toys.
14. Fixed Telephones.
15. Mobile Phones.
16. Household appli

As mentioned above, technological devices are generally made up of e-waste consisting of: polymers, about 30% of which are plastics, refractory oxides, about 30% of which are ceramics, and 40% of which are metals, such as highly toxic metals (Aguilera, 2010). When these products accumulate in the ecosystem, they generate toxic repercussions for living beings, affecting the fauna and flora to a great extent.

in addition, more components that are not biodegradable, which generate greenhouse gas emissions, contributing to atmospheric pollution. As all diesel derivatives, such as gasoline and diesel, oil, gas (Rodríguez, 2019).

Over 800,000 years, atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased to alarming levels. Carbon dioxide concentrations have increased by 40 percent since the first industrialization due to emissions from fossil fuels and net emissions from land use change. Even at the marine level, about 30% of anthropogenic carbon dioxide has been

absorbed, causing acidification (Rodríguez, 2019). Therefore, it is necessary a transition to the renewable energy sector where it contributes to the considerable reduction of CO2 emissions.

In conclusion, the effects of technological pollution are as follows (Ecofiltro, 2022):

1. Atmospheric pollution
2. Exploitation of natural resources
3. Destruction of forests, rivers, and lakes
4. Sedimentation and waste of large quantities of water.
5. Disposal of technological waste
6. Soil and marine pollution

Companies Vs Energy Demand

Emerging technologies play a key role in sustainable development by providing solutions without compromising the ecosystem or social welfare. Current value chains such as SAP and Apple have transcended country borders because of their ability and willingness to implement these technologies to generate positive change.

Apple has such good brand positioning and recognition that when you ask any member of the external public about their preference in terms of cell phones, tablets or computers, they will

surely mention apple in one of those categories (Chayka, 2017).

In fact, in 2018 it was published that Apple uses 100% renewable energy in all its franchises for the production of technological devices, since all its suppliers are committed and add to the production of 100% renewable or alternative energy sources. (Apple, 2018) This implies a huge breakthrough in the industry since being pioneers of such an event gives them a competitive advantage as sustainable trends that generate responsible consumption drive that public to redirect their buying habits.

Other developments that give Apple a competitive advantage:

1. 23 of its suppliers committed to working with 100% renewable energy, ofwhich nine are new suppliers (Apple, 2018).

2. Clean energy from supplier projects avoided the emission of more than 1.5million tons of greenhouse gases in 2017 (Apple, 2018).

3. This company has a platform that provides commercial renewable energysolutions in different regions worldwide (Apple, 2018).

4. More than 85% of suppliers have registered on Apple's clean energy portal(Apple, 2018).

On the other hand, SAP's social and environmental commitment is unparalleled. This entity has an area focused on sustainable development, called SAPsustainability. A place where they

provide their clients with specific solutions on how to address corporate challenges from a socially responsible and eco-friendly perspective (SAP , 2023).

In addition, its entire organizational structure and corporate strategy is centered on its three fundamental pillars, zero emissions, zero waste and zero inequality. Therefore, they focus on reverse logistics and circular economy productions in order to generate changes within their product portfolio and at the same time with the objective of instilling awareness and responsible consumption (SAP , 2023).

RESPONSIBLE TECHNOLOGY MANAGEMENT

Relationship between CSR and Green IT

As sustainability is the point where green information technologies and corporate responsibility converge, it is essential to understand its conceptualization and conception. According to the United Nations this term is defined as meeting the needs of the present generations without compromising the ability of future generations to meet their own (United Nations , s.f.) thus cover the needs of our society by taking care of the ecosystem can be in fact the path to assure the quality of life for the other generations.

As stated at the beginning, the term sustainable development was introduced in the

Brundtland report in 1987, used in a general way as the means to contemplate and meet the needs of current generations without compromising those of future generations. According to Elkington, author and operational director in corporate responsibility and sustainable development, the term within a company aims to provide social, economic, and environmental benefits, is called the ***Triple bottom line*** *TBL* (GIL LAFUENTE,, BARCELLOS, & LUCIANO, 2011) John Elkington pointed out in 1997 that, in order to be a sustainable society, there are three requirements that have to be accomplished:

1. Renewable resource use indicator **smaller than** regeneration rates
2. Indicator of non-renewable resource use **smaller than** rate at whichsustainable renewable substitutes are being developed.
3. Emissions pollution indicator **smaller than** assimilative capacity of theenvironment.

All three conditions point to the same thing, the need to preserve the environment by assessing and maintaining signs of contamination or damage less than the agility of the solution (Alhaddi, 2015). Sustainability is the representation of the development and evolution of society towards a much more comfortable one in which the natural environment with important cultural and economic achievements are dedicated to future generations (Alhaddi, 2015).

The above is due to the fact that, in the present financial benefits are obtained and cultural

advances such as responsible consumption are responsible. Since the triple bottom line is the framework or means to measure the performance of a company from three essential areas, social, environmental, and economic (Alhaddi, 2015). In other words, TBL refers to the social, economic, and environmental policies impacts that constitute the fruit of the implementation and study of sustainability in the corporate environment.

Furthermore, the promotion of responsible consumption and green corporate practices are the key indicators to achieve the sustainable goals. Bear the above on mind because companies are the bigger user of natural resources, reason why they must ensure a responsible consumption, production and delivery of their services and products inside and outside the company. Here what is known as CSR or corporate social responsibility plays a key role (Bernal-Conesa, Briones-Penalver, & De Nieves-Nieto, 2016).

CSR is the tool to develop competitive advantage by ensuring awareness of the social and environmental care while implementing responsible and ethical practices insidethe companies (He, 2012). As an example, and as a representative advantage, some companies donate part of the income they receive for the motivation of funding projects to give support to resolve social issues or needs. To perusing the sustainability goal, the tool is to achieve green IT implementation since it helps to fulfil the fundamental topics that belong to sustainability. Those are the three important aspects mentioned above of sustainability (Chen & Chou, 2016).

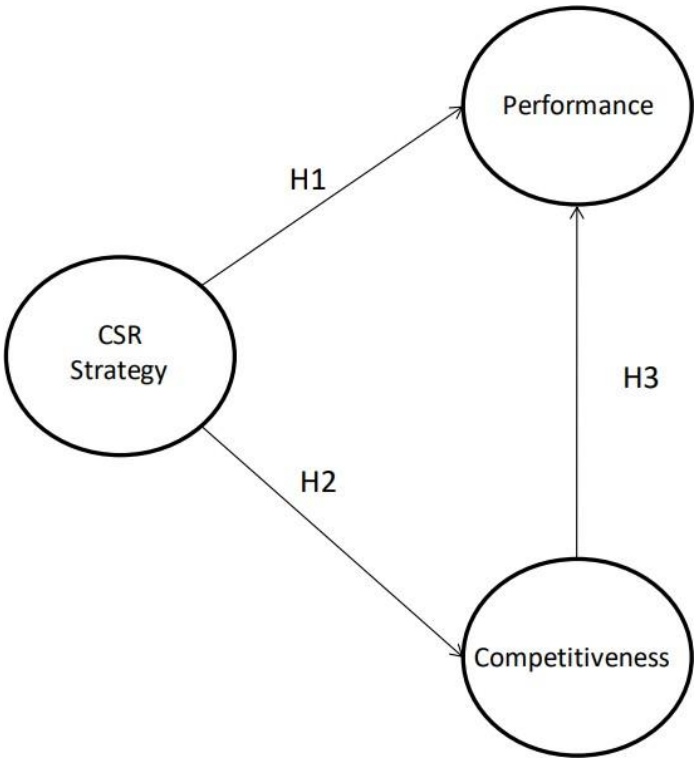
Some studies have shown that the implementation of CSR in organizations has a positive

relationship with financial benefits and, more specifically, that technological industries can increase their economic performance through responsible practices and habits (Bernal-Conesa, Briones-Penalver, & De Nieves-Nieto, 2016).

The objective of the above data analyses was to determine the impact of CSR strategies on the competitiveness and performance of Spanish technological firms. The results showed that these strategies have a significant effect on competitiveness, but the impact of CSR strategies on performance is not as clear, which is in line with other studies' findings (Muñoz et al., 2015). If the mediating role of competitiveness is considered, CSR has a positive influence on performance. These results, therefore, highlight the need to recognize that CSR strategies area driver of performance through competitiveness and that CSR has an important role in technology companies.

Figure 9

Conceptual Research Model, 2017



Note. Obtained from Impacts of the CSR strategies of technology companies on performance and competitiveness, page 4.

Figure 9 shows the relationship between each of the author's hypotheses and the main stakeholders, CSR strategy, competitiveness, and performance. Where the relationship between CSR and performance is that there is a positive impact in companies that exercise their productive activity in a responsible way, so green technology techniques should be adopted in line with the corporate strategy. (Bernal Conesa, Briones Peñalver,& de Nieves Nieto, 2017) , i.e., if the focus is zero CO2 emissions, then on a quarterly or annual basis the carbon footprint should be calculated.

Then there is H2, which refers to the relationship between CSR and competitiveness, where it is possible to analyze that the greater the integration of innovative and conscious processes, the more competitive opportunities there will be in a global environment. (Bernal Conesa, Briones Peñalver, & de Nieves Nieto, 2017), According to the study in question, those companies oriented towards a sustainable corporate strategy undeniably have a better internal organizational structure and, in addition, a good working environment with higher productivity.

Finally, the relationship between competitiveness and performance, which is self-explanatory, since the greater the competitiveness, the greater the productivity, the more proactive the search for solutions and the greater the possibility of addressing issues from different perspectives.

The table below is the prof of the empirical results of the effects on the implementation of CSR strategies inside a company. This demonstrates a positive effect on competitiveness, which is directly related to performance what proves the connection between competitiveness, performance, and CSR in a direct and positive way (Bernal Conesa, Briones Peñalver, & de Nieves Nieto, 2017). The implementation of socially responsible strategies translates into an ethical or moral positioning on the part of organizations and generates intangibles of high value (Bernal Conesa, Briones Peñalver, & de Nieves Nieto, 2017).

Figure 10

Loadings and cross-loadings for measurement model, 2023

Items	*CSR Strategy*	*Performance*	*Competitiveness*
EST01	**0.832**	0.390	0.325
EST02	**0.715**	0.268	0.269
EST03	**0.819**	0.365	0.487
EST04	**0.763**	0.242	0.338
EST05	**0.775**	0.303	0.328
EST06	**0.856**	0.351	0.446
EST07	**0.875**	0.403	0.444
EST08	**0.798**	0.504	0.519
EST09	**0.848**	0.440	0.439
EST10	**0.845**	0.540	0.567
EST11	**0.830**	0.471	0.568
EST12	**0.884**	0.461	0.501
EST13	**0.904**	0.544	0.558
EST14	**0.808**	0.434	0.513
PER01	0.424	**0.862**	0.490
PER02	0.305	**0.797**	0.566
PER03	0.241	**0.736**	0.471
PER04	0.467	**0.817**	0.456
PER05	0.483	**0.775**	0.799
PER06	0.557	**0.889**	0.710
PER07	0.487	**0.921**	0.717
PER08	0.469	**0.904**	0.633
PER09	0.319	**0.792**	0.587
COM01	0.440	0.764	**0.777**
COM02	0.546	0.635	**0.794**
COM03	0.458	0.686	**0.868**
COM04	0.487	0.674	**0.835**
COM05	0.432	0.555	**0.769**
COM06	0.421	0.632	**0.827**
COM07	0.461	0.728	**0.884**
COM08	0.393	0.678	**0.849**
COM09	0.482	0.642	**0.866**
COM10	0.442	0.581	**0.872**
COM11	0.428	0.487	**0.806**
COM12	0.479	0.667	**0.891**
COM13	0.519	0.562	**0.835**
COM14	0.396	0.444	**0.735**
COM15	0.432	0.485	**0.768**
COM16	0.463	0.511	**0.827**
COM17	0.633	0.655	**0.884**

Note. Obtained from Impacts of the CSR strategies of technology companies on performance and competitiveness, page 5.

On the other hand, sustainability has another part that attracts companies a lot and that is innovation. This concept has a large area of work but in this study, it will be pointed out as Green IT innovation since the advances that IT has shown today are mostly for the benefit of a comfortable and healthy society, what we know as the era of digitalization, this situation has positioned the advancement of it as technological innovations (Sydle, 2023). Bearing this on mind Green IT innovation can be define as the production, receiving and execution of new ideas, processes, products or services of IT that reduces the environmental impact of IT designed to benefits organization's stakeholders (Zaman & Sedera, 2015). In Fact, the Green IT are one of the principles of CSR and of course, both are the path to being sustainable.

Understanding the above, clients, suppliers, stakeholders and the other third partiesthat are influencers inside and outside the company need to be aware of the green status of the company, since it is now a primary requirement and also because it gives a plus when we talk about reduction of costs, optimization, and digitalizationof processes in a responsible approach.

To conclude, organizational innovation is linked to sustainability in a very abroad way. However, sustainability can be oriented, this means that is an eco-innovative strategic that involves capabilities. Eco- innovation can be referred as forms of innovation that allow reducing of environmental impacts, here we can visualize a similar purpose of green IT, but both have different forms to address the impacts, innovation with creativity and green IT with responsible use of technology and administration here we have the connection with CSR.

It is worth clarifying that corporate social responsibility focused on the pillar of green technologies is not a simple trend for some companies this year 2023, in fact for some companies, providing green initiatives is mandatory, through administrative innovation which implies the introduction of new procedures, policies and organizational forms (Zaman & Darshana Sedera, 2015).

Sustainable strategies to address energy issues.

As it was mentioned above, the social and economic progress represent the stability, comfortable and healthy ecosystem, the path to obtain it is currently implementing sustainable policies. Each enterprise that wants to increase its sustainable accreditation must first create a Green IT policy that covers the creation, usage, and disposal of IT goods (Zaman & Sedera, 2015). To pursue the sustainable goal, its necessary to create policies and indicators to measure and demonstrate the changes inside the company by obey the governmental initiatives and environmental worries.

In this regard, Green IT can thus be more concisely function as the process that focuses on the strategic deployment of operations and information technology to dynamically, sustainably and responsibly align business-oriented goals with greenobjectives for the entire duration of operations (Mann, Grant, & Singh Mann, 2009).

The company with sustainable initiatives and proposals must then make a reflective choice and strategy on IT products and services (Jayo, 2014), in addition, activities such as trainings, cultural workshops and adaptability with the use of energy efficient tools. The development of IT infrastructure oriented to environmental concerns helps to reduce the damage that the company itself has generated (Jayo, 2014). Therefore, you are leveraging and implementing responsible practices within the organizational structure. Exposing the importance of being conscious and green to internal audiences is also a way to attract potential external audiences.

The following are the steps to success in implementing green initiatives on the corporate environment: the basic prerequisites for any organization thinking about going green are establishing green IT rules and communicating them to the intern public, and once settled, the company has the obligation to ensure they were transferred and referred with the stakeholders and have their buy-in. Further, Green IT should be associated with the current structural strategies and have administrators' commitment to thisinitiative because organizations that, unrelatedly of their size, perceived the environmental issues as a business and opportunity challenge have prospered(Zaman & Sedera, 2015).

Another strategy is to generate alliances with suppliers and partners that are currently committed to the use of 100% alternative sources, as established in chapter 2.4 where the sustainable activities that Apple is exercising are exposed. Also alliances with expert agencies in the disposal of technological products at the end of their useful life, in order to integrate sustainable

techniques such as reverse logistics, in fact in the newspaper El País, a publication was made this year on how precious metals such as gold are being saved within the technological scrap in Germany, it is an international mining company that recycles metal elements (Limón, 2023).

Esta nueva iniciativa nacida en Alemania, propiedad de Dow y Mura espera operar en el 2025, instalación que supone entregar aproximadamente 120 kilotones por año (KTA) de capacidad de reciclaje. El objetivo es implementar materia prima circular para producción polietileno y además la descarbonización de activos para reducir impacto de GHG (Revista Map, 2022).

Moreover, this study provides the certificates obtained by joining the exchange are (Berrly, 2022):

1. **EMAS:** instrument to evaluate other companies on their environmentalperformance.
2. **ISO 14000:** Standards created for companies to know their impact on theenvironment, it works as a framework for quality management.
3. **LCA:** It is an analysis of the product life cycle, where it evaluates theimpact on the extraction of raw materials up to the final disposal.

B CORP: Certificate of standards that measures the social andenvironmental performance of a company.

METHODOLOGY

Study based on the book Research Methodology sixth edition.Chapter 2 part 2 The quantitative research process

The quantitative study

The present study has a quantitative approach that represents a set of sequential and evidential processes, based on concepts, knowledge and predictive procedures supported by the initial hypothesis.

Type of Study

The study is cross-sectional because it allowed us to focus on a comparison of certain characteristics or situations in workers of companies that focus on information technology and companies that are oriented to renewable alternatives and where the data are collected in a certain period. (Hernández Sampieri, Fernández Collado, & Baptista Lucio, 2014)

Respondents' profile

In this research we considered professionals working in the information technology and renewable energy industry in the city of Bogota, Colombia, who were interested in the topic.

Inclusion criteria

- Professionals located in Colombia, particularly in the capital city of Bogotá.
- Professionals with a current employment contract in force during the firstsemester of 2023.
- Professionals who are active at the time of applying the survey.
- Professionals who belong to the areas of corporate responsibility, innovation,renewable energies, and information technology.
- Professionals interested in answering the surveys

Exclusion

- Personnel who, once accepted to participate in the study, do not fill out thesurvey or fill it out incompletely. Survey or fills it out incompletely.
- Officials who are not employees of information technology and renewableenergy companies.
- Professionals who are on leave, vacations, or any other novelty at the timeof applying the survey.

Questionnaire's structure and content

A. Instrument

A Sensitivity Survey was used, Name of the instrument "Exploratory Sensitivity Survey-knowledge and adherence in renewable energies".

Obtained from "Factors Associated with the Application of Biosafety Measures Taken by Nursing Professionals " (CAMACUARI CARDENAS, 2020) Adapted by Valentina Medina Lopez.

It is constituted by 24 items organized in 2 dimensions: individual factors (15 items), organization factors (9 items); being evaluated for the verification questions by a dichotomous nominal type scale with answers: yes (1) and no (0) where the final value will be favorable and unfavorable; and by a Likert frequency scale with 4 types of answers: Never (0), Occasionally (1), Usually (2) and Always (3) for the implementation questions.

The questions used in this project were the following:

Table 1

Questionnaire's structure

Component 1
<u>Individual</u>
1. Are you over 25 years of age?
2. Have you ever worked in an entity related to the IT or renewable energy industry?
3. Is the time in the area where you work longer than 1 year?
4. Do you understand the priorities of the technology industry focused on solving environmental problems?
5. Do you know what sustainable solutions have been proposed to address the energy crisis?
6. Do you know what the effects are generated in the environment due to technological consumption? Which is

growing
7. Do you believe that renewable energies help to reduce costs?
8. Do you know about Green IT?
9. Do you know about renewable energies?
10. Do you know what the feasible conditions are to install this type of technology?
11. Do you know what benefits are generated by the use and implementation of renewable energy sources?
12. If you know if there are established solutions, do you know which ones have been more successful than others, from a corporate point of view?
13. If your answer above was yes, please write down the solutions
14. Are you motivated to perform related activities that benefit the

environment?

15. From your individual perspective, could green technologies be used to generate a positive impact on the environment?
Component 2
<u>Organizational</u>
16. Does your company have a sustainable physical environment (inputs, processes, raw materials, etc.)?
17. In your company have you seen that there is or has been a definition of areas focused on sustainability, renewable energy and/or philanthropic activities?
18. Do you believe that your company has sufficient installed capacity to deal with renewable energies?
19. Do you know if your entity has programs focused on renewable energies?
20. Do you currently know if there are people trained in renewable energy and/or green information technologies within the institution?
21. Does the institution of which you are a member have existing institutional regulations in terms of sustainability?
22. In the company you are part of, do you

provide training on energy crisis, renewable energies, green technology?
23. Have you heard or do you know if your institution proposes sustainable solutions to the energy crisis?
24. Does your institution hire people trained in the sustainable development industry?

Note: obtained from "Factors Associated with the Application of Biosafety Measures Taken by Nursing Professionals" (CAMACUARI CARDENAS, 2020) Adaptado por Valentina Medina Lopez.

Table Measurement variables.

Table 2

Table Measurement variables.

Individual	**Organizational**
Age	Physical Environment
Work Time	Focus Areas
Priorities	Sufficient installed capacity
Sustainable solutions	Programs focused on renewable energies
Effects	Corporate proposals
Knowledge renew energies reduce f able	Regulations

costs	
Costs	Programs
Renewable energy	Training
green information	Corporate solutio established ns re
Feasible conditions	
Benefits	
Impact	
Individual Perspective	

Note: obtained from "Factors Associated with the Application of Biosafety Measures Taken by Nursing Professionals" (CAMACUARI CARDENAS, 2020) Adaptado por Valentina Medina Lopez.

B. Operationalization

The data are described in the survey: "Exploratory Sensitivity Survey-knowledge and adherence to renewable energies.

Table.

Table 3

Indicators and criteria

Dimensions	**Indicators**	**Items - question**	**Scale**	**Criteria and Ranges**

D1 Individual Individual Factors	• Age • Involvement in technology and/or renewableenergy industry. • Time in the organizational area. • Knowledge of technology industry priorities to address environmental issues. • Knowledge of solutions • Knowledge of renewable energy	1 to 12, 14	Nominal Dichotomous	Favorable Unfavorable

	• nowledge ofGreen IT • nowledge offeasible conditions toinstall this green technology. • nowledge of benefits brought by Green IT • nowledge of solutions t hathave been most successful			

	i naddressing environmental crisis. • otivation to be sustainable. • e cognition of theimpact that Green IT brings			

D2 Organizational Factors	• Physical environment • Installed capacity. • Programs focused on renewableenergy. • People trained in Green IT and/orrenewable energysources. • Regulations	16, 18 to 21	Nominal Dichotomous	Favorable Unfavorable
D2 Organizational Factors	• Areas focused on sustainability and/or renewableenergies. • Training on energy crisis issues • Knowledge of solutions proposed by the institution.	17, 22 to 24	Likert of Frequency	Never (0) Occasionally (1) Usually (2) Always (3)

	• e cruitment of people trained in sustainable development.			

Note *Obtained from "Factors Associated with the Application of Biosafety Measures Taken by Nursing Professionals" (CAMACUARI CARDENAS, 2020) Adaptedby Valentina Medina Lopez.*

C. Scale of responses

- Verification: yes (1) and no (0)
- Probability: (1)" Always" (4)" Usually" (3)" Occasionally" or (0)"
- Never
- Ranges: Unfavorable (0 - 11) and favorable (12 - 23)

D. Validity of the instrument

The validation of the instrument was carried out from two points of view; by expert judgment: understood as the opinion given by people with experience in the subject and who are recognized by other people as experts in the subject, who have the power to provide information, evidence, judgments and assessments, For which the concept was requested to Dr. Daniela Moreno

- Environmental Engineer, director of operations of a multinational company working on issues ofwho gave her concept of content validity of the instrument referring to Sufficiency and Applicability (Annex 2).

Data collection

Application of the instrument

The structured survey was sent to the 100 participants via e-mail for completion, which should be done through a link, https://forms.gle/cyEwH6SC7pZvR6T38, which had a FORM format, the estimated time for delivery was 8 days and all the contacts were left in case any doubt was generated, once completed it was sent via e-mail.

Given the nature of this study and the target population, and due to conditions, such as availability of shifts, location, etc., it was not possible to apply the instrument to all respondents. It was not possible to apply the instrument to everyone, however, a census quota of almost 85% was achieved, so inferential tests (hypothesis tests) are not carried out in this study.

RESULTS & ANALYSIS

Data analysis

As this was a quantitative study, descriptive statistical analysis was used, so the data were calculated in Excel, using the JASP program version (0.16.2). The following steps were included in the analysis:

A. The variables, which would explain the data obtained, were defined,subsequently a coding was.

B. The variables, which would explain the data obtained, were defined and thencoded individually by items.

C. Consolidation of the information in a data matrix.

D. Definitions and data collection were obtained, which were the input to define

the

E. The data matrix was defined, and a short name was defined for each variable,

F. A short name was defined for each variable, which would be equivalent to an item, indicator, category or case, and the distribution in the data matrix was as follows: variables were recorded in columns and cases in rows.

G. The information obtained from the application of the 88 surveys was consolidated in a database, which in turn was taken to the application.

H. Execution of descriptive analysis and cross-referencing of

individual and organizational variables were performed.

I. The data was processed by performing a parametric analysis, calculating frequencies, cross tables, and contingency tables.

Pilot Test

Prior to the start of data collection in the field. The survey format and all its variables were reviewed with technical and methodological advisors, and an opinion and suggestion was requested from Dr. Daniela Moreno, director of operations of a multinational company with expertise in the subject, given her profile and knowledge.

As a recommendation, the survey was applied to a small group of professionals of the

The survey was applied to a small group of professionals from the SAP solutions Institution in Bogotá Colombia, a total of 5 professionals after authorization and signature of the informed consent, with the objective of identifying suggestions regarding the content of the tool used. Some of the factors that were evaluated:

- The time taken to complete the survey.
- Wording of the survey, clarity of the variables
- Suggestions for addition or removal of variables.
- Compliance with the selected inclusion and exclusion

criteria.

The comments and suggestions from the participants helped us to better address some response instructions, and to identify questions that present greater complexity in terms of comprehension or response time.

Note: Results of the survey applied to the pilot test participants.

Conclusions of this test

- Was evidenced that it is of great value to carry out the survey to allprofessionals identified in areas related to the topic under study.
- Was possible to evaluate that the instructions for filling out the survey wereunderstood by most of the participants.
- The comments and suggestions of the participants helped us to orient the questions.
- The pilot test allowed us to demonstrate the feasibility of the survey in our baseline study; and how the tool is applicable to our evaluated population, as well as the relevance of the questions and their measurement.

Descriptive Analysis

We proceeded to analyze the data obtained from the variables by performing a parametricanalysis and using the frequencies of the most important variables.

parametric analysis, and the frequencies of the variables with the greatest impact were usedimpact:

- Age
- Work Time
- Time Area
- Priorities
- Sustainable solutions
- Effects
- Costs
- Green information
- Renewable energies
- Conditions
- Benefits
- Impact
- Motivation
- Individual Perspective
- Physical Environment

- Focus Areas
- Training
- Corporate Proposals
- Personnel / Employees
- Capacity
- Programs
- Trained Professional
- Regulations

Contingency table analysis was also applied in order to evaluate if there was any associationbetween variables some of these crosstabs were:

- Do you know what sustainable solutions have been proposed to address theenergy crisis?
- Do you know what sustainable solutions have been proposed to address theenergy crisis? vs Do you believe that renewable energies help in reducing costs?
- Do you know about renewable energies? vs Do you know if your entity hasPrograms focused on renewable energies?
- Do you know about green information technology? Do you know whatbenefits are generated by the use and implementation of renewable energy sources?

Bivariate analysis

Bivariate crosses (by pairs of variables) were made between attributes or nominal variables, in order to identify if there was any degree of association (dependence) between them, and thus identify trends in the responses of the participants in this sensitization study.

Given the importance of identifying common causes in respondents' perceptions, a bivariate analysis of a few crucial questions of the instrument is presented below to give indications of trends in respondents' behaviors.

In your company have you seen that there is or has been a definition of areas focused on sustainability, renewable energy and/or philanthropic activities? Vs Does your institution hire people trained in the sustainable development industry?

Table 4

Contingency Tables

Contingency Tables

	Human Talen

Focused Areas		Usually	Always	Occasionally	Never	Total
Usually	Count	18.000	1.000	5.000	0.000	24.000
	% of total	20.455 %	1.136 %	5.682 %	0.000 %	27.273 %
Always	Count	7.000	6.000	1.000	0.000	14.000
	% of total	7.955 %	6.818 %	1.136 %	0.000 %	15.909 %
Occasionally	Count	2.000	1.000	16.000	10.000	29.000
	% of total	2.273 %	1.136 %	18.182 %	11.364 %	32.955 %
Never	Count	0.000	0.000	2.000	19.000	21.000
	% of total	0.000 %	0.000 %	2.273 %	21.591 %	23.864 %

Note: Adaptado por Valentina Medina Lopez.

The graph shows that the companies have worked on the issue of sustainability and do sowith the following participation.

- Occasionally 27.2% (24) of the professionals hired are trained in sustainability and renewable energies and 32.9% (29) are never trained.
- Occasionally 32.9% (29) of the corporations have areas focused on sustainability and renewable energies and 27.2% (24) usually have these areas clearly defined.

Does the institution of which it is a part provide training on energy crisis, renewable energies, green technology?" vs. "Does the institution of which it is a part hire people trained in the sustainable development industry?"

Contingency Tables

		Trainings				
		Usually	**Always**	**Occasionally**	**Never**	**Total**
Count	Usually	22.000	1.000	4.000	0.000	27.000
	% of total	25.000 %	1.136 %	4.545 %	0.000 %	30.682 %
Always	Count	3.000	5.000	0.000	0.000	8.000
	% of total	3.409 %	5.682 %	0.000 %	0.000 %	9.091 %
Occasionally	Count	3.000	0.000	17.000	4.000	24.000
	% of total	3.409 %	0.000 %	19.318 %	4.545 %	27.273 %
	Count	0.000	0.000	10.000	19.000	29.000
	% of total	0.000 %	0.000 %	11.364 %	21.591 %	32.955 %
	Count	28.000	6.000	31.000	23.000	88.000

Crossing these two variables we found that occasionally 35.2% (31) institutions hire stafftrained in sustainable development, while 31.8% (28) are staff hired and trained in this topic.

In case you know if there are established solutions, do you know which ones have been more successful than others, from a corporate point of view? " vs Do you think your company has sufficient installed capacity to address the renewable energy issue?"

Table 6

Contingency Table #3

Contingency Tables

Impact		Ability		
		Yes	**No**	**Total**
Yes	Count	17.000	3.000	20.000
	% of total	19.767 %	3.488 %	23.256 %
No	Count	29.000	37.000	66.000
	% of total	33.721 %	43.023 %	76.744 %
Total	Count	46.000	40.000	86.000
	% of total	53.488 %	46.512 %	100.000 %

Note: Adaptado por Valentina Medina Lopez.

- 53.4% (46) of the respondent's state that the companies where they work have the installed capacity and physical environment to address sustainability issues and46.5% (40) state that their entities do not have these areas.
- 76.7% (66) answered that they do not know of any solutions that thecompanies have implemented at the corporate level.

Inferential Analysis

Given the nature of the study and the target population, the purpose was to census them all; however, due to conditions such as availability of shifts and location, the instrument was not applied to all, but a census quota of almost 85% was achieved; therefore, inferential tests (statistical hypothesis tests) are not performed.

Results Analysis

A. Age

Table 7 . Total, population surveyed

Descriptive Statistics

	Age
Valid	88
Missing	0
Mean	1.136
Std. Deviation	0.345
Minimum	1.000
Maximum	2.000

Mode is if (over 25 years old)Mean is if (over 25 years old)

Table 8 Frequencies for Age

Frequencies for Age

Age	Frequ	Per	Valid	Cumulative

ge	**ency**	**cent**	**Percent**	**Percent**	
	Y	76	86.	86.364	86.364
es			364		
	N	12	13.	13.636	100.000
o			636		
	T	88	100		
otal			.000		

Professionals over 25 years old 86.3% (76) and 13.6% (12) of those under 25 years of age.

Figure 11

Distribution Plots: Age

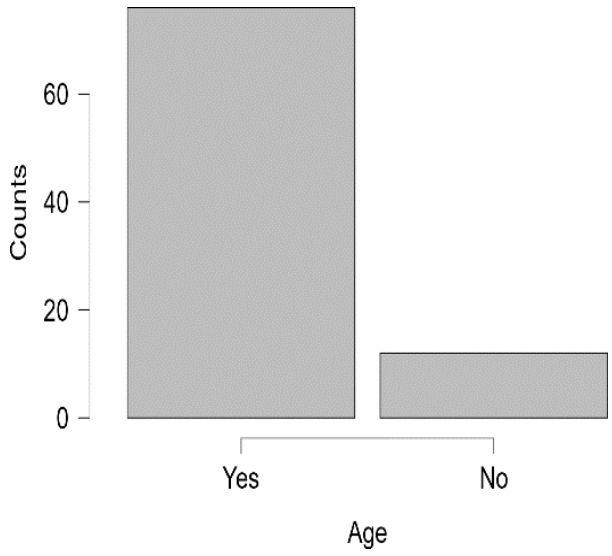


Figure 12.

Frequencies for Age

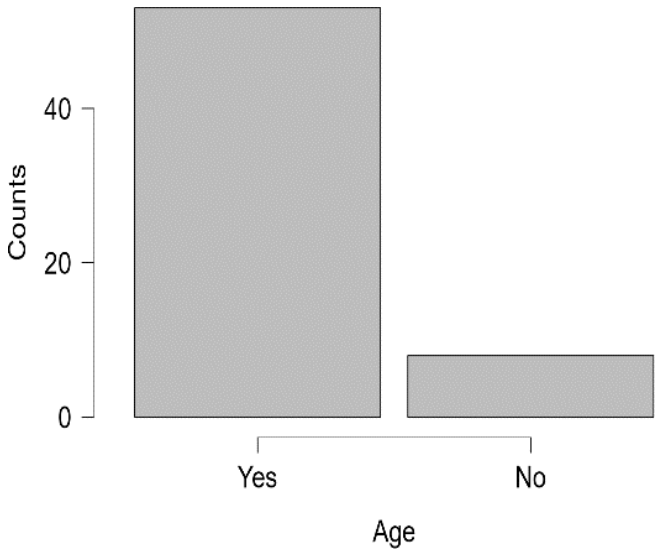


Table 9

Frequency for Age #2

Frequencies for Age

	l	A	Fre	P	Valid	Cumulative
ffects	**ge**	**quency**	**ercent**	**Percent**	**Percent**	
	`	Y	58	8	85.294	85.294
es	es		5.294			
		N	10	1	14.706	100.000
	o		4.706			
		M	0	0		
	issing		.000			
		T	68	1		
	otal		00.000			
	l	Y	18	9	90.000	90.000
o	es		0.000			
		N	2	1	10.000	100.000
	o		0.000			
		M	0	0		
	issing		.000			
		T	20	1		
	otal		00.000			

Facts:

- 85.2 % (58) of professionals over 25 years old know the effects generated in the environment due to technological consumption. Which is growing.

- 14.7% (10) of those under 25 years of age are aware of the effects of technological consumption on the environment. This is increasing.

- 18 professionals over 25 years old and 2 professionals under 25 years old do not know this effect.

B. Sustainable Solutions

Table 10

Frequency for Sustainable Solutions

Frequencies For Sustainable Solutions

Sustainable Solutions	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	51	57.955	57.955	57.955
No	37	42.045	42.045	100.000
Missing	0	0.000		
Total	88	100.000		

Facts:

- 57.9% (51) know what sustainable solutions are and which ones have been proposed to address the energy crisis at the corporate level.

- 42% (37) do not know what solutions have been proposed at the corporate level.

Age vs Technology priorities to solve environmental crisis

Table 11

Frenquecies for Age

Priorities	Age	A	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	Yes	Y	53	86.885	86.885	86.885
		N	8	13.115	13.115	100.000
		M	0	0	.000	
		T	61	100.000		
No	Yes	Y	23	85.185	85.185	85.185

	N	4	1	14.815	100.000
o			4.815		
	M	0	0		
issing			.000		
	T	27	1		
otal			00.000		

Note: Adaptado por Valentina Medina Lopez.

Facts:

Of those over 25 years of age, 86.8% (53) are aware of the industry's priorities in technologyfocused on environmental issues and 13.1% (8) of those under 15 years of age are also aware of these priorities.

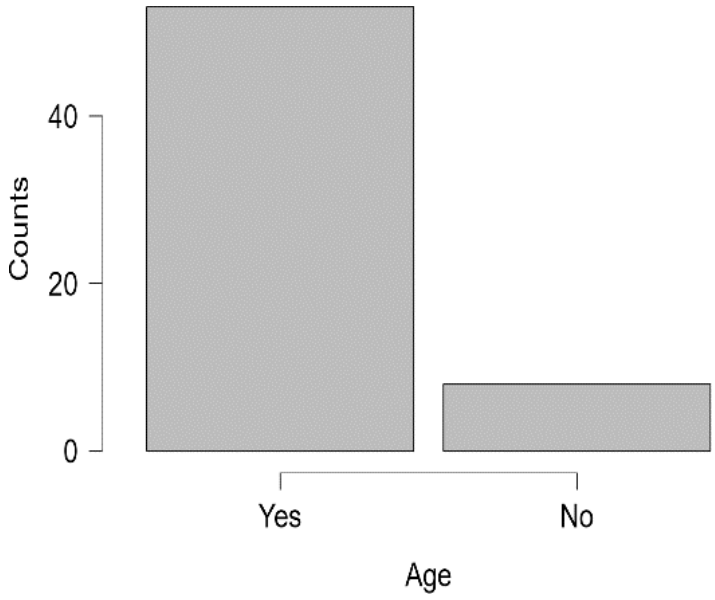
Distribution Plots:

Age: Participation by age range over 25 years old(86.8%)

Yes: Over 25 years

Figure 12

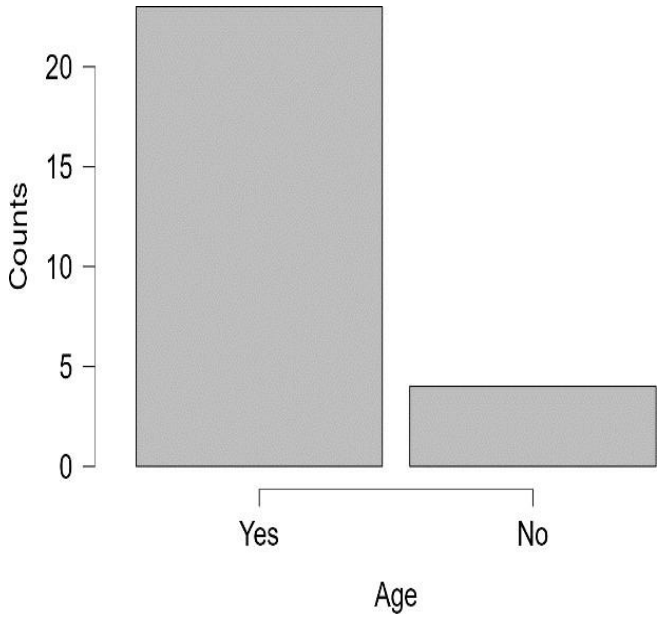
Participation by age range over 25 years old



Number of participations by age range under 25 years old (13.1 %)

Figure 13

Number of participations by age range under 25 years old



C. Technology industry priorities focused on solving environmental issues Vs Trained Persons.

Table 12 Frequencies for Trained profesionals

Conditions	Trained profesionals	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	Yes	26	66.667	66.667	66.667
	No	13	33.333	33.333	100.000
	Missing	0	.000		
	Total	39	100.000		

			00.000		
No	Yes	14	2	28.571	28.571
			8.571		
	No	35	7	71.429	100.000
			1.429		
	Missing	0	0		
			.000		
	Total	49	1		
			00.000		

Facts:

- Of those surveyed, only 39 are trained professionals and 49 are not trained.
- 26 professionals corresponding to 66.6% of the 39 who are trained in renewable energies and know about green information, know what the viable conditions are to install at the corporate level, and 14 of these professionals do not know these conditions.

D. Physical Environment Vs Professionals in the Technology Industry

Table 13

Frequencies for Labor Time

Phy1cal environment	Labor Time	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	Yes	42	82.353	82.353	82.353
	No	9	17.647	17.647	100.000

Note: Adaptado por Valentina Medina Lopez.

Phy1cal environment	Labor Time	Frequency	Percent	Valid Percent	Cumulative Percent
	Total	51	100.000		
No	Yes	21	56.757	56.757	56.757
	No	16	43.243	43.243	100.000
	Total	37	100.000		

Facts:

- 51 professionals have worked in companies related to the information technology industry and renewable energies and of these 82.3% (42) say that in their companies there is a sustainable physical environment, and only 17.6% (9) of these professionals say that their companies do not have these physical conditions.

E. Focused Areas

Table 14

Frequencies for Focused Area*s*

Focused Areas	Frequency	Percent	Valid Percent	Cumulative Percent
Usually	24	27.273	27.273	27.273
Always	14	15.909	15.909	43.182
Occasionally	29	32.955	32.955	76.136
Never	21	23.864	23.864	100.000

Total	88	100.000

Note: Adaptado por Valentina Medina Lopez.

Facts:

Of the 88 respondents, when asked if their company has areas focused on sustainability,renewable energy and/or philanthropic activities, the result was as follows:

- Usually 27.2% (24)
- Always 15.9% (14)
- Occasionally 32.9% (29)
- Never 23.8% (21)

F. Institution's response to the energy crisis

Table 15

Frequencies for Corporate Proposals

Corporate Proposals	Frequency	Percent	Valid Percent	Cumulative Percent
Usually	26	29.545	29.545	29.545
Always	9	10.227	10.227	39.773

Occasionally	23	26.1	26.136	65.909
	36			
Never	30	34.0	34.091	100.000
	91			
Total	88	100.		
	000			

Note: Adaptado por Valentina Medina Lopez.

Facts:

When asked if your corporation or entity proposes sustainable solutions to the energy crisis,the participation was as follows:

- Usually 29.5% (26)
- Always 10.2% (9)
- Occasionally 26.1% (23)
- Never 34% (30)

G. Trained Human Talent

Table 16

Frequencies for Human Talent.

Human Talent	Frequency	Percent	Valid Percent	Cumulative Percent
Usually	27	30.682	30.682	30.682
Always	8	9.091	9.091	39.773
Occasionally	24	27.273	27.273	67.045
Never	29	32.955	32.955	100.000
Total	88	100.000		

Note: Adaptado por Valentina Medina Lopez.

Facts:

According to the respondents' companies hire personnel trained in sustainable developmentwith the following participation:

- Usually 30.6% (27)
- Never 32.9% (29)

 And only 9% (they take these profiles into account) and 27.2% (24) do itoccasionally.

H. Green IT benefit

Table 17

Contingency Tables

	Conditions	
Green Information	**Yes**	**No**	**Total**
Yes	33	2	45
No	6	7	43
Total	39	9	88

Note: Adaptado por Valentina Medina Lopez.

Facts:

 Of the total number of respondents, 45 are aware of green information technology, 33 know the benefits of using and implementing renewable energy, only

12 arenot aware of the benefits of this knowledge.

4.3. Discussion

In the results obtained from this research with an important census quota of our study population, to which the survey was applied as a measuring instrument, a high degree of reliability, validity and association was obtained, according to our consultant, which provided a good level of reliability, thus showing the correlation that exists between the evaluated variables, both personal and institutional.

The statistical data obtained from the bivariate and multivariate analysis allowed us to continue with the quantitative data and the subsequent construction of the descriptive data to obtain a total reliability of the instrument, thus achieving a reliable and useful analysis.

In that order we find that 86.8% (53) of those over 25 years of age are aware of the industry's priorities in technology focused on environmental problems and 13.1% (8) of those who are not over 25 years of age are also aware of these priorities.

Another of the points emphasized in the survey was the knowledge of green information and also the knowledge of the viable conditions to install areas and policies at the corporate level

that support everything related to sustainability.

Of the 88 respondents, when asked if their company has areas focused on sustainability, renewable energy and/or philanthropic activities, the results were as follows:

- Usually 27.2% (24)
- Always 15.9% (14)
- Occasionally 32.9% (29)
- Never 23.8% (21)

Some factors that have a direct impact on the results obtained are directly related to the knowledge, training and definition of clear areas and policies by the institutions. The literature states that the analysis of the correlation coefficients between the factors of personal or institutional dimensions is fundamental in quantitative studies with descriptive results and analysis, since it allows to make a cross between the factors that influence or are significant (Oviedo Celina & Campo Arias, 2005) and those that do not (Oviedo Celina & Campo Arias, 2005).

Some of the results obtained from these crossings and analysis of the variables are that occasionally 35.2% (31) of the institutions hire personnel trained in sustainable development, while 31.8% (28) are personnel hired and trained in this subject, and this type of results show that risk behaviors can be generated with respect to the institutional norms and guidelines and this leads to mistakes being made when carrying out practices by the personnel.

53.4% (46) of the respondents stated that the companies where they work have the installed capacity and physical environment to address sustainability issues and 46.5% (40) stated that their entities do not have these areas.

76.7% (66) answered that they do not know of any solutions that the companies have implemented at the corporate level, which means that there is no adherence to any guidelines related to sustainability.

The study also made a descriptive analysis and coincided with some of our findings, which we cite in the conclusions.

CONCLUSIONS & PRACTICAL RECOMMANDATIONS

Conclusions

Factors were identified that are directly and indirectly associated with the energy crisis thatis currently growing, such as the lack of knowledge of related issues or the absence of:

At the individual level:

- Technology industry priorities focused on solving

environmental issues.

- Green information technology.
- Renewable energy.
- Benefits generated by the use and implementation of renewable energysources.
- Corporate policies aimed at reducing the energy crisis.
- Lack of motivation to carry out related activities that benefit the environment.
- Lack of knowledge of the effects generated in the environment due totechnological consumption.

Institutional level:

- Existing institutional regulations in terms of sustainability.
- Staff trained in renewable energies and/or green information technologieswithin the institution.
- Lack or deficiency in the implementation of programs focused on renewableenergies.
- Sufficient physical environment and installed capacity to address therenewable energies issue.

- No sustainable solutions to the energy crisis are proposed or researched.

The energy problem is mainly due to electronic pollution, the growing demand for electronic pollution, the growing demand for electronic devices and the conventional sources used for the development of such devices. These three facts are directly related andsequential. Given the need for consumerism and interconnectivity that exists after the pandemic, the figures in sales of mobile devices increased ostentatiously, we must generate collective awareness and responsible consumption in order to regulate these trends and improve the conditions of our ecosystem.

The real solution to the environmental crisis is green information technology. For years there has been a misuse and trade of technological resources, practices such as programmed obsolescence instigate the irresponsible and excessive consumption of devices, an impact that is already generating environmental repercussions.

In conclusion, the primary agents of change and transition to responsible practices are the companies, the corporate environment is the facilitator of trends, the generator of responsible awareness and the economically stable instrument that can intervene in technological pollution and contribute significantly to the preservation of the environment.

These primary actors are the ones in charge of promoting the necessary knowledge and integrating processes, people and tools that contribute. According to the study conducted in Bogota Colombia, it is evident the lack of knowledge that the internal public, i.e. employees, have about practices and solutions in which the company is working to generate sustainable development, even they do not know if the company is able to face a problem that involves the whole environment, the energy crisis is not an unknown issue, people know that it is happening and have the motivation to deal with it, but do not have the tools, knowledge and support or support necessary to do it.

For this reason, the following chapter 5.2 presents a suggested corporate strategic action plan to mitigate the negative effects caused by bad practices, and/or a guide to understand how to take on this challenge.

Common and currently active solutions within the technology industry

According to what was exposed in chapter 1.4 massive consumption of technology, some solutions are identified in common and that in fact have been seen in other companies of the same sector:

1. internal areas specialized in sustainability issues and responsible energy use.

2. Allied suppliers and customers committed to sustainable development.

3. Corporate strategies aimed at GHG reduction through the measurement ofcarbon footprint by areas.

4. Tree planting

5. Recycling and waste management

6. Solar energy: installation of solar panels in factories and industrial areasbelonging to the company.

Implementing renewable energy sources within an organization generates a competitive advantage.

- Unlimited source, hence, its name.
- Environmentally friendly, contributing to the reduction of CO2 emissions.
- Versatile, because it can be produced in any region globally.
- It is constantly evolving, due to innovation and technological scope,allowing them to be increasingly more efficient and with a wider range of scope.
- It is much more profitable.
- It generates new employment opportunities.

Recommendations based on the theoretical framework and the empirical result.

This research suggests the need to continue and deepen the thematic, as to what factors are more influential to achieve the adherence of all staff to strategies aimed at minimizing the energy crisis, of course this is achieved if the corporate level has policies aimed at implementing sustainable solutions to address the energy crisis.

All this through the strengthening of the norms that regulate everything related to renewable energies, bearing in mind the projection for all areas of the institution. Thus, contributing to scientific and practical knowledge and demonstrating the importance of controlling and recognizing all the factors and practices that affect environmental damage.

It is recommended to describe and deepen the topic of renewable energies at the level of Colombia to find more scientific evidence, by having other population perspectives, there will be a broader knowledge of their own working conditions that impact.

New research is important to achieve the welfare and prevention of environmental risks generating knowledge to understand the dynamics of this sector such as information technology and renewable energy, it is for these reasons as a result of the research the following is proposed:

Suggested organizational action plan.

According to the advances unleashed by the fourth industrial revolution, it is the answer to the current environmental crisis, by means of emerging technologies of which renewable energy sources are a part.

In joining the challenge of being sustainable, companies must implement the following action plan:

1. Contextualize the internal public in terms of current environmental crisesand which ones will be the company's priority.

2. Train your internal audience on sustainability issues, concept definition,drivers, and competitive advantages.

3. Raise staff awareness through workshops and cultural activities.

4. Promote the workshops and trainings: Focus, internal and external audiences.

5. Promote the importance of efficient and sustainable digitization.

6. Open areas where responsible solutions can be proposed.

7. Evaluate facilities with experts in Green IT and renewable energies.

8. Install renewable energy sources, such as solar panels.

9. Failing that, optimize the use of data centers and technology plants: ITinfrastructure experts.

10. Allow and promote the creation of philanthropic programs: volunteering,collection of school supplies, social education programs, among others.

Sustainable Techniques

It is recommended to hire experts on

- Circular economy
- Reverse logistics
- Renewable energy sources
- TSR: Technological Social Responsibility
- Carbon footprint measurement

On the road to generate impact in the production and development chain, so that sustainable changes can be made in the useful life of the marketed product, raw material alternatives, and biodegradation at the end of the cycle.

This will greatly reduce the carbon footprint, knowing beforehand that GHGs generate atmospheric pollution and global warming since the release of these is precisely due to the burning of products made up of compounds and toxic metal elements.

LIMITATIONS & FUTURE DIRECTIONS

For the development of this study, the following limitations in terms of the study methodology were encountered.

1. Although a pilot test was carried out to socialize and answer the survey, itdid not reach 100% coverage of the professionals that had been projected.
2. It was identified that not all the population that answered the survey workedin or were related to sustainability areas and/or topics.
3. Colombia does not have a complete and broad education on sustainabilityissues or green techniques, so this limits the response options within the surveys conducted.
4. There is not a considerable number of professionals in the technology sectorthat know about current techniques in which the sector is involved at a sustainable level.

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