Lisbon School of Economics & Management
Universidade de Lisboa

MASTER IN MANAGEMENT (MIM)

MASTERS FINAL WORK

INTERNSHIP REPORT

CHALLENGES AND TRENDS OF THE ENERGY SECTOR – THE CASE OF EDP COMERCIAL

JOSÉ LUÍS SILVEIRO FAÍSCA

OCTOBER 2024

Lisbon School of Economics & Management
Universidade de Lisboa

MASTER IN MANAGEMENT (MIM)

MASTERS FINAL WORK

INTERNSHIP REPORT

CHALLENGES AND TRENDS OF THE ENERGY SECTOR – THE CASE OF EDP COMERCIAL

JOSÉ LUÍS SILVEIRO FAÍSCA

SUPERVISOR: PROF. JOANNA KATARZYNA KRYWALSKA DA SILVEIRA SANTIAGO

OCTOBER 2024

Lisbon School of Economics & Management
Universidade de Lisboa

MASTER IN MANAGEMENT (MIM)

MASTERS FINAL WORK

INTERNSHIP REPORT

CHALLENGES AND TRENDS OF THE ENERGY SECTOR – THE CASE OF EDP COMERCIAL

JOSÉ LUÍS SILVEIRO FAÍSCA

SUPERVISOR: PROF. JOANNA KATARZYNA KRYWALSKA DA SILVEIRA SANTIAGO

JURY:

PRESIDENT: PROF. MARIA EDUARDA SOARES

RAPPORTEUR: PROF. JOÃO ANTÓNIO ESTÊVÃO

SUPERVISOR: PROF. JOANNA KRYWALSKA SANTIAGO

OCTOBER 2024

Acknowledgements

To my supervisor, Professor Joanna Santiago for the guidance, support and patience throughout this process.

To Diogo Matos e Silva for guiding me through my internship, and all my colleagues for everything they taught me.

To my family, with a special thanks to my parents, sister, and grandmother for all the support and confidence during this journey.

To my friends for all the help and interest.

To all, a very sincere thanks.

Abstract

The incredible emergence of renewable energy technologies such as solar, wind, and electric vehicles is causing major shifts in a considerably different global energy system, that just went through one of the worst energy crisis in decades that left an impact on people and organization around the world.

As the study is carried out within the scope of EDP Comercial, a Portuguese company operating in the energy sector, the specific case of EDP Comercial is studied, and its main objective is to analyze how the evolving energy landscape is affecting the company by evaluating how its strategy aligns with the challenges and trends of the sector, and to provide recommendations for improving the company that hosted the internship.

This study is based on a qualitative methodology, conducted through interviews with professionals in relevant positions at EDP Comercial. The findings outline effective strategies, and considerations on the energy sector, comparing them with existing literature.

The results obtained allow us to interpret that the influence that the transformation of the energy sector has had on EDPC is evident, and it is clear that the company's main objective is to act as a facilitator in the energy transition process and to be the partner for total decarbonization of customers around the world by offering and investing in integrated energy solutions and digitalization, combating structural challenges that affect the sector, and evolving through an updated organizational model with the objective of supporting sustainable growth and implementing the company’s Business Plan.

At an academic level, this study aims to contribute to a better understanding of the evolving energy landscape, and to analyze the impact it is having on organizations, with a special focus on EDP Comercial. At a business level, it allows organizations to appreciate the importance of investment associated with the energy transition, in order to increase their efficiency and sustainable growth.

Keywords: Energy Transition, Decarbonization, Digitalization, Decentralization, Strategic Planning

Resumo

O incrível crescimento de tecnologias de energia renovável, como a energia solar, eólica e os veículos elétricos, está a provocar grandes mudanças num sistema energético global consideravelmente diferente, e que acabou de passar por uma das piores crises energéticas das últimas décadas e que impactou pessoas e organizações de todo o mundo.

Sendo o estudo realizado no âmbito da EDP Comercial, uma empresa portuguesa que opera no sector energético, é estudado o caso específico da EDP Comercial, e tem como principal objetivo analisar a forma como a evolução do panorama energético está a afetar a empresa, avaliando a forma como a sua estratégia se alinha com os desafios e tendências do sector, e fornecer recomendações para melhorar a empresa que recebeu o estágio.

Este estudo assenta numa metodologia qualitativa, conduzida através de entrevistas a profissionais com cargos relevantes na EDP Comercial. Os resultados apontam estratégias eficazes e considerações sobre o sector energético, comparando-as com a literatura existente.

Os resultados obtidos, permitem interpretar que é evidente a influencia que a transformação do setor energético teve na EDPC, sendo notório que o principal objetivo da empresa é agir como facilitador no processo de transição energética e de ser o parceiro para descarbonização total de clientes de todo o mundo oferecendo e investindo em soluções energéticas integradas e digitalização, combatendo desafios estruturais que afetam o setor, e evoluindo através de um modelo organizacional atualizado com o objetivo de suportar crescimento sustentável e implementar o seu Plano de Negócios.

A nível académico, este estudo pretende contribuir para uma melhor compreensão do panorama energético em evolução, e analisar o impacto que este está a ter nas organizações, com foco especial na EDP Comercial. A nível empresarial, permite às organizações valorizar a importância do investimento associado à transição energética, de forma a aumentar a sua eficiência e crescimento sustentável.

Palavras-Chave: Transição Energética, Decarbonização, Digitalização, Decentralização, Planeamento Estratégico

Abbreviations

EDPC: *EDP Comercial*

SDGs: *Sustainable Development Goals*

GHG: *Greenhouse Gas*

IT: *Information Technology*

AI: *Artificial Intelligence*

IoT: *Internet of Things*

ETS: *Emissions Trading System*

P&C: *Planning and Control*

PPA: *Power Purchase Agreement*

UN: *United Nations*

EU: *European Union*

IEA: *International Energy Agency*

DG: *Distributed Generation*

EV: *Electric Vehicles*

Table of Contents

Table of Tables

Table of Figures

Chapter 1 – Introduction

1.1. Study Background

Currently, the energy sector continues to depend significantly on non-renewable energy sources, such as natural gas, coal, and oil, on a global scale (Rapier, 2023). However, Europe is witnessing an accelerated transition toward carbon-neutral energy sources, signaling a pivotal shift in the landscape of energy production and consumption (Widuto, 2023).

The process of drastically reducing or eliminating carbon dioxide (CO2) and other greenhouse gas (GHG) emissions from the atmosphere is known as decarbonization (Finkbeiner & Bach, 2021). Many nations have set objectives to achieve the point at which the amount of greenhouse gases evacuated from the atmosphere equals the amount of greenhouse gas emissions entering the atmosphere, also known as net zero GHG emissions by 2050 to prevent the world temperature from rising by more than 1.5°C above pre-industrial levels.. In order for this to happen, rapid decarbonization initiatives are required (IBM, 2023). However, to sustain the energy transition, energy investments may need to increase by 4% annually (Ellis, 2022), moreover the energy sector still presents a lot of challenges, such as policy and regulation, technology, finance, sectoral developments, and geopolitics (Henderson, 2021).This report aims to study the transformation of the energy sector, based on the case study of EDP Comercial, a company operating in this sector. Its objective is to understand how the sector's transformation affected the company and analyze the measures taken to address it.

1.2. The Main Objective

The present internship report aims at the conclusion of the Master in Management (MiM) with a major in Finance at ISEG School of Economics and Management. The internship was undertaken at EDP Comercial, EDP Group's company that operates in the free energy market and strives to be a global energy company and lead the way as an enabler of energy transition.

The objective of this report is two folded. Firstly, it aims to analyze how the evolving energy landscape is affecting companies which operate within the energy sector, with special attention to the company of the internship by evaluating how the company's

strategy aligns with the challenges and trends of the energy sector. This analysis will relate to the second objective, that is to establish a set of recommendations to the company of the internship. These recommendations will focus on improving efficiency, sustainability efforts, and achieving more agile processes within the company. At an academic level, the present research aims to enhance the existing literature on the role played by the transformation of the energy sector in the company's performance.

In the case of EDP Comercial, its strategy and mission are directly entangled with the transformation of the energy sector as it aims to contribute to the fight against climate change, and lead the way in decarbonization, innovation, and social initiatives within the sector. Therefore, on a business level, the main conclusions and findings of this research aim to understand what impact the sector had on EDPC's strategy.

Accordingly, the main questions that will be addressed are:

> Q1: How is the transformation of the energy sector influencing the company's operations and strategic decisions?
> Q2: In what ways is the company aligning its strategy to address the emerging challenges and trends within the energy sector?

1.3. Structure of the Report

The present report has six sections. It begins with an introduction describing the background of the internship and stating the main problem and research questions of this study and the structure of the report. Chapter 2 concentrates on a literature review starting with a general overview of the transformation of the energy sector is facing with the help of a deep dive into the topics of energy transition towards decarbonization, digitalization, and decentralization, the infrastructure challenges the sector is facing, the importance of energy independence, and additional remarks on the sector. Chapter 3 consists, of a presentation of the company and a description of the internship, the first also takes into account the company's key performance indicators, its impact on the SDGs, its products and services, and a description of the business sector in which the company operates and its competitors, while the latter counts with a presentation of the Strategic Planning Department, the scheduled program, the main activities performed and key results. Chapter 4 consists of a frame of reference that connects the actions taken with the literature review and presents the conceptual model that guides the empirical research in this study. The fourth chapter also details the research methodology, structure of the

interviews, sample characterization, data analysis, and the discussion of the main findings. Chapter 5 offers recommendations to the company and, finally, the report ends in the sixth chapter with its conclusions, main limitations, and suggestions for further research.

Chapter 2 - Literature Review

2.1. The Evolving Energy Landscape: from Non-Renewables to Carbon-Neutral Solutions

Currently, the energy sector still relies heavily on non-renewable energy sources including natural gas, coal, and oil on a global scale (Rapier, 2023). However, the switch to carbon-neutral energy sources is quickening in Europe. In 2020, nuclear, hydroelectric, solar, wind, and solar combined to produce 66% of all the electricity consumed on the continent. These sources may account for as much as 80% of the mix by 2030 (Petcu, 2022). Despite the move towards energy transition, the energy sector still presents a lot of challenges, such as policy and regulation, technology, finance, sectoral developments, and geopolitics (Henderson, 2021). Indeed, to influence the adoption of renewable energy sources and advancements in energy efficiency, nations have access to a variety of policies and measures. Jaeger (2021) stated that these policies come in many forms, from tax breaks or exemptions to capital grants, self-consumption, or energy efficiency laws and regulations, among others.

Daszkiewicz (2020) implied that the use of renewables in all sectors can be sped up by various energy plans, targets, and the majority of policies aimed at lowering investment costs. However, these policy instruments can be modified and used to encourage advancements in the field of energy efficiency. The majority of price-finding processes (such as auctions or administratively set tariffs) are relevant to renewable energy sources that provide power (Daszkiewicz, 2020). Secondly, according to Ellis (2022), to sustain the energy transition, energy investments may need to increase by 4% annually, with new technologies accounting for more than 65% of investments through 2035. In the next 15 years, renewables are expected to represent more than 30% of all expenditures made in the world (excluding transmission and distribution upgrades). Additionally, allied with the economic feasibility technical possibilities continue to push new barriers. Henderson (2021) stated that will be crucial to track scientific and

technological development to determine what future carbon-free energy breakthroughs might happen to further disrupt the energy system.

Henderson (2021) also addressed the consequences for geopolitics as the mechanics of the energy transition raise the question of what the world's energy landscape will be like in thirty years and who may benefit and lose out from the changes presently taking place. As stated by Bricout et al. (2022) oil and gas have dominated the geopolitics of energy for more than 50 years, with concerns about trade flows, energy security, and economic power at the forefront. However, if climate targets are to be fulfilled, changes to the energy landscape are unavoidable (IPCC, 2022).

2.2. The Evolving Landscape of Carbon Emission Reduction

Rowling (2020) suggested that reducing carbon dioxide emissions from the energy sector is necessary to mitigate the effects of major challenges such as climate change. The first move towards this goal was made at the Earth Summit in Rio de Janeiro in 1992, where the conference's main goal was to "achieve [...] stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"[1]. This convention was followed by the Kyoto Protocol, signed in 1997, tying together developed nations and placing a greater burden on them under "common but differentiated responsibility and respective capabilities"[2]. Finally, the latest actions towards the reduction of carbon emissions were made in 2015 by both the Paris Agreement, and the 2030 Agenda for Sustainable Development, adopted by all members of the UN (United Nations, 2023). According to Papadis and Tsatsaronis (2020), despite these efforts carbon emissions have been steadily rising, given the low prices of emission allowances which makes greenhouse gas-friendly investments not appealing for most countries aligned with the fact that the population of the planet has been rising gradually and is expected to reach 10 billion people by 2060 which presupposes that the need for energy will only increase, and consequently carbon dioxide emissions.

According to Jackson et al. (2018), notwithstanding the uncertainty surrounding further carbon dioxide emission rises in 2019, they seem plausible given the continued

[1] Retrieved, 08 January 2024, from What is Greenhouse Gas Data? | UNFCCC
[2] Retrieved, 08 January 2024, from Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC) - Climate Nexus

expansion in the consumption of oil and natural gas as well as the robust growth anticipated for the global economy. Singh (2024) implied that even while emissions have decreased and economies in many developing nations have risen over the past ten years, the growth of fossil fuel-based energy sources continues to outpace the development of low-carbon sources and activities. According to Liu et al. (2023), CO2 emissions will continue to rise due to a strong global economy, insufficient emission reductions in affluent nations, and a demand for more energy in developing nations whose per capita emissions are still far lower than those of wealthier countries. Evans and Viisainen (2023) stated that peak emission levels won't be reached until the production of fossil fuels is rapidly replaced by technologies favoring decarbonization (with low carbon emissions), even if global energy demand continues to rise (Soeder, 2022).

2.2.1. Decarbonization Challenges

Borghesi and Vergalli (2022) suggested that energy transition towards decarbonization is subject to challenges and restrictions that result from environmental sustainability, the security of energy supply, and economic stability. Midgley (2019) implied that decarbonization proves challenging because even though many emission reduction strategies are typically beneficial over a long-term horizon a large upfront expenditure may be necessary. As implied by McKinsey & Company (2022), between 2021 and 2050, it will probably cost $275 trillion to reach decarbonization, with electricity production, transportation, and buildings accounting for 75% of the expenditures on physical assets. As a result, it is anticipated that electricity prices will increase as renewable resources are developed and the grid infrastructure is improved (McKinsey & Company, 2022). Although consumers may initially pay higher energy bills, the cost of electricity from renewable sources will probably decline over time due to decreased operating expenses (Cho, 2022).

Another challenge, as stated by Papadis and Tsatsaronis (2020) is that energy is provided under the constraints of the existing economic climate. Yet, increasing the sustainability of the energy industry and advancing decarbonization can be accomplished by putting more emphasis on serving the socio-ecological system and less on private profit (Krishnan et al., 2022). Political constraints that can occur during the implementation of cutting-edge technological solutions must be taken into account while discussing economic stability (Lamb & Minx, 2020). This is particularly true for choices like the delivery of fuels or energy between regions with various political systems. Future

energy systems must guarantee the security of the energy supply, which is easier to do in an environment with stable political conditions (Bocca and Ashraf, 2022).

According to The Economist (2022), the transition to a decarbonized energy sector will be costly, a source of discontent and political unrest, as well as a chance for populist parties to gain power in a democratic system and, by their policies and actions, to derail the decarbonization process.

2.2.2. Decarbonization Solutions

According to Teter and Voswinkel (2023) as far as decarbonization solutions are concerned, transport continues to be one of the most carbon-intensive industries due to its heavy reliance on oil products, which currently account for 91% of final energy use in transportation globally. Many nations and manufacturers view electric vehicles, not only for private customers but also for public fleets, as the most viable option, and thanks to special policies, EV sales are exhibiting encouraging trends in China, the USA, and Europe (IEA, 2023). The usage of fuel cell vehicles powered by hydrogen, which can ensure longer ranges and quicker refueling periods, may be a potential complement to electrification (Noussan et al., 2020).

Finally, Drozdz et al. (2021), suggested that one of the answers to climate change is the shift towards green and low-carbon cities. This solution is given a lot of weight, (Duygan et al., 2022) argued that smart cities are becoming the focus of creative solutions and, consequently, of economic growth, and as such, demand careful research and evaluation, and shows advancements in energy, transportation, construction, and development of green building standards.

2.3. The Role of Decentralization in Accelerating the Energy Transition and Enhancing Socioeconomic Development

Decentralization is a crucial component in quickening the energy transition (Schoolman, 2019). There are a huge number of energy consumers, pieces of equipment, and demand patterns that need to be coordinated (Fukuizumi, 2020). Energy-producing facilities are located closer to the location of energy consumption in a decentralized energy system. It decreases the need for fossil fuels, boosts eco-efficiency, and enables the best possible use of renewable energy sources and combined heat and power (Mugambiwa & Rapholo, 2023). Decentralized energy systems are used to bring power sources closer to the consumer. Dash (2021) stated that due to the dispersed location of end users, it is possible

to lower the associated economic and environmental costs by sourcing energy generation in a similarly decentralized manner. According to Lingyan et al. (2022), decentralized energy generation avoids or reduces the need for transmission and distribution infrastructure, saving money and losses. Compared to big, centralized generation systems, it is more efficient, flexible, and economical (Nadeem et al., 2023). It can use a variety of energy sources and technologies, and it can operate independently or in conjunction with the grid (Nadeem et al., 2023).

Maximizing the advantages of energy availability for socioeconomic development requires decentralized renewable energy solutions connected to livelihoods (Noor, 2019). Investments in energy connections can be converted into higher incomes for businesses and communities, local employment, increased adaptability, and general well-being through the use of renewable energy sources (IRENA, 2022).

Dash (2021) implied that a very different picture appears when one considers energy decentralization in terms of ecosystems rather than just domestic consumption. For example, Dash (2021) advanced that an excellent use case for energy decentralization is an electric vehicle charging station. He suggested that installing one would be a beneficial approach to monetize their real estate and amass new data-based insights on their clients, such as the types of cars they drive, how frequently they charge them, what they do while they charge, etc. Moreover, according to Alstone et al. (2015) reducing transmission losses makes the system more effective than centralizing energy, which is one benefit of decentralizing energy. Because customers don't have to rely on a narrow range of energy sources, there is more national supply security (Ganani, 2024). Furthermore, Strandberg (2021) suggested that, as decision-making, accountability, and ownership shift from a national to a regional or local level, decentralized energy systems are more resource-efficient since there are fewer lost power miles between production and consumption, as well as, creating chances for local businesses by requiring decentralized enterprises to build, manage, and maintain the facilities.

The uninterrupted benefits of decentralization cannot, however, be provided by technologies alone. Rural electrification requires institutional development, capacity building, financing, and support from policies to be successful (OECD, 2019). When expanding access to economically disadvantaged communities, electric firms, and energy suppliers occasionally postpone the project because they don't believe it to be profitable (Noor, 2019). In addition, for several socioeconomic and political reasons, government

organizations prioritize expanding access to metropolitan areas over rural ones (Asif, 2022).

Decentralization also raises issues on the technical and financial since not only, demand response technology is currently not a viable choice for the majority of poor nations because it requires consistent, dependable internet connectivity, but also in comparison to big central plants, distributed generating sources frequently have higher capital costs per kW, in part because of the connection transaction expenses (Unescap, 2023).

As per Wu et al. (2021), it seems digitalization will make it possible to integrate decentralized energy sources, so it may promote greater decentralization in several ways: utilizing real-time data and analytics to control energy flows and improve grid operation, smart grids make sure that distributed energy resources and storage systems are integrated into the grid (China, 2023); real-time data on energy production and consumption is collected by IoT devices like sensors and meters, enabling a data-driven system and a whole new network design for power generation, distribution, and consumption; in a market-oriented energy system that encourages energy trade and sharing, blockchain technology ensures transparent transactions between many actors (Cooper, 2023).

Additionally, local communities can also have a pivotal role when it comes to implementing strategies towards decentralization, Arvanitopoulos et al. (2022) suggested that local governments can demonstrate significant political support for corporate investments in new energy infrastructure by creating sustainable energy plans, establishing climate action goals, or announcing climate emergencies, along with the fact that local communities could make use of the renewable resources accessible to them or adapt to the climatic circumstances in their area (Arvanitopoulos et al. 2022). Resources including solar, wind, bioenergy, and geothermal energy are crucial for decarbonizing supply chains (Bojek, 2023).

2.4. Digitalization in the Energy Sector

The energy sector has been undergoing a global digital transition for many years now (IEA, 2017). Akberdina and Osmonova (2021) stated that successful digital transformation depends on the development and maintenance of skills, knowledge, and expertise. This is crucial for energy firms, which are going through significant changes as they move toward a low-carbon economy and renewable energy (Simonovich & Beato,

2023). According to the International Energy Agency (2017), the rate of energy's digitalization is accelerating. Energy businesses have increased their investment in digital technologies significantly during the past few years. Since 2014, the amount of money invested globally in digital power infrastructure and software has increased by over 20% yearly, reaching USD 47 billion in 2016 (40% greater than the amount invested in gas-fired power generation globally) (IEA, 2017).

As stated by Światowiec-Szczepańska and Stępień (2022), artificial neural networks (ANN), artificial intelligence (AI), blockchain, Internet of Things (IoT), robotic process automation (RPA), machine learning, big data mining, or cloud computing are the most frequently mentioned digital technologies used in the energy sector (although they are still not widely used).

Internet of Things

As suggested by Motlagh et al. (2020), the energy sector benefited from the early stages of IoT by reducing the risk of output loss or blackouts by monitoring and regulating equipment and processes. Additionally, since electricity is consumed as soon as it is produced, IoT can help power generation firms to be able to forecast needs, produce, maintain, and supply electricity at an ideal level (Dibal et al., 2023). The primary difficulties with outdated power plants are their dependability, efficiency, environmental effects, and maintenance problems (Ramamurthy & Jain, 2017). The power industry's outdated equipment and inadequate maintenance issues can cause significant energy losses and unreliability (Marsh, 2013). IoT can also help to lessen some of these management difficulties in power plants. This lowers the cost of maintenance while improving the system's efficiency and reliability (Routray, 2021).

Dharfizi (2018) stated that IoT also brought a wide range of opportunities to our daily lives by digitizing buildings, factories, and even the entire city with sensors for data collecting and monitoring that will allow administrators and decision-makers to optimize daily operations, resulting in less wasteful energy use and emissions. Furthermore, organizations and individuals have the chance to monitor their energy use, adjust and lower their energy demand, and increase efficiency thanks to IoT technology installed in residential and commercial facilities (Pressac, 2022). Commercial, residential, and industrial buildings have a significant impact on the environment and the overall cost of energy use (Pourbeik, 2021).

Bhattacharjee and Nandi (2020) referred that since the hottest research areas for improving corporate operations include balancing supply and demand as clients connect to a smart microgrid and sensor technology, big data, and data analytics, it is a fact that utilizing existing infrastructure, such as microgrids, power-to-gas (P2G) hydrogen systems, and renewable energy technologies, the Internet of Things in sustainable energy systems can address community energy security challenges with little environmental and cultural impact (Salam, 2019).

Blockchain

Światowiec-Szczepańska and Stępień (2022) indicated that blockchain technology enables the efficient management of the growing complexity of the energy sector's structure and networks. This is done by simultaneously and thoroughly monitoring all energy flows, regardless of their size or distance. Chitchyan and Murkin (2018) suggested that another area of active research is the use of blockchain for IoT and, consequently, energy efficiency in smart homes. The use of smart contracts as a method of communication, automation, and rule enforcement between devices in this scenario could allow blockchain to play a significant role in data control and decision support for large-scale IoT (Kirli et al., 2022).

Furthermore, according to Shu et al. (2022), blockchain technology was utilized to stop fraud in carbon trading. Here, a blockchain-based alternative to the Emissions Trading System (ETS) was created. Blockchain assisted in ensuring trustworthy, secure transactions and embedding a reputation system to promote long-term investment in ETS (Shu et al., 2022). However, the best use of blockchain in the energy sector is its potential impact on energy company operations, as stated by Andoni et al. (2019). The main impact would be on billing as companies can realize distributed generator and consumer billing automation, have the potential for energy micropayments, and payment systems for prepaid meters that may be advantageous to utility providers (Andoni et al., 2019).

Li, Hui, and Zhang (2023) implied that blockchain technology may enhance the management of microgrids and decentralized energy systems. Furthermore, Appasani et al. (2022) stated that smart grid applications can gain additional advantages from data standardization made possible by blockchain technology, alongside secure data transport. Moreover, blockchains could facilitate the development of trade platforms connecting all actors across the supply chain, thus improving overall grid management (Ganne, 2018)

Artificial Intelligence (AI)

Artificial intelligence (AI) is the capacity of a digital computer or robot operated by a computer to carry out actions frequently performed by intelligent beings (Copeland, 2024). The phrase is widely used about the effort to create artificial intelligence (AI) systems that possess human-like cognitive abilities like the capacity for reasoning, meaning-finding, generalization, and experience-based learning (Copeland, 2024).

The energy sector is seen as a promising field for AI, given the vast volumes of data that the electrical system is capable of producing in real-time, Światowiec-Szczepańska and Stępień (2022) gave the example that the application of AI can be used in power network design, energy generation, transmission, and sales.

Küfeoglu et al. (2019) suggested that during the phases of power grid design, building, operation, and maintenance, intelligent systems assist decision-makers in making more complex decisions. According to Rozite et al. (2023), AI is anticipated to be utilized in smart grid operations, as well as, for better forecasting about renewable generation (Carrington, 2021). Furthermore, Serban and Lytras (2020) also suggested that nowadays, intelligent systems can be applied in a variety of ways in the energy markets, including smart match of supply with demand, intelligent storage, centralized control systems, and smart microgrids. However, Küfeoglu et al. (2019) implied that in the presence of complicated algorithms and equipment subject to operational hazards in real-time, the energy system, as a complex structure, inevitably faces a security of supply risk. Owing to the physical power networks' inherent complexity, even small variations have the potential to cause catastrophic breakdowns.

2.4.1. Challenges for the Digitalization of Energy Systems

From a managerial perspective, having a workforce that is appropriately qualified and has the skills necessary to use and creatively develop the relevant technology comes first and foremost, as well as a managerial vision supported by managerial and technological know-how for creating such digital-based energy systems and of course the capital to invest in these technologies (Booth et al., 2020). Światowiec-Szczepańska and Stępień (2022) suggested that even if these prerequisites or obstacles are satisfied from the perspective of the organization, and even if the need to implement them is legitimate and prioritized, challenges in the deployment and usage of digital technology may result from outside circumstances.

Finally, according to the International Energy Agency (2017), the potential for increased digitalization may be constrained by incomplete information, technical deficiencies, and cultural barriers. Companies without in-depth technical knowledge in the field may find it difficult to make sense of it and comprehend how they might benefit from the new technology available. Additionally, Slade (2021) indicated that several infrastructure facilities throughout the world were set up decades ago and may not have the necessary infrastructure to support emerging digital technologies. Furthermore, using digital technologies to enhance power system planning may be significantly hampered by data acquisition challenges (Janin et al., 2021).

Additional challenges also arise, such as those relating to cybersecurity, data access governance, data protection, and privacy, and the rising energy use of the IT industry (European Commission, 2022).

2.5. Challenges and Investment Needs in the Global Energy Transition

The global energy infrastructure is facing unheard-of challenges as the 21st century progresses. Over the next 25 years, it is expected that the world's energy consumption will increase by more than a third, mostly due to a rapidly expanding global population (IEA, 2022). Marr (2022) suggested that renewable energy sources must be used extensively and in large quantities to meet energy demand. However, because many wealthy countries lack dependable large-scale energy grids, the change will be more challenging to implement. Additionally, the inadequacies of many electric grid networks will become an ever more obvious impediment to the widespread adoption of renewable energy as demand for it rises due to rising domestic use, rising electric vehicle adoption, and industrial change (Popovich & Plumer, 2023).

Unforeseeable attacks and contingencies caused by humans or natural disasters pose constant threats to the security of power systems. As the largest man-made carbon dioxide emitter, the energy industry is undergoing a series of reforms, aiming to reduce its carbon footprint and impact on climate change (Wang & Tseng, 2012).

Furthermore, a community may consider buildings like refineries, coal power plants, and high-voltage transmission lines to be undesirable. As a result, because the local population is acclimated to the infrastructure, new installations are frequently built in the same areas as the prior ones. This implies that locations picked in the 1980s could still be used in 2080 and beyond (Paskal, 2009).

Another challenge involves investments as energy infrastructure, like other types of infrastructure, is shamefully underfunded, poorly maintained, and not stable or robust enough to meet future demands in many locations (Okafor, 2020). Therefore, the inadequacies of many electric grid networks will become an ever more obvious impediment to the widespread adoption of renewable energy, thus an unprecedented level of capital investment in the electric grid will be needed to support the energy transition (Brown et al., 2022).

2.6. Additional Remarks on the Energy Sector

Global Energy Market Disruptions

The ongoing conflict in Ukraine underlined how dependent global economies are on fossil fuels and drove up oil and gas prices significantly elsewhere. The role of Russia in the world's energy markets and the structure of those markets were significantly changed (IEA, 2022). Consequently, to fill the supply gaps, the E.U. then approached major gas providers in nations including Norway, Algeria, and the United States as well as liquefied natural gas producers in Africa and the Middle East in 2022. Therefore, governments in Western Europe were compelled to take action to protect consumers as a result, establishing a price cap in the UK and comparable safeguards in all of the EU member states (Arrow & Wood-Robertson, 2023).

One of the major effects of Russia's invasion of Ukraine has been to make energy security a major worry, globally. Additionally, according to the International Energy Agency (2022), it will hasten the peak in the world consumption of fossil fuels, with gas demand now anticipated to join oil and coal in doing so near the conclusion of the current decade.

White (2022) implied that while it is anticipated that global emissions will peak around 2025, they will still be significantly higher than the amount required to meet the Paris Agreement's aim. A quick transition to a low-carbon world is necessary, but it will need a great deal of work on the part of organizations, corporations, and individuals (White, 2022).

Investment and Policies Responses

According to the International Energy Agency (2022), the current crisis is reshaping energy investment and trade flows in ways that will have a substantial impact on the future

of energy (overall global energy investment will increase). Energy transitions gain speed when fossil fuel prices are high because they provide substantial incentives to reduce reliance on them or use them more effectively (IEA, 2022). Yet, there are several significant limitations to this trend toward clean energy investment, like higher cost of capital that can make companies reticent of capital expenditure (Thomson, 2023).

To keep up with the investment responses, 2022 also brought some policies to help mitigate the energy crisis, such as the Inflation Reduction Act of 2022, to significantly reduce the country's carbon emissions by the end of this decade (Badlam et al., 2022), and the REPowerEU Plan in light of Russia's invasion of Ukraine, the European Commission's plan to make Europe independent from Russian fossil fuels well before 2030 while accelerating the green transition and boosting the robustness of the EU's whole energy system (European Commission, 2022).

2.7. Energy Dependence and its Importance

Importance of Energy Dependence

Russian gas accounted for 45% of the EU's gas imports in 2021, per information from the (IEA, 2022). The Russian invasion of Ukraine following EU measures to decrease imports of fossil fuels from this nation has brought attention to Europe's reliance on Russian natural gas (Yanatma, 2023).

According to the World Health Organization (2022), energy shortages and security concerns were exacerbated by the COVID-19 epidemic and the conflict in Ukraine, increasing the volatility of energy costs and delaying the achievement of Sustainable Development Goal (SDG) 7's goal of achieving universal access to affordable, dependable, sustainable, and modern energy by 2030 (WHO, 2022).

According to the World Bank (2023), most nations are affected by energy price shocks, particularly those that import energy. They are unable to significantly reduce energy price volatility, which causes energy rationing in some nations and rising poverty.

Consequences of energy dependence:

- Instability in the energy supply: a country's dependency on other nations for a portion of its energy needs can lead to changes in the energy supply because this

is a factor that is not solely under the control of the importing country (Martin, 2022).

- The effects on the economy: because the economy relies on foreign nations for energy, the price of energy fluctuates often, creating volatility in the price of energy. As a result, this reliance on energy may cause the countries' trade balance to be negative (Martin, 2022).

Carfora et al. (2022) stated that among the most important determinants of economic growth and development are energy independence and the security of the energy supply. Bocca and Ashraf (2022) claimed that issues relating to dependence rates, energy prices (and volatility), energy source shortages, and environmental protection were faced by countries that wanted to achieve adequate levels of energy security.

According to Nature Energy (2023) in the long term, these same countries also faced issues relating to the political stability of supplier nations, investments, and policies to support domestic renewable energy sources.

Challenges of Energy Dependence

The biggest challenge facing energy dependence consists in the political stability or instability in transit countries, as proved by Russia's invasion of Ukraine since Russia is a major supplier of gas and oil to Europe (Dennison and Zerka, 2022).

Two-fifths of the gas burnt by Europeans in 2021 comes from Russia. And more than a quarter of the crude oil that the EU imports come from Russia. The EU imported energy from Russia worth $108 billion in 2021 (Edmond, 2022). The majority of the energy used in Europe is imported, thus the ongoing price changes and variations have a direct impact on the economy, therefore in certain European countries, the rate of economic growth is significantly impacted by the substantial financial deductions made from their domestic budgets, which also delays the adjustment to renewable energies as a solution to fight their dependency on other countries (Elbassoussy, 2019).

Energy Independence and Transition to a Decarbonized Economy

In addition to being essential for the economy's decarbonization, renewable energy sources also provide energy independence, price stability, and more regional wealth (Bocca and Ashraf, 2022). The key to solving this and other economic, environmental, and geopolitical issues may be to step up investment in clean and efficient technologies

(Sustainability for All, 2023). The International Renewable Energy Agency (2022) affirms this in its latest report World Energy Transitions Outlook 2022. According to the same report, 80% of the world's population resides in nations that import fossil fuels. In this manner, the report emphasizes the limitless availability of renewable energy sources because they derive from freely available natural resources like the sun, wind, sea, etc, and thus, contribute to reducing global energy dependence (IRENA, 2022).

The European Commission has set 2030 as the deadline to end Europe's energy dependence on Russia. The proposal commits to using renewable energy and includes measures like looking for alternate natural gas providers (European Commission, 2023).

Furthermore, as stated by Elbassoussy (2019), an additional solution to fight energy dependence can pass by stockpiling energy resources as a defense against potential supply disruptions. In the event of a crisis, these stocks must be available for use.

Chapter 3 – Company and Internship Overview

3.1. EDP Group

EDP - Energias de Portugal, S.A. ("EDP") is a Portuguese energy company with its headquarters in Avenida 24 de Julho 12 in Lisbon. The activities of the group are currently concentrated on the supply of natural gas and electricity, as well as their generation, transmission, and distribution. The organization also works in allied fields like engineering, laboratory testing, professional training, energy services, and property management, even if they are complementary (EDP, 2023). The Group counts around 13000 employees, operates in 28 markets, and has over 9 million clients in electricity and natural gas (EDP, 2023).

EDP Comercial, SA

EDP Comercial is the EDP Group's company that operates in the free market of energy and offers a wide range of energy and services. It was founded in 1976, EDP Comercial's headquarters is located in Lisbon, and its CEO is Vera Pinto Pereira. EDP Comercial positions itself on the far end of the EDP Group value chain, in the commercialization macroprocess, as well as, in both the processes of realization and commercialization of services of certification and energy efficiency. EDPC is an energetic partner in the markets it operates, with an enlarged, innovative, and trustworthy offer of solutions with

unique benefits based on the scale, accessibility, and in superior know–how in energy management, respecting sustainability and social responsibility commitments, and guaranteeing the capacity of satisfying all its client's energetic needs in a competitive and differentiated way (EDP, 2023; Portugal Gov, 2023).

3.1.1. Vision, Mission, and Values

The company strives daily toward an explicit vision: to be a global energy company and leader in energy transaction, with a commitment to the environment and to provide superior value for people (EDP, 2023).

The Group's mission is to increasingly contribute to the fight against climate change, and lead the way in decarbonization, innovation, and social initiatives within the energy sector. It is also based on fundamental values exteriorized by the attitudes and behaviors of its collaborators, confidence from all stakeholders, excellence in the performing of all activities, sustainability aiming at improving the quality of life of present and future generations, the objective of being 100% by 2030, and finally innovation targeting the creation of superior value in all the group's areas of activity (EDP, 2023).

3.1.2. Impact on the SDGs

According to its 2022 Annual Report and through its commitments, values, and actions (mentioned above) it is evident that EDP is dedicated at achieving the Sustainable Development Goals (SDGs) of the United Nations and has established specific objectives for 9 of the 17 SDGs, through a €24 billion investment program for the years 2021–2025.

SDG 7 - Clean and affordable energy, SDG 9 - Industry, innovation, and infrastructure, SDG 11 - Sustainable cities and communities, and SDG 13 - Climate action, are all directly impacted by the company's key activities. As shown in Apendix 2.

3.2. Business Sector and Main Competitors

3.2.1. Business Sector

EDP originally began as a Portuguese utility company and developed into a major worldwide energy player and pioneer of the energy transition. Today, the company is located in the energy business sector, meaning that it encompasses a direct or indirect relation between businesses engaged in energy production and distribution because it offers electricity and natural gas to more than nine million customers in 29 markets (EDP,

2023). In Portugal, the energy sector is crucial to the national economy, it is a complicated system that involves many continuously changing agents and corporations forced to adapt to the global challenges.

Triggered by Russia's invasion of Ukraine the current energy crisis is the first global one in recorded history, since according to (International Energy Agency, 2022) although the incredibly quick economic recovery following the pandemic, caused the energy markets to tighten up in 2021 once Russia invaded Ukraine in February 2022, the situation quickly worsened and turned into a full-fledged global energy crisis. Natural gas prices hit record highs, which had an impact on electricity prices in several markets. The price of oil reached its highest point since 2008. This can mean a further boost for renewable energy, which perfectly meets EDP's reiterated goal of being 100%green by 2030. Therefore, as suggested by Edmond (2022) the COVID-19 pandemic, the conflict in Ukraine, and the resulting unrest in the energy markets make it evident that the global energy transition must simultaneously fulfill the requirements of environmental sustainability, energy security, and economic development. 2023 seems to be a crucial year to accelerate an energy transition as the energy crisis persists.

Arrow and Wood-Robertson (2023) suggested that prices for gas and electricity are probably going to stay high. The war in Ukraine and other macroeconomic conditions are likely to remain unaltered, and suppliers will have purchased items recently at premium costs to guarantee supply security for the coming year. Consumers will ultimately pay these rates, therefore the government will continue to face pressure to give them and businesses some kind of protection.

According to Deloitte (2023) energy, resources, and industrials industry outlooks, 2023 will be "yet another year, to plan for the unplanned"[3].

3.2.2. Main Competitors

Even though EDP Comercial has the biggest market share of any company in the energy sector in Portugal the competition is being increasingly felt since a growing number of businesses are attempting to enter and invest in the renewable energy sector as a result of the growing demand for renewable energy sources. Currently, Endesa, Iberdrola, Galp,

[3] Retrieved 05 October 2024 from Energy, Resources, and Industrials Industry Outlooks 2023 | Deloitte Global

and GoldEnergy are competitive players in the energy sector that use different strategies. GoldEnergy uses a low-cost approach to increase its market share, the company barely provides further services, whereas Galp offers a wide variety of subscription services and has natural gas for domestic use and diesel/gasoline as its main businesses. On the other hand, Iberdrola stands out for offering 100% green electricity.

3.3. Products and Services

EDP Comercial does not limit itself only to the commercialization of natural gas or electricity tariffs counting with many diverse energy efficiency services. The company mainly divides its offering in two segments, commercializing for both residential and business customers. In addition to energy, the company specializes in the creation, installation, and maintenance of energy production projects using renewable sources, with a heavy emphasis photovoltaic solar systems and electric mobility (EDP, 2023).

Aligned with the goal of leading energy transition and sustainability aiming at improving the quality of life of present and future generations, and innovation targeting the creation of superior value, the company provides the option to install photovoltaic solar systems without the need to make any upfront payments through the PPA Model.

3.4. Internship Scope

The candidate has joined EDP Comercial – SA for a professional internship that lasted between the 8th of September of 2022 and the 15th of March of 2023. The internship took place in the Strategic Planning Department, and during its tenure, it was composed of 5 elements. The team is part of the Planning and Control Direction of EDP Comercial (that also integrates the teams of Business Control and Financial Report, and Business Control and Financial Report – New Geographies). The department is responsible for supporting the board in the definition and attainment of the main strategic lines by planning and controlling the development of the activities inherent to the Business Plan and Budget and supporting EDPC's business units in the definition of pricing and in the appraisal of new business opportunities that may arise so that the company can provide the intended results and keep up its growth trajectory.

3.5. Main Activities

During the internship, the candidate was a member of the Strategic Planning Department for 6 months. This way, the main activities/tasks carried out (from September to January) were focused on the budget definition for 2023 and the reforecast of 2022, as well as the elaboration of EDPC's Business Plan (integrated into the Group's Business Plan) to 2023/26. In this scope, provide support in the construction of the documents to present to the CAE the ambitions for the following business lines: Energy, Solar, Public and Private Mobility, and Other Services, either for Portugal, as well as, for Spain, Italy, and Poland. Additionally, from January until the end of the internship, in March, the candidate performed assistance and revision, when applicable, of the defined ambitions in the Budget and Business Plan and elaboration of the impact of endogenous and exogenous alterations; support in the construction of models for the appraisal of projects to define pricing that allows reaching the Group's objectives of rentability; and elaboration of financial analysis ad hoc.

The internship program had the following schedule:

- BU23 and BP23/26 – September to January
- Assistance and revision of ambitions – January to March
- Appraisal Models – November to March
- Financial Analysis Ad Hoc – November to March

The first activity with the company was an onboarding program aimed at welcoming newly hired employees and interns and getting them acquainted with EDPC's mission, values, and way of work, providing them with the right tools to perform the soon-to-be assigned jobs and orientate them by letting them know how their role would impact the company.

The completion of the onboarding was a one–on–one with the Head of the Strategic Planning department through the way of a summary and the presentation of a timeline of both what the department would be responsible for in the coming months and what each team member's role would be within the department. In succession of the onboarding, the candidate was responsible for assisting and supporting the other team members, as well as, receiving the data and preparing the presentations via PowerPoint for the Budget 2023 and the Business Plan 2024-2026 (as it is stated in the scheduled

program above). Firstly, succeeded the undertaking of some E-learning courses made available by the company, these courses included chapters with tests of multiple-choice answers about topics, such as cybersecurity, the confidentiality of data, or the energy market. Following these activities, the candidate began going through presentations of past budgets and business plans not only to get acquainted with what financial and operational indicators would be presented, but also how they would be presented, and the presentations' type structure. The process of drafting a budget presentation started with a draft of the slides designed by the Head of the department and delivered to the candidate, which would give life to this proposal of structure.

The department would prepare and undertake five presentations to the board through October and November. Following these presentations, the next steps were to meet the challenges given by the board, as well as, to make the necessary changes according to the revised ambitions.

In the aftermath of the budget and business plan process and until the end of the internship (January to March) the candidate was given the task of undertaking new developments that would facilitate and improve analysis that would be utilized and incorporated in the 2024 budget process.

Chapter 4 – Project Development

4.1. Conceptual Framework

The conceptual framework of this study on the role of decarbonization, decentralization, and digitalization in the transformation the energy sector is undergoing was constructed based on the works of several authors.

Decarbonization is essential to lessen the effects of major issues such as climate change by promoting the switch to renewable sources (Rowling, 2022). Regarding decentralization, it is a crucial component in quickening the energy transition (Schoolman, 2019) as energy-producing facilities are located closer to the location of energy consumption decreasing the need for fossil fuels and boosting energy efficiency (Mugambiwa & Rapholo, 2023). Finally, digitalization is crucial for companies acting in the energy sector as they move toward a low-carbon economy and renewable energy (Simonovich & Beato, 2023) through the employment of tools like IoT, AI, and blockchain for their sustainable development (Światowiec-Szczepańska and Stępień,

2022). All three trends are also heavily influenced by the economic climate and government policies (since they are very investment-oriented), and technological evolution that enables new tools and software to facilitate its implementation. According to the aforementioned and the literature review, figure 1 depicts the proposed conceptual model.

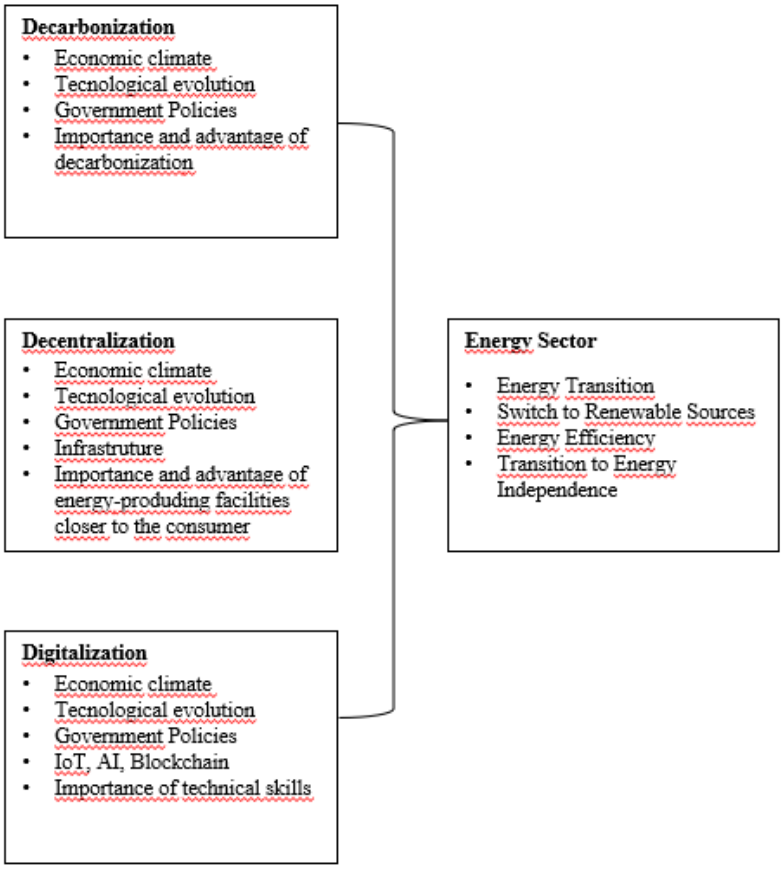

Figure 1 - Conceptual Framework
Source: Author's Elaboration based on Rowling (2022), Schoolman (2019), Mugambiwa & Rapholo (2023), Simonovich & Beato (2023), Światowiec-Szczepańska and Stępień (2022)

Table I consists of a reference board that links the subjects/concepts addressed in the literature review with the activities performed in the internship presented by the referenced authors. These subjects were included in the following reference board, to complement one another and give the report's structure a wider and more insightful perspective.

Table I - Frame of Reference

Challenges and Trends of the Energy Sector	References
The Evolving Energy Landscape	Rapier, 2023; Petcu, 2022; Jaeger, 2021; Daszkiewicz, 2020; Ellis, 2022; Henderson, 2021; Bricout et al., 2022; IPCC, 2022
❑ Transition of the Energy Sector from non-renewables to carbon neutral solutions	
The Evolving Landscape of Carbon Emission Reduction	Rowling, 2020; United Nations, 2023; Papadis and Tsatrasonis, 2020; Jackson, et al., 2018; Singh, 2024; Liu et al., 2023; Evans and Viisainen, 2023; Soeder, 2022; Borghesi and Vergalli, 2022; Midgley, 2019; McKinsey & Company, 2022; Cho, 2022; Krishnan, et al., 2022; Lamb and Minx, 2020; WEF, 2022; Economist, 2022; Noussan et al. 2020; Drozdz et al. 2021; Environment U. N., 2017; IEA, 2023; Duygan, et al., 2022
❑ Energy transition towards decarbonization ❑ Decarbonization Challenges ❑ Decarbonization Solutions	
Decentralization	Schoolman, 2019; Mugambiwa and Rapholo, 2023; Lingyan, et al., 2022; Nadeem, et al., 2023; Fukuizumi, 2020; Asif, 2022; Dash, 2021; Strandberg, 2021; Noor, 2019; Finly, 2019; OECD, 2019;Unescap, 2023; Cooper, 2023; Arvanitopoulos, et al., 2022; IRENA, 2022; Alstone, et al., 2015; Wu, et al., 2021; China, 2023; Bojeck, 2023
❑ The Role of Decentralization in Accelerating Energy Transition and Enhacing Socioeconomic Development	
Digitalization in the Energy Sector	Akberdina & Osmonova, 2021; IEA, 2017; Światowiec-Szczepańska and Stepień, 2022; Motlagh, et al., 2020; Chitchyan and Murkin, 2018; Copeland, 2023; Kufeoglu et al., 2019; Serban and Lytras, 2020; Dharfizi, 2018; Bhattacharjee and Nandi, 2019; Salam, 2019; Andoni et al., 2019; Pourbeik, 2021; Booth, et al., 2020; _Directorate-General for Energy, 2021; Simonovic and Beato, 2023; Dibal, et al., 2023; Ramamurthy and Jain, 2017; Marsh, 2013; Routray, 2021; Pressac, 2022; Kirli, et al., 2022; Shu, et al., 2022; Li, et al., 2023; Appasani et al., 2022; Ganne, 2018; Rozite, et al., 2023; Carrington, 2021; Slade, 2021; Janin, et al., 2021
❑ Digitalization in the Energy Sector ❑ Blockchain, IoT, and AI ❑ Challenges for the Digitalization of Energy Systems	
Challenges and Investment Needs in the Global Energy Transition	IEA, 2022; Popovich and Plumer, 2023; Marr, 2022; Wang and Tseng, 2012; Paskal, 2009; Okafor, 2020; Brown, et al., 2022
❑ Grid challenges ❑ Investment challenges	
Additional Remarks on the Energy Sector	Arrow and Wood-Robertson, 2023; IEA, 2022; White, 2022; Thomson, 2023; Badlam, et al., 2022; European comission, 2022
❑ Global Energy Market Disruptions ❑ Investment and Policies Responses	
Energy Dependence and its Importance	IEA, 2022; Yanatma, 2023; WHO, 2022; The World Bank, 2023;_Martin, 2022; Carfora, et al., 2021; Bocca and Ashraf, 2022; Edmond 2022; Elbassoussy, 2019; Sustainability for All, 2023;_IRENA, 2022; European Comission, 2023; Nature Energy, 2023; Dennison and Zerka, 2022; WEF, 2022;
❑ Importance of Energy Dependence ❑ Challenges of Energy Dependence ❑ Energy Independence and Transition to a Decarbonized Economy	

Source: Author's Elaboration

4.2. Methodological Approach

This study follows Saunders' "Research Onion" framework (2007), a flexible structure applicable to various research methodologies (Becker et al., 2012). According to Saunders et al. (2007), research should progress from the outer layers to the inner layers of the "Research Onion," which illustrate the stages involved in the development of a research project, including Research Philosophy, Research Approach, Research Strategies, Research Choices, and Research Time Horizon (Saunders et al., 2019).

The research philosophy employed in this study is interpretivism, as the goal is to interpret how the interviewees, who hold significant roles within the company, perceive its actions and participation in the energy transition. The research approach is inductive, as the research focus was established after data collection (Peters, 2010). The research strategy is classified as a case study, as it involves gathering detailed, specific data from key individuals. The research choice is a mono-method, as the study only utilizes qualitative data, and the time horizon is cross-sectional, given that the data was collected at a specific point in time rather than over an extended period. Finally, the data collection consisted of three semi-structured interviews with specialized professionals in management positions at EDP Comercial.

4.3. Data Collection Method

The data collection method focused on a single approach that consists of the implementation of techniques for the collection of primary qualitative data. Moreover, it was also performed a collection of secondary complementary information.

The collection of the aforementioned primary data was performed using a semi-structured interview. The participants were selected based on their strategic roles at EDP Comercial. Accordingly, the interviews were conducted with the subdirectors of EDP Comercial's, Planning and Control department, Diogo Matos e Silva (Interview 1) and Joel Ferreira (Interview 2), and a member of the Financial Planning and Analysis team, Pedro Lourenço (Interview 3), to obtain a deeper knowledge of the company's context, regarding its budget and business plan for the following years, eventual management issues, and other important aspects given the internship report's objectives. The interviews were conducted online via Microsoft Teams and the interviewees authorized the use of the data collected.

The chosen method for the data collection was the interview as it allows to gather more in-depth information and enables the interviewee to evaluate the future and reflect on the past of both the company and the energy sector as a whole. The data collection was undertaken at a single point in time, due to the time constraints and deadline of the report.

4.4. Structure of the Interviews

As it was mentioned, the collection of the primary data for this study was made through a structured interview, both interviews had the same set of questions in the same order to

make the comparison and analysis easier, however leaving room for the interviewees to develop their thoughts and answers by using open-ended questions (Adhabi & Anozie, 2017).

The interviews began with introductory questions to get the interviewees to feel comfortable to improve the overall quality of the interview, and consequently, the data collected, while at the same time assessing if their qualifications, skills, and job performed in the company give them the ability to provide valid and valued answers in light of the report's topic (questions 1 and 2). Then, the interview advanced with questions regarding the energy sector's challenges and trends which allowed to link the data collected to the literature review. For example, questions 5 and 12. Finally, it closed up with questions about how the company will strategize for the future, and how will that future be impacted by the sector's transformation, such as question 18. For the complete list of interview questions, please consult Appendix 1.

4.5. Sample Characterization

This study consisted of interviewing three specialized professionals, two of them in management positions at EDP Comercial. In terms of the age range of the sample, respondents were adults 30 - 40 years old. Table II presents the three interviewees.

Table II - Sample Characterization

	Position in the Company	Years in the Company	Academic Background	Professional Background
Interviewee 1	P&C Subdirector	10	Finance	Planning and Control
Interviewee 2	P&C Subdirector	1,5	Economics	Consulting; Planning and Control
Interviewee 3	P&C Specialist	12	Management	Consulting; Planning and Control

Source – Author's Elaboration

4.6. Data Analysis

As mentioned above, the interviews were made with three members of the P&C, two of them being in management positions of the Financial Planning and Business Control and Financial Report of EDPC, to capture an insight into the company's strategy for both the short and long term given the current challenges and trends, mainly the ones mentioned in the report's literature review (decarbonization, decentralization, digitalization) of the energy sector (which EDPC is inserted in), concerning the current landscape of the sector.

4.6.1. Transformation of the Energy Sector

Based on the three interviews the energy sector is going through a severe transformation. Interviewee 2 gave the following characterization of the sector:

> *"I would characterize EDPC's sector as a sector undergoing great change mainly focused on energy transition with special attention to higher levels of investment and a very different social perception than how it was years ago, that is, decentralized energy, less polluting energies, also focused in mitigating risk by promoting energy decentralization and enhancing energy independence from external countries (e.g. the dependency on the Arabic Peninsula for crude oil, and natural gas from Russia). Furthermore, the sector is highly focused on decarbonization (the more efficient this transition is the better the caption of energy is)."* (verbatim Interviewee 2)

When asked what impact Russia's invasion of Ukraine had on the sector, the interviewees promptly responded it had a massive impact on the sector:

> *"Russia's invasion of Ukraine had a massive impact on the energy sector in many ways, especially in retail companies accounts due to the price increase we are all aware of. Additionally, increasingly more clear that war and inflation will cause major delays in investments in renewables."* (verbatim Interviewee 1)

> *"Russia's invasion of Ukraine had a massive impact on the energy sector due to the gas distribution problem that led to higher energy prices (thus the focus on mitigating the risk of dependence from external countries), on the other hand solar financials became better and investment in renewables increased.".* (verbatim Interviewee 2)

Interviewee 3 also refers to the fact the war in Ukraine resulted in volatility in energy prices and high inflation.

Regarding the challenges faced by the sector given the transformation it is undergoing, Interviewee 1 highlights how energy transition will force companies to rapidly adapt their product offering in order to move to carbon neutral solutions whereas Interviewee 2 focuses on the challenges posed by digitalization such as being cost-efficient, attracting qualified human resources, and smart investing at a time of high interest rates.

> *"In my opinion the biggest challenge companies in the energy sector face for 2023 and beyond is to be able to manage the energy transition, with regard to new products and services that customers will need to have."* (verbatim Interviewee 1)

> *"In my opinion the main trends in the sector right now are some of what I have mentioned in the previous question, such as decentralization and decarbonization, aligned with investment in energies like solar, wind, and hydrogen. The main challenges are: increased national and international*

competition, being more cost-efficient - digitalization, achieving more agile processes, investment capacity of each company/country at a time of high interest rates, monetary risk, attracting technical human resources with the necessary skills, and with investment in new functions (constant technological evolution creates risks due to the rapid obsolescence of products, supply chains, etc.)" (verbatim Interviewee 2)

Still regarding this subject Interviewee 3 stated that the main threat to the company is the volatility in energy prices, but also focused on the electrification trend as an opportunity to help EDPC fulfill its mission:

"the greatest threat to EDP Commercial is the volatility in energy prices, while a huge opportunity the company has is to "enter" in the electrification trend (swapping out fossil fuel-consuming devices or procedures, such as gas boilers and internal combustion engines, with electrically powered alternatives, such heat pumps, and electric vehicles)". (verbatim Interviewee 3)

4.6.2. Strategy to Face the Sector's Challenges and Trends

Comparing the three interviews it's evident that all three interviewees are aligned on the fact that the company is aiming at being an enabler of energy transition:

"in my opinion and considering my 10 plus years in the company EDPC's mission is mainly to be an enabler of energy transition" (verbatim Interviewee 1)

"In a nutshell, I believe that EDPC's primary objective is to facilitate the energy transition." (verbatim Interviewee 2)

"EDPC's mission and objectives is to be the partner for total decarbonization of all its clients around the world, by offering integrated energy solutions and guaranteeing the efficient delivery of its products and a perfect customer experience" (verbatim Interviewee 3)

Regarding EDPC's strategy for both short and long-term, interviewees 1 and 2 present two different points of view, Interviewee 1 mentions an approach focused on the connection with the customer based on the company's large market share in Portugal:

"In order to continue being one the main players in the energy sector in Iberia and continue affirming itself in the rest of Europe, EDP Comercial is aiming at strengthening the connection with customers based on more networking. (...) In Portugal, EDPC clearly has an advantage for being a very old company with more market share, and thus benefiting from the "first mover" advantage and keep deserving the trust of the Portuguese people by keeping the excellence in performing of all activities and aiming at improving the quality of life of present and future generations." (verbatim Interviewee 1)

On the other hand Interviewee 2 mentions an approach more focused on investment in the continuous development of new green energy products:

> *"The company intends on betting heavily on digitalization, reduction of manual processes, bureaucracy, creating a leaner structure, faster processes, focus heavily on solar dg, electric mobility, energy sales - guaranteeing green energy sources, attracting resources with the competence to carry out this processes, keeping agile investment, focus on maintaining results by reducing fixed and variable costs, and constant development of new green solutions for the client (batteries, solar apartments, Local Energy Communities - taking advantage of existing space in a company that uses this to distribute energy to neighbors, by doing this the company is taking advantage of unoccupied space to distribute green energy to neighbours".* (verbatim Interviewee 2)

Additionally, Interviewee 3 mentioned that given the current sector landscape, the company is changing its structure to reach more agile processes and be more efficient in order to successfully implement its Business Plan of becoming 100% green by 2030, while promoting sustainable growth.

> *"an updated organizational model that proposes a matrixial organizational structure, with the objective of creating a more streamlined, efficient, and agile organization, with the capacity to support growth and the successful implementation of EDP's Business Plan.".* (verbatim Interviewee 3)

Based on interviews 1 and 2 EDP's strategy is in accordance with the evolving energy landscape from non-renewable energy to carbon-neutral solutions which is supported by the company's business plan that clearly states the goal of becoming 100% green by 2030. Furthermore, Interviewee 3 presents the example that EDP is closing coal-fired power stations and focusing on renewable sources.

> *"Yes, EDPC's strategy is heading towards the decarbonization of the energy sector, given that the last business plan presented has as a plan for a 100% green company in 2030."* (verbatim Interviewee 1)

> *"Yes, EDPC's strategy is geared towards the decarbonization of the energy sector, as evidenced by the fact that the most recent business plan submitted included a goal of having a fully green firm by 2030. Also, the company intends to reach net zero by 2040."* (verbatim Interviewee 2)

> *"Some examples that EDP's strategy is in accordance with the decarbonization of the energy sector are the closure of coal-fired power stations and focus on renewable sources."* (verbatim Interviewee 3)

Moreover, interviews 1 and 3 present examples of specific measures the company is taking to deal with the energy sector's infrastructure challenges. Interviewee 1 mentions the centralizing of the totality of the company's procurement in an European unit that will benefit of economies of scale, while Interviewee 3 points out the development of the asset

management team, a measure that will increase the effectiveness of the maintenance and operation procedures.

> *"In order to deal with the energy sector's infrastructure challenges EDP Comercial is creating a European procurement unit to centralize all procurement and take advantage of economies of scale"* (verbatim Interviewee 1)

> *"The organizational evolution that I mentioned in one of the previous questions led to the development of the asset management team, that will surely help the company deal with the sector's infrastructure challenges. Furthermore, another relevant measure to help deal with this issue is portfolio diversification (eg. Solar DG+batteries and Electric Mobility)".* (verbatim Interviewee 3)

Regarding digitalization and decentralization Interviewee 1 focused on the importance of the company's investment in IT and the distribution of products to different segments. Interviewee 3 also pointed out that the company is becoming more efficient and streamlining their processes by promoting the use of digital channels and self-service mechanisms by the customers:

> *"Regarding decentralization the company is, for example, distributing solar with different product typologies (B2B, Bronze, B2C, and LECs), and continuously delivering new products that create value for the customers, such as, solar for apartments and solar batteries. Regarding digitalization the company has a large annual investment in IT (of around a couple million euros) aiming for internal efficiency, analysis of information, improvement of the operational component and research, and for customers to improve processes."***.** (verbatim Interviewee 1)

> *"the company is promoting the use of digital channels and self-service mechanisms".* (verbatim Interviewee 3)

4.7. Discussion of the Main Findings

4.7.1. Transformation of the Energy Sector

The study meant to analyze the transformation of the energy sector, in regard to how its challenges and trends have affected the company. The opinion of Interviewee 2 emphasizes that EDPC's sector is undergoing massive change focused on energy transition with special attention on higher investment, which is in line with the ideas presented by Petcu (2022) and Ellis (2022), who argued that the move to energy transition needs to be sustained by an annually increase in investment of 4%. Furthermore, all three interviews mentioned that Russia's invasion of Ukraine and consequent rise in energy

prices had a massive impact on the sector due to the gas distribution issue that caused volatility in energy prices, following the International Energy Agency (2022).

Regarding the importance of energy independence, Carfora et al. (2022) stated that among the most important determinants of economic growth and development are energy independence and the security of the energy supply. Bocca and Ashraf (2022) claimed that issues relating to dependence rates, energy prices (and volatility), energy source shortages, and environmental protection were faced by countries that wanted to achieve adequate levels of energy security. The ideas presented by the interviewees and explained in interview 2 support the literature exposed.

The trends followed by the sector presented by Mugambiwa and Rapholo (2023), and Simonovich and Beato (2023) were digitalization, crucial for energy firms which are going through significant changes as they move toward a low-carbon economy and renewable energy, and decentralization as it decreases the need for fossil fuels, boosts eco-efficiency, and enables the best possible use of renewable energy sources. These trends are depicted in this study with the opinion reported in interview 2. Additionally, Interviewee 3 underlined the growth in investment and utilization of renewable sources like solar, wind, and hydrogen, which according to Petcu (2022) may account for as much as 80% of all the electricity consumed in Europe.

Still regarding challenges faced by the energy sector Booth et al. (2020) stated that priorities should be given first to having a workforce that is suitably trained and equipped to use and innovate with the relevant technology, as well as a managerial vision for developing such digitally based energy systems that is backed by technological know-how and, of course, the funds to invest in these technologies. Interviewee 2 supports this literature referring that the main challenges are being more cost-efficient in digitalization, achieving more agile processes, investment capacity of each company/country at a time of high interest rates, and attracting technical human resources with the necessary skills.

Światowiec-Szczepańska and Stępień (2022) suggested that challenges in the deployment and usage of digital technology may result from outside circumstances. Furthermore, according to the International Energy Agency (2017), the potential for increased digitalization may be constrained by incomplete information, technical deficiencies, and cultural barriers. These are verified by Interviewee 3 which stated the

intermittency of renewable technologies was a concern regarding the slowdown of energy transition.

4.7.2. Strategy to Face the Sector's Challenges and Trends

The following question of this report focuses on the measures taken by the company to face the energy sector's transformation. Regarding the infrastructure challenges faced by the energy sector, Brown et al. (2022) stated that the inadequacies of many electric grid networks will become an ever more obvious impediment to the widespread adoption of renewable energy, thus an unprecedented level of capital investment in the electric grid will be needed to support the energy transition. Interviewee 1 gave the example that the company is establishing a European procurement unit to centralize all procurement and take advantage of economies of scale to address these problems. Moreover, Interviewee 3 also gave the example that with the company's organizational evolution a development of the Asset Management team is taking place in order to deal with infrastructure challenges.

The example presented by Interviewee 2 regarding the company's investment in the continuous development of new green energy products for customers (batteries, solar apartments, local energy communities, which make use of available space in a business to distribute energy to neighbors - by doing this, the business is utilizing vacant space to distribute green energy to nearby residents), is in line with the advantages of decentralized energy systems pointed in the literature review by Strandberg (2021) and Arvanitopoulos et al. (2022). Interviewee 3 also verified the literature of Noussan et al., 2020, that described electrification as an opportunity for companies committed to decarbonization.

According to the International Energy Agency (2017), the rate of energy's digitalization is accelerating. Since 2014, there has been a yearly growth of more than 20% in the amount of money invested globally in digital power infrastructure and software. This statement is verified by Interviewee 2 by implying a large annual investment in IT made by EDPC. Interview 2 also verifies the literature of Andoni et al. (2019) that implied that IT investment is crucial for the improvement of the operational component of companies and for customers to improve processes, such as consumer billing automation. Moreover, the quotes from Interviewee 2 mirror the ideas put forward by Routray (2021) according to whom digitalization helps lower costs of maintenance while improving systems efficiency and reliability in power plants, as well as, improving

networks not ready for decentralized distribution. Interviewee 3 also stated that the company is promoting the usage of digital channels and self-service mechanisms, this mirrors the ideas of Akberdina and Osmonova (2021) according to whom successful digital transformation depends on the development and maintenance of skills, knowledge, and expertise.

All three interviewees also agree on the importance of E-Mobility as one of the industries of the future that will be growing quickly. This idea is verified by the literature of the International Energy Agency (2023) which states that many nations and manufacturers view electric vehicles as the most viable option for decarbonization, and thanks to special policies, EV sales are exhibiting encouraging trends in China, the USA, and Europe.

Chapter 5. Recommendations for the Company

Considering the findings from the internship and the analysis of the data collected, the following recommendations provide ways for the company to continue positioning itself as an enabler of energy transition. These recommendations aim to improve efficiency, cost reduction, sustainability efforts, and achieve more agile processes.

5.1. Meticulous monitoring of IT investments in the sector

From the information gathered, it was observed that being cost-efficient in digitalization while achieving more agile processes is one of the company's biggest challenges. Hence, tracking public and private-sector investment in the sector is essential to improve the efficiency and effectiveness of resource allocation, given that constant technological evolution creates risks of rapid obsolescence of products or supply chains. Furthermore, it will certainly help to attract technical human resources with the necessary skills to embrace technological development.

Additionally, to be cost-efficient and gather value from its investment in IT, the company should analyze and closely monitor the benefits that it expects should come from the investment in each initiative.

5.2. Promoting SDGs

From the data collection, it was noted that sustainability efforts are discussed at higher levels, proved by the fact that the company's most recent business plan submitted

included a goal of having a fully green firm by 2030. The company could promote SDGs within the office by sensitizing employees to take actions focused on specific SDGs, e.g. SDGs 7, 9, 11, and 13 that are directly impacted by the company's key activities (as depicted in Figure 2). Thus, the company can cultivate a culture of sustainability and responsibility at all levels that signal to the market that it is taking operational initiatives to achieve the proposed goal by encouraging employee participation in sustainability initiatives and sharing progress and achievements in sustainability efforts through internal communications.

Chapter 6 – Conclusions, Contributions, Limitations and Suggestions for the Future Research

6.1. Conclusions

The internship carried out in EDP Comercial allowed the consolidation of the insights gathered through the Master's Degree and their implementation in a corporate context. The objectives outlined in the beginning were achieved and it is possible to present an answer to the established questions.

Answering the first question: "How is the transformation of the energy sector influencing the company's operations and strategic decisions?", it must be mentioned that the transformation of the energy sector is significantly influencing EDP Comercial's operations and strategic decisions. The volatility of energy prices, the shift towards green energy solutions, and the challenges posed by the sector's evolution are having a direct impact on the company. EDP Comercial is adapting to the global transition from non-renewable to carbon-neutral energy sources, aligning with trends that highlight the growing importance of sustainability. However, the energy transition still presents challenges such as increased competition, the need for cost-efficient digitalization, and the ability to attract skilled technical human resources to manage new infrastructure and technologies. Moreover, financial and geopolitical factors, such as rising interest rates and policy regulations, further complicate the landscape.

The company's operations reflect these changes, as EDP Comercial's primary objective is to facilitate the global energy transition and support decarbonization efforts for its clients. According to interviewees in management positions at the company, EDP aims to be a leader in the green energy sector by 2030, with a commitment to providing

integrated energy solutions. This is reinforced by EDP's recent business plan, which outlines its goal to become a fully green corporation within the next decade. The company is evolving not only in response to market demands but also through strategic alignment with global energy policies and technological advancements, which are critical to remaining competitive.

Answering the second query: "In what ways is the company aligning its strategy to address the emerging challenges and trends within the energy sector?", it is worth mentioning that to address the challenges and trends in the energy sector, EDP Comercial is taking several strategic measures. One key initiative is the establishment of a European procurement unit, which aims to enhance the company's efficiency in managing infrastructure and operation processes. The company is also investing heavily in asset management to optimize maintenance and operations, which is critical for dealing with infrastructure-related issues as the energy grid modernizes to accommodate more renewable energy sources.

Additionally, EDP Comercial is investing in the continuous development of green energy products, such as batteries, solar energy solutions for apartment buildings, and local energy communities, to meet the growing consumer demand for sustainable energy options. The company's digitalization efforts, supported by substantial IT investments, are another major component of its strategy, helping streamline operations and improve customer interaction. EDP is also updating its organizational model to create a more agile, efficient structure that can support its growth objectives and ensure the successful implementation of its business plan. These strategic initiatives collectively position EDP Comercial to better navigate the complexities of the energy sector's transformation and capitalize on new opportunities in the green energy market.

6.2. Main Contributions

In light of the study's findings, it offers both theoretical and practical contributions.

At an academic level, this research contributes to the understanding of the energy sector's transformation, particularly focusing on the shift from non-renewables to carbon-neutral energy solutions. It emphasizes the crucial role of digitalization and decentralization in accelerating the energy transition, promoting innovation, and driving socioeconomic development. The study also highlights how companies in the energy

sector must adapt to these changes to remain competitive, providing valuable insights into the broader implications of these trends on business strategies and operations.

On a practical, business level, the study is highly relevant for organizations navigating the challenges and trends associated with the energy sector's transformation. It identifies the growing importance of digitalization and the substantial investments required to implement cost-efficient technologies. Attracting and retaining skilled technical talent to manage these advancements is a critical challenge. Moreover, the transition to carbon-neutral solutions demands continuous innovation in green energy products and the capacity to overcome infrastructural challenges.

The research also provides two specific recommendations for EDP Comercial. By adopting these, the company can continue to position itself as a leader in energy transition by leveraging IT investments for cost efficiency, promoting sustainability initiatives, reducing operational costs, and achieving greater agility in its processes. These insights are crucial for businesses aiming to align their strategies with the evolving landscape of the energy sector and ensure long-term success.

6.3. Limitations and Suggestions for Further Studies

Energy transition is a hot topic in current times, due to the many reasons mentioned in the report, therefore it will always be a subject of interest to scholars. While there is some literature on past events, there still is a lack of papers regarding the recent events (the COVID–19 Pandemic and Russia's invasion of Ukraine) that completely changed the way this topic will be addressed in the future, that being one limitation regarding the completion of this report.

Additionally, the scope of the interviews conducted for this study was constrained to employees within the same department, this is another limitation. Expanding the research to managers of different departments could provide a broader view of the transformation of the energy sector and how it affects the company.

As a result of this study, future research on the subject is suggested. It would be relevant to carry out quantitative research that mixed with data from interviews would give a more detailed view of the energy sector and how it is affecting companies' strategies.

References

Adhabi, E. a. R., & Anozie, C. B. L. (2017). Literature review for the type of interview in qualitative research. *International Journal of Education, 9*(3), 86. https://doi.org/10.5296/ije.v9i3.11483

Akberdina, V., & Osmonova, A. (2021). Digital transformation of energy sector companies. In *E3S Web of Conferences* (Vol. 250, p. 06001). EDP Sciences. https://doi.org/10.1051/e3sconf/202125006001

Alstone, P., Gershenson, D., & Kammen, D. M. (2015). Decentralized energy systems for clean electricity access. *Nature Climate Change*, *5*(4), 305–314. https://doi.org/10.1038/nclimate2512

Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., & Peacock, A. (2019). Blockchain technology in the energy sector: A systematic review of challenges and opportunities. *Renewable & Sustainable Energy Reviews*, *100*, 143–174. https://doi.org/10.1016/j.rser.2018.10.014

Appasani, B., Mishra, S. K., Jha, A. V., Mishra, S. K., Enescu, F. M., Sorlei, I. S., Bîrleanu, F. G., Takorabet, N., Thounthong, P., & Bizon, N. (2022). Blockchain-Enabled Smart Grid Applications: architecture, challenges, and solutions. *Sustainability*, *14*(14), 8801. https://doi.org/10.3390/su14148801

Arvanitopoulos, T., Wilson, C., & Ferrini, S. (2022). Local conditions for the decentralization of energy systems. *Regional Studies*, *57*(10), 2037–2053. https://doi.org/10.1080/00343404.2022.2131756

Asif, M. (2022). Digitalization in Energy Sector. In *Wiley* (pp. 347–355). https://doi.org/10.1002/9783527831425.ch16

Badlam, J., Cox, J., Kumar, A., Mehta, N., O'Rourke, S., & Silvis, J. (2022). The Inflation Reduction Act: Here's what's in it'. *Link: https://www. mckinsey. com/industries/public-sector/our-insights/the-inflation-reduction-act-heres-whats-in-it*.

Becker, S., Bryman, A., & Ferguson, H. (2012). Understanding research for social policy and social work : themes, methods and approaches. In Policy Press eBooks. https://ci.nii.ac.jp/ncid/BB11096589

Bhattacharjee, S., & Nandi, C. (2020). Technical, economic, feasibility and comparative analysis of three different configurations of energy system to control intermittency of renewable energy. *Social Science Research Network*. https://doi.org/10.2139/ssrn.3512405

Bocca, R., & Ashraf, M. (2022, May 11). *Fostering effective energy Transition 2022*. World Economic Forum. https://www.weforum.org/publications/fostering-effective-energy-transition-2022/

Bojek, Bahar, Briens, Criswell, Moorhouse, & Martinez. (2023). Renewables. In *IEA*. https://iea.blob.core.windows.net/assets/96d66a8b-d502-476b-ba94-54ffda84cf72/Renewables_2023.pdf

Booth, A., Patel, N., & Smith, M. (2020, September 3). *Digital transformation in energy: Achieving escape velocity*. McKinsey & Company.

https://www.mckinsey.com/industries/oil-and-gas/our-insights/digital-transformation-in-energy-achieving-escape-velocity

Borghesi, S., & Vergalli, S. (2022). The European Green Deal, energy transition and decarbonization. *Environmental & Resource Economics*, *83*(1), 1–3. https://doi.org/10.1007/s10640-022-00726-6

Bricout, A., Slade, R., Staffell, I., & Halttunen, K. (2022). From the geopolitics of oil and gas to the geopolitics of the energy transition: Is there a role for European supermajors? *Energy Research & Social Science*, *88*, 102634. https://doi.org/10.1016/j.erss.2022.102634

Brown, G., Chan, B., Clune, R., & Cutler, Z. (2022, February 1). *Upgrade the grid: Speed is of the essence in the energy transition*. McKinsey & Company. https://www.mckinsey.com/capabilities/operations/our-insights/global-infrastructure-initiative/voices/upgrade-the-grid-speed-is-of-the-essence-in-the-energy-transition

Carfora, A., Pansini, R. V., & Scandurra, G. (2022). Energy dependence, renewable energy generation and import demand: Are EU countries resilient? *Renewable Energy*, *195*, 1262–1274. https://doi.org/10.1016/j.renene.2022.06.098

Carrington, J. (2021, September 15). *AI is transforming the grid. Here's how.* World Economic Forum. https://www.weforum.org/agenda/2021/09/how-ai-is-transforming-decarbonising-and-cleaning-up-the-grid/

China, C. R., & China, C. R. (2023, July 25). *Optimizing energy production with the latest smart grid technologies*. IBM Blog. https://www.ibm.com/blog/optimizing-energy-production-with-the-latest-smart-grid-technologies/

Chitchyan, R., & Murkin, J. (2018). Review of Blockchain Technology and its Expectations: Case of the Energy Sector. *ResearchGate*. https://www.researchgate.net/publication/323694477_Review_of_Blockchain_Technology_and_its_Expectations_Case_of_the_Energy_Sector

Cho. (2022, April 22). *What is decarbonization, and how do we make it happen?* State of the Planet. https://news.climate.columbia.edu/2022/04/22/what-is-decarbonization-and-how-do-we-make-it-happen/

Cooper, J. (2023). Decentralization and the Energy Transition. *EE Power*. https://eepower.com/tech-insights/decentralization-and-the-energy-transition/#

Copeland, B. (2024, June 11). *Artificial intelligence (AI) | Definition, Examples, Types, Applications, Companies, & Facts*. Encyclopedia Britannica. https://www.britannica.com/technology/artificial-intelligence

Dash, A. (2021, September 7). Energy Decentralization: Why it's a Big Deal for Every Business - Utility Analytics Institute. *Utility Analytics*. https://utilityanalytics.com/2021/08/energy-decentralization-why-its-a-big-deal-for-every-business/

Daszkiewicz, K. (2020). Policy and regulation of energy transition. In *Lecture notes in energy* (pp. 203–226). https://doi.org/10.1007/978-3-030-39066-2_9

Deloitte. (2023). *2023 Energy, Resources, and Industrials | Industry Outlooks*. Deloitte United Kingdom.

https://www.deloitte.com/be/en/Industries/energy/research/2023-energy-resources-and-industrials-industry-outlooks.html

Dennison, S., & Zerka, P. (2022, November 24). *Tracking Europe's energy security: Four lessons from the EU's new energy deals*. ECFR. https://ecfr.eu/article/tracking-europes-energy-security-four-lessons-from-the-eus-new-energy-deals/

Dharfizi, A. D. H. (2018). The Energy Sector and the Internet of Things â€"Sustainable Consumption and Enhanced Security through Industrial Revolution 4.0. Journal of International Studies, 14, 99-117.

Dibal, P., Onwuka, E., Zubair, S., Nwankwo, E., Okoh, S., Salihu, B. A., & Mustaphab, H. (2023). Processor power and energy consumption estimation techniques in IoT applications: A review. *Internet of Things*, *21*, 100655. https://doi.org/10.1016/j.iot.2022.100655

Drożdż, W., Kinelski, G., Czarnecka, M., Wójcik-Jurkiewicz, M., Maroušková, A., & Zych, G. (2021). Determinants of Decarbonization—How to realize sustainable and low carbon cities? *Energies*, *14*(9), 2640. https://doi.org/10.3390/en14092640

Duygan, M., Fischer, M., Pärli, R., & Ingold, K. (2022). Where do Smart Cities grow? The spatial and socio-economic configurations of smart city development. *Sustainable Cities and Society*, *77*, 103578. https://doi.org/10.1016/j.scs.2021.103578

Edmond. (2022). *How much energy does the EU import from Russia?* European Business Review.

EDP. (2023). *About us*. edp.com. https://www.edp.com/en/about-us

EDP. (2023). *EDP em Portugal*. EDP Portugal. https://portugal.edp.com/pt-pt/edp-em-portugal

EDP. (2023). *EDP entities*. https://jobs.edp.com/content/EDP-Entities/?locale=en_US

EDP. (2023). *Integrated Annual Report 2022*. https://www.edp.com/sites/default/files/2023-08/Integrated%20Report%202022%20-%20website%20version.pdf

EDP. (2023). *Particulares*. EDP Comercial. https://www.edp.pt/particulares/

Elbassoussy, A. (2019). European energy security dilemma: major challenges and confrontation strategies. *Review of Economic and Political Science*, *4*(4), 321–343. https://doi.org/10.1108/reps-02-2019-0019

Ellis, D. (2022). Top 10 issues facing the energy industry. *Energy Digital*. https://energydigital.com/top10/top-10-issues-facing-the-energy-industry

European Commission (2022). *Action plan on the digitalisation of the energy sector – roadmap launched* (2021, July 27). https://commission.europa.eu/news/action-plan-digitalisation-energy-sector-roadmap-launched-2021-07-27_en

European Commission (2022). *REPowerEU*. (2022, May 18). https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en#:~:text=REPowerEU%20is%20the%20European%20Commission%E2%80%99s%20plan%20to%20make,as%20a%20Union%2C%20Eu

European Commission (2023). *EU action to address the energy crisis*. (2023). https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/eu-action-address-energy-crisis_en

Finkbeiner, M., & Bach, V. (2021). Life cycle assessment of decarbonization options—towards scientifically robust carbon neutrality. ˜ *the œInternational Journal of Life Cycle Assessment*, *26*(4), 635–639. https://doi.org/10.1007/s11367-021-01902-4

Fukuizumi, Y. (2020, September 14). *3 trends that will transform the energy industry*. World Economic Forum. https://www.weforum.org/agenda/2020/09/3-trends-transform-energy-industry/

Ganani, L. (2024, November 5). Beyond the grid: the case for decentralized Energy Systems - EIS. EIS. https://eiscouncil.org/beyond-the-grid-the-case-for-decentralized-energy-systems/

Ganne, E. (2018). *WTO | Can blockchain revolutionize international trade?* https://www.wto.org/english/res_e/publications_e/blockchainrev18_e.htm

Henderson, J., & Sen, A. (2021). *The Energy Transition: Key challenges for incumbent and new players in the global energy system*. https://www.oxfordenergy.org/wpcms/wp-content/uploads/2021/09/Energy-Transition-Key-challenges-for-incumbent-players-in-the-global-energy-system-ET01.pdf

IBM. (2023). *What is decarbonization? | IBM*. https://www.ibm.com/topics/decarbonization

IEA (2017). *Digitalization and Energy – Analysis - IEA*. (2017, November 1). https://www.iea.org/reports/digitalisation-and-energy

IEA (2022), *A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas*, IEA, Paris https://www.iea.org/reports/a-10-point-plan-to-reduce-the-european-unions-reliance-on-russian-natural-gas

IEA. (2023). *Executive summary – Global EV Outlook 2023 – Analysis - IEA*. https://www.iea.org/reports/global-ev-outlook-2023/executive-summary

IPCC. (2022). *The Evidence Is Clear: The Time for Action Is Now. We Can Halve Emissions by 2030.* https://unfccc.int/news/the-evidence-is-clear-the-time-for-action-is-now-we-can-halve-emissions-by-2030

IRENA (2022). *Fostering Livelihoods with Decentralised Renewable Energy: An Ecosystems Approach*. (2022, January 1). https://www.irena.org/publications/2022/Jan/Fostering-Livelihoods-with-Decentralised-Renewable-Energy

Jackson, R. B., Quéré, C. L., Andrew, R. M., Canadell, J. G., Korsbakken, J. I., Liu, Z., Peters, G. P., & Zheng, B. (2018). Global energy growth is outpacing decarbonization. *Environmental Research Letters*, *13*(12), 120401. https://doi.org/10.1088/1748-9326/aaf303

Jaeger, J. (2021, October 6). *These are the key factors driving the growth of renewables*. World Economic Forum. https://www.weforum.org/agenda/2021/10/which-factors-accelerate-the-growth-of-renewable-energy/

Janin, H., Latz, J., Sato, K., & Sauer, B. (2021, March 11). *The digital power plant of the future*. McKinsey & Company. https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-digital-power-plant-of-the-future

Kirli, D., Couraud, B., Robu, V., Salgado-Bravo, M., Norbu, S., Andoni, M., Antonopoulos, I., Negrete-Pincetic, M., Flynn, D., & Kiprakis, A. (2022). Smart contracts in energy systems: A systematic review of fundamental approaches and implementations. *Renewable & Sustainable Energy Reviews*, *158*, 112013. https://doi.org/10.1016/j.rser.2021.112013

Krishnan, M., Samandari, H., Woetzel, L., Smit, S., Pacthod, D., Pinner, D., Nauclér, T., Tai, H., Farr, A., Wu, W., & Imperato, D. (2022, January 25). *The net-zero challenge: Accelerating decarbonization worldwide*. McKinsey & Company. https://www.mckinsey.com/capabilities/sustainability/our-insights/the-net-zero-challenge-accelerating-decarbonization-worldwide

Küfeoğlu, Liu, Anaya, & Pollitt. (2019). *Digitalisation and New Business Models in Energy Sector*. https://www.eprg.group.cam.ac.uk/wp-content/uploads/2019/06/1920-Text.pdf

Lamb, W. F., & Minx, J. C. (2020). The political economy of national climate policy: Architectures of constraint and a typology of countries. *Energy Research & Social Science*, *64*, 101429. https://doi.org/10.1016/j.erss.2020.101429

Li, Hui, & Zhang. (2023, October 1). *Decentralized energy management of microgrid based on Blockchain-Empowered Consensus Algorithm with collusion Prevention*. IEEE Journals & Magazine | IEEE Xplore. https://ieeexplore.ieee.org/document/10075483

Lingyan, M., Zhao, Z., Malik, H. A., Razzaq, A., An, H., & Hassan, M. (2022). Asymmetric impact of fiscal decentralization and environmental innovation on carbon emissions: Evidence from highly decentralized countries. *Energy & Environment*, *33*(4), 752–782. https://doi.org/10.1177/0958305x211018453

Liu, Z., Deng, Z., Davis, S., & Ciais, P. (2023). Monitoring global carbon emissions in 2022. *Nature Reviews. Earth & Environment*, *4*(4), 205–206. https://doi.org/10.1038/s43017-023-00406-z

Marr, B. (2022, February 14). The 3 Biggest Future Trends (And Challenges) in the Energy sector. *Forbes*. https://www.forbes.com/sites/bernardmarr/2022/02/11/the-3-biggest-future-trends-and-challenges-in-the-energy-sector/

Marsh. (2013). *Common Causes of Large Losses in the Global Power Sector*.

Martin, E. (2022). Energy dependence, what is it and how do renewables play a role? https://www.narasolar.com/en/what-is-energy-dependence/

McKinsey & Company (2022). *The cost will not be net zero*. (2022, February 18). https://www.mckinsey.com/featured-insights/sustainable-inclusive-growth/chart-of-the-day/the-cost-will-not-be-net-zero

Midgley, C. (2019). The biggest challenges to decarbonization are still ahead. *S&P Global*. https://www.spglobal.com/commodityinsights/en/market-insights/blogs/electric-power/120919-the-biggest-challenges-to-decarbonization-are-still-ahead

Motlagh, N. H., Mohammadrezaei, M., Hunt, J., & Zakeri, B. (2020). Internet of things (IoT) and the energy sector. *Energies*, *13*(2), 494. https://doi.org/10.3390/en13020494

Mugambiwa, & Rapholo. (2023). Towards achieving Sustainable Development Goal 7 (Affordable and Clean Energy) through a transition to decentralised energy systems in South Africa. *ResearchGate*. https://doi.org/10.20525/ijrbs.v12i4.2576

Nadeem, T. B., Siddiqui, M., Khalid, M., & Asif, M. (2023). Distributed energy systems: A review of classification, technologies, applications, and policies. *Energy Strategy Reviews*, *48*, 101096. https://doi.org/10.1016/j.esr.2023.101096

Nature Energy. (2023). *Nature Energy*, *8*(10), 1047. https://doi.org/10.1038/s41560-023-01398-2

Noor. (2019). *Decentralized Renewable Energy for improving energy access in the LDCs | MIT Climate Portal*. MIT Climate Portal. https://climate.mit.edu/posts/decentralized-renewable-energy-improving-energy-access-ldcs

Noussan, M., Hafner, M., & Tagliapietra, S. (2020). The future of transport between digitalization and decarbonization. In *SpringerBriefs in energy*. https://doi.org/10.1007/978-3-030-37966-7

OECD (2019). "Decentralisation: Its benefits and challenges", in *Making Decentralisation Work: A Handbook for Policy-Makers*, OECD Publishing, Paris, https://doi.org/10.1787/d8bc40c6-en.

Okafor, J. (2023, October 27). *7 Challenges for renewable energy Preventing adoption*. TRVST. https://www.trvst.world/renewable-energy/challenges-for-renewable-energy/

Papadis, E., & Tsatsaronis, G. (2020). Challenges in the decarbonization of the energy sector. *Energy*, *205*, 118025. https://doi.org/10.1016/j.energy.2020.118025

Paskal, C. (2009). The vulnerability of energy infrastructure to environmental change. London: Chatham House.

Petcu, I. (2022, July 8). *Energy transition: the transformation of the energy sector*. https://www.eurelectric.org/in-detail/energytransition

Peters, I. (2010). Flick, Uwe. 2011. Introducing Research Methodology: A Beginner's Guide to doing a research Project. Los Angeles: SAGE. Manusya Journal of Humanities, 13(1), 81–82. https://doi.org/10.1163/26659077-01301006

Popovich, N., & Plumer, B. (2023, June 12). Why the U.S. Electric Grid Isn't Ready for the Energy Transition. *The New York Times*. https://www.nytimes.com/interactive/2023/06/12/climate/us-electric-grid-energy-transition.html

Portugal Gov (2023). *EDP Comercial - ePortugal.gov.pt*. (2023). EDP Comercial - gov.pt (www.gov.pt)

Pourbeik, P. (2021, November 2). *How to use IoT for energy efficiency and sustainability*. IoT Agenda. https://www.techtarget.com/iotagenda/feature/How-to-use-IoT-for-energy-efficiency-and-sustainability

Pressac. (2022, January 31). *Why energy monitoring is the key to reducing your organisation's carbon emissions*. Pressac Communications. https://www.pressac.com/insights/why-energy-monitoring-is-the-key-to-reducing-your-organisations-carbon-emissions/

Ramamurthy, A., & Jain, P. (2017, August). *The internet of Things in the power Sector: Opportunities in Asia and the Pacific*. Asian Development Bank. http://dx.doi.org/10.22617/WPS178914-2

Rapier, R. (2023, August 6). Global Energy trends: Insights from the 2023 Statistical Review of World Energy. *Forbes*. https://www.forbes.com/sites/rrapier/2023/08/06/global-energy-trends-insights-from-the-2023-statistical-review-of-world-energy/

Routray. (2021). *IoT assisted power electronics for modern grids*. IEEE Smart Grid. https://smartgrid.ieee.org/bulletins/june-2021/iot-assisted-power-electronics-for-modern-grids

Rowling, M. (2020, September 23). *"Net-zero" emissions: What is it and why does it matter so much?* World Economic Forum. https://www.weforum.org/agenda/2020/09/carbon-emissions-net-zero-global-warming-climate-change/

Rozite, Miller, & Who. (2023, November 2). *Why AI and energy are the new power couple – Analysis - IEA*. IEA. https://www.iea.org/commentaries/why-ai-and-energy-are-the-new-power-couple

Salam, A. (2019). Internet of things in sustainable energy systems. In *Internet of things* (pp. 183–216). https://doi.org/10.1007/978-3-030-35291-2_6

Saunders, M., Lewis, P., & Thornhill, A. (2007). Research Methods for Business Students (4th edn). https://epubs.surrey.ac.uk/815387/

Saunders, M., Lewis, P., & Thornhill, A. (2019). Research methods for business students, 8th ed. In Pearson eBooks. http://dspace.uniten.edu.my/handle/123456789/18304

Schoolman. (2019). Decentralizing energy for a High-Demand, Low-Carbon world. *One Earth*, *1*(4), 388–391. https://doi.org/10.1016/j.oneear.2019.12.005

Serban, & Lytras. (2020). *Artificial intelligence for smart renewable energy sector in Europe—Smart energy infrastructures for next generation smart cities*. IEEE Journals & Magazine | IEEE Xplore. https://ieeexplore.ieee.org/abstract/document/9076660

Shu, Z., Liu, W., Fu, B., Li, Z., & He, M. (2022). Blockchain-enhanced trading systems for construction industry to control carbon emissions. *Clean Technologies and Environmental Policy*, *24*(6), 1851–1870. https://doi.org/10.1007/s10098-022-02292-3

Simonovich, L., & Beato, F. (2023, September 8). *Digitalization: a threat and opportunity for energy companies*. World Economic Forum. https://www.weforum.org/agenda/2023/01/why-digitalization-is-a-threat-and-opportunity-for-energy-companies-davos-2023/

Singh, S. (2024). The relationship between growth in GDP and CO2 has loosened; it needs to be cut completely – Analysis - IEA. In IEA.

https://www.iea.org/commentaries/the-relationship-between-growth-in-gdp-and-co2-has-loosened-it-needs-to-be-cut-completely

Slade, L. (2021). *Emerging technologies and the future of infrastructure*. Oliver Wyman. https://www.marshmclennan.com/insights/publications/2021/february/emerging-technologies-and-the-future-of-infrastructure.html

Soeder, D. (2022). Replacing fossil fuels. In *Springer eBooks* (pp. 109–144). https://doi.org/10.1007/978-3-031-15381-5_6

Strandberg. (2021, February 17). *Decentralized energy systems give advantages*. The International Institute for Industrial Environmental Economics. https://www.iiiee.lu.se/article/decentralized-energy-systems-give-advantages

Sustainability for All. (2023). *Renewable energies, the big bet against energy dependence*. (2023). https://www.activesustainability.com/renewable-energy/energy-dependence/?_adin=01833301559

Światowiec-Szczepańska, J., & Stępień, B. (2022). Drivers of Digitalization in the Energy Sector—The Managerial Perspective from the Catching Up Economy. *Energies*, *15*(4), 1437. https://doi.org/10.3390/en15041437

Teter, J., & Voswinkel, F. (2023). Transport - Energy System. In IEA. https://www.iea.org/energy-system/transport#programmes

The Economist. (2022, November 18). A whole new global energy system is emerging. *The Economist*. https://www.economist.com/the-world-ahead/2022/11/18/a-whole-new-global-energy-system-is-emerging

Thomson, E. (2023, October 6). *Financing the energy transition in developing economies is a challenge. Here are 3 ways to support it*. World Economic Forum. https://www.weforum.org/agenda/2023/08/financing-energy-transition-developing-economies/

Unescap. (2023). *Decentralized energy system*. https://www.unescap.org/sites/default/files/14.%20FS-Decentralized-energy-system.pdf

United Nations. (2023). *What is the Paris Agreement?* https://unfccc.int/process-and-meetings/the-paris-agreement

Viisainen, & Evans. (2023, October 26). *Analysis: Global CO2 emissions could peak as soon as 2023, IEA data reveals*. Carbon Brief. https://www.carbonbrief.org/analysis-global-co2-emissions-could-peak-as-soon-as-2023-iea-data-reveals/

Wang, L., & Tseng, C. (2012). Special issue on Challenges and Opportunities in the 21st Century Energy Infrastructure. *Journal of Energy Engineering*, *138*(2), 31–32. https://doi.org/10.1061/(asce)ey.1943-7897.0000072

White, A. (2022, May 20). *IPCC report: urgent climate action needed to halve emissions by 2030*. World Economic Forum. https://www.weforum.org/agenda/2022/04/ipcc-report-mitigation-climate-change/

Widuto, A. (2023). Energy transition in the EU. Brussels: EPRS.

Wood-Robertson, J. (2023). *2023 Predictions: Energy and Infrastructure sector outlook*. https://www.shoosmiths.com/insights/articles/2023-predictions-energy-and-infrastructure-sector-outlook

World Bank Group. (2022, June 22). Report: COVID-19 slows progress toward universal energy access. *World Bank*. https://www.worldbank.org/en/news/press-release/2022/06/01/report-covid-19-slows-progress-towards-universal-energy-access

World Health Organization: WHO. (2022). Report: COVID-19 slows progress towards universal energy access. https://www.who.int/news/item/01-06-2022-report--covid-19-slows-progress-towards-universal-energy-access

Wu, Y., Wu, Y., Guerrero, J. M., & Vasquez, J. C. (2021). Digitalization and decentralization driving transactive energy Internet: Key technologies and infrastructures. *International Journal of Electrical Power & Energy Systems*, *126*, 106593. https://doi.org/10.1016/j.ijepes.2020.106593

Yanatma. (2023, February 24). Europe's 'energy war' in data: How have EU imports changed since Russia's invasion of Ukraine? *Euronews*. https://www.euronews.com/green/2023/02/24/europes-energy-war-in-data-how-have-eu-imports-changed-since-russias-invasion-of-ukraine

Appendix

Appendix 1 – Interviews

Interview 1 (Joel Ferreira – P&C Subdirector at EDP Comercial)

Q1: What was your academic and professional background until you reached your current position in the company EDP Comercial?

Answer: On the path to reach my current position in EDP Comercial – Subdirector in the P&C Team (Head of Business Control and Financial Report – New Geographies) I first took a Master's degree in Finance by Faculdade de Economia do Porto, that was followed by 10 years of professional experience in P&C team in EDP Group.

Q2: How long have you been performing your current position at EDP Comercial?

Answer: I have been performing my current position at EDP Comercial for 1,5 years.

Q3: What are your plans for your professional future?

Answer: As there is always room for improvement, my plans for my short to mid-term future are to develop managements skills and continue improving technical skills, which are both skills that I think are crucial to continue improving in my position within the company.

Q4: What are, in your opinion, the mission, values and objectives of EDP Comercial?

Answer: Putting it in short words, in my opinion and considering my 10 plus years in the company EDPC's mission is mainly to be an enabler of energy transition. Whereas its values are those shared and aligned with the EDP group: sustainability aiming at improving the quality of life of present and future generations, and efficiency in the performing of all activities.

Q5: How do you characterize and evaluate the sector in which EDP Comercial is inserted?

Answer: To characterize and evaluate the sector in which EDP Comercial is inserted (energy sector) regarding its current landscape I would two adjectives: very competitive, and highly regulatory.

Q6: Which challenges and trends do you identify in this sector for 2023 and beyond?

Answer: In my opinion, the biggest challenge companies in the energy sector face for 2023 and beyond is to be able to manage the energy transition, with regard to new products and services that customers will need to have.

Q7: What are the main threats and opportunities the company is currently facing?

Answer: In my opinion, the main threat EDP Comercial is currently facing is the entry of more players in the market, while the main opportunity is customer loyalty with new products and services.

Q8: How does the company intend to position itself today, and in the future?

Answer: In order to continue being one the main players in the energy sector in Iberia and continue affirming itself in the rest of Europe, EDP Comercial is aiming at strengthening the connection with customers based on more networking.

Q9: How do you characterize the national and international competition of the company and how does EDP Comercial differentiate itself from its competitors?

Answer: In Portugal, EDPC clearly has an advantage for being a very old company with more market share, and thus benefiting from the "first mover" advantage and keep deserving the trust of the Portuguese people by keeping the excellence in performing of all activities and aiming at improving the quality of life of present and future generations.

Q10: To your knowledge has the company been having recruiting difficulties?

Answer: No.

Q11: What impact have you seen Russia's invasion of Ukraine had on the energy sector? Do you think it can decelerate progress in the sector?

Answer: Russia's invasion of Ukraine had a massive impact on the energy sector in many ways, especially in retail companies accounts due to the price increase we are all aware of. Additionally, increasingly more clear that war and inflation will cause major delays in investments in renewables.

Q12: Has the recent rise in energy prices globally had an impact on the demand for renewable energy, and if so, how?

Answer: The huge increase in energy prices has led globally to a huge increase in demand of renewable energy, especially for solar energy, so that we can get closer to achieve energy independence and do not become dependent (or rather become increasingly less dependent) on gas from Russia.

Q13: What other concerns do you think are currently particularly relevant in terms of affecting the energy transition?

Answer: My concern regarding the slowdown of the energy transition is inflation and its effects on investment in green energy.

Q14: Where do you currently think that E-Mobility is headed?

Answer: I think E-Mobility is one of the businesses of the future, and it is accelerating in order to have a stable network throughout Europe.

Q15: Is EDP's strategy in accordance with the decarbonization of the energy sector?

Answer: Yes, EDPC's strategy is heading towards the decarbonization of the energy sector, given that the last business plan presented has as a plan for a 100% green company in 2030.

Q16: What is EDP Comercial doing regarding both the digitalization and decentralization trends on the sector?

Answer: In order to develop those trends (crucial to achieve energy transition) EDP Comercial is making a huge investment on digitalization with the creation of a specific unit for all projects that may have an impact on the business.

Q17: How is EDP Comercial dealing with the energy sector's infrastructure challenges?

Answer: In order to deal with the energy sector's infrastructure challenges EDP Comercial is creating a European procurement unit to centralize all procurement and take advantage of economies of scale.

Q18: What are EDP Comercial's main objectives for short and long term?

Answer: EDPC's main strategic objective for both short and long term goes through the move from a national company to a European platform, which is evident due to the acquisitions of companies in Italy, Poland, Belgium, France, and Germany.

Interview 2 (Diogo Matos e Silva – P&C Subdirector at EDP Comercial)

Q1: What was your academic and professional background until you reached your current position in the company EDP Comercial?

Answer: On the path to reach my current position in EDP Comercial – Subdirector in the P&C Team (Head of Strategic Planning) I first took a Bachelor's degree in Economics by ISEG, a post-graduation in NOVA School of Business and Economics and an executive program in applied business analytics in the Massachusetts Institute of Technology that was followed by 15 years of professional experience, 6 of them in KPMG (first as an audit assistant, then as a senior auditor, and then as a senior associate – T&R forensic), 2 and a half as a senior consultant at Deloitte, 4 as the Head of Planning and Management Control at Moey, and finally the last 1 and a half year as the deputy director in the P&C team of EDP Comercial.

Q2: How long have you been performing your current position at EDP Comercial?

Answer: I have been performing my current position at EDP Comercial for 1,5 years.

Q3: What are your plans for your professional future?

Answer: Since there is always potential for growth, my goals for the foreseeable future include improving technical skills, which I believe are essential for maintaining my position's improvement within the organization.

Q4: What are, in your opinion, the mission, values and objectives of EDP Comercial?

Answer: In a nutshell, I believe that EDPC's primary objective is to facilitate the energy transition. While its values are those shared and in line with the EDP group, including sustainability, and aiming to improve the quality of life for both current and future generations, and efficiency in the execution of all activities.

Q5: How do you characterize and evaluate the sector in which EDP Comercial is inserted?

Answer: I would characterize EDPC's sector as a sector undergoing great change mainly focused on energy transition with special attention to higher levels of investment and a very different social perception than how it was years ago, that is, decentralized energy, less polluting energies, also focused in mitigating risk

by promoving energy decentralization and enhancing energy independence from external countries (e.g. the dependency on the Arabic Peninsula for crude oil, and natural gas from Russia). Furthermore, the sector is highly focused on decarbonization (the more efficient this transition is the better the captation of energy is).

Q6: Which challenges and trends do you identify in this sector for 2023 and beyond?

Answer: In my opinion the main trends in the sector right now are some of what I have mentioned in the previous question, such as decentralization and decarbonization, aligned with investment in energies like solar, wind, and hydrogen. The main challenges are: increased national and international competition, being more cost-efficient - digitalization, achieving more agile processes, investment capacity of each company/country at a time of high interest rates, monetary risk, attracting technical human resources with the necessary skills, and with investment in new functions (constant technological evolution creates risks due to the rapid obsolescence of products, supply chains, etc.)

Q7: What are the main threats and opportunities the company is currently facing?

Answer: In my opinion, the greatest risk that EDP Commercial now faces is the entry of more organizations into the market, but the main potential is client loyalty through the introduction of new goods and services.

Q8: How does the company intend to position itself today, and in the future?

Answer: The company intends on betting heavily on digitalization, reduction of manual processes, bureaucracy, creating a leaner structure, faster processes, focus heavily on solar dg, electric mobility, energy sales - guaranteeing green energy sources, attracting resources with the competence to carry out this processes, keeping agile investment, focus on maintaining results by reducing fixed and variable costs, and constant development of new green solutions for the client (batteries, solar apartments, Local Energy Communities - taking advantage of existing space in a company that uses this to distribute energy to neighbors, by doing this the company is taking advantage of unoccupied space to distibute green energy to neighbours.

Q9: How do you characterize the national and international competition of the company and how does EDP Comercial differentiate itself from its competitors?

Answer: EDPC is a fairly established business in Portugal with a larger market share. To differentiate itself the company focus on delivering packs of new solutions, maintaining great quality of customer service and follow-up, resolution of questions/problems, price competitiveness, and keep delivering new products.

Q10: To your knowledge has the company been having recruiting difficulties?

Answer: No.

Q11: What impact have you seen Russia's invasion of Ukraine had on the energy sector? Do you think it can decelerate progress in the sector?

Answer: Russia's invasion of Ukraine had a massive impact on the energy sector due to the gas distribution problem that led to higher energy prices (thus the focus on mitigating the risk of dependence from external countries), on the other hand solar financials became better and investment in renewables increased.

Q12: Has the recent rise in energy prices globally had an impact on the demand for renewable energy, and if so, how?

Answer: Much like as said in the previous question global demand for renewable energy, particularly solar energy, has skyrocketed as a result of the sudden increase in energy prices, allowing us to move closer to achieving energy independence and reducing our reliance on Russian gas.

Q13: What other concerns do you think are currently particularly relevant in terms of affecting the energy transition?

Answer: Inflation and its effects on investments in green energy are my main worries in relation to the energy transition's slowing.

Q14: Where do you currently think that E-Mobility is headed?

Answer: I said in one of the first question that E-Mobility was one of EDPC's focus and in my opinion it is one of the industries of the future and will be growing quickly.

Q15: Is EDP's strategy in accordance with the decarbonization of the energy sector?

Answer: Yes, EDPC's strategy is geared towards the decarbonization of the energy sector, as evidenced by the fact that the most recent business plan submitted included a goal of having a fully green firm by 2030. Also the company intends of reaching net zero by 2040.

Q16: What is EDP Comercial doing regarding both the digitalization and decentralization trends on the sector?

Answer: Regarding decentralization the company is, for example, distributing solar with different product typologies (B2B, Bronze, B2C, and LECs), and continuously delivering new products that create value for the customers, such as, solar for apartments and solar batteries. Regarding digitalization the company has a large annual investment in IT (of around a couple million euros) aiming for internal efficiency, analysis of information, improvement of the operational component and research, and for customers to improve processes.

Q17: How is EDP Comercial dealing with the energy sector's infrastructure challenges?

Answer: In order to deal with the energy sector's infrastructure challenges EDP Comercial is dealing with maintenance of solar pannels and charging points, fighting for the improvement of networks not ready for decentralized distribution like the enhancement of its reading capacity to understand what should be consumed at each moment or whether it should be stored or not, and investing and implementing large solar, wind power plants to allow independence and decentralization.

Q18: What are EDP Comercial's main objectives for short and long term?

Answer: The transition from a national corporation to a European platform is the primary strategic goal of EDPC in the medium and long terms, as evidenced by the company's acquisitions in Italy, Poland, Belgium, France, and Germany, as well as, facilitating energy transition and improving the quality of life for both current and future generations.

Interview 3 (Pedro Miguel Lourenço – P&C Specialist at EDP Comercial)

Q1: What was your academic and professional background until you reached your current position in the company EDP Comercial?

Answer: Before joining EDP Comercial where I'm at for 12 years now, I took a Bachelor's degree in Management, followed by 5 years in Consulting with a Master's degree in between.

Q2: How long have you been performing your current position at EDP Comercial?

Answer: I have been performing my current position in the P&C team of EDP Comercial for 6 years.

Q3: What are your plans for your professional future?

Answer: There is always something to learn. With that being said, my goal is to keep learning mainly to improve my soft and technical skills.

Q4: What are, in your opinion, the mission, values and objectives of EDP Comercial?

Answer: EDPC's mission and objectives is to be the partner for total decarbonization of all clients around the world, by offering integrated energy solutions and guaranteeing the efficient delivery of its products and a perfect customer experience.

Q5: How do you characterize and evaluate the sector in which EDP Comercial is inserted?

Answer: EDPC's sector is in fast transformation towards energy transition, with all the baggage that comes with it, that is, higher levels of investment and increasing competition.

Q6: Which challenges and trends do you identify in this sector for 2023 and beyond?

Answer: Utilization of renewable sources and decentralization, aligned with investment in energies like solar, wind, and hydrogen.

Q7: What are the main threats and opportunities the company is currently facing?

Answer: In my opinion, the greatest threat to EDP Commercial is the volatility in energy prices, while a huge opportunity the company has is to "enter" in the electrification trend (swapping out fossil fuel-consuming devices or procedures, such as gas boilers and internal combustion engines, with electrically powered alternatives, such heat pumps and electric vehicles).

Q8: How does the company intend to position itself today, and in the future?

Answer: EDPC intends on being a reference player on the energy transition process, by prioritizing solar development, electric mobility, and energy sales in order to ensure the availability of sustainable energy sources, draw in personnel qualified to handle these tasks, and maintaining flexible investment. Additionally, given the current sector landscape heavily marked by a transformation of the energy sector with all the challenges and trends that come with it, the company is evolving by the means of an updated organizational model that proposes a matrixial organizational structure, with the objective of creating a more streamlined, efficient, and agile organization, with the capacity to support growth and the successful implementation of EDP's Business Plan.

Q9: How do you characterize the national and international competition of the company and how does EDP Comercial differentiate itself from its competitors?

Answer: Both national and international competition is increasing. EDPC differentiates itself from its competitors by brand differentiation (the company is an established brand in Portugal, with a larger market share), product portfolio by delivering packs of new solutions, and by the level of customer service.

Q10: To your knowledge has the company been having recruiting difficulties?

Answer: No, I don't think so.

Q11: What impact have you seen Russia's invasion of Ukraine had on the energy sector? Do you think it can decelerate progress in the sector?

Answer: The energy sector was severely impacted by Russia's invasion of Ukraine, because of the gas distribution issue that resulted in volatility in energy prices, and high inflation.

Q12: Has the recent rise in energy prices globally had an impact on the demand for renewable energy, and if so, how?

Answer: Yes, the rise in energy prices had a global impact on the demand for renewable energies. For example, the sharp rise in energy prices has caused solar energy to soar, putting us one step closer to energy independence and lowering our dependence on Russian gas.

Q13: What other concerns do you think are currently particularly relevant in terms of affecting the energy transition?

Answer: My concerns regarding the slowdown of energy transition is the intermittency of renewable technologies, and the aforementioned volatility of energy prices, due to the impact it can have on green energy investment.

Q14: Where do you currently think that E-Mobility is headed?

Answer: I think i tis headed to the gradual replacement of the internal combustion car fleet and the growth of charging points network.

Q15: Is EDP's strategy in accordance with the decarbonization of the energy sector?

Answer: Certainly, as seen by the fact that the most recent business plan published includes a goal of establishing a fully green corporation by 2030. The company also plans to achieve net zero by 2040. Some examples that EDP's strategy is in accordance with the decarbonization of the energy sector are the closure of coal-fired power stations and focus on renewable sources.

Q16: What is EDP Comercial doing regarding both the digitalization and decentralization trends on the sector?

Answer: Regarding decentralization, the company is focused on the evolution of its product portfolio and delivering new products – eg. Solar DG. On the other hand, regarding digitalization, the company is promoting the use of digital channels and self-service mechanisms.

Q17: How is EDP Comercial dealing with the energy sector's infrastructure challenges?

Answer: The organizational evolution that I mentioned in one of the previous questions led to the development of the asset management team, that will surely help the company deal with the sector's infrastructure challenges. Furthermore, another relevant measure to help deal with these issue is portfolio diversification (eg. Solar DG+batteries and Electric Mobility).

Q18: What are EDP Comercial's main objectives for short and long term?

Answer: Facilitating energy transition and delivering value to customers through portfolio diversification, economic, operational and organizational efficiency, as well as, profitability.

Appendix 2 – EDP's Impact on SDGs

Source: EDP website (Integrated Annual Report 2022)